Draft baseline and monitoring methodology AM00XX

"Air separation using cryogenic energy recovered from the vaporization of LNG"

I. SOURCE, DEFINITIONS AND APPLICABILITY

Sources

This baseline and monitoring methodology is based on the following proposed new methodology:

- NM0313 "Air separation using cryogenic energy of LNG", prepared by Global Climate Change Institute of the Tsinghua University, China Datang Corporation, China National Offshore Oil Corp. Energy Technology & Services Limited and ECO-TEC ASIA (BEIJING) CO., LTD

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.

For more information regarding the proposed new methodologies and the tools as well as their consideration by the CDM Executive Board (the 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/or

"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:

Liquefied natural gas (LNG). Liquefied natural gas is natural gas (predominantly methane, CH_4) that has been converted temporarily to liquid form for ease of storage or transport.

Cryogenic energy. Cryogenic energy is an exergy contained in low temperature materials such as liquefied gases.

Air separation. Air separation is the process whereby air is separated into its individual gases (such as O_2, N_2, Ar).

New air separation plant. A new air separation plant is a newly constructed air separation plant that has no operational history.

New LNG vaporization plant. For the purpose of this methodology, a new LNG vaporization plant is (i) a newly constructed LNG vaporization plant with no operational history or (ii) a recently constructed LNG

vaporization plant that does not yet have an operational history of at least three years at the start of the project activity.

Existing LNG vaporization plant. For the purpose of this methodology, an existing LNG vaporization plant is a LNG vaporization plant that has an operational history of at least three years at the start of the project activity.

Applicability

This methodology is applicable to project activities that consist of the construction and operation of a new air separation plant that utilizes the cryogenic energy recovered from a LNG vaporization plant. The LNG vaporization plant can be new or existing.

This methodology is applicable under the following conditions:

(a) The new air separation plant meets its cooling energy demand totally or partially from recovered cryogenic energy from a LNG vaporization plant;

(b) The purity of the oxygen and nitrogen produced by the new air separation plant is equal to or higher than 99.5%;[1]

(c) The new air separation plant is located at the same site as the LNG vaporization plant from which the cryogenic energy is recovered. Therefore, the cryogenic energy carrier is not stored or freighted to a different site;

(d) It is possible to operate the new air separation plant both with or without the use of cryogenic energy from the LNG vaporization plant. Hence, the operational tests during the commissioning of the plant, as required for the determination of baseline parameters, can be conducted;

(e) The technology employed at the new air separation plant during time periods when cryogenic energy from the LNG vaporization plant is not available should be the same technology as the one identified in the selection of the baseline scenario as per the "Procedure for the selection of the baseline scenario and demonstration of additionality" section hereunder.[2] Moreover, during these time periods, the air separation plant is capable to provide the same amount and quality of air separation products as when operated with cryogenic energy from the LNG vaporization plant;

(f) In case that the LNG vaporization plant is new, it is possible to operate the plant both with or without the recovery of cryogenic energy. Hence, the operational tests during the commissioning of the plant, as required for the determination of baseline parameters, can be conducted;

(g) The technology employed at the LNG vaporization plant during time periods when cryogenic energy from the LNG vaporization plant is not utilized by the air separation plant, should be the same technology as one identified in the selection of the baseline scenario as per the "Procedure for the selection of the baseline scenario and demonstration of additionality" section hereunder.[2]

[1] This threshold on the purity of the air separation plant products ensures that cryogenic energy is required in the process, as this level of purity can only be reached through the use of cryogenic energy.

[2] This provision is required as the baseline emissions are calculated for the same type of technology as the one deployed in the project activity during time periods where cryogenic energy is not available, and not for a hypothetical baseline technology.

In the case of an existing LNG vaporization plant, the following conditions also apply:

(a) The existing practice for the vaporization of LNG is to utilize either:

(i) Heating vaporizers where heat is generated by the combustion of fossil fuels, such as submerged combustion vaporizers, or the consumption of electricity, such as electric heaters;

(ii) Ambient vaporizers where the heat comes from the ambient water or air, such as open rack vaporizers or ambient-air vaporizers; or

(iii) A mix of (i) and (ii).

(b) The cryogenic energy from the existing LNG vaporization plant was not utilized for useful purposes and was being wasted prior to the implementation of the project activity. This shall be demonstrated by both of the following evidences:

- **Design specifications and layout diagrams**. The project participants should present the design specifications and layout diagrams of the LNG vaporization plant as provided by the manufacturer, and, where applicable, the design specifications and layout diagrams resulting from any subsequent modifications to the plant undertaken prior to the implementation of the project activity, showing that the cryogenic energy was wasted; and

- **On-site check**. The DOE shall conduct an on-site check prior to the implementation of the project activity that confirms that no equipment for the recovery and utilization of cryogenic energy was installed prior to the implementation of the project activity.

(c) The project activity does not result in significant changes in the quality or quantity of outputs of the existing LNG vaporization plant. The compliance with this condition is to be supported by: (i) Historical and present sales records, and (ii) Historical and present production records that include the chemical composition and energy content of the marketable products.

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

Finally, this methodology is only applicable if the most plausible baseline scenario, as identified per the "Procedure for the selection of the baseline scenario and demonstration of additionality" section hereunder, is:

(d) For new LNG vaporization:

- Scenario V3; or

- Scenario V2 only if the installed capacity of the LNG vaporization plant is equal to or higher than 1.0 billion cubic feet per day (bcfd).[3]

(e) For existing LNG vaporization: scenario V2 or V3; and

(f) For air separation: scenario S2, S3 or S4.

[3] This provision ensures that the selection of the LNG vaporization technology, for a new plant that uses fossil fuels or electricity instead of ambient heat, is driven by market and ambient conditions, due to the plant's production scale, and is not driven by the CDM revenue.

II. BASELINE METHODOLOGY PROCEDURE

Project boundary

The spatial extent of the project boundary encompasses:

(a) The LNG vaporization plant;

(b) The air separation plant;

(c) The power plants connected to the grid which supplied electricity to the project activity.

Simplified diagrams of the baseline and project scenarios are presented in Figures 1 and 2.

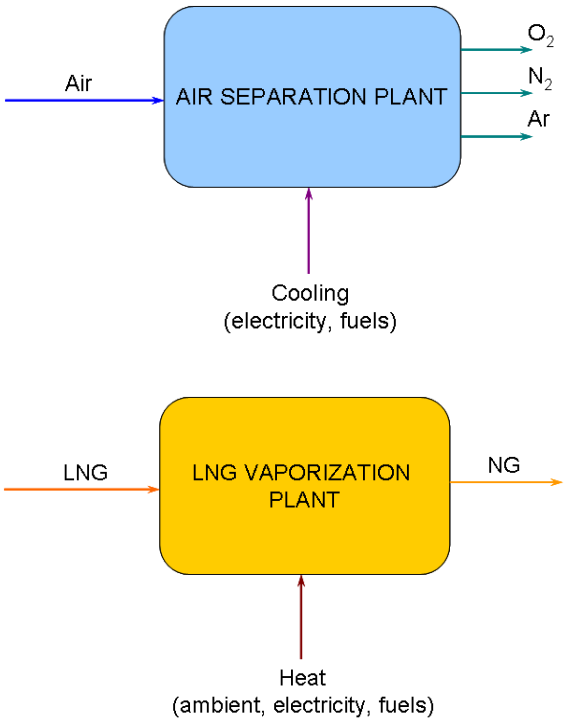

Figure 1: Diagram of the baseline scenario

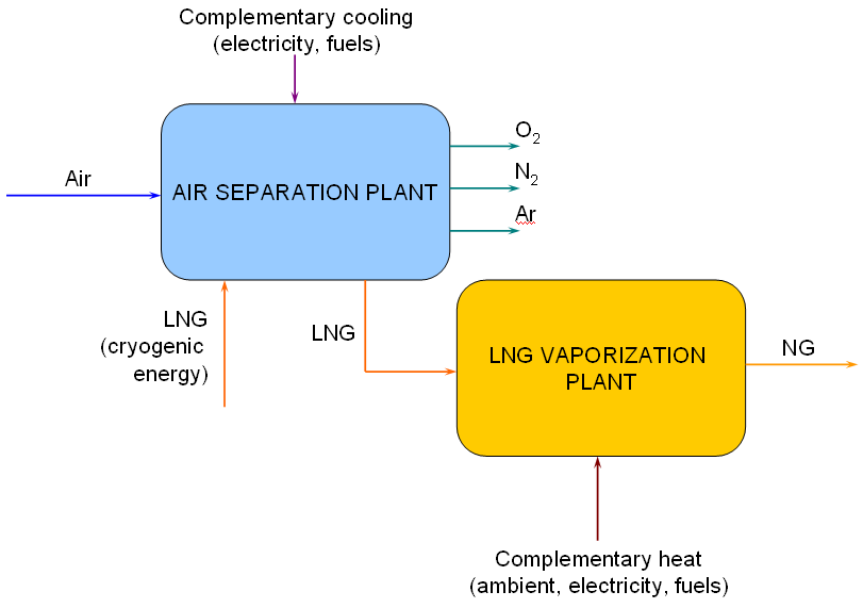

Figure 2: Diagram of the project activity

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

Table 1: Overview on emission sources included in or excluded from the project boundary

