Draft revision to the approved baseline and monitoring methodology AM0009

"Recovery and utilization of gas from oil wells that would otherwise be flared or vented"

I. SOURCE, DEFINITIONS AND APPLICABILITY

Sources

This baseline and monitoring methodology is based on elements from the following proposed methodologies:

- NM0026 "Rang Dong Oil Field Associated Gas Recovery and Utilization Project" prepared by Japan Vietnam Petroleum Co. Ltd;
- NM0227 "Recovery of methane from on- and off-shore oil fields that otherwise will be vented into the atmosphere" prepared by SOCAR in collaboration with ICF International.

This methodology also refers to the latest approved versions of the following tools:

- "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion";
- "Tool to calculate baseline, project and/or leakage emissions from electricity consumption";
- "Combined tool to identify the baseline scenario and demonstrate additionality";
- "Tool for the assessment and demonstration of additionality".

For more information regarding the proposed new methodologies and the tools as well as their consideration by the Executive Board please refer to <http://cdm.unfccc.int/goto/MPappmeth>.

Selected approach from paragraph 48 of the CDM modalities and procedures

"Existing actual or historical emissions, as applicable".

and

"Emissions from a technology that represents an economically attractive course of action, taking into account barriers to investment".

Definitions

For the purpose of this methodology, the following definitions apply:

Associated gas. Natural gas found in association with oil, either dissolved in the oil or as a cap of free gas above the oil.

Gas-lift. An artificial lift method for oil wells exploitation in which gas is injected into the production tubing to reduce the hydrostatic pressure of the fluid column. The resulting reduction in bottomhole pressure allows the reservoir liquids to enter the wellbore at a higher flow rate.

Gas-lift gas. High-pressure gas used for gas-lift in the oil wells.

Recovered gas. The associated gas and/or gas-lift gas recovered from the project oil wells.

Processing plant. A facility designed to separate ~~substances or make new substances~~ or process hydrocarbons through chemical, physical or physical-chemical procedures in order to produce marketable hydrocarbon and other (e.g. sulphur) products.

Applicability

The methodology is applicable to project activities that recover and utilise associated gas and/or gas-lift gas from oil wells. The associated gas and/or gas-lift gas ~~that~~ was ~~previously~~ flared or vented prior to the implementation of the project activity.

The methodology is applicable under the following conditions:

- Under the project activity ~~Associated gas at oil wells is~~, the recovered ~~and transported to~~ gas is:
    - Consumed on-site to meet energy demands; and/or
    - Transported to and compressed into a gas pipeline without prior processing; and/or
    - Transported to a ~~A~~ processing plant where ~~e.g.~~ it is processed into hydrocarbon products (e.g. dry gas, ~~liquefied petroleum gas~~ (LPG~~)~~, and condensate) that are transported and sold to final consumer(s).~~are produced; and/or~~
    - ~~An existing natural gas pipeline without processing.~~
- The project activity does not lead to changes in the process of oil-production, such as an increase in the quantity or quality of oil extracted, in the oil-wells within the project boundaries.
- The injection of any gases into the oil reservoir and its production system is allowed in the project activity only for the purpose of the gas-lift process;
- All ~~associate gas~~ recovered gas comes from oil wells that are in operation and are producing oil at the time of the recovery of the associated gas and/or gas-lift gas; and
- ~~The recovered gas and the products (dry gas, LPG and condensate) are likely to substitute in the market only the same type of fuels or fuels with a higher carbon content per unit of energy;~~
- ~~The utilization of the associated gas due to the project activity is unlikely to lead to an increase of fuel consumption in the respective market;~~
- ~~The project activity will not lead to changes (negative or positive) in the volume or composition of oil or high-pressure gas extracted at the production site;~~
- Data (quantity and fraction of carbon) are accessible on the products of the gas processing plant and on the gas recovered from other oil exploration facilities in cases where these facilities supply recovered gas to the same gas processing plant;
- ~~No gas coming from a gas lift system is used by the project activity.~~

In addition, the applicability conditions included in the tools referred to above apply.

Finally, the methodology is only applicable if the identified baseline scenario is: ~~the continuation of the current practice of either flaring or venting of the associated gas.~~

- The continuation of the current practice of either venting (scenario G1) or flaring (scenario G2) of the associated gas and/or gas-lift gas; and
- The continued operation of the existing oil and gas infrastructure without processing of any recovered associated gas and/or gas-lift gas and without any other significant changes (scenario P4); and
- In the case where gas-lift is used under the project activity: the gas-lift gas under the baseline uses the same source as under the project activity and the same quantity as under the project activity (scenario O1).

~~Projection and adjustment of project and baseline emissions on the basis of oil production~~

~~Project as well as baseline emissions depend on the quantity of gas recovered, which is linked to the oil production. Oil production may be projected with the help of a reservoir simulator, reflecting the rock and fluid properties in the oil reservoir. As projections of the oil production, the methane content of the gas and other parameters involve a considerable degree of uncertainty, the quantity and composition of the recovered gas are monitored ex post and baseline and project emissions are adjusted respectively during monitoring.~~

~~The validating DOE shall confirm that estimated emission reductions reported in the CDM-PDD are based on estimates provided in the survey used for defining the terms of the underlying oil production project as per the production sharing contract.~~

~~At verification the verifying DOE shall check the production data for oil and associate gas and compare them with the initial production target as per the information provided in survey used for defining the terms of the underlying oil production project. If the oil production differs significantly from the initial production target, then it should be checked that this is not intentional, and that such a scenario is properly addressed by the production sharing contract between the contracted party(ies).~~

II. BASELINE METHODOLOGY PROCEDURE

Project boundary

The project boundary encompasses:

- The project oil reservoir and oil wells where the associated gas and/or gas-lift gas is collected;
- The site where the associated gas and/or gas-lift gas was flared or vented in the absence of the project activity;
- The gas recovery, pre-treatment, transportation ~~and delivery~~ infrastructure, including where applicable, ~~new collection and transmission pipelines, reservoirs, control and measurement equipment and~~ compressors;
- The ~~processing facility using the recovered associated~~ source of gas-lift gas.

