Project design document form for CDM project activities

(Version 08.0)

Complete this form in accordance with the Attachment "Instructions for filling out the project design document form for CDM project activities" at the end of this form.

PROJECT DESIGN DOCUMENT (PDD)	
Title of the project activity	InfraVest Guanyin Wind Farm Project - Taiwan
Version number of the PDD	Version 1.0
Completion date of the PDD	10/03/2017
Project participant(s)	InfraVest Wind Power Group South Pole Carbon Asset Management Ltd.
Host Party	Taiwan
Applied methodology(ies) and, where applicable, applied standardized baseline(s)	Approved consolidated baseline methodology ACM0002 "Consolidated methodology for Grid-connected electricity generation from renewable sources ", Version 17
Sectoral scope(s) linked to the applied methodology(ies)	Sectoral Scope 1: Energy Industries (Renewable Source)
Estimated amount of annual average GHG emission reductions	94,291

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

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The project involves the development of a 43.7 MW onshore wind farm located in Taoyuan-Guanyin (called hereafter: Guanyin wind farm).

The wind farm is constructed and operated by InfraVest Wind Power Group (hereafter InfraVest). The project comprises 19 Enercon E70 wind turbines, each having a capacity of 2.3MW. At full capacity, the aggregated output of the project is expected to be of 142,866 MWh/year, which is to be delivered to the regional state electricity authority, Taipower. Accordingly, the project will lead to carbon dioxide emission reduction since it will avoid the use of fossil fuel in the electricity generating system. The annual emission reductions are estimated as 94,291tCO2e/year.

Contribution to sustainable development:

The project contributes significantly to the region's sustainable development. The specific goals for the project are to:

• reduce the greenhouse gas emissions in Taiwan by replacing fossil fuel based power generation;

• produce clean, renewable energy that contributes to alleviate the global warming;

• contribute to the development of the wind energy sector in Taiwan;

• provide clean electricityof equivalent 38,654 households'[1] annual demand to the grid;

• create local employment both during the construction and operational phase;

• technology and know-how transfer as the employees are trained by German wind turbine manufacturer Enercon on maintenance, safety and operational issues;

• contribute to the reduction of pollutants such as sulphur dioxide, nitrogen oxides and particles resulting from the electricity generation from fossil fuels in Taiwan;

• contribute to Taiwan's energy sustainability and security by reducing the dependency on fossil fuel imports.

A.2. Location of project activity

A.2.1. Host Party

>>

Taiwan

A.2.2. Region/State/Province etc.

>>

Taoyuan County

A.2.3. City/Town/Community etc.

>>

Guanyin Townships

A.2.4. Physical/Geographical location

>>

The wind farm is located in Guanyin Township, Taoyuan County, West Taiwan.

The proposed project activity is distributed in this zone which is at the geographical position of 25° 2'39.69"N, 121° 4'53.51"E. The location is depicted in the map shown below.

Picture 1.: Location in Taiwan

Picture 2: Location of the Guanyin wind farm.

A.3. Technologies and/or measures

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The proposed project activity is a new wind power project. The total installed capacity of the proposed project is 43.7 MW. It comprises 19 horizontal-axis, upwind, gearless, 3-bladed wind turbines, Enercon E70. The turbine capacity is rated at 2.3 MW, and tower height is 65 m.

Braking systems of the turbine include: three independent blade pitch systems, rotor brake, and rotor lock. Cutout wind speed is determined at 28-34 m/s, with Enercon storm control. Remote monitoring of this turbine type applies Enercon Scada system.

The technical data of the turbine units is given in the table below.

Rated power	2,300 kW
Rotor diameter	71 m
Hub height	58-113m
Wind class (IEC)	IEC/NVN I
Turbine concept	Gearless, variable speed, variable pitch control
Rotor	
Type:	Upwind rotor with active pitch control
Direction of rotation	Clockwise
Number of blades	3
Swept area	3,959 m2
Blade material	Fiberglass (epoxy resin); intergrated lightning protection
Rotational speed	Variable, 6-21.5 rpm
Pitch control	ENERCON blade pitch system, one independent pitching system per rotor blade with allocated emergency supply
Drive train with generator	
Hub	Rigid
Main bearings	Dual-row tapered/single-row cylindrical roller bearings
Generator	ENERCON direct-drive synchronous annular generator

Grid feeding	ENERCON converter
Braking systems	3 independent blade pitch systems with emergency supply
Yaw control	Active via adjustment gears, load-dependent damping
Cut-out wind speed	28-34 m/s (with ENERCON storm control)
Remote monitoring	ENERCON SCADA

Table 1. Characteristics of the wind turbine E70

A.4. Parties and project participants

Party involved (host) indicates host Party	Private and/or public entity(ies) project participants (as applicable)	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Taiwan (host)	InfraVest Wind Power Group (private entity)	No
Switzerland	South Pole Carbon Asset Management Ltd. (private entity)	No

A.5. Public funding of project activity

>>

There is no public funding from Annex I countries involved in the project activity.