Source		Gas	Included?	Justification / Explanation
Baseline Scenario	Emissions from fossil fuel combustion for LNG vaporization	CO_2	Yes	Main emission source
		CH_4	No	Excluded for simplification. This is conservative
		N_2O	No	Excluded for simplification. This is conservative
	Emissions from electricity consumption for LNG vaporization	CO_2	Yes	Main emission source
		CH_4	No	Excluded for simplification. This is conservative
		N_2O	No	Excluded for simplification. This is conservative
	Emissions from fossil fuel combustion for air separation	CO_2	Yes	Main emission source
		CH_4	No	Excluded for simplification. This is conservative
		N_2O	No	Excluded for simplification. This is conservative
	Emissions from electricity consumption for air separation	CO_2	Yes	Main emission source
		CH_4	No	Excluded for simplification. This is conservative
		N_2O	No	Excluded for simplification. This is conservative

Project Activity	Emission from fossil fuel combustion for LNG vaporization and air separation	CO_2	Yes	Main emission source
		CH_4	No	Excluded for simplification
		N_2O	No	Excluded for simplification
	Emission from electricity consumption for LNG vaporization and air separation	CO_2	Yes	Main emission source
		CH_4	No	Excluded for simplification
		N_2O	No	Excluded for simplification

Procedure for the selection of the baseline scenario and demonstration of additionality

The selection of the baseline scenario and the demonstration of additionality should be conducted using the latest approved version of the "Combined tool to identify the baseline scenario and demonstrate additionality". The following additional guidance should be used when applying the tool:

When applying sub-step 1(a) of the tool, alternative scenarios should be separately determined for:

(a) LNG vaporization; and

(b) Air separation.

Identify all alternative scenarios that provide outputs or services, i.e. vaporization of LNG (including the possible use of the associated cryogenic energy) and products of air separation process, with comparable quality as the proposed CDM project activity. For the purpose of identifying relevant alternative scenarios, provide an overview of other technologies or practices used for LNG vaporization and air separation that have been implemented prior to the start of the project activity or are currently underway in the country.

Alternative scenarios for LNG vaporization

The alternative scenarios for LNG vaporization should include, *inter alia*:

V1: The proposed project activity not undertaken as a CDM project activity;

V2: The use of heating vaporizers where heat is generated by the combustion of fossil fuels, such as submerged combustion vaporizers, or the consumption of electricity, such as electric heaters, and no utilization of the cryogenic energy from the LNG;

V3: The use of ambient vaporizers where the heat comes from the ambient water or air, such as open rack vaporizers or ambient-air vaporizers, and no utilization of the cryogenic energy from the LNG;

V4: ` The use of process vaporizers where heat comes from thermal or chemical processes other than the air separation process which utilizes the cryogenic energy of LNG, such as power plants, cogeneration plants, or chemical processes.

Alternative scenarios for air separation

The alternative scenarios for air separation should include, *inter alia*:

S1: The proposed project activity not undertaken as a CDM project activity;

S2: Air separation through cryogenic liquefaction process using vapour compression refrigerators (driven by electric motors);

S3: Air separation through cryogenic liquefaction process using vapour compression refrigerators (driven by turbines/engines that combust fossil fuels);

S4: Air separation through cryogenic liquefaction process using absorption refrigerators/chillers that combust fossil fuels.

Emission Reductions

Emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y - LE_y \quad \textbf{(1)}$$

Where:
ER_y = Emissions reductions in year y (tCO_2)
BE_y = Baseline emissions in year y (tCO_2)
PE_y = Project emissions in year y (tCO_2)
LE_y = Leakage emissions in year y (tCO_2)

Baseline Emissions

Baseline emissions are calculated as:

$$BE_y = BE_{VP,y} + BE_{AS,y} \quad (2)$$

Where:
BE_y = Baseline emissions in year y (tCO_2)
$BE_{VP,y}$ = Baseline emissions from LNG vaporization in year y (tCO_2)
$BE_{AS,y}$ = Baseline emissions from air separation in year y (tCO_2)

Step 1: Determination of $BE_{VP,y}$

Case 1.A: The baseline scenario is the use of ambient vaporizers

If the baseline scenario for LNG vaporization is identified as V3, then the baseline emissions from LNG vaporization ($BE_{VP,y}$) are conservatively regarded as 0.[4]

Case 1.B: The baseline scenario is the use of heating vaporizers based on fossil fuels or electricity

If the baseline scenario for LNG vaporization is identified as V2, the baseline emissions from LNG vaporization should be calculated as:

$$BE_{VP,y} = BE_{VP,EL,y} + BE_{VP,FF,y} \quad \textbf{(3)}$$

[4] If the project participants wish to determine baseline emissions from this scenario, they can propose a request for revision to the methodology, providing equations to calculate baseline emissions from the various types of vaporizers where heat comes from the ambient water or air.

Where:

$BE_{VP,y}$ = Baseline emissions from LNG vaporization in year *y* (tCO_2)
$BE_{VP,EL,y}$ = Baseline emissions from electricity consumption for LNG vaporization in year *y* (tCO_2)
$BE_{VP,FF,y}$ = Baseline emissions from combustion of fossil fuels for LNG vaporization in year *y* (tCO_2)

Sub-step 1.B.1: Determination of $BE_{VP,EL,y}$

Baseline emissions from electricity consumption for LNG vaporization in year *y* ($BE_{VP,EL,y}$) should be calculated as follows:

$$BE_{VP,EL,y} = BE_{EC,y} \quad \textbf{(4)}$$

Where:

$BE_{VP,EL,y}$ = Baseline emissions from electricity consumption for LNG vaporization in year *y* (tCO_2)
$BE_{EC,y}$ = Baseline emissions from electricity consumption in year *y* (tCO_2).

The baseline emissions from electricity consumption in year *y* ($BE_{EC,y}$) shall be calculated as per the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption". When applying the tool, the parameter $EC_{BL,k,y}$ in the tool shall be replaced by the electricity consumption for LNG vaporization, calculated as follows:

$$EC_{BL,k,y} = EC_{BL,VP,y} = k_{VP,EL} \cdot m_{LNG,y} \quad \textbf{(5)}$$

Where:

$EC_{BL,VP,y}$ = Baseline electricity consumption for LNG vaporization in year *y* (MWh)
$k_{VP,EL}$ = Electricity consumption rate for LNG vaporization in the baseline scenario (MWh/tonne of LNG)
$m_{LNG,y}$ = Amount of LNG vaporized in the project activity in year *y* (tonne)

Determination of $k_{VP,EL}$ at a new LNG vaporization plant

If the project activity is implemented at a new LNG vaporization plant, the electricity consumption rate $k_{VP,EL}$ shall be determined as the minimum value between: (i) an *ex-ante* measurement during the commissioning of the new LNG vaporization plant by undertaking an operational test of the plant, and (ii) The electricity consumption in the baseline calculated based on the cryogenic energy provided to the air separation plant and the electricity consumption of the LNG vaporization plant in the project activity in the year *y* of the crediting period. Hence, $k_{VP,EL}$ shall be calculated as follows:

$$k_{VP,EL} = MIN\left\{\frac{EC_{VP,com}}{m_{LNG,com}}; \frac{EC_{VP,CR,y}}{m_{LNG,y}}\right\} \quad \textbf{(6)}$$

with

$$EC_{VP,CR,y} = \frac{\sum_{h=1}^{8760}\left[\left(HS_{LNG,out,h,y} - HS_{LNG,in,h,y}\right) \cdot LNG_{h,y}\right] \cdot 3.6}{\eta_{VP,BL}} + EC_{VP,PJ,y} \quad \textbf{(7)}$$

Where:

$k_{VP,EL}$	=	Electricity consumption rate for LNG vaporization in the baseline scenario (MWh/tonne of LNG)
$EC_{VP,com}$	=	Electricity consumption for vaporization of LNG during the operational test at the commissioning of the new LNG vaporization plant (MWh)
$EC_{VP,CR,y}$	=	Electricity consumption for vaporization of LNG calculated based on the cryogenic energy provided to the air separation plant and the electricity consumption of the LNG vaporization plant in the project activity during year *y* (MWh)
$EC_{VP,PJ,y}$	=	Electricity consumption for LNG vaporization in the project activity in year *y* (MWh)
$HS_{LNG,out,h,y}$	=	Average specific enthalpy of the LNG stream at the outlet of the cryogenic recovery heat exchanger in the hour *h* of the year *y* (GJ/tonne of LNG)
$HS_{LNG,in,h,y}$	=	Average specific enthalpy of the LNG stream at the inlet of the cryogenic recovery heat exchanger in the hour *h* of the year *y* (GJ/tonne of LNG)
$LNG_{h,y}$	=	Total amount of LNG that flows through the cryogenic recovery heat exchanger in the hour *h* of the year *y* (tonne)
$\eta_{VP,BL}$	=	Default efficiency of the energy conversion unit in the baseline vaporization plant
$m_{LNG,com}$	=	Amount of LNG vaporized during the operational test at the commissioning of the new LNG vaporization plant (tonne)
$m_{LNG,y}$	=	Amount of LNG vaporized in the project activity in year *y* (tonne)
h	=	Hour[5] in year *y* of the crediting period
3.6	=	conversion factor from GJ to MWh

The parameters $EC_{VP,com}$ and $m_{LNG,com}$ should be audited by an independent engineering firm, present during the operational test. The operational test should be conducted following all operational specifications from the manufacturer, with no recovery of cryogenic energy, and at optimum operational conditions of the plant.

