**Joint Crediting Mechanism Approved Methodology TH_AM002**

**"Energy Saving by Introduction of Multi-stage Oil-Free Air Compressor"**

## A. Title of the methodology

Energy Saving by Introduction of Multi-stage Oil-Free Air Compressor, Version 021.0

## B. Terms and definitions

| Terms | Definitions |
|---|---|
| Multi-stage oil-free air compressor | A device with more than one compression stage without using lubricating oil to compress air, nitrogen or inert gases to make the pressure of gas higher than that of the inlet. |
| Specific conditions | The specific conditions for this methodology are defined as below, following ISO 1217:2009.<br>Ambient temperature = 20 degrees Celsius,<br>Ambient pressure = 0 MPa (Gauge pressure),<br>Relative humidity = 0%,<br>Cooling water/air = 20 degrees Celsius,<br>Effective working pressure at discharge valve = 0.7 MPa (Gauge pressure). |
| Free air delivery (FAD) | The actual quantity of compressed air converted to the inlet conditions of the compressor. The unit is $m^3$/min. |
| Periodical check | A periodical investigation of air compressor conducted by manufacturer or agent who is authorized by the manufacturer, in order to maintain air compressor performance. |
| Specific power (SP) | An indicator of efficiency of air compressor, calculated with electric motor power (nominal output power) [kW] and free air delivery [$m^3$/min]<br>$$\mathbf{SP} = \frac{\mathbf{Motor\ power\ [kW]}}{\mathbf{FAD\ [m^3/min]}}$$ |

## C. Summary of the methodology

| Items | Summary |
|---|---|
| *GHG emission reduction measures* | This methodology applies to the project that aims at saving energy by introducing multi-stage oil-free air compressor in manufacturing process of semiconductors. |
| *Calculation of reference emissions* | Reference emissions are GHG emissions from using reference air compressor, calculated with power consumption of project air compressor, specific power (SP) of reference/project air compressors and $CO_2$ emission factor for electricity consumed. |
| *Calculation of project emissions* | Project emissions are GHG emissions from using project air compressor, calculated with power consumption of project air compressor and $CO_2$ emission factor for electricity consumed. |
| *Monitoring parameters* | ● Power consumption of project air compressor<br>● The amount of fuel consumed and the amount of electricity generated by captive power, where applicable. |

## D. Eligibility criteria

This methodology is applicable to projects that satisfy all of the following criteria.

| | |
|---|---|
| Criterion 1 | Project air compressor is a non-inverter type multi-stage oil-free air compressor with an electric motor power of 55kW, 75kW, 110kW, 132kW, 145kW, 160kW, or 200kW installed in manufacturing process of semiconductors. |
| Criterion 2 | Periodical check is planned more than one (1) time annually. |

## E. Emission Sources and GHG types

| Reference emissions | |
|---|---|
| Emission sources | GHG types |
| Electricity consumption by air compressor | $CO_2$ |
| **Project emissions** | |
| Emission sources | GHG types |
| Electricity consumption by air compressor | $CO_2$ |

## F. Establishment and calculation of reference emissions

### F.1. Establishment of reference emissions

Reference emissions are calculated by multiplying power consumption of project air compressor, specific power (SP) for reference/project air compressors, and $CO_2$ emission factor for electricity consumed.

SP of reference air compressor is conservatively set as a default value in the following manner to ensure the net emission reductions.

1. The most efficient value is selected for each motor power of air compressors from the collected SP values available in Thai market and determined as the reference SP.
2. The value of SP is defined as $SP_{RE,sc,i}$ described in Section I.

**F.2. Calculation of reference emissions**

$$\mathbf{RE_p} = \sum_{\mathbf{i}} \left\{ \mathbf{EC_{PJ,i,p}} \times \left( \mathbf{SP_{RE,sc,i}} \div \mathbf{SP_{PJ,sc,i}} \right) \times \mathbf{EF_{elec}} \right\}$$

$RE_p$ : Reference emissions during the period *p* [$tCO_2$/p]
$EC_{PJ,i,p}$ : Power consumption of project air compressor *i* during the period *p* [MWh/p]
$SP_{PJ,sc,i}$ : SP of project air compressor *i* calculated under the specific conditions [kW·min/$m^3$]
$SP_{RE,sc,i}$ : SP of reference air compressor *i* under the specific conditions [kW·min/$m^3$]
$EF_{elec}$ : $CO_2$ emission factor for consumed electricity [$tCO_2$/MWh]