The greenhouse gases included in or excluded from the project boundary are shown in **Table 1**.

Table 1: Emissions sources included in or excluded from the project boundary

	Source	Gas	Included?	Justification / Explanation
Baseline	~~Venting of associated gas (if applicable)~~	~~CO_2~~	~~No~~	~~Assumed negligible~~
		~~CH_4~~	~~Yes~~	~~Main source of emissions in the baseline~~
		~~N_2O~~	~~No~~	~~Assumed negligible~~
	Combustion of fossil fuels at end-users that are produced from non-associated gas or other fossil sources ~~Flaring of associated gas (if applicable)~~	CO_2	Yes	Main source of emissions in the baseline
		CH_4	No	Minor source, neglection is conservative ~~It is assumed that flaring results in complete oxidation of carbon in associated recovered gas, resulting in a conservative baseline~~
		N_2O	No	Minor source, neglection is conservative ~~Assumed negligible~~
	~~Consumption of other fossil fuels in place of the recovered gas~~	~~CO_2~~	~~No~~	~~Recovered gas replaces an equivalent amount of natural gas or fuel with higher carbon intensity in the system with same or higher emissions from combustion~~
		CH_4	No	
		N_2O	No	
	~~Fugitive emissions from natural gas consumed in place of recovered gas~~	~~CO_2~~	~~No~~	~~Recovered gas replaces an equivalent amount of natural gas or fuel with higher carbon intensity in the system with same or higher emissions from combustion~~
		~~CH_4~~	~~No~~	
		~~N_2O~~	~~No~~	
Project Activity	~~Fugitive emissions during collection and transportation of the recovered gas~~	~~CO_2~~	~~No~~	~~Assumed negligible~~
		~~CH_4~~	~~Yes~~	~~Included~~
		~~N_2O~~	~~No~~	~~Assumed negligible~~
	~~Fugitive emissions from accidents~~	~~CO_2~~	~~No~~	~~Assumed negligible~~
		~~CH_4~~	~~Yes~~	~~Fugitive CH_4 emissions may occur if there is an equipment failure in equipment transporting associated gas to the processing plant in the project scenario.~~
		~~N_2O~~	~~No~~	~~Assumed negligible~~
	Energy use for the recovery, pre-treatment, transportation, and if applicable, ~~processing~~ compression of the recovered gas	CO_2	Yes	Main source of emissions in the project ~~Energy is produced from the recovered gas and/or the combustion of fossil fuels and import of electricity from the grid~~
		CH_4	No	Assumed negligible
		N_2O	No	Assumed negligible