SECTION B. Application of selected approved baseline and monitoring methodology and standardized baseline

B.1. Reference of methodology and standardized baseline

>>

Approved consolidated monitoring methodology ACM0002 “Consolidated monitoring methodology

for zero-emissions grid-connected electricity generation from renewable sources”, Version 17.

The methodology ACM0002/Version 18 is available at:

http://cdm.unfccc.int/methodologies/PAmethodologies/approved.html

Additionality Tool

The “Tool for the Demonstration and Assessment of Additionality”, Version 7.0 is used to demonstrate the additionality of the project activity.

The tool is available at:

http://cdm.unfccc.int/methodologies/PAmethodologies/approved.html

B.2. Applicability of methodology and standardized baseline

>>

The methodology ACM0002 (Version 17) is applicable to the proposed project because the proposed project meets all the applicability criteria stated in the methodology:

• This methodology is applicable to grid-connected renewable energy power generation project activities that:

(a) Install a Greenfield power plant;

(a) Involve a capacity addition to (an) existing plant(s);

(b) Involve a retrofit of (an) existing operating plants/units;

(c) Involve a rehabilitation of (an) existing plant(s)/unit(s); or

(d) Involve a replacement of (an) existing plant(s)/unit(s).

The project is a new power plant at a site where no renewable power plant was operated prior to the implementation of the project activity.

The methodology is applicable under the following conditions:

(a) The project activity may include renewable energy power plant/unit of one of the following types: hydro power plant/unit with or without reservoir, wind power plant/unit, geothermal power plant/unit, solar power plant/unit, wave power plant/unit or tidal power plant/unit;

(b) In the case of capacity additions, retrofits, rehabilitations or replacements (except for wind, solar, wave or tidal power capacity addition projects the existing plant/unit started commercial operation prior to the start of a minimum historical reference period of five years, used for the calculation of baseline emissions and defined in the baseline emission section, and no capacity expansion, retrofit, or rehabilitation of the plant/unit has been undertaken between the start of this minimum historical reference period and the implementation of the project activity.

The project consists of installation of a wind power plant and is a grid-connected electricity generation project

The methodology is not applicable to:

(a) Project activities that involve switching from fossil fuels to renewable energy sources at the site of the project activity, since in this case the baseline may be the continued use of fossil fuels at the

site;

(b) Biomass fired power plants/units.

The project does not involve switching from fossil fuel use to renewable energy at the site of the project activity; and The geographic and system boundaries for the relevant electricity grid can be clearly identified and information on the characteristics of the grid is available. The project will be connected to the regional state electricity authority, Taipower.

B.3. Project boundary

According to the methodology ACM 0002, since the proposed project is a grid connected wind power project, only CO2 emissions from fossil fuels fired power plants in baseline scenario need to be considered.

Source		GHGs	Included?	Justification/Explanation
Baseline scenario	CO2 emissions from electricity generation in fossil fuel fired power plants that are displaced due to the project activity	CO2	Yes	Main emission source
		CH4	No	Minor emission source
		N2O	No	Minor emission source
Project scenario	Emission Sources of Project Activity	CO2	No	Excluded. It is a clean energy project.
		CH4	No	Excluded. It is a clean energy project.
		N2O	No	Excluded. It is a clean energy project.

According to the “Tool to calculated the emission factor for an electricity system”, a project electricity system is defined by the spatial extent of the power plants that are physically connected through transmission and distribution lines to the project activity and that can be dispatched without significant transmission constraints. Similarly, the connected electricity system, e.g. national or international, is defined as an electricity system that is connected by transmission lines to the project electricity system. Power plants within the connected electricity system can be dispatched

without significant transmission constraints but transmission to the project electricity system has significant transmission constraint.Since Taiwan is an island with no cable connection with the continent, there is no connected electricity system indicated in region. The spatial extent of the Project Boundary is defined as the insular electricity grid operated by Taipower.

B.4. Establishment and description of baseline scenario

>>

The methodology ACM0002 determines the baseline scenario through the following:

If the project activity is the installation of a new grid-connected renewable power plant/unit, the baseline scenario is the following:

"Electricity delivered to the grid by the project activity would have otherwise been generated by the operation of grid-connected power plants and by the addition of new generation sources, as reflected in the combined margin (CM) calculations described in the "Tool to calculate the emission factor for an electricity system".