## G. Calculation of project emissions

$$\mathbf{PE_p} = \sum_{\mathbf{i}} \left( \mathbf{EC_{PJ,i,p}} \times \mathbf{EF_{elec}} \right)$$

$PE_p$ : Project emissions during the period *p* [$tCO_2$/p]
$EC_{PJ,i,p}$ : Power consumption of project air compressor *i* during the period *p* [MWh/p]
$EF_{elec}$ : $CO_2$ emission factor for consumed electricity [$tCO_2$/MWh]

## H. Calculation of emissions reductions

$$\mathbf{ER_p = RE_p - PE_p}$$

$ER_p$ : Emission reductions during the period *p* [$tCO_2$/p]

$RE_p$ : Reference emissions during the period *p* [$tCO_2$/p]

$PE_p$ : Project emissions during the period *p* [$tCO_2$/p]

## I. Data and parameters fixed *ex ante*

The source of each data and parameter fixed *ex ante* is listed as below.

| Parameter | Description of data | Source |
|---|---|---|
| $EF_{elec}$ | $CO_2$ emission factor for consumed electricity.<br>When project air compressor consumes only grid electricity or captive electricity, the project participant applies the $CO_2$ emission factor respectively.<br><br>When project air compressor may consume both grid electricity and captive electricity, the project participant applies the $CO_2$ emission factor with lower value.<br><br>[$CO_2$ emission factor]<br>For grid electricity: The most recent value available from the source stated in this table at the time of validation<br><br>For captive electricity, it is determined based on the following options:<br><br>~~a) 0.8*~~<br>~~*The most recent value available from CDM approved small scale methodology AMS-I.A at the time of validation is applied.~~<br><br>a~~b~~) Calculated from its power generation efficiency ($\eta_{elec}$ [%]) obtained from manufacturer's specification | [Grid electricity]<br>The most recent value available at the time of validation is applied and fixed for the monitoring period thereafter. The data is sourced from "Grid Emission Factor (GEF) of Thailand", endorsed by Thailand Greenhouse Gas Management Organization unless otherwise instructed by the Joint Committee.<br><br>[Captive electricity]<br>For the option a)<br>~~CDM approved small scale methodology: AMS-I.A~~<br><br>~~For the option b)~~<br>Specification of the captive power generation system provided by the manufacturer ($\eta_{elec}$ [%]).<br>$CO_2$ emission factor of the fossil fuel type used in the captive power generation system ($EF_{fuel}$ [$tCO_2$/GJ]) |

| | | |
|---|---|---|
| | The power generation efficiency based on lower heating value (LHV) of the captive power generation system from the manufacturer's specification is applied;<br>$EF_{elec} = 3.6 \times \frac{100}{\eta_{elec}} \times EF_{fuel}$<br><br>be) Calculated from measured data<br>The power generation efficiency calculated from monitored data of the amount of fuel input for power generation ($FC_{PJ,p}$) and the amount of electricity generated ($EG_{PJ,p}$) during the monitoring period *p* is applied. The measurement is conducted with the monitoring equipment to which calibration certificate is issued by an entity accredited under national/international standards;<br>$EF_{elec} = FC_{PJ,p} \times NCV_{fuel} \times EF_{fuel} \times \frac{1}{EG_{PJ,p}}$<br>Where:<br>$NCV_{fuel}$ : Net calorific value of consumed fuel [GJ/mass or weight]<br><br>Note:<br>In case the captive electricity generation system meets all of the following conditions, the value in the following table may be applied to $EF_{elec}$ depending on the consumed fuel type.<br><br>● The system is non-renewable generation system<br>● Electricity generation capacity of the system is less than or equal to 15 MW<br><br>fuel type / Diesel fuel / Natural gas | For the option be)<br>Generated and supplied electricity by the captive power generation system ($EG_{PJ,p}$ [MWh/p]).<br>Fuel amount consumed by the captive power generation system ($FC_{PJ,p}$ [mass or weight/p]).<br>Net calorific value ($NCV_{fuel}$ [GJ/mass or weight]) and $CO_2$ emission factor of the fuel ($EF_{fuel}$ [$tCO_2/GJ$]) in order of preference:<br>1) values provided by the fuel supplier;<br>2) measurement by the project participants;<br>3) regional or national default values;<br>4) IPCC default values provided in tables 1.2 and 1.4 of Ch.1 Vol.2 of 2006 IPCC Guidelines on National GHG Inventories. Lower value is applied.<br><br>[Captive electricity with diesel fuel]<br>CDM approved small scale methodology: AMS-I.A.<br><br>[Captive electricity with natural gas]<br>2006 IPCC Guidelines on National GHG Inventories for |