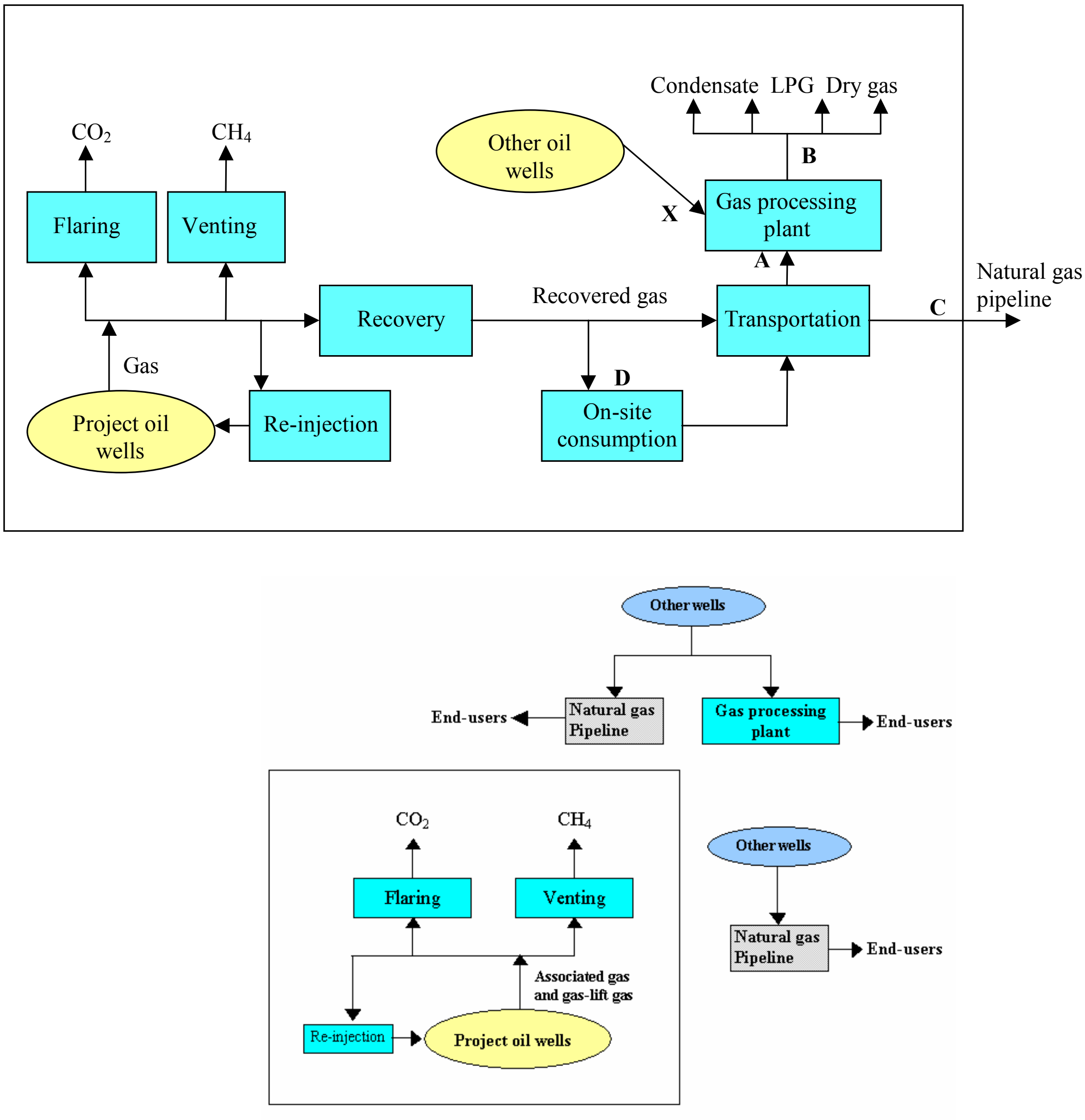

Figure 1: Schematic illustration of the baseline activity

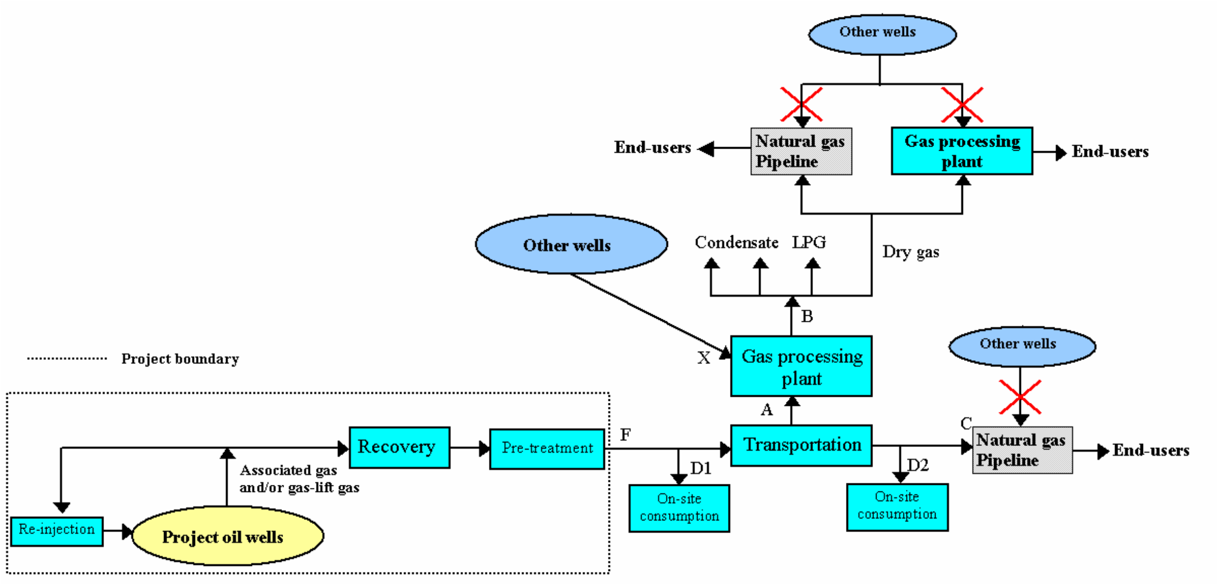

Figure ~~1~~2: Schematic illustration of the project activity

The project area may encompass several wells under a Production Sharing Contract (PSC) with a production target.

Identification of the baseline scenario and demonstration of additionality

Project participants shall apply the following ~~steps to identify the baseline scenario~~ procedure.

Step 1: Identify plausible alternative scenarios

The project activity involves three components. Plausible alternative scenarios should include alternatives for the following components:

Plausible alternative baseline scenarios for the associated gas and/or gas-lift gas from the project oil wells could include, *inter alia*:

G1: Release of the associated gas and/or gas-lift gas into the atmosphere at the oil production site (venting);
G2: Flaring of the associated gas and/or gas-lift gas at the oil production site;
G3: On-site use of the associated gas and/or gas-lift gas for power generation;
G4: On-site use of the associated gas and/or gas-lift gas for liquefied natural gas (LNG) production;
G5: Injection of the associated gas and/or gas-lift gas into an oil or gas reservoir;
G6: Recovery, transportation, processing ~~and distribution~~ of the associated gas and/or gas-lift gas and distribution of products thereof to end-users without being registered as a CDM project activity;
G7: Recovery, transportation and compression of the associated gas and/or gas-lift gas into a gas pipeline without prior processing, without being registered as a CDM project activity;
G8: Consumed on-site to meet energy demands without being registered as a CDM project activity;

G9: Recovery, transportation and utilization of the associated gas and/or gas-lift gas as feedstock for manufacturing of ~~a~~ useful products.

Plausible alternative baseline scenarios for oil and gas infrastructure should include the proposed project activity and all relevant scenarios for any existing or new gas processing plants, pipelines, compressors, etc. They depend heavily on the context of the proposed project but could include, *inter alia*:

P1: Construction of a processing plant for the purpose of processing the recovered gas, in the same way as in the project activity, without being registered as a CDM project activity;
P2: Construction of a processing plant of a lower capacity than under the project activity, which processes only non-associated gas and no recovered gas;
P3: Supplying recovered gas to an existing gas processing plant and constructing the necessary infrastructure, without being registered as a CDM project activity;
P4: Continuation of the operation of the existing oil and gas infrastructure without processing of any recovered associated gas and/or gas-lift gas and without any other significant changes;
P5: Supplying recovered gas to a gas pipeline without prior processing and without being registered as a CDM project activity.

Plausible alternative baseline scenarios for the use of gas-lift could include, *inter alia*:

O1: Gas from the same source as under the project activity and in the same quantity as under the project activity, is used for the gas-lift system;
O2: Gas from a different source than under the project activity but using the same quantity of gas-lift gas as under the project activity, is used for the gas-lift system;
O3: Gas from the same source as under the project activity but using a different quantity of gas-lift gas, is used for the gas-lift system;
O4: Gas from a different source than under the project activity and in a different quantity than under the project activity, is used for the gas-lift system;
O5: No gas-lift system is utilized.

Realistic combinations of these three components should be identified and considered as possible alternative scenarios to the proposed project activity. The identified combinations should be transparently described and be illustrated in schematic diagrams in the CDM-PDD.