Determination of $k_{VP,EL}$ at an existing LNG vaporization plant

If the project activity is implemented at an existing LNG vaporization plant, the electricity consumption rate $k_{VR,EL}$ shall be determined as the minimum value between: (i) The historical data from the most recent three years prior to the implementation of the project activity, and (ii) The electricity consumption in the baseline calculated based on the cryogenic energy provided to the air separation plant and the electricity consumption of the LNG vaporization plant in the project activity in the year *y* of the crediting period. Hence, $k_{VR,EL}$ shall be calculated as follows:

$$k_{VP,EL} = MIN\left\{\frac{\sum_{x=1}^{3} EC_{VP,x}}{\sum_{x=1}^{3} m_{LNG,x}}; \frac{EC_{VP,CR,y}}{m_{LNG,y}}\right\} \quad \textbf{(8)}$$

[5] For each hour when the LNG stream is not sent to the cryogenic recovery heat exchanger, the value of $LNG_{h,y}$, $HS_{LNG,out,h,y}$ and $HS_{LNG,in,h,y}$ should be zero.

with

$$EC_{VP,CR,y} = \frac{\sum_{h=1}^{8760}\left[\left(HS_{LNG,out,h,y} - HS_{LNG,in,h,y}\right)\cdot LNG_{h,y}\right]\cdot 3.6}{\eta_{VP,BL}} + EC_{VP,PJ,y} \quad \textbf{(9)}$$

Where:

$k_{VP,EL}$	=	Electricity consumption rate for LNG vaporization in the baseline scenario (MWh/tonne of LNG)
$EC_{VP,x}$	=	Historical electricity consumption for LNG vaporization in year *x* prior to the implementation of the CDM project activity (MWh)
$EC_{VP,CR,y}$	=	Electricity consumption for vaporization of LNG calculated based on the cryogenic energy provided to the air separation plant and the electricity consumption of the LNG vaporization plant in the project activity during year *y* (MWh)
$EC_{VP,PJ,y}$	=	Electricity consumption for LNG vaporization in year *y* (MWh)
$HS_{LNG,out,h,y}$	=	Average specific enthalpy of the LNG stream at the outlet of the cryogenic recovery heat exchanger in the hour h of the year *y* (GJ/tonne of LNG)
$HS_{LNG,in,h,y}$	=	Average specific enthalpy of the LNG stream at the inlet of the cryogenic recovery heat exchanger in the hour h of the year *y* (GJ/tonne of LNG)
$LNG_{h,y}$	=	Total amount of LNG that flows through the cryogenic recovery heat exchanger in the hour h of the year *y* (tonne)
$\eta_{VP,BL}$	=	Default efficiency of the energy conversion unit in the baseline vaporization plant
$m_{LNG,x}$	=	Amount of LNG vaporized at the project site in year *x* prior to the implementation of the project activity (tonne)
$m_{LNG,y}$	=	Amount of LNG vaporized in the project activity in year *y* (tonne)
x	=	The most recent three years prior to the implementation of the project activity
h	=	Hour[6] in year *y* of the crediting period
3.6	=	conversion factor from GJ to MWh

Sub-step 1.B.2: Determination of $BE_{VP,FF,y}$

Baseline emissions from the combustion of fossil fuels for LNG vaporization should be calculated as follows:

$$BE_{VP,FF,y} = k_{VP,FF} \cdot m_{LNG,y} \quad \textbf{(10)}$$

Where:

$BE_{VP,FF,y}$	=	Baseline emissions from combustion of fossil fuels for LNG vaporization in year *y* (tCO_2)
$k_{VP,FF}$	=	Emission intensity of LNG vaporization from the use of fossil fuels in the baseline scenario (tCO_2/tonne of LNG)
$m_{LNG,y}$	=	Amount of LNG vaporized in the project activity in year *y* (tonne)

[6] For each hour when the LNG stream is not sent to the cryogenic recovery heat exchanger, the value of $LNG_{h,y}$, $HS_{LNG,out,h,y}$ and $HS_{LNG,in,h,y}$ should be zero.

Determination of $k_{VP,FF}$ at a new LNG vaporization plant

If the project activity is implemented at a new LNG vaporization plant, the emission intensity of LNG vaporization from the use of fossil fuels in the baseline scenario shall be determined as the minimum value between: (i) An *ex-ante* measurement during the commissioning of the new LNG vaporization plant by undertaking an operational test of the plant, and (ii) The fossil fuels consumption in the baseline calculated based on the cryogenic energy provided to the air separation plant and the fossil fuels consumption of the LNG vaporization plant in the project activity in the year *y* of the crediting period. Hence, $k_{VP,FF}$ shall be calculated as follows:

$$k_{VP,FF} = MIN\left\{\frac{FF_{VP,com} \cdot NCV_{VP,com} \cdot EF_{VP,com}}{m_{LNG,com}}; \frac{FF_{VP,BL,y} \cdot NCV_{VP,y} \cdot EF_{VP,y}}{m_{LNG,y}}\right\} \quad \textbf{(11)}$$

with

$$FF_{VP,BL,y} = \frac{\sum_{h=1}^{8760}\left[\left(HS_{LNG,out,h,y} - HS_{LNG,in,h,y}\right) \cdot LNG_{h,y}\right]}{NCV_{VP,y} \cdot \eta_{VP,BL}} + \sum_{i} FF_{VP,i,y} \quad \textbf{(12)}$$

Where:

$k_{VP,FF}$ = Emission intensity of LNG vaporization process from the use of fossil fuels in the baseline scenario (tCO_2/tonne of LNG)

$FF_{VP,com}$ = Amount of fossil fuels for vaporization of LNG during the operational test at the commissioning of the new LNG vaporization plant (volume or mass unit)

$FF_{VP,BL,y}$ = Amount of fossil fuels that would be used for LNG vaporization in the baseline during year *y* (volume or mass unit)

$FF_{VP,i,y}$ = Amount of fossil fuel type i used for LNG vaporization in the project activity in year *y* (volume or mass unit)

$NCV_{VP,com}$ = Average net calorific value of the least carbon intensive fossil fuel combusted during the operational test at the commissioning of the new LNG vaporization plant (GJ per volume or mass unit)

$NCV_{VP,y}$ = Average net calorific value of the least carbon intensive fossil fuel used for LNG vaporization in year *y* (GJ per volume or mass unit)

$EF_{VP,com}$ = CO_2 emission factor of the least carbon intensive fossil fuel among the fuel identified in the baseline selection, the fuel specified by the manufacturer, the project fuel and the fuel used during the operational test run at the commissioning of the new LNG vaporization plant (tCO_2/GJ)

$EF_{VP,y}$ = CO_2 emission factor of the least carbon intensive fossil fuel used for LNG vaporization in year *y* (tCO_2/GJ)

$HS_{LNG,out,h,y}$ = Average specific enthalpy of the LNG stream at the outlet of the cryogenic recovery heat exchanger in the hour h of the year *y* (GJ/tonne of LNG)

$HS_{LNG,in,h,y}$ = Average specific enthalpy of the LNG stream at the inlet of the cryogenic recovery heat exchanger in the hour h of the year *y* (GJ/tonne of LNG)

$LNG_{h,y}$ = Total amount of LNG that flows through the cryogenic recovery heat exchanger in the hour h of the year *y* (tonne)

$\eta_{VP,BL}$ = Default efficiency of the energy conversion unit in the baseline vaporization plant

$m_{LNG,com}$ = Amount of LNG vaporized during the operational test at the commissioning of the new LNG vaporization plant (tonne)
$m_{LNG,y}$ = Amount of LNG vaporized in the project activity in year *y* (tonne)
h = Hour[7] in year *y* of the crediting period
i = All fossil fuel types used for air separation in year *y*

The parameters $FF_{VP,com}$ and $m_{LNG,com}$ should be audited by an independent engineering firm, present during the operational test. The operational test shall be conducted following all operational specifications from the manufacturer, with no recovery of cryogenic energy, and at optimum operational conditions of the plant.