| | | |
|---|---|---|
| | $EF_{elec}$ \| 0.8 *1 \| 0.46 *2<br><br>*1 The most recent value at the time of validation is applied.<br>*2 The value is calculated with the equation in the option a) above. The lower value of default effective $CO_2$ emission factor for natural gas (0.0543 $tCO_2/GJ$), and the most efficient value of default efficiency for off-grid gas turbine systems (42%) are applied. | the source of EF of natural gas. CDM Methodological tool "Determining the baseline efficiency of thermal or electric energy generation systems version02.0" for the default efficiency for off-grid power plants. |
| $SP_{RE,sc,i}$ | The SP of the reference air compressor *i* for each motor power is set as a default value in this methodology as shown in the table below.<br><br>**Motor Power [kW] \| Reference SP**<br>55 \| 5.73<br>75 \| 6.00<br>110 \| 5.67<br>132 \| 5.84<br>145 \| 6.14<br>160 \| 5.65<br>200 \| 5.49<br><br>It is noted that the SP value is calculated under the specific conditions | Specifications of project air compressor *i* prepared for the quotation or factory acceptance test data by manufacturer.<br><br>The default SP value is derived from the result of survey on SP of non-inverter oil-free air compressors from manufacturers that have high market share in Thailand.<br><br>The $SP_{RE,sc,i}$ is revised if necessary from survey result which is conducted by JC or project participants every three years. |
| $SP_{PJ,i}$ | SP of project air compressor *i* under the project specific conditions. | Specifications of project air compressor *i* prepared for the quotation or factory acceptance test data by manufacturer. |
| $SP_{PJ,sc,i}$ | SP of project air compressor *i* under the specific conditions is calculated by the following equation: | Specifications of project air compressor *i* prepared for the quotation or factory acceptance test data by manufacturer. |

| | | |
|---|---|---|
| | $SP_{PJ,sc,i} = \mathrm{SP}_{PJ,i} \times \frac{T_{s,PJ,sc,i}}{T_{s,PJ,i}} \times \left[\left(\frac{P_{d,PJ,sc,i}}{P_{s,PJ,sc,i}}\right)^{\frac{k-1}{m_i k}} - 1\right] \div \left[\left(\frac{P_{d,PJ,i} + 0.101}{P_{s,PJ,i}}\right)^{\frac{k-1}{m_i k}} - 1\right]$<br><br>$k$: Heat capacity ratio (Dried Air) = 1.4<br>$m_i$: Number of compression stages of project air compressor $i$<br>$P_{s,PJ,i}$: Suction pressure of project air compressor $i$ under the project specific conditions [MPa(abs)] (Default value is set at atmospheric pressure = 0.101[MPa(abs)])<br>$P_{s,PJ,sc,i}$: Suction pressure of project air compressor $i$ under the specific conditions [MPa(abs)] (Default value is set at atmospheric pressure = 0.101[MPa(abs)])<br>$T_{s,PJ,i}$: Suction temperature of project air compressor $i$ under the project specific conditions [K] (Value from the product catalogue or manufacturer's specification)<br>$T_{s,PJ,sc,i}$: Suction temperature of project air compressor $i$ under the specific conditions [K] (Default value is set at 293.0[K])<br>$P_{d,PJ,i}$: Discharge pressure of project air compressor $i$ under the project specific conditions [MPa(Gauge pressure)] (Value from the product catalogue or manufacturer's specification)<br>$P_{d,PJ,sc,i}$: Discharge pressure of project air compressor $i$ under the specific conditions [MPa(abs)] (= 0.101[MPa(abs)] + 0.7 [MPa(Gauge pressure)] = 0.801[MPa(abs)]) | |