Step 2: Evaluate legal aspects

In evaluating legal aspects, the following issues should be addressed:

- Are the alternatives permitted by law or other (industrial) agreements and standards?
- Are there laws or other regulations (e.g. environmental regulations) which implicitly restrict certain alternatives?

All baseline alternatives shall be in compliance with all applicable legal and regulatory requirements, even if these laws have objectives other than GHG reductions. If an alternative does not comply with all applicable legislation and regulations, such an alternative should be eliminated unless it is demonstrated, based on an examination of current practice in the country or region in which the law or regulation applies, that applicable legal or regulatory requirements are systematically not enforced and that non-compliance is widespread.

Step 3: Evaluate the economic attractiveness of alternatives

The economic attractiveness is assessed for those alternative scenarios that are feasible in technical terms and that are identified as permitted by law or other (industrial) agreements and standards in Step 2. The economic attractiveness is assessed by determining an expected Internal Rate of Return (IRR) of each alternative scenario, following the guidance for the investment analysis in the latest approved version of the "Tool for the assessment and demonstration of additionality". The IRR should be determined using, *inter alia*, the following parameters as applicable to the relevant scenario:

- Overall projected ~~gas~~ production of associated gas and/or gas-lift gas;
- The projected quantity of gas recovered, ~~excluding~~ gas flared, vented, ~~or~~ consumed on-site, processed in a gas processing plant and/or compressed into a pipeline;
- The agreed price for the delivery of recovered gas (e.g. from a Production Sharing Contract) to the gas pipeline or gas processing plant (if operated by a third party);
- The net calorific value of the recovered gas;
- Capital expenditure for all oil and gas infrastructure needed in the relevant scenario, such as gas recovery facilities, pipelines, and gas processing plant (if applicable) etc. (CAPEX);
- All operational expenditure associated with the respective scenario (OPEX);
- All revenues from the operation of the alternative scenario, such as revenues from selling processed gas or other products of the gas processing plant or electricity;
- Any profit sharing agreements and cost recovery, ~~including~~ such as cost savings through the substitution of products by the recovered gas, if applicable.

If venting or flaring of the associated gas at a given location is not outright banned but instead is subject to taxes or fines, the impact of these taxes and fines should be considered in the IRR calculation.

The alternative scenario that is economically the most attractive course of action is considered as the baseline scenario. Proceed to the next step ~~The project activity can be considered additional,~~ if the IRR of the project activity is lower than the hurdle rate of the project participants (typically about 10%) and if the most plausible baseline scenario is not the project activity without being registered as a CDM project activity; otherwise, the project activity is not additional.

The DOE should verify what value for the IRR is typical for this type of investment in the respective Host country. The calculations should be described and documented transparently.

~~Note: The methodology is only applicable if the identified baseline scenario is the continuation of the current practice of either flaring or venting of the associated gas.~~

Step 4: Common practice analysis

Apply the "common practice analysis", following the guidance for the investment analysis in the latest approved version of the "Tool for the assessment and demonstration of additionality".

The project can be deemed additional if the requirements of the common practice analysis are fulfilled.

Baseline emissions

~~It is assumed that all associated gas is flared and carbon is converted into carbon dioxide. This is a conservative assumption, as accounting of methane emissions from flaring would increase the total amount of baseline emissions.~~

Project activities under this methodology reduce emissions by recovering associated gas and/or gas-lift gas and utilizing the recovered gas. The utilization of the recovered gas displaces the use of other fossil fuel sources. For example, the use of recovered gas in a processing plant can displace the use of non-associated gas in that processing plant. In another situation, the recovered gas may be compressed into a natural gas pipeline, thereby displacing the processing of non-associated gas in a gas processing plant at another site. The exact emission effects are difficult to determine and would require an analysis of the whole fuel supply chain up to the end-users for both the project activity and the baseline scenario. This methodology provides for a simplified and conservative calculation of emission reductions, assuming that the use of recovered gas displaces the use of methane – the fossil fuel with the lowest direct CO_2 emissions. Emissions from processing and transportation of fuels to end-users are neglected for both the project activity and the baseline scenario, as it is assumed that these emissions are similar in their magnitude and level out.

Baseline emissions are calculated as follows:

$$\cancel{BE_y = (V_{A,y} + V_{D,y} + V_{C,y}) \cdot w_{carbon,A,y} \cdot \frac{44}{12} \cdot \frac{1}{1000}} \qquad \cancel{(1)}$$

$$BE_y = V_{F,y} \cdot NCV_{RG,F,y} \cdot EF_{CO2,Methane} \qquad (1)$$

Where:

BE_y	=	Baseline emissions during the period y, (tCO_2e)
$\cancel{V_{A,y}}$	=	~~Volume of the gas at inlet to gas processing plant at point A in Figure 1 during the period y, (m^3)~~
$\cancel{V_{D,y}}$	=	~~Volume of the gas used for electricity generation measured at inlet to electricity generation facility (point D in Figure 1 during the period y, (m^3)~~
$\cancel{V_C}V_{F,y}$	=	Volume of ~~the~~ total recovered gas ~~entering the transmission pipeline~~ measured at point ~~C~~ F in Figure ~~1~~ 2, after pre-processing and before the part of the recovered gas may be used on-site, during the period y, (Nm^3)
$NCV_{RG,F,y}$	=	Net calorific value of recovered gas measured at point F in Figure 2 during the period y, (TJ/Nm^3)
$EF_{CO2,Methane}$	=	CO_2 emission factor for methane (tCO_2/TJ)

~~$w_{carbon,A,y}$ = Average content of carbon in the recovered gas measured at point A Figure 1 during the period y, (kgC/m³)~~

~~The average carbon content in the gas $w_{carbon,A,y}$ is determined from regular measurements of the composition of the gas, taking into account the molecular weight of all fractions of the gas.~~

Project emissions

The following sources[1] of project emissions are accounted in this methodology:

- CO_2 emissions due to consumption of fossil fuels ~~combustion~~ for the recovery, pre-treatment, transportation, and, if applicable, compression of the recovered ~~processing of the~~ gas up to the points A and C in Figure 2;
- CO_2 emissions due to the use of electricity for the recovery, pre-treatment, transportation, and, if applicable, compression of the recovered gas up to the points A and C in Figure 2.
- ~~CO_2 emission due to consumption of other fuels in place of the recovered gas;~~
- ~~CH_4 and CO_2 emissions from leaks, venting and flaring during the recovery, transport and processing of recovered gas.~~

~~If these emission sources are under the control of the project participants, they should be included and considered as project emissions within the project boundary. This is for example the case, if the transportation system and the gas processing plant are operated by the project participants.~~

~~If these emission sources are not under control of the project participants, they should be considered and calculated as leakage effects. This is the case if project participants do not operate the transportation system and/or the gas processing plant. However, in both cases the methodological approach described below has to be followed to calculate emissions.~~

Project emissions are calculated as follows:

$$\cancel{PE_y = PE_{CH4,gas,y} + PE_{CO2,fossilfuels,y} + PE_{CO2,elec,y}} \quad \text{~~(2)~~}$$

$$PE_y = PE_{CO2,fossilfuels,y} + PE_{CO2,elec,y} \quad (2)$$

Where:

PE_y	=	Project emissions in the period y, (tCO_2e)
~~$PE_{CH4,gas,y}$~~	~~=~~	~~CH_4 emissions due to venting, leaks or flaring of the recovered gas during the transportation and processing of the associated gas during the period y, (tCO_2e)~~
$PE_{CO2,fossilfuels,y}$	=	CO_2 emissions due to consumption of fossil fuels ~~including the associated gas if applicable,~~ for the recovery, ~~collection~~ pre-treatment, transportation, and, if applicable, ~~processing~~ compression of the ~~associated~~ recovered gas up to the points A and C in Figure 2 during the period y, (tCO_2e)

[1] Other sources of project emissions such as emissions from leaks, venting and flaring during the recovery, transportation and processing of recovered gas are assumed to be of similar magnitude in the baseline scenario.

$PE_{CO2,elec,y}$ = CO_2 emissions due to the use of electricity for ~~the~~ recovery, ~~collection~~ pre-treatment, transportation and, if applicable, compression ~~processing~~ of the ~~associated~~ recovered gas up to the points A and C in Figure 2 during the period *y*, (tCO_2e)

~~*CH_4 project emissions from venting, leak or flaring of the associated gas*~~

~~CH_4 emissions from the leaks, flaring and venting of the associated gas during its processing are not calculated from single emission sources, but a carbon mass balance is conducted between points A, B, and X in Figure 1:~~

$$PE_{CH4,gas,y} = \frac{m_{carbon,A,y} \cdot (m_{carbon,A,y} + m_{carbon,X,y} - m_{carbon,B,y})}{m_{carbon,A,y} + m_{carbon,X,y}} \cdot \frac{16}{12} \cdot \frac{1}{1000} \cdot GWP_{CH4} \quad (3)$$

with

$$m_{carbon,A,y} = V_{A,y} \cdot w_{carbon,A,y} \quad (4)$$

$$m_{carbon,B,y} = V_{dry\ gas,B,y} \cdot w_{carbon,dry\ gas,B,y} + m_{LPG,B,y} \cdot w_{carbon,LPG,B,y} + m_{condensate,B,y} \cdot w_{carbon,condensate,B,y} \quad (5)$$

$$m_{carbon,X,y} = \sum_i V_{X,y} \cdot w_{Carbon,X,y} \quad (6)$$

~~Where:~~

~~$PE_{CH4,gas,y}$ = CH_4 emissions due to leaks, flaring or venting of the recovered gas during the period *y*, (tCO_2e)~~

~~$m_{carbon,A,y}$ = Quantity of carbon in the recovered gas, measured at point A in Figure 1 during the period *y*, (kg)~~

~~$m_{carbon,B,y}$ = Quantity of carbon in the products (dry gas, LPG, condensate) leaving the gas processing plant at point B in Figure 1 during the period *y*, (kg)~~

~~$m_{carbon,X,y}$ = Quantity of carbon in the recovered gas from other oil wells at all points X in Figure 1 during the period *y*, (kg)~~

~~$V_{A,y}$ = Volume of the gas recovered at point A in Figure 1 during the period *y*, (m^3). In the case, when part of the associated gas, entering the processing facility, is used for the energy generation within the facility, the corresponding amount of the associated gas should be subtracted from $V_{A,y}$ and accounted under the project emissions from the use of fossil fuels (see section below)~~

~~$w_{carbon,A,y}$ = Average content of carbon in the gas recovered at point A in Figure 1 during the period *y*, (kgC/m^3)~~

~~$w_{carbon,condensate,B,y}$ = Average content of carbon in condensate at point B in Figure 1 during the period *y*, (kgC/m^3)~~

~~$m_{condensate,B,y}$ = Quantity of condensate that is produced in the gas processing plant (point B in Figure 1) during the period *y* in kg~~

~~$w_{carbon,LPG,B,y}$ = Average content of carbon in LPG at point B in Figure 1 during the period *y*, (kgC/m^3)~~

~~$m_{LPG,B,y}$ = Quantity of LPG produced in the gas processing plant (point B in Figure 1) during the period *y*, (kg)~~

~~$w_{carbon,dry\ gas,B,y}$~~	~~=~~	~~Average content of carbon in dry gas at point B in Figure 1 during the period y, (kgC/m³)~~
~~$V_{dry\ gas,B,y}$~~	~~=~~	~~Volume of dry gas produced in the gas processing plant (point B in Figure 1) during the period y, (m³)~~
~~$V_{X,y}$~~	~~=~~	~~Volume of the gas recovered from oil well i, measured at point X in Figure 1 during the period y, (m³)~~
~~$w_{carbon,X,y}$~~	~~=~~	~~Average content of carbon in the gas recovered from oil well i, measured at point X in Figure 1 during the period y, (kgC/m³)~~

~~The carbon content of the products ($w_{Carbon,dry\ gas,B,y}$, $w_{Carbon,LPG,B,y}$, $w_{Carbon,condensate,B,y}$) may be taken from project specifications, if products are homogeneous in their composition, or should be monitored if the carbon content of the products varies.~~

Project emissions from the consumption of fossil fuels

Project emissions $PE_{CO2,fossilfuels,y}$ ~~from~~ due to the ~~use~~ consumption of fossil fuels, including the recovered gas, if applicable for the ~~collection,~~ recovery, pre-treatment, transportation, and, if applicable, compression ~~processing~~ of the ~~associated~~ recovered gas are calculated applying the latest approved version of the “Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion” where process j correspond~~s~~ to ~~the~~ a source of fuel combustion (e.g. a compressor, etc). ~~of fossil fuels~~ All applicable emission sources should be documented transparently in the CDM-PDD and in monitoring reports.