Determination of $k_{VP,FF}$ at an existing LNG vaporization plant

If the project activity is implemented at an existing LNG vaporization plant, the emission intensity of LNG vaporization from the use of fossil fuels in the baseline scenario shall be determined as the minimum value between: (i) The historical data from the most recent three years prior to the implementation of the project activity, and (ii) The fossil fuels consumption in the baseline calculated based on the cryogenic energy provided to the air separation plant and the fossil fuels consumption of the LNG vaporization plant in the project activity in the year *y* of the crediting period. Hence, $k_{VP,FF}$ shall be calculated as follows:

$$k_{VP,FF} = MIN\left\{\frac{\sum_{x=1}^{3}\sum_{i} FF_{VP,i,x}\cdot NCV_{i,x}\cdot EF_{i,x}}{\sum_{x=1}^{3} m_{LNG,x}};\frac{FF_{VP,BL,y}\cdot NCV_{VP,y}\cdot EF_{VP,y}}{m_{LNG,y}}\right\} \quad \textbf{(13)}$$

with,

$$FF_{VP,BL,y} = \frac{\sum_{h=1}^{8760}\left[\left(HS_{LNG,out,h,y} - HS_{LNG,in,h,y}\right)\cdot LNG_{h,y}\right]}{NCV_{VP,y}\cdot\eta_{VP,BL}} + \sum_{i} FF_{VP,i,y} \quad \textbf{(14)}$$

Where:
$k_{VP,FF}$ = Emission intensity of LNG vaporization process from the use of fossil fuels in the baseline scenario (tCO_2/tonne of LNG)
$FF_{VP,i,x}$ = Amount of fossil fuel *i* used for LNG vaporization in year *x* prior to the implementation of the CDM project activity (volume or mass unit)
$FF_{VP,BL,y}$ = Amount of fossil fuels that would be used for LNG vaporization in the baseline during year *y* (volume or mass unit)
$FF_{VP,i,y}$ = Amount of fossil fuel type i used for LNG vaporization in the project activity in year *y* (volume or mass unit)

[7] For each hour when the LNG stream is not sent to the cryogenic recovery heat exchanger, the value of $LNG_{h,y}$, $HS_{LNG,out,h,y}$ and $HS_{LNG,in,h,y}$ should be zero.

$NCV_{i,x}$	=	Average net calorific value of fossil fuel *i* used for LNG vaporization in year *x* prior to the implementation of the CDM project activity (GJ per volume or mass unit)
$NCV_{VP,y}$	=	Average net calorific value of the least carbon intensive fossil fuel used for LNG vaporization in year *y* (GJ per volume or mass unit)
$EF_{i,x}$	=	CO_2 emission factor of fossil fuel *i* used for LNG vaporization in year *x* prior to the implementation of the CDM project activity (tCO_2/GJ)
$EF_{VP,y}$	=	CO_2 emission factor of the least carbon intensive fossil fuel used for LNG vaporization in year *y* (tCO_2/GJ)
$HS_{LNG,out,h,y}$	=	Average specific enthalpy of the LNG stream at the outlet of the cryogenic recovery heat exchanger in the hour h of the year *y* (GJ/tonne of LNG)
$HS_{LNG,in,h,y}$	=	Average specific enthalpy of the LNG stream at the inlet of the cryogenic recovery heat exchanger in the hour h of the year *y* (GJ/tonne of LNG)
$LNG_{h,y}$	=	Total amount of LNG that flows through the cryogenic recovery heat exchanger in the hour h of the year *y* (tonne)
$\eta_{VP,BL}$	=	Default efficiency of the energy conversion unit in the baseline vaporization plant
$m_{LNG,x}$	=	Amount of LNG vaporized at the project site in year *x* prior to the implementation of the project activity (tonne)
$m_{LNG,y}$	=	Amount of LNG vaporized in the project activity in year *y* (tonne)
x	=	The most recent three years prior the implementation of the project activity
h	=	Hour[8] in year *y* of the crediting period
i	=	All fossil fuel types used for air separation in year *y*

Step 2: Determination of $BE_{AS,y}$

Case 2.A: The baseline scenario is the use of electrically-driven equipment for air separation

If the baseline scenario is identified as S2, the baseline emissions from air separation should be calculated using the latest version of the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption", as follows:

$$BE_{AS,y} = BE_{EC,y} \quad \textbf{(15)}$$

Where:

$BE_{AS,y}$	=	Baseline emissions from air separation in year *y* (tCO_2)
$BE_{EC,y}$	=	Baseline emissions from electricity consumption in year *y* (tCO2).

The baseline emissions from electricity consumption in year *y* ($BE_{EC,y}$) shall be calculated as per the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption". When applying the tool, the parameter $EC_{BL,k,y}$ in the tool should be replaced by the electricity consumption for air separation calculated as follows:

$$EC_{BL,k,y} = EC_{AS,y} = k_{AS,EL} \cdot m_{AS,y} \quad \textbf{(16)}$$

[8] For each hour when the LNG stream is not sent to the cryogenic recovery heat exchanger, the value of $LNG_{h,y}$, $HS_{LNG,out,h,y}$ and $HS_{LNG,in,h,y}$ should be zero.

Where:

$EC_{AS,y}$	=	Electricity consumption for the air separation process in the baseline during year *y* (MWh)
$k_{AS,EL}$	=	Electricity consumption rate of air separation (MWh/Nm^3 or MWh/tonne)
$m_{AS,y}$	=	Amount of air separation products produced in the project activity in year *y* (Nm^3 or tonne)

Determination of $k_{AS,EL}$

The electricity consumption rate of air separation shall be determined as the minimum value between: (i) An *ex ante* measurement during the commissioning of the new air separation plant by undertaking an operational test of the plant, and (ii) The electricity consumption in the baseline calculated based on the cryogenic energy provided to the air separation plant and the electricity consumption of the air separation plant in the project activity in the year *y* of the crediting period. Hence, $k_{AS,EL}$ shall be calculated as follows:

$$k_{AS,EL,y} = \text{MIN}\left\{\frac{EC_{AS,com}}{m_{AS,com}}; \frac{EC_{AS,BL,y}}{m_{AS,y}}\right\} \quad \textbf{(17)}$$

with

$$EC_{AS,BL,y} = \frac{\sum_{h=1}^{8760}\left[\left(HS_{LNG,out,h,y} - HS_{LNG,in,h,y}\right)\cdot LNG_{h,y}\right]\cdot 3.6}{\eta_{AS,BL}} + EC_{AS,PJ,y} \quad \textbf{(18)}$$

Where:

$k_{AS,EL,y}$	=	Electricity consumption rate of air separation in year *y* (MWh/Nm^3 or MWh/tonne)
$EC_{AS,com}$	=	Electricity consumption for air separation during the operational test at the commissioning of the new air separation plant (MWh)
$EC_{AS,BL,y}$	=	Energy that would be consumed for air separation in the baseline during year *y* (MWh)
$EC_{AS,PJ,y}$	=	Electricity consumption for air separation in year *y* (MWh)
$HS_{LNG,out,h,y}$	=	Average specific enthalpy of the LNG stream at the outlet of the cryogenic recovery heat exchanger in the hour h of the year *y* (GJ/tonne of LNG)
$HS_{LNG,in,h,y}$	=	Average specific enthalpy of the LNG stream at the inlet of the cryogenic recovery heat exchanger in the hour h of the year *y* (GJ/tonne of LNG)
$LNG_{h,y}$	=	Total amount of LNG that flows through the cryogenic recovery heat exchanger in the hour h of the year *y* (tonne)
$\eta_{AS,BL}$	=	Default efficiency of the energy conversion unit in the baseline air separation plant
$m_{AS,com}$	=	Amount of air separation products that has been produced during the operational test at the commissioning of the new air separation plant (Nm^3 or tonne)
$m_{AS,y}$	=	Amount of air separation products produced in the project activity in year *y* (Nm^3 or tonne)
h	=	Hour[9] in year *y* of the crediting period

[9] For each hour when the LNG stream is not sent to the cryogenic recovery heat exchanger, the value of $LNG_{h,y}$, $HS_{LNG,out,h,y}$ and $HS_{LNG,in,h,y}$ should be zero.

3.6 = conversion factor from GJ to MWh

The parameters $EC_{AS,com}$ and $m_{AS,com}$ should be audited by an independent engineering firm, present during the operational test. The operational test should be conducted following all operational specifications from the manufacturer, with no recovery of cryogenic energy, and at optimum operational conditions of the plant.