History of the document

| Version | Date | Contents revised |
|---|---|---|
| 02.0 | 21 August 2017 | JC3, Annex 10 |

| | | |
|---|---|---|
| | | Revision to:<br>● Add conditions to apply 0.80 or 0.46 as a $CO_2$ emission factor for captive electricity |
| 01.0 | 23 August 2016 | Decision by the Joint Committee.<br>Initial approval. |
| | | |

## Monitoring Plan Sheet (Input Sheet) [Attachment to Project Design Document]

**Table 1: Parameters to be monitored *ex post***

| (a) Monitoring point No. | (b) Parameters | (c) Description of data | (d) Estimated Values | (e) Units | (f) Monitoring option | (g) Source of data | (h) Measurement methods and procedures | (i) Monitoring frequency | (j) Other comments |
|---|---|---|---|---|---|---|---|---|---|
| (1) | $EC_{PJ,i,p}$ | Power consumption of project air compressor *i* during the period *p* | - | MWh/p | Option C | Monitored data | Data is measured by measuring equipments in the factory.<br>- Specification of measuring equipments:<br>1) Electrical power meter is applied for measurement of electrical power consumption of project air compressor.<br>2) Meter is certified in compliance with national/international standards on electrical power meter.<br>- Measuring and recording:<br>1) Measured data is recorded and stored in the measuring equipments.<br>2) Recorded data is checked its integrity once a month by responsible staff.<br>- Calibration:<br>In case a calibration certificate issued by an entity accredited under national/international standards is not provided, such measuring equipment is required to be calibrated. | Continuously | Input on "MPS (input_separate)" |
| (2) | $FC_{PJ,p}$ | The amount of fuel input for power generation during monitoring period *p* | | mass or weight/p | Option B | Invoice from fuel supply company | Data is collected and recorded from the invoices by the fuel supply company. | Continuously | for option b) |
| (3) | $EG_{PJ,p}$ | The amount of electricity generated during the monitoring period *p* | | MWh/p | Option C | Monitored data | Data is measured by measuring equipments in the factory.<br>- Specification of measuring equipments:<br>1) Electrical power meter is applied for measurement of electrical power consumption of project air compressor.<br>2) Meter is certified in compliance with national/international standards on electrical power meter.<br>- Measuring and recording:<br>1) Measured data is recorded and stored in the measuring equipments.<br>2) Recorded data is checked its integrity once a month by responsible staff.<br>- Calibration:<br>In case a calibration certificate issued by an entity accredited under national/international standards is not provided, such measuring equipment is required to be calibrated. | Continuously | for option b) |