~~In case when a part of the associated gas is used as fuel within the project boundary, related project emissions should be included in $PE_{CO2,fossilfuels,y}$.~~

Project emissions from consumption of electricity

Project emissions $PE_{CO2,elec,y}$ ~~from~~ due to the use of electricity for the ~~collection,~~ recovery, pre-treatment, transportation, and, if applicable, ~~processing~~ compression of the ~~associated~~ recovered gas are calculated applying the latest approved version of the “Tool to calculate baseline, project and/or leakage emissions from electricity consumption”. All applicable sources of electricity consumption should be documented transparently in the CDM-PDD and in monitoring reports.

Leakage

No leakage emission is considered.

~~*Changes in CO_2 emissions due to the substitution of fuels at end users*~~

~~Project participants should assess:~~

- ~~Whether the supply of additional fuels by the project activity to the market will lead to additional fuel consumption;~~
- ~~Whether the fuels of the project activity substitute fuels with a lower carbon intensity (e.g. if electricity generation with the recovered gas substitutes renewable electricity generation).~~

~~For this purpose the market of the products should be analyzed. If such leakage effects may result from the project activity, emission reductions should be adjusted for these leakage effects respectively in a conservative manner. Where the fuels of the project activity substitute fuels with a higher carbon intensity, emission reductions should as a conservative assumption not be adjusted.~~

Emission reductions

Emission reductions are calculated as follows:

$$\cancel{ER_y = BE_y - PE_y - LE_y} \qquad \text{~~(7)~~}$$

$$ER_y = BE_y - PE_y \qquad \textbf{(3)}$$

Where:

ER_y	=	Emission reductions in the period *y,* (t CO_2e)
BE_y	=	Baseline emissions in the period *y,* (t CO_2e)
PE_y	=	Project emissions in the period *y,* (t CO_2e)
~~LE_y~~	~~=~~	~~Leakage emissions in the period *y,* (t CO_2e)~~

Changes required for methodology implementation in 2nd and 3rd crediting periods

(a) Consistent with guidance by the Executive Board, project participants shall assess the continued validity of the baseline and update the baseline. In order to assess the continued validity of the baseline, project participants should apply the procedure to determine the most plausible baseline scenario, as outlined above. The crediting period may only be renewed if the application of the procedure shows that the baseline scenario determined in the registered CDM-PDD still applies;

(b) It shall be demonstrated that the project activity is not a common practice using the procedure defined in the Common Practice step of the "Combined tool to identify the baseline scenario and demonstrate additionality". The Designated Operational Entity shall evaluate the common practice with the information provided regarding the practices applied to handling of the associated gas in the Host country;

(c) The introduction of laws and regulations requiring flaring or utilization of the associated gas and/or the rate of compliance with the existing relevant laws/regulations shall also be assessed to determine the continued validity of the baseline.

Data and parameters not monitored

In addition to the parameters listed in the tables below, the provisions on data and parameters not monitored in the tools referred to in this methodology apply.

~~**Data / parameter:**~~	~~GWP_{CH4}~~
~~Data unit:~~	~~tCO_2e/tCH_4~~
~~Description:~~	~~Global warming potential for CH_4~~
~~Source of data:~~	~~IPCC~~
~~Measurement procedures (if any):~~	~~21 for the first commitment period. Shall be updated according to any future COP/MOP decisions.~~
~~Any comment:~~	~~---~~

Data / parameter:	$EF_{CO2,Methane}$
Data unit:	tCO_2/TJ
Description:	CO_2 emission factor for methane
Source of data:	The Energy Information Administration (EIA), Department of Energy, USA <http://www.eia.doe.gov/oiaf/1605/coefficients.html> presents the default emission factor of 115.258 pounds of CO_2 per million BTU.
Value to be applied:	49.55 tCO_2/TJ
Any comment:	---

III. MONITORING METHODOLOGY

All data collected as part of monitoring should be archived electronically and be kept at least for 2 years after the end of the last crediting period. 100% of the data should be monitored if not indicated otherwise in the tables below. All measurements should be conducted with calibrated measurement equipment according to relevant industry standards.

The CDM-PDD will have to include minimal procedures to ensure that the data collection and retention will be made properly.

In addition, the monitoring provisions in the tools referred to in this methodology apply.

Projection and adjustment of project and baseline emissions on the basis of oil production

Project as well as baseline emissions depend on the quantity of associated gas and gas-lift gas recovered, which is linked to the oil production. Oil production may be projected with the help of a reservoir simulator, reflecting the rock and fluid properties in the oil reservoir. As projections of the oil production, the methane content of the gas and other parameters involve a considerable degree of uncertainty, the quantity and composition of the recovered gas are monitored ex post and baseline and project emissions are adjusted respectively during monitoring.

The validating DOE shall confirm that estimated emission reductions reported in the CDM-PDD are based on estimates provided in the survey used for defining the terms of the underlying oil production project as per the production sharing contract.

At verification the verifying DOE shall check the production data for oil and associated gas and gas-lift gas and compare them with the initial production target as per the information provided in survey used for defining the terms of the underlying oil production project. If the oil production differs significantly from the initial production target, then it should be checked that this is not intentional, and that such a scenario is properly addressed by the production sharing contract between the contracted party(ies).