Case 2.B: The baseline scenario is the use of fossil-fuel-driven equipment for air separation

If the baseline scenario is identified as being S3 or S4, the baseline emissions from air separation should be calculated as:

$$BE_{AS,y} = k_{AS,FF} \cdot m_{AS,y} \quad \textbf{(19)}$$

Where:

$BE_{AS,y}$ = Baseline emissions from air separation in year *y* (tCO_2)
$k_{AS,FF}$ = Emissions intensity for air separation due the use of fossil fuels in the baseline (tCO_2/Nm^3 or tCO_2/tonne)
$m_{AS,y}$ = Amount of air separation products produced in the project activity in year *y* (Nm^3 or tonne)

Determination of $k_{AS,FF}$

The parameter $k_{AS,FF}$ shall be determined as the minimum value between: (i) An *ex ante* measurement during the commissioning of the new air separation plant by undertaking an operational test of the plant, and (ii) The fossil fuels consumption in the baseline calculated based on the cryogenic energy provided to the air separation plant and the fossil fuels consumption of the air separation plant in the project activity in the year *y* of the crediting period. Hence, $k_{AS,EL}$ shall be calculated as follows:

$$k_{AS,FF} = MIN\left\{\frac{FF_{AS,com} \cdot NCV_{AS,com} \cdot EF_{AS,com}}{m_{AS,com}}; \frac{FF_{AS,BL,y} \cdot NCV_{AS,y} \cdot EF_{AS,y}}{m_{AS,y}}\right\} \quad \textbf{(20)}$$

with,

$$FF_{AS,BL,y} = \frac{\sum_{h=1}^{8760}\left[\left(HS_{LNG,out,h,y} - HS_{LNG,in,h,y}\right) \cdot LNG_{h,y}\right]}{NCV_{AS,y} \cdot \eta_{AS,BL}} + \sum_{i} FF_{AS,i,y} \quad \textbf{(21)}$$

Where:

$k_{AS,FF}$ = Emissions intensity for air separation due the use of fossil fuels in the baseline (tCO_2/Nm^3 or tCO_2/tonne)
$FF_{AS,com}$ = Amount of fossil fuels used for air separation during the operational test at the commissioning of the new air separation plant (volume or mass unit)
$FF_{AS,BL,y}$ = Amount of energy produced by combustion of fossil fuels that would be used for air separation in the baseline during year *y* (volume or mass unit)
$FF_{AS,i,y}$ = Amount of fossil fuel type i used for air separation in the project activity in year *y* (volume or mass unit)

$NCV_{AS,com}$ = Average net calorific value of the least carbon intensive fossil fuel combusted during the operational test at the commissioning of the new air separation plant (GJ per volume or mass unit)

$NCV_{AS,y}$ = Average net calorific value of the least carbon intensive fossil fuel used for air separation in year *y* (GJ per volume or mass unit)

$EF_{AS,com}$ = CO_2 emission factor of the least carbon intensive fossil fuel among the fuel identified in the baseline selection, the fuel specified by the manufacturer, the project fuel and the fuel used during the operational test run at the commissioning of the new air separation plant (tCO_2/GJ)

$EF_{AS,y}$ = CO_2 emission factor of the least carbon intensive fossil fuel used for air separation in year *y* (tCO_2/GJ)

$HS_{LNG,out,h,y}$ = Average specific enthalpy of the LNG stream at the outlet of the cryogenic recovery heat exchanger in the hour h of the year *y* (GJ/tonne of LNG)

$HS_{LNG,in,h,y}$ = Average specific enthalpy of the LNG stream at the inlet of the cryogenic recovery heat exchanger in the hour h of the year *y* (GJ/tonne of LNG)

$LNG_{h,y}$ = Total amount of LNG that flows through the cryogenic recovery heat exchanger in the hour h of the year *y* (tonne)

$\eta_{AS,BL}$ = Default efficiency of the energy conversion unit in the baseline air separation plant

$m_{AS,com}$ = Amount of air separation products that has been produced during the operational test at the commissioning of the new air separation plant (Nm^3 or tonne)

$m_{AS,y}$ = Amount of air separation products produced in the project activity in year *y* (Nm^3 or tonne)

h = Hour[10] in year *y* of the crediting period

i = All fossil fuel types used for air separation in year *y*

The parameters $FF_{AS,com}$ and $m_{AS,com}$ should be audited by an independent engineering firm, present during the operational test. The operational test shall be conducted following all operational specifications from the manufacturer, with no recovery of cryogenic energy, and at optimum operational conditions of the plant.

Project emissions

For the purpose of determining project emissions, project participants shall include the following emissions sources:

- CO_2 emissions from electricity consumption in the project activity in year *y*;
- CO_2 emissions from fossil fuel consumption in the project activity in year *y*.

[10] For each hour when the LNG stream is not sent to the cryogenic recovery heat exchanger, the value of $LNG_{h,y}$, $HS_{LNG,out,h,y}$ and $HS_{LNG,in,h,y}$ should be zero.

For all scenarios, project emissions are calculated as follows:

$$PE_y = PE_{EC,VP,y} + PE_{EC,AS,y} + PE_{FF,VP,y} + PE_{FF,AS,y} \quad \textbf{(22)}$$

Where:

PE_y = Project emissions in year *y* (tCO_2)
$PE_{EC,VP,y}$ = Project emissions from electricity consumption for LNG vaporization in year *y* (tCO_2)
$PE_{EC,AS,y}$ = Project emissions from electricity consumption for air separation in year *y* (tCO_2)
$PE_{FF,VP,y}$ = Project emissions from combustion of fossil fuels for LNG vaporization in year *y* (tCO_2)
$PE_{FF,AS,y}$ = Project emissions from combustion of fossil fuels air separation in year *y* (tCO_2)

Determination of $PE_{EC,VP,y}$

Project emissions from electricity consumption for LNG vaporization in year *y* ($PE_{EC,VP,y}$) should be calculated using the latest version of the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption". The parameter $EC_{PJ,j,y}$ of the above tool should be replaced by the monitored parameter electricity consumption for LNG vaporization ($EC_{VP,y}$).

Determination of $PE_{EC,AS,y}$

Project emissions from electricity consumption for air separation in year *y* ($PE_{EC,AS,y}$) should be calculated using the latest version of the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption". The parameter $EC_{PJ,j,y}$ of the above tool should be replaced by the monitored parameter electricity consumption for air separation ($EC_{AS,y}$).

Determination of $PE_{FF,VP,y}$

Project emissions from combustion of fossil fuels for LNG vaporization in year *y* ($PE_{FF,VP,y}$) should be calculated using the latest version of the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion", where the source *j* in the tool corresponds to all fossil fuel combustion processes on-site in the LNG vaporization plant.

Determination of $PE_{FF,AS,y}$

Project emissions from combustion of fossil fuels for air separation in year *y* ($PE_{FF,AS,y}$) should be calculated using the latest version of the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion", where the source *j* in the tool corresponds to all fossil fuel combustion processes on-site in the air separation plant.

Leakage

In case the end users of the air separation products are not in the same place as the project location, leakage due to transportation of the air separation products should be considered. The emissions due to the fossil fuel combustion for transportation of air separation cryogenic products (such as O_2, N_2 transported by truck) and associated loss of products during transport should be considered as leakage emissions.

$$LE_y = LE_{FF,TR,y} + LE_{LOSS,TR,y} \quad \textbf{(23)}$$

Where:

LE_y = Leakage emissions in year y (tCO_2)
$LE_{FF,TR,y}$ = Leakage emissions from fossil fuel combustion for transportation of air separation products in year y (tCO_2)
$LE_{LOSS,TR,y}$ = Leakage emissions from loss of air separation products in the transportation in year y (tCO_2)

Leakage emissions from fossil fuel combustion for transportation of air separation products are calculated as:

$$\mathrm{LE_{FF,TR,y}} = \sum_{\mathrm{i}} \mathrm{FF_{TR,i,y}} \cdot \mathrm{NCV_{TR,i,y}} \cdot \mathrm{EF_{TR,i,y}} \quad \textbf{(24)}$$

Where:

$LE_{FF,TR,y}$ = Leakage emissions from fossil fuel combustion for transportation of air separation products in year y (tCO_2)
$FF_{TR,i,y}$ = Quantity of fossil fuel type i consumed for transportation of air separation products in year y (mass or volume unit)
$NCV_{TR,i,y}$ = Net calorific value of the fuel type i for transportation of air separation products in year y (GJ/mass or volume unit)
$EF_{TR,i,y}$ = CO_2 emission factor of fuel type i used for transportation of air separation products in year y (tCO2/GJ)

Leakage emissions from loss of air separation products in the transportation are calculated as:

$$\mathrm{LE_{LOSS,TR,y}} = \frac{\mathrm{m_{AS,shipped,y}} - \mathrm{m_{AS,delivered,y}}}{\mathrm{m_{AS,y}}} \cdot \mathrm{BE_{AS,y}} \quad \textbf{(25)}$$

Where:

$LE_{LOSS,TR,y}$ = Leakage emissions from loss of air separation products in the transportation in year y (tCO_2)
$m_{AS,shipped,y}$ = Amount of air separation products shipped to end-users in year y (Nm^3 or tonne)
$m_{AS,delivered,y}$ = Amount of air separation products delivered to end-users in year y (Nm^3 or tonne)
$m_{AS,y}$ = Amount of air separation products that has been separated within the project boundary in year y (Nm^3 or tonne)
$BE_{AS,y}$ = Baseline emissions from air separation in year y (tCO_2)

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

At the start of the second and third crediting period, project participants have to:

(a) Assess the continued validity of the baseline;

(b) Update the baseline information.