**Table 2: Project-specific parameters to be fixed *ex ante***

| (a) Parameters | (b) Description of data | (c) Estimated Values | (d) Units | (e) Source of data | (f) Other comments |
|---|---|---|---|---|---|
| $EF_{elec}$ | [For grid electricity]<br>$CO_2$ emission factor for consumed electricity | | $tCO_2/MWh$ | The most recent value available at the time of validation is applied and fixed for the monitoring period thereafter. The data is sourced from "Grid Emission Factor (GEF) of Thailand", endorsed by Thailand Greenhouse Gas Management Organization unless otherwise instructed by the Joint Committee. | |
| $EF_{elec}$ | [For captive electricity]<br>$CO_2$ emission factor for consumed electricity<br>**Option a** | 0.000 | $tCO_2/MWh$ | Power generation efficiency obtained from manufacturer's specification. | Calculated |
| $EF_{elec}$ | [For captive electricity]<br>$CO_2$ emission factor for consumed electricity<br>**Option b** | 0.000 | $tCO_2/MWh$ | The power generation efficiency calculated from monitored data of the amount of fuel input for power generation and the amount of electricity generated. | Calculated |
| $EF_{elec}$ | [For captive electricity]<br>In case the captive electricity generation system meets all of the following conditions;<br>- The system is non-renewable generation system<br>- Electricity generation capacity of the system is less than or equal to 15 MW | | $tCO_2/MWh$ | [Captive electricity with diesel fuel]<br>CDM approved small scale methodology: AMS-I.A.<br><br>[Captive electricity with natural gas]<br>2006 IPCC Guidelines on National GHG Inventories for the source of EF of natural gas.<br>CDM Methodological tool "Determining the baseline efficiency of thermal or electric energy generation systems version02.0" for the default efficiency for off-grid power plants. | |
| $SP_{RE,sc,i}$ | Specific power (SP) of reference air compressor *i* under the specific conditions | - | $kW \cdot min/m^3$ | Selected from the default values set in the methodology | Input on "MPS (input_separate)" |
| $SP_{PJ,i}$ | Specific power (SP) of project air compressor *i* under the project specific conditions | - | $kW \cdot min/m^3$ | Specifications of project air compressor *i* prepared for the quotation or factory acceptance test data by manufacturer | Input on "MPS (input_separate)" |
| $P_{d,PJ,i}$ | Discharge pressure of project air compressor *i* under the project specific conditions | - | MPa(Gauge pressure) | Specifications of project air compressor *i* prepared for the quotation or factory acceptance test data by manufacturer | Input on "MPS (input_separate)" |
| $T_{s,PJ,i}$ | Suction temperature of project air compressor *i* under the project specific conditions | - | K | Specifications of project air compressor *i* prepared for the quotation or factory acceptance test data by manufacturer | Input on "MPS (input_separate)" |
| $m_i$ | Number of compression stages of project air compressor *i* | - | - | Catalogues or specifications of project air compressor *i* | Input on "MPS (input_separate)" |
| $SP_{PJ,sc,i}$ | Specific power (SP) of project air compressor *i* calculated under the specific conditions | - | $kW \cdot min/m^3$ | Calculated with the following equation;<br>$SP_{PJ,sc,i} = SP_{PJ,i} \times (T_{s,PJ,sc,i}/T_{s,PJ,i}) \times [(P_{d,PJ,sc,i} / P_{s,PJ,sc,i})^{(k-1)/m_i k} - 1] / [(P_{d,PJ,i} + 0.101) / (P_{s,PJ,sc,i})^{(k-1)/m_i k} - 1]$<br><br>k: Heat capacity ratio (Dried Air) = 1.4<br>$m_i$: number of compression stages of project air compressor *i*<br>$P_{s,PJ,i}$: Suction pressure of project air compressor *i* under the project specific conditions [MPa(abs)] (Default value is set at atmospheric pressure = 0.101[MPa(abs)])<br>$P_{s,PJ,sc,i}$: Suction pressure of project air compressor *i* under the specific conditions [MPa(abs)] (Default value is set at atmospheric pressure = 0.101[MPa(abs)])<br>$T_{s,PJ,i}$: Suction temperature of project air compressor *i* under the project specific conditions [K] (Value from the product catalogue or manufacturer's specification)<br>$T_{s,PJ,sc,i}$: Suction temperature of project air compressor *i* under the specific conditions [K] (Default value is set at 293.0[K])<br>$P_{d,PJ,i}$: Discharge pressure of project air compressor *i* [MPa(Gauge pressure)] (Value from the product catalogue or manufacturer's specification)<br>$P_{d,PJ,sc,i}$: Discharge pressure of project air compressor *i* under the specific conditions [MPa] (= 0.101[MPa(abs)] + 0.7 [MPa(Gauge pressure)] = 0.801[MPa(abs)]) | |
| $\eta_{elec}$ | Power generation efficiency | | % | Specification of the captive power generation system provided by the manufacturer | |
| $NCV_{fuel}$ | Net calorific value of consumed fuel | | GJ/mass or weight | In order of preference:<br>1) values provided by the fuel supplier;<br>2) measurement by the project participants;<br>3) regional or national default values;<br>4) IPCC default values provided in table 1.2 of Ch.1 Vol.2 of 2006 IPCC Guidelines on National GHG Inventories. Lower value is applied. | |
| $EF_{fuel}$ | $CO_2$ emission factor of consumed fuel | | $tCO_2/GJ$ | In order of preference:<br>1) values provided by the fuel supplier;<br>2) measurement by the project participants;<br>3) regional or national default values;<br>4) IPCC default values provided in table 1.4 of Ch.1 Vol.2 of 2006 IPCC Guidelines on National GHG Inventories. Lower value is applied. | |

**Table3: *Ex-ante* estimation of $CO_2$ emission reductions**

| $CO_2$ emission reductions | Units |
|---|---|
| 0 | $tCO_2/p$ |

**[Monitoring option]**

| | |
|---|---|
| Option A | Based on public data which is measured by entities other than the project participants (Data used: publicly recognized data such as statistical data and specifications) |
| Option B | Based on the amount of transaction which is measured directly using measuring equipments (Data used: commercial evidence such as invoices) |
| Option C | Based on the actual measurement using measuring equipments (Data used: measured values) |