~~Uncertainty assessment~~

~~'Permissible uncertainty' shall be expressed as the 95% confidence interval around the measured value, for normally distributed measurements. The uncertainty associated with each parameter should be assessed, for example, by calculating the probable uncertainty as the mean deviation divided by the square root of the number of measurements. If this uncertainty is within the 95% confidence interval, than it is considered permissible uncertainty, and no action must be taken.~~

~~If not, then the uncertainty should be assessed as low (<10%), medium (10-60%) or high (>60%). Percent uncertainty may be calculated by dividing the mean of the parameter by the probable uncertainty and multiply by 100% to get percent uncertainty. If percent uncertainty is <10%, the uncertainty is considered low. A detailed explanation of quality assurance and quality control procedures must be described for parameters with medium or high uncertainty in an attempt to decrease uncertainty, and to ensure that emissions reductions calculations are not compromised. In the case of a parameter with medium or high uncertainty, a sensitivity analysis should be performed to determine the potential of the uncertainty of the parameter to affect the emissions reduction calculation. The authenticity of the uncertainty levels should be verified by the DOE at the project verification stage.~~

Data and parameters monitored

~~Data / parameter:~~	~~$w_{A,CH4,y}$~~
~~Data unit:~~	~~$kgCH_4/m^3$~~
~~Description:~~	~~Average content of methane in recovered gas~~
~~Source of data:~~	~~Chemical analysis (e.g., gas chromatography)~~
~~Measurement procedures (if any):~~	~~Analysis should be performed in conjunction with measurement of the volume of recovered gas. Measurements should be taken at the point(s) where recovered gas enters the gas processing facility.~~
~~Monitoring frequency:~~	~~Weekly~~
~~QA/QC procedures:~~	~~Data should be measured using accurate and calibrated equipment~~
~~Any comment:~~	~~---~~

~~Data / Parameter:~~	~~$V_{A,y}$~~
~~Data unit:~~	~~m^3~~
~~Description:~~	~~Volume of the recovered gas at inlet to the gas processing plant at point A in Figure 1 during the period *y*~~
~~Source of data:~~	~~Flow meter (e.g., diaphragm gouge)~~
~~Measurement procedures (if any):~~	~~Data should be measured using accurate and calibrated flow meters~~
~~Monitoring frequency:~~	~~Continuously~~
~~QA/QC procedures:~~	~~Volume of gas should be completely metered with regular calibration of metering equipment~~
~~Any comment:~~	~~---~~

Data / Parameter:	~~V_C~~ $V_{F,y}$
Data unit:	Nm^3
Description:	Volume of the total recovered gas ~~entering the transmission pipeline~~ measured at point ~~C~~ F in Figure ~~1~~ 2, after pre-treatment and before the part of the recovered gas is used on-site, during the period *y*
Source of data:	Flow meter (e.g., diaphragm gouge)
Measurement procedures (if any):	Data should be measured using ~~accurate and~~ calibrated flow meters. Measurements should be taken at the point(s) where recovered gas exits the pre-treatment plant ~~pipeline built under the project activity and enters the pre-existing pipeline for further transportation and use~~
Monitoring frequency:	Continuously
QA/QC procedures:	Volume of gas should be completely metered with regular calibration of metering equipment. The measured volume should be converted to the volume at normal temperature and pressure using the temperature and pressure at the time to measurement.
Any comment:	---

Data / Parameter:	$NCV_{RG,F,y}$
Data unit:	TJ/Nm^3
Description:	Net calorific value of recovered gas measured at point F in Figure 2 during the period *y*
Source of data:	On site measurement
Measurement procedures (if any):	Measurements should be undertaken in line with national or international fuel standards
Monitoring frequency:	At least monthly
QA/QC procedures:	The laboratories performing NCV measurements should have ISO17025 accreditation or justify that they can comply with similar quality standards
Any comment:	---

~~**Data / Parameter:**~~	~~$V_{D,y}$~~
~~Data unit:~~	~~m^3~~
~~Description:~~	~~Volume of the recovered gas used for electricity generation measured at inlet to electricity generation facility (point D in Figure 1 during the period *y*~~
~~Source of data:~~	~~Flow meter (e.g., diaphragm gouge)~~
~~Measurement procedures (if any):~~	~~Data should be measured using accurate and calibrated flow meters. Measurements should be taken at the point(s) where recovered gas exits the pipeline built under the project activity and enters the pre-existing pipeline for further transportation and use~~
~~Monitoring frequency:~~	~~Continuously~~
~~QA/QC procedures:~~	~~Volume of gas should be completely metered with regular calibration of metering equipment~~
~~Any comment:~~	~~---~~

~~**Data / Parameter:**~~	~~$w_{carbon,A,y}$~~
~~Data unit:~~	~~kgC/m^3~~
~~Description:~~	~~Average content of carbon in the recovered gas measured at point A in Figure 1 during the period *y*~~
~~Source of data:~~	~~Chemical analysis (e.g., gas chromatography)~~
~~Measurement procedures (if any):~~	~~Analysis should be performed in conjunction with measurement of the volume of recovered gas. Measurements should be taken at the point(s) where recovered gas enters the gas processing facility.~~
~~Monitoring frequency:~~	~~Weekly~~
~~QA/QC procedures:~~	~~Data should be measured using accurate and calibrated equipment~~
~~Any comment:~~	~~---~~

~~**Data / Parameter:**~~	~~$V_{dry\ gas,B,y}$~~
~~Data unit:~~	~~m^3~~
~~Description:~~	~~Volume of dry gas produced in the gas processing plant (point B in Figure 1)~~
~~Source of data:~~	~~---~~
~~Measurement procedures (if any):~~	~~Measurement with e.g. orifice meters~~
~~Monitoring frequency:~~	~~Continuously~~
~~QA/QC procedures:~~	~~---~~
~~Any comment:~~	~~---~~