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:	$EC_{AS,com}$
Data unit:	MWh
Description:	Electricity consumption for air separation during the operational test at the commissioning of the new air separation plant
Source of data:	Operational test data at the commissioning of the new air separation plant
Measurement procedures (if any):	Use calibrated electricity meters
Any comment:	Measurements shall be audited by an independent engineering firm, present during the operational test

Data / Parameter:	$EC_{VP,com}$
Data unit:	MWh
Description:	Electricity consumption for vaporization of LNG during the operational test at the commissioning of the new LNG vaporization plant
Source of data:	Operational test data at the commissioning of the new air separation plant
Measurement procedures (if any):	Use calibrated electricity meters
Any comment:	Measurements shall be audited by an independent engineering firm, present during the operational test

Data / Parameter:	$EC_{VP,x}$
Data unit:	MWh
Description:	Historical electricity consumption for LNG vaporization in year *x* prior to the implementation of the CDM project activity
Source of data:	Historical data from the LNG vaporization plant
Measurement procedures (if any):	-
Any comment:	-

<table>
<tr><td>Data / Parameter:</td><td>$EF_{AS,com}$</td></tr>
<tr><td>Data unit:</td><td>tCO_2/GJ</td></tr>
<tr><td>Description:</td><td>CO_2 emission factor of the least carbon intensive fossil fuel among the fuel identified in the baseline selection, the fuel specified by the manufacturer, the project fuel and the fuel used during the operational test run at the commissioning of the new air separation plant</td></tr>
<tr><td>Source of data:</td><td>The following data sources may be used if the relevant conditions apply:
<table>
<tr><th>Data source</th><th>Conditions for using the data source</th></tr>
<tr><td>(a) Values provided by the fuel supplier in invoices</td><td>This is the preferred source</td></tr>
<tr><td>(b) Measurements by the project participants</td><td>If (a) is not available</td></tr>
<tr><td>(c) Regional or national default values</td><td>If (a) is not available.
These sources can only be used for liquid fuels and should be based on well-documented, reliable sources (such as national energy balances)</td></tr>
<tr><td>(d) IPCC default values at the lower limit of the confidence interval with 95% confidence level, as provided in Table 1.2 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories</td><td>If (a) is not available</td></tr>
</table></td></tr>
<tr><td>Measurement procedures (if any):</td><td>For (a) and (b): measurements should be undertaken in line with national or international fuel standards</td></tr>
<tr><td>Any comment:</td><td>For (a): if the fuel supplier does provide the NCV value and the CO_2 emission factor on the invoice and these two values are based on measurements for this specific fuel, this CO_2 factor should be used. If another source for the CO_2 emission factor is used or no CO_2 emission factor is provided, options (b), (c) or (d) should be used</td></tr>
</table>

<table>
<tr><td>Data / Parameter:</td><td>$EF_{i,x}$</td></tr>
<tr><td>Data unit:</td><td>tCO_2/GJ</td></tr>
<tr><td>Description:</td><td>CO_2 emission factor of fossil fuel i used for LNG vaporization in year x prior to the implementation of the CDM project activity</td></tr>
<tr><td>Source of data:</td><td>The following data sources may be used if the relevant conditions apply:
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<tr><th>Data source</th><th>Conditions for using the data source</th></tr>
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<tr><td>Any comment:</td><td>For (a): if the fuel supplier does provide the NCV value and the CO_2 emission factor on the invoice and these two values are based on measurements for this specific fuel, this CO_2 factor should be used. If another source for the CO_2 emission factor is used or no CO_2 emission factor is provided, options (b), (c) or (d) should be used</td></tr>
</table>

<table>
<tr><td>Data / Parameter:</td><td>$EF_{VP,com}$</td></tr>
<tr><td>Data unit:</td><td>tCO_2/GJ</td></tr>
<tr><td>Description:</td><td>CO_2 emission factor of the least carbon intensive fossil fuel among the fuel identified in the baseline selection, the fuel specified by the manufacturer, the project fuel and the fuel used during the operational test run at the commissioning of the new LNG vaporization plant</td></tr>
<tr><td>Source of data:</td><td>The following data sources may be used if the relevant conditions apply:
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<tr><th>Data source</th><th>Conditions for using the data source</th></tr>
<tr><td>(a) Values provided by the fuel supplier in invoices</td><td>This is the preferred source</td></tr>
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<tr><td>Any comment:</td><td>For (a): if the fuel supplier does provide the NCV value and the CO_2 emission factor on the invoice and these two values are based on measurements for this specific fuel, this CO_2 factor should be used. If another source for the CO_2 emission factor is used or no CO_2 emission factor is provided, options (b), (c) or (d) should be used</td></tr>
</table>

Data / Parameter:	$FF_{AS,com}$
Data unit:	volume or mass unit
Description:	Amount of fossil fuels used for air separation during the operational test at the commissioning of the new air separation plant
Source of data:	Operational test data at the commissioning of the new air separation plant
Measurement procedures (if any):	-
Any comment:	Measurements shall be audited by an independent engineering firm, present during the operational test

Data / Parameter:	$FF_{VP,com}$
Data unit:	volume or mass unit
Description:	Amount of fossil fuel *i* used for LNG vaporization in year *x* prior to the implementation of the CDM project activity
Source of data:	Operational test data at the commissioning of the new air separation plant
Measurement procedures (if any):	-
Any comment:	Measurements shall be audited by an independent engineering firm, present during the operational test

Data / Parameter:	$FF_{VP,i,x}$
Data unit:	volume or mass unit
Description:	Amount of fossil fuel *i* used for LNG vaporization in year *x* prior to the implementation of the CDM project activity
Source of data:	Historical data of LNG vaporization plant
Measurement procedures (if any):	-
Any comment:	-

Data / Parameter:	LNG historical quality and quantity
Data unit:	-
Description:	Quality and quantity of the final products from the LNG vaporization plant during the most recent three years prior the implementation of the project activity
Source of data:	Sales and production records of the LNG vaporization plant
Measurement procedures (if any):	According to operational and production standards established in the LNG vaporization plant, for the final products of the plant the following parameters are to be determined: • Chemical composition of final products; • Energy content of final products; • Annual quantity produced of final product
Any comment:	This not monitored parameter is required for existing LNG vaporization plants, in order to comply with the following applicability condition of the present baseline methodology: • *"The project activity does not result in significant changes in the quality and quantity of outputs of the existing LNG vaporization plants. The compliance with this condition is to be supported by (i) historical and present sales records, and (ii) historical and present production records that include the chemical composition and energy content of the marketable products."*

Data / Parameter:	$m_{AS,com}$
Data unit:	Nm^3 or tonne
Description:	Amount of air separation products that has been produced during the operational test at the commissioning of the new air separation plant
Source of data:	Measurements during the operational test
Measurement procedures (if any):	This parameter represents the sum of all air separation products such as O_2, N_2, Ar, etc.
Any comment:	Measurements shall be audited by an independent engineering firm, present during the operational test

Data / Parameter:	$m_{LNG,com}$
Data unit:	tonne
Description:	Amount of LNG vaporized during the operational test at the commissioning of the new LNG vaporization plant
Source of data:	Measurements during the operational test
Measurement procedures (if any):	-
Any comment:	Measurements shall be audited by an independent engineering firm, present during the operational test

Data / Parameter:	$m_{LNG,x}$
Data unit:	tonne
Description:	Amount of LNG vaporized at the project site in year *x* prior to the implementation of the project activity
Source of data:	Historical data from the LNG vaporization plant
Measurement procedures (if any):	-
Any comment:	-

<table>
<tr><td>Data / Parameter:</td><td>$NCV_{AS,com}$</td></tr>
<tr><td>Data unit:</td><td>GJ per volume or mass unit (e.g. GJ/m³, GJ/ton)</td></tr>
<tr><td>Description:</td><td>Average net calorific value of the least carbon intensive fossil fuel combusted during the operational test at the commissioning of the new air separation plant (GJ per volume or mass unit)</td></tr>
<tr><td>Source of data:</td><td>The following data sources may be used if the relevant conditions apply:
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These sources can only be used for liquid fuels and should be based on well-documented, reliable sources (such as national energy balances)</td></tr>
<tr><td>(d) IPCC default values at the lower limit of the confidence interval with 95% confidence level, as provided in Table 1.2 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories</td><td>If (a) is not available</td></tr>
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<tr><td>Measurement procedures (if any):</td><td>For (a) and (b): measurements should be undertaken in line with national or international fuel standards</td></tr>
<tr><td>Any comment:</td><td>QA/QC procedures: verify that the values under (a), (b) and (c) are within the uncertainty range of the IPCC default values as provided in Table 1.2, Vol. 2 of the 2006 IPCC Guidelines. If the values out of this range, collect additional information from the testing laboratory to justify the outcome or conduct additional measurements. The laboratories in (a), (b) or (c) should have ISO17025 accreditation or justify that they can comply with similar quality standards</td></tr>
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<table>
<tr><td>Data / Parameter:</td><td>$NCV_{VP,com}$</td></tr>
<tr><td>Data unit:</td><td>GJ per volume or mass unit</td></tr>
<tr><td>Description:</td><td>Average net calorific value of the least carbon intensive fossil fuel combusted during the operational test at the commissioning of the new LNG vaporization plant</td></tr>
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<tr><td>Data / Parameter:</td><td>$NCV_{i,x}$</td></tr>
<tr><td>Data unit:</td><td>GJ per volume or mass unit</td></tr>
<tr><td>Description:</td><td>Average net calorific value of fossil fuel i used for LNG vaporization in year x prior to the implementation of the CDM project activity</td></tr>
<tr><td>Source of data:</td><td>The following data sources may be used if the relevant conditions apply:
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<tr><td>(b) Measurements by the project participants</td><td>If (a) is not available</td></tr>
<tr><td>(c) Regional or national default values</td><td>If (a) is not available.
These sources can only be used for liquid fuels and should be based on well-documented, reliable sources (such as national energy balances)</td></tr>
<tr><td>(d) IPCC default values at the lower limit of the confidence interval with 95% confidence level, as provided in Table 1.2 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories</td><td>If (a) is not available</td></tr>
</table></td></tr>
<tr><td>Measurement procedures (if any):</td><td>For (a) and (b): measurements should be undertaken in line with national or international fuel standards</td></tr>
<tr><td>Any comment:</td><td>QA/QC procedures: verify that the values under (a), (b) and (c) are within the uncertainty range of the IPCC default values as provided in Table 1.2, Vol. 2 of the 2006 IPCC Guidelines. If the values out of this range, collect additional information from the testing laboratory to justify the outcome or conduct additional measurements. The laboratories in (a), (b) or (c) should have ISO17025 accreditation or justify that they can comply with similar quality standards</td></tr>
</table>