## Monitoring Report Sheet (Input Sheet) [For Verification]

**Table 1: Parameters monitored *ex post***

| (a) Monitoring period | (b) Monitoring point No. | (c) Parameters | (d) Description of data | (e) Monitored Values | (f) Units | (g) Monitoring option | (h) Source of data | (i) Measurement methods and procedures | (j) Monitoring frequency | (k) Other comments |
|---|---|---|---|---|---|---|---|---|---|---|
| | (1) | $EC_{PJ,i,p}$ | Power consumption of project air compressor *i* during the period *p* | - | MWh/p | Option C | Monitored data | Data is measured by measuring equipments in the factory.<br>- Specification of measuring equipments:<br>1) Electrical power meter is applied for measurement of electrical power consumption of project air compressor.<br>2) Meter is certified in compliance with national/international standards on electrical power meter.<br>- Measuring and recording:<br>1) Measured data is recorded and stored in the measuring equipments.<br>2) Recorded data is checked its integrity once a month by responsible staff.<br>- Calibration:<br>In case a calibration certificate issued by an entity accredited under national/international standards is not provided, such measuring equipment is required to be calibrated. | Continuously | Input on "MRS (input_separate)" |
| | (2) | $FC_{PJ,p}$ | The amount of fuel input for power generation during monitoring period *p* | | mass or weight/p | Option B | Invoice from fuel supply company | Data is collected and recorded from the invoices by the fuel supply company. | Continuously | for option b) |
| | (3) | $EG_{PJ,p}$ | The amount of electricity generated during the monitoring period *p* | | MWh/p | Option C | Monitored data | Data is measured by measuring equipments in the factory.<br>- Specification of measuring equipments:<br>1) Electrical power meter is applied for measurement of electrical power consumption of project air compressor.<br>2) Meter is certified in compliance with national/international standards on electrical power meter.<br>- Measuring and recording:<br>1) Measured data is recorded and stored in the measuring equipments.<br>2) Recorded data is checked its integrity once a month by responsible staff.<br>- Calibration:<br>In case a calibration certificate issued by an entity accredited under national/international standards is not provided, such measuring equipment is required to be calibrated. | Continuously | for option b) |