~~**Data / Parameter:**~~	~~$w_{carbon,dry\ gas,B,y}$~~
~~Data unit:~~	~~kgC/m³~~
~~Description:~~	~~Average content of carbon in dry gas at point B in Figure 1~~
~~Source of data:~~	~~---~~
~~Measurement procedures (if any):~~	~~Measurement with gas chromatography~~
~~Monitoring frequency:~~	~~Weekly~~
~~QA/QC procedures:~~	~~---~~
~~Any comment:~~	~~---~~

~~**Data / Parameter:**~~	~~$m_{LPG,B,y}$~~
~~Data unit:~~	~~t~~
~~Description:~~	~~Quantity of LPG produced in the gas processing plant (point B in Figure 1)~~
~~Source of data:~~	~~---~~
~~Measurement procedures (if any):~~	~~Measurement with e.g. coriolis meters~~
~~Monitoring frequency:~~	~~Continuously~~
~~QA/QC procedures:~~	~~---~~
~~Any comment:~~	~~---~~

~~**Data / Parameter:**~~	~~$w_{carbon,LPG,B,y}$~~
~~Data unit:~~	~~kgC/m³~~
~~Description:~~	~~Average content of carbon in LPG at point B in Figure 1~~
~~Source of data:~~	~~---~~
~~Measurement procedures (if any):~~	~~Measurement with gas chromatography~~
~~Monitoring frequency:~~	~~Weekly~~
~~QA/QC procedures:~~	~~---~~
~~Any comment:~~	~~---~~

~~**Data / Parameter:**~~	~~$m_{condensate,B,y}$~~
~~Data unit:~~	~~t~~
~~Description:~~	~~Quantity of condensate produced in the gas processing plant (point B in Figure 1)~~
~~Source of data:~~	~~---~~
~~Measurement procedures (if any):~~	~~Measurement with e.g. coriolis meters~~
~~Monitoring frequency:~~	~~Continuously~~
~~QA/QC procedures:~~	~~---~~
~~Any comment:~~	~~---~~

~~**Data / Parameter:**~~	~~$w_{carbon,condensate,B,y}$~~
~~Data unit:~~	~~kgC/m³~~
~~Description:~~	~~Average content of carbon in condensate at point B in Figure 1~~
~~Source of data:~~	~~---~~
~~Measurement procedures (if any):~~	~~Measurement with gas chromatography~~
~~Monitoring frequency:~~	~~Weekly~~
~~QA/QC procedures:~~	~~---~~
~~Any comment:~~	~~---~~

~~**Data / Parameter:**~~	~~$V_{X,y}$~~
~~Data unit:~~	~~m³~~
~~Description:~~	~~Volume of the gas recovered from oil well *i*, measured at inlet to the gas processing plant at point X in Figure 1 during the period *y*~~
~~Source of data:~~	~~---~~
~~Measurement procedures (if any):~~	~~Data should be measured using accurate and calibrated flow meters (e.g., diaphragm gouge)~~
~~Monitoring frequency:~~	~~Continuously~~
~~QA/QC procedures:~~	~~Volume of gas should be completely metered with regular calibration of metering equipment~~
~~Any comment:~~	~~---~~

~~**Data / Parameter:**~~	~~$w_{carbon,X,y}$~~
~~Data unit:~~	~~kgC/m³~~
~~Description:~~	~~Average content of carbon in the gas recovered from oil well *i*, measured at point X in Figure 1 during the period *y*~~
~~Source of data:~~	~~---~~
~~Measurement procedures (if any):~~	~~Measurement with gas chromatography~~
~~Monitoring frequency:~~	~~Weekly~~
~~QA/QC procedures:~~	~~---~~
~~Any comment:~~	~~---~~

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History of the document

Version	Date	Nature of revision(s)
04	EB 46, Annex # 25 March 2009	Revision to: • Expand the scope of the methodology by allowing the use of gas coming to the surface from gas-lift systems; • Modify the project activity diagram; • Adjust the table for emission sources in the project boundary section; • Include provisions to identify plausible alternative baseline scenarios for a gas processing facility and gas-lift gas; • Simplify the procedure to calculate baseline emissions; • Neglect project emissions related to gas leaks, venting and flaring during the recovery, transport and processing of the recovered gas; • Eliminate the leakage emissions section; and • Eliminate the uncertainty assessment section.
03.3	EB 44, Annex 6 28 November 2008	Editorial revision to delete the term 'transportation' from the section "CH4 project emissions from venting, leak or flaring of the associated gas".
03.2	EB 42, Annex 4 26 September 2008	Editorial revision to correct equation 3 under project emissions.
03.1	EB 39, Paragraph 22 16 May 2008	"Tool to calculate baseline, project and/or leakage emissions from electricity consumption" replaces the withdrawn "Tool to calculate project emissions from electricity consumption".
03	EB 36, Annex 6 30 November 2007	Revision to: • Expand the applicability of the methodology by introducing a new baseline scenario where the associated gas is vented in the absence of the project activity; • Introduce an option of supplying part of the captured gas directly to the existing natural gas grid without processing; • Introduce project emissions from the use of electricity and fossil fuels for project activities where electricity and fossil fuels are used for capture, transportation and processing of the associated gas; • Incorporate "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion", "Tool to calculate project emissions from electricity consumption" and "Combined tool to identify the baseline scenario and demonstrate additionality".
02.1	22 June 2007	The methodology was editorially revised to add the guidance provided by the Board at its thirty-second meeting (paragraph 23 of thirty-second meeting report) in the following sections: (i) Projection and adjustment of project and baseline emissions; and (ii) Note below the QA/QC table (on Page 15). Guidance by the Board: "The Board clarified that the validating DOE shall confirm that estimated flare reduction in the CDM-PDD for project activities using approved methodology AM0009 are based on estimates provided in the survey used for defining the terms of the underlying oil production project. At verification the DOE shall check the production data for oil and associate gas and compare it with initial production target. If the oil production differs significantly from initial production target, then it should be checked upon verification that this is not intentional, and that such a scenario is properly addressed by the contract between the contracted party(ies)."
02	EB 19, Annex 5 13 May 2005	Revision to introduce project emissions from the transportation of the associated gas and project emissions from accidents.

01	EB13, Annex 3 26 March 2004	Initial adoption.