Data / Parameter:	$\eta_{AS,BL}$
Data unit:	-
Description:	Default efficiency of the energy conversion unit in the baseline air separation plant
Source of data:	For the new air separation plant, use the highest efficiency of the energy conversion unit at optimal operational conditions as per the technical specifications provided by the manufacturer of the plant
Measurement procedures (if any):	-
Any comment:	This value shall be audited by the independent engineering firm present during the operational test

Data / Parameter:	$\eta_{VP,BL}$
Data unit:	-
Description:	Default efficiency of the energy conversion unit in the baseline vaporization plant
Source of data:	For a new LNG vaporization plant: use the highest efficiency of the energy conversion unit at optimal operational conditions as per the technical specifications provided by the manufacturer of the plant. For an existing LNG vaporization plant: use the highest historical efficiency of the energy conversion unit recorded during the three most recent years prior the implementation of the project activity
Measurement procedures (if any):	-
Any comment:	This value shall be audited by the independent engineering firm present during the operational test

III. MONITORING METHODOLOGY

Monitoring procedures

Describe and specify in the CDM-PDD all monitoring procedures, including the type of measurement instrumentation used and the responsibilities for monitoring and QA/QC procedures that will be applied. Where the methodology provides different options (e.g. use of default values or on-site measurements), specify which option will be used. Meters should be installed, maintained and calibrated according to equipment manufacturer instructions and be in line with relevant standards. If such standards are not available, use national standards. If a national standard is not available, then use international standards.

All monitoring should be attended to by appropriate and adequate personnel, as assessed by the project developer. All data collected as part of monitoring should be archived electronically and be kept at least for two years after the end of the last crediting period. One hundred per cent 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.

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

Data and parameters monitored

Data / Parameter:	$EC_{AS,PJ,y}$
Data unit:	MWh
Description:	Electricity consumption for air separation in year *y*
Source of data:	Onsite measurements from project participants
Measurement procedures (if any):	Use of calibrated electric meter at the connection point of the air separation plant with the distribution electric line supplying all electricity requirements to the facility
Monitoring frequency:	Daily

QA/QC procedures:	The amount of electricity consumed shall be cross-checked with the amounts of electricity: (i) Purchased from the electric grid or (ii) Imported from captive power plants
Any comment:	-

Data / Parameter:	$EC_{VP,PJ,y}$
Data unit:	MWh
Description:	Electricity consumption for LNG vaporization in the project activity in year *y*
Source of data:	Onsite measurements from project participants
Measurement procedures (if any):	Use of calibrated electric meter at the connection point of the LNG vaporization plant with the distribution electric line supplying all electricity requirements to the facility
Monitoring frequency:	Daily
QA/QC procedures:	The amount of electricity consumed shall be cross-checked with the amounts of electricity: (i) Purchased from the electric grid or (ii) Imported from captive power plants
Any comment:	-

Data / Parameter:	$EF_{AS,y}$
Data unit:	tCO_2/GJ
Description:	CO_2 emission factor of the least carbon intensive fossil fuel used for air separation in year *y*
Source of data:	The following data sources may be used if the relevant conditions apply:

Data source	Conditions for using the data source
(a) Values provided by the fuel supplier in invoices	This is the preferred source
(b) Measurements by the project participants	If (a) is not available
(c) Regional or national default values	If (a) is not available. These sources can only be used for liquid fuels and should be based on well-documented, reliable sources (such as national energy balances)
(d) IPCC default values at the upper limit of the confidence interval with 95% confidence level, as provided in Table 1.2 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories	If (a) is not available

Measurement procedures (if any):	For (a) and (b): measurements should be undertaken in line with national or international fuel standards
Monitoring frequency:	Monthly
QA/QC procedures:	-
Any comment:	For (a): if the fuel supplier does provide the NCV value and the CO_2 emission factor on the invoice and these two values are based on measurements for this specific fuel, this CO_2 factor should be used. If another source for the CO_2 emission factor is used or no CO_2 emission factor is provided, options (b), (c) or (d) should be used

Data / Parameter:	$EF_{TR,i,y}$
Data unit:	tCO_2/GJ
Description:	CO_2 emission factor of fuel type *i* used for transportation of air separation products in year *y*
Source of data:	The following data sources may be used if the relevant conditions apply:

Data source	Conditions for using the data source
(a) Values provided by the fuel supplier in invoices	This is the preferred source
(b) Measurements by the project participants	If (a) is not available
(c) Regional or national default values	If (a) is not available. These sources can only be used for liquid fuels and should be based on well-documented, reliable sources (such as national energy balances)
(d) IPCC default values at the upper limit of the confidence interval with 95% confidence level, as provided in Table 1.2 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories	If (a) is not available

Measurement procedures (if any):	For (a) and (b): measurements should be undertaken in line with national or international fuel standards
Monitoring frequency:	Monthly
QA/QC procedures:	-
Any comment:	For (a): if the fuel supplier does provide the NCV value and the CO_2 emission factor on the invoice and these two values are based on measurements for this specific fuel, this CO_2 factor should be used. If another source for the CO_2 emission factor is used or no CO_2 emission factor is provided, options (b), (c) or (d) should be used

<table>
<tr><td>Data / Parameter:</td><td>$EF_{VP,y}$</td></tr>
<tr><td>Data unit:</td><td>tCO_2/GJ</td></tr>
<tr><td>Description:</td><td>CO_2 emission factor of the least carbon intensive fossil fuel used for LNG vaporization in year y</td></tr>
<tr><td>Source of data:</td><td>The following data sources may be used if the relevant conditions apply:
<table>
<tr><th>Data source</th><th>Conditions for using the data source</th></tr>
<tr><td>(a) Values provided by the fuel supplier in invoices</td><td>This is the preferred source</td></tr>
<tr><td>(b) Measurements by the project participants</td><td>If 9a) is not available</td></tr>
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These sources can only be used for liquid fuels and should be based on well-documented, reliable sources (such as national energy balances)</td></tr>
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<tr><td>Measurement procedures (if any):</td><td>For (a) and 9b): measurements should be undertaken in line with national or international fuel standards</td></tr>
<tr><td>Monitoring frequency:</td><td>Monthly</td></tr>
<tr><td>QA/QC procedures:</td><td>-</td></tr>
<tr><td>Any comment:</td><td>For (a): if the fuel supplier does provide the NCV value and the CO_2 emission factor on the invoice and these two values are based on measurements for this specific fuel, this CO_2 factor should be used. If another source for the CO_2 emission factor is used or no CO_2 emission factor is provided, options (b), (c) or (d) should be used</td></tr>
</table>

Data / Parameter:	$FF_{AS,i,y}$
Data unit:	volume or mass unit
Description:	Amount of fossil fuel type *i* used for air separation in the project activity in year *y*
Source of data:	Onsite measurements from project participants
Measurement procedures (if any):	-
Monitoring frequency:	Daily
QA/QC procedures:	The amount of fossil fuel used shall be cross-checked with data in the invoices from fuel purchased
Any comment:	-

Data / Parameter:	$FF_{TR,i,y}$
Data unit:	volume or mass unit
Description:	Quantity of fossil fuel type *i* consumed for transportation of air separation products in year *y*
Source of data:	Plant records
Measurement procedures (if any):	-
Monitoring frequency:	Daily
QA/QC procedures:	The amount of fossil fuel used shall be cross-checked with data from the transport operator
Any comment:	-

Data / Parameter:	$FF_{VP,i,y}$
Data unit:	volume or mass unit
Description:	Amount of fossil fuel type i used for LNG vaporization in the project activity in year *y*
Source of data:	Onsite measurements from project participants
Measurement procedures (if any):	-
Monitoring frequency:	Daily
QA/QC procedures:	The amount of fossil fuel used shall be cross-checked with data in the invoices from fuel purchased
Any comment:	-