**Table 2: Project-specific parameters fixed *ex ante***

| (a) Parameters | (b) Description of data | (c) Estimated Values | (d) Units | (e) Source of data | (f) Other comments |
|---|---|---|---|---|---|
| $EF_{elec}$ | [For grid electricity]<br>$CO_2$ emission factor for consumed electricity | | $tCO_2/MWh$ | The most recent value available at the time of validation is applied and fixed for the monitoring period thereafter. The data is sourced from "Grid Emission Factor (GEF) of Thailand", endorsed by Thailand Greenhouse Gas Management Organization unless otherwise instructed by the Joint Committee. | |
| $EF_{elec}$ | [For captive electricity]<br>$CO_2$ emission factor for consumed electricity<br>**Option a** | 0.000 | $tCO_2/MWh$ | Power generation efficiency obtained from manufacturer's specification. | Calculated |
| $EF_{elec}$ | [For captive electricity]<br>$CO_2$ emission factor for consumed electricity<br>**Option b** | 0.000 | $tCO_2/MWh$ | The power generation efficiency calculated from monitored data of the amount of fuel input for power generation and the amount of electricity generated. | Calculated |
| $EF_{elec}$ | [For captive electricity]<br>In case the captive electricity generation system meets all of the following conditions;<br>- The system is non-renewable generation system<br>- Electricity generation capacity of the system is less than or equal to 15 MW | | $tCO_2/MWh$ | [Captive electricity with diesel fuel]<br>CDM approved small scale methodology: AMS-I.A.<br><br>[Captive electricity with natural gas]<br>2006 IPCC Guidelines on National GHG Inventories for the source of EF of natural gas.<br>CDM Methodological tool "Determining the baseline efficiency of thermal or electric energy generation systems version02.0" for the default efficiency for off-grid power plants. | |
| $SP_{RE,sc,i}$ | Specific power (SP) of reference air compressor *i* under the specific conditions | - | $kW \cdot min/m^3$ | Selected from the default values set in the methodology | Input on "MPS (input_separate)" |
| $SP_{PJ,i}$ | Specific power (SP) of project air compressor *i* under the project specific conditions | - | $kW \cdot min/m^3$ | Specifications of project air compressor i prepared for the quotation or factory acceptance test data by manufacturer | Input on "MPS (input_separate)" |
| $P_{d,PJ,i}$ | Discharge pressure of project air compressor *i* under the project specific conditions | - | MPa(Gauge pressure) | Specifications of project air compressor i prepared for the quotation or factory acceptance test data by manufacturer | Input on "MPS (input_separate)" |
| $T_{s,PJ,i}$ | Suction temperature of project air compressor *i* under the project specific conditions | - | K | Specifications of project air compressor i prepared for the quotation or factory acceptance test data by manufacturer | Input on "MPS (input_separate)" |
| $m_i$ | Number of compression stages of project air compressor *i* | - | - | Catalogues or specifications of project air compressor i | Input on "MPS (input_separate)" |
| $SP_{PJ,sc,i}$ | Specific power (SP) of project air compressor *i* calculated under the specific conditions | - | $kW \cdot min/m^3$ | Calculated with the following equation;<br>SPPJ,sc,i = SPPJ,i ×(Ts,PJ,sc,i/Ts,PJ,i) × [(Pd,PJ,sc,i / Ps,PJ,sc,i)^{(k-1)/mik} - 1] / [((Pd,PJ,i + 0.101) / (Ps,PJ,sc,i))^{(k-1)/mik} - 1]<br><br>k: Heat capacity ratio (Dried Air) = 1.4<br>mi: number of compression stages of project air compressor i<br>Ps,PJ,i: Suction pressure of project air compressor i under the project specific conditions [MPa(abs)] (Default value is set at atmospheric pressure = 0.101[MPa(abs)])<br>Ps,PJ,sc,i: Suction pressure of project air compressor i under the specific conditions [MPa(abs)] (Default value is set at atmospheric pressure = 0.101[MPa(abs)])<br>Ts,PJ,i: Suction temperature of project air compressor i under the project specific conditions [K] (Value from the product catalogue or manufacturer's specification)<br>Ts,PJ,sc,i: Suction temperature of project air compressor i under the specific conditions [K] (Default value is set at 293.0[K])<br>Pd,PJ,i: Discharge pressure of project air compressor i [MPa(Gauge pressure)] (Value from the product catalogue or manufacturer's specification)<br>Pd,PJ,sc,i: Discharge pressure of project air compressor i under the specific conditions [MPa] (= 0.101[MPa(abs)] + 0.7 [MPa(Gauge pressure)] = 0.801[MPa(abs)]) | |
| $\eta_{elec}$ | Power generation efficiency | | % | Specification of the captive power generation system provided by the manufacturer | |
| $NCV_{fuel}$ | Net calorific value of consumed fuel | | GJ/mass or weight | In order of preference:<br>1) values provided by the fuel supplier;<br>2) measurement by the project participants;<br>3) regional or national default values;<br>4) IPCC default values provided in table 1.2 of Ch.1 Vol.2 of 2006 IPCC Guidelines on National GHG Inventories. Lower value is applied. | |
| $EF_{fuel}$ | $CO_2$ emission factor of consumed fuel | | $tCO_2/GJ$ | In order of preference:<br>1) values provided by the fuel supplier;<br>2) measurement by the project participants;<br>3) regional or national default values;<br>4) IPCC default values provided in table 1.4 of Ch.1 Vol.2 of 2006 IPCC Guidelines on National GHG Inventories. Lower value is applied. | |

**Table3: *Ex-post* calculation of $CO_2$ emission reductions**

| Monitoring Period | $CO_2$ emission reductions | Units |
|---|---|---|
| | 0 | $tCO_2/p$ |

**[Monitoring option]**

| | |
|---|---|
| Option A | Based on public data which is measured by entities other than the project participants (Data used: publicly recognized data such as statistical data and specifications) |
| Option B | Based on the amount of transaction which is measured directly using measuring equipments (Data used: commercial evidence such as invoices) |
| Option C | Based on the actual measurement using measuring equipments (Data used: measured values) |