Data / Parameter:	$HS_{LNG,in,h,y}$
Data unit:	GJ/tonne of LNG
Description:	Average specific enthalpy of the LNG stream at the inlet of the cryogenic recovery heat exchanger in the hour *h* of the year *y*
Source of data:	Plant data
Measurement procedures (if any):	Use calibrated flow meters, pressure gauges and temperature indicators, at the inlet of the cryogenic recovery heat exchanger, in order to determine the enthalpy of the fluid
Monitoring frequency:	Hourly
QA/QC procedures:	Regular calibration procedures to be adopted for all monitoring instruments
Any comment:	A national or international engineering standard shall be followed for the determination of the enthalpy

Data / Parameter:	$HS_{LNG,out,h,y}$
Data unit:	GJ/tonne of LNG
Description:	Average specific enthalpy of the LNG stream at the outlet of the cryogenic recovery heat exchanger in the hour h of the year *y*
Source of data:	Plant data
Measurement procedures (if any):	Use calibrated flow meters, pressure gauges and temperature indicators, at the outlet of the cryogenic recovery heat exchanger, in order to determine the enthalpy of the fluid
Monitoring frequency:	Hourly
QA/QC procedures:	Regular calibration procedures to be adopted for all monitoring instruments
Any comment:	A national or international engineering standard shall be followed for the determination of the enthalpy

Data / Parameter:	$LNG_{h,y}$
Data unit:	tonnes
Description:	Total amount of LNG that flows through the cryogenic recovery heat exchanger in the hour h of the year *y*
Source of data:	Onsite measurements from project participants
Measurement procedures (if any):	Use of flow meters
Monitoring frequency:	Hourly
QA/QC procedures:	Regular calibration procedures to be adopted for all monitoring instruments
Any comment:	-

Data / Parameter:	LNG quality and quantity
Data unit:	-
Description:	Quality and quantity of the final products from the LNG vaporization plant in year *y*
Source of data:	Sales and production records of the LNG vaporization plant
Measurement procedures (if any):	According to operational and production standards established in the LNG vaporization plant, for the final products of the plant the following parameters are to be determined: • Chemical composition of final products; • Energy content of final products; • Annual quantity produced of final product
Monitoring frequency:	Annually

QA/QC procedures:	QA/QC procedures established by the LNG vaporization plant for operation and production
Any comment:	This monitored parameter is required for existing LNG vaporization plants, in order to comply with the following applicability condition of the present baseline methodology: • *"The project activity does not result in significant changes in the quality and quantity of outputs of the existing LNG vaporization plants. The compliance with this condition is to be supported by (i) historical and present sales records, and (ii) historical and present production records that include the chemical composition and energy content of the marketable products."*

Data / Parameter:	$m_{AS,delivered,y}$
Data unit:	Nm^3 or tonne
Description:	Amount of air separation products delivered to end-users in year *y*
Source of data:	Onsite measurements from project participants
Measurement procedures (if any):	This parameter represents the sum of all air separation products such as O2, N2, Ar, etc, received by end-users
Monitoring frequency:	Monthly
QA/QC procedures:	The amount of air separation products delivered to end-users shall be cross-checked with data in the sale invoices
Any comment:	-

Data / Parameter:	$m_{AS,shipped,y}$
Data unit:	Nm^3 or tonne
Description:	Amount of air separation products shipped to end-users in year *y*
Source of data:	Onsite measurements from project participants
Measurement procedures (if any):	This parameter represents the sum of all air separation products such as O2, N2, Ar, etc.. Volumetric measurement from truck gage, mass meter or weight ticket after delivery to customer. The information will be converted to Nm3 or keep as tonne using appropriate conversion factors for the absolute pressure and temperature of the product
Monitoring frequency:	After each delivery to customers
QA/QC procedures:	The delivery to each customer will generate a ticket/bill that will be kept for at least two years. The volume gage and tank, or scale will be calibrated every year. The amount of air separation products should be cross-checked by an annual mass balance based on sold amount and/or stock changes
Any comment:	-

Data / Parameter:	$m_{AS,y}$
Data unit:	Nm^3 or tonne
Description:	Amount of air separation products that has been separated within the project boundary in year *y*
Source of data:	Onsite measurements from project participants

Measurement procedures (if any):	This parameter represents the sum of all air separation products such as O2, N2, Ar, etc.. Volume measurement on storage tank by differential pressure, or mass meter after process or weighing device incorporate on storage tank
Monitoring frequency:	Daily
QA/QC procedures:	The production logs will be kept for at least two years. The volume gage and tank, or scale will be calibrated every two year
Any comment:	The amount of air separation products should be cross-checked with the amounts of products sold and stock changes

Data / Parameter:	$m_{LNG,y}$
Data unit:	tonne
Description:	Amount of LNG vaporized in the project activity in year *y*
Source of data:	On-site measurements using mass flow meters
Measurement procedures (if any):	A gas measuring bridge before the distribution pipeline will registered the amount of gas vaporized and delivered to customers
Monitoring frequency:	On line, dedicated equipment with datalogger or equivalent to register the data
QA/QC procedures:	The meter will be calibrated every year. The amount of LNG vaporized should be cross-checked by an annual mass balance based on purchased and/or sold amount and/or stock changes
Any comment:	-

Data / Parameter:	$NCV_{AS,y}$
Data unit:	GJ per volume or mass unit (e.g. GJ/m³, GJ/ton)
Description:	Average net calorific value of the least carbon intensive fossil fuel used for air separation in year *y*
Source of data:	The following data sources may be used if the relevant conditions apply:

Data source	**Conditions for using the data source**
(a) Values provided by the fuel supplier in invoices	This is the preferred source
(b) Measurements by the project participants	If (a) is not available
(c) Regional or national default values	If (a) is not available. These sources can only be used for liquid fuels and should be based on well-documented, reliable sources (such as national energy balances)
(d) IPCC default values at the upper limit of the confidence interval with 95% confidence level, as provided in Table 1.2 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories	If (a) is not available

Measurement procedures (if any):	For (a) and (b): measurements should be undertaken in line with national or international fuel standards
Monitoring frequency:	Monthly
QA/QC procedures:	Verify that the values under (a), 9b) and (c) are within the uncertainty range of the IPCC default values as provided in Table 1.2, Vol. 2 of the 2006 IPCC Guidelines. If the values out of this range, collect additional information from the testing laboratory to justify the outcome or conduct additional measurements. The laboratories in 9a), (b) or (c) should have ISO17025 accreditation or justify that they can comply with similar quality standards
Any comment:	-

Data / Parameter:	$NCV_{TR,i,y}$
Data unit:	GJ per volume or mass unit (e.g. GJ/m³, GJ/ton)
Description:	Net calorific value of the fuel type *i* for transportation of air separation products in year *y*
Source of data:	The following data sources may be used if the relevant conditions apply:

Data source	Conditions for using the data source
(a) Values provided by the fuel supplier in invoices	This is the preferred source
(b) Measurements by the project participants	If (a) is not available
(c) Regional or national default values	If (a) is not available. These sources can only be used for liquid fuels and should be based on well-documented, reliable sources (such as national energy balances)
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Measurement procedures (if any):	For (a) and (b): measurements should be undertaken in line with national or international fuel standards
Monitoring frequency:	Monthly
QA/QC procedures:	Verify that the values under (a), (b) and (c) are within the uncertainty range of the IPCC default values as provided in Table 1.2, Vol. 2 of the 2006 IPCC Guidelines. If the values out of this range, collect additional information from the testing laboratory to justify the outcome or conduct additional measurements. The laboratories in (a), 9b) or (c) should have ISO17025 accreditation or justify that they can comply with similar quality standards
Any comment:	-

<table>
<tr><td>Data / Parameter:</td><td>$NCV_{VP,y}$</td></tr>
<tr><td>Data unit:</td><td>GJ per volume or mass unit (e.g. GJ/m³, GJ/ton)</td></tr>
<tr><td>Description:</td><td>Average net calorific value of the least carbon intensive fossil fuel used for LNG vaporization in year y</td></tr>
<tr><td>Source of data:</td><td>The following data sources may be used if the relevant conditions apply:
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<tr><td>Any comment:</td><td>-</td></tr>
</table>

Data / Parameter:	O_2 & N_2 purity
Data unit:	%
Description:	Purity of the oxygen and nitrogen stream produced and commercialized in year *y*
Source of data:	Sales and production records of the air separation plant
Measurement procedures (if any):	Purity calculation should be done following a national or international standards
Monitoring frequency:	For each shipment of final product from the air separation plant
QA/QC procedures:	QA/QC procedures from the used national or international standard used shall be followed
Any comment:	This monitoring provision is require to comply with the following applicability condition of the present baseline methodology: • *"The purity of the oxygen and nitrogen produced by the new air separation plant is equal to or higher than 99.5%"*

IV. REFERENCES AND ANY OTHER INFORMATION

Not applicable.

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History of the document

Version	Date	Nature of revision(s)
01	EB 55, Annex # 30 July 2010	To be considered at EB 55.
Decision Class: Regulatory **Document Type**: Standard **Business Function**: Methodology		