The baseline scenario for this project activity is the equivalent electricity service provided by Taipower with the grid emission factor estimated ex-ante as per the "Tool to calculate the emission factor for an electricity system".

The operating margin emission factor (EFgrid, OM,y) of Taiwan is 0.690 tCO2e/MWh and the build margin emission factor (EF grid,BM,y) is 0.570 tCO2e/MWh. The defaults weights for wind power are sued as specified in the emission factor tool: W_{OM}=0.75; wBM=0.25. Thus the result of the Baseline Emission Factor calculation is 0.660 tCO2e/MWh.

B.5. Demonstration of additionality

>>

This section has been assessed and validated in the first crediting period.

B.6. Emission reductions

B.6.1. Explanation of methodological choices

>>

The approved consolidated baseline and monitoring methodology ACM0002 (version 17.0) "Grid-connected electricity generation from renewable sources" has been used.

The methodology was applied with the following tools:

- Tool for the demonstration and assessment of additionality (Version 07.0.0)

- Tool to calculate the emission factor for an electricity system (Version 05.0.0)

1. Project Emission

As per ACM0002, the project emission for most renewable energy (including wind farm) project activities is zero (PE_y=0).

2. Baseline Emission

As per ACM0002, baseline emissions include only CO_2 emissions from electricity generation in fossil fuel fired power plants that are displaced due to the project activity, calculated as follows:

$BE_y = EG_{PJ,y} * EF_{grid,CM,y}$

Where:

BE_y: Baseline emissions in year y (tCO_2/yr)

$EG_{PJ,y}$: Quantity of net electricity generation that is produced and fed into the grid as a result of the implementation of the CDM project activity in year y (MWh/yr)

$EF_{grid,CM,y}$: Combined margin CO_2 emission factor for grid connected power generation in year y calculated using the latest version of the "Tool to calculate the emission factor for an electricity system" (tCO_2/MWh)

The proposed project is the installations of new grid-connected renewable power plants at sites where no renewable power plant was operated prior to the implementation of the project activity, so:

$EG_{PJ,y} = EG_{facility,y}$

Where:

$EG_{facility,y}$: Quantitiy of net electricity generation supplied by the project plant/nit to the grid in year y (MWh/yr)

3. Leakage

For the leakage, according to ACM0002, no leakage emissions are considered. The main emissions potentially giving rise to leakage in the context of electric sector projects are emissions

arising due to activities such as power plant construction and upstream emissions from fossil fuel use (e.g. extraction, processing, transport). These emissions sources are neglected.

Therefore, the leakage in this project is zero as well (LE_y=0).

4. Emission reductions

Emission reductions of the project are calculated as follows:

$ER_y=BE_y-PE_y$

Where：

ER: Emission reductions in year y (tCO_2e/yr)

BE_y: Baseline emissions in year y (tCO_2/yr)

PE_y: Project emissions in year y (tCO2/yr)

After simplification, the final result for calculating this project's emission reduction is the following:

$ER_y=EG_{facility,y}*EF_{grid,CM,y}$

Emission Factor

The Baseline Emission Factor is calculated as a Combined Margin, using the weighted average of the operating margin and build margin.

$EF_{gird,CM,y}=EF_{gird,OM,y}* w_{OM}+EF_{grid,BM,y}* w_{BM}$

$EF_{gird,CM,y}$:Operating Margin Emission Factor (tCO_2/MWh)

$EF_{gird,BM,y}$: Build margin emission factor (t CO_2/MWh)

w_{OM}: Weighting of operating margin emission factor

w_{BM}: Weighting of build margin emission factor

Based on above equation, the operating margin emission factor ($EF_{gird,OM,y}$) of Taiwan is 0.690 tCO_2/MWh and the build margin emission factor ($EF_{gird,BM,y}$) is 0.570 tCO_2/MWh. The defaults weights for wind power are used as specified in the emission factor tool: w_{OM}=0.75; w_{BM}=0.25. The result of the Baseline Emission Factor calculation is 0.660 tCO_2/MWh. The calculations are presented in Appendix 4.

B.6.2. Data and parameters fixed ex ante

Data / Parameter	EG_y
Unit	MWh
Description	Net electricity generated in the project electricity system in year y
Source of data	Energy Balances in Taiwan
Value(s) applied	See Table in Appendix 4
Choice of data or Measurement methods and procedures	Net electricity generated and delivered to the grid by all power sources serving the system, not including low-cost/must-run power plants/units
Purpose of data	Calculation of baseline emissions
Additional comment	

Data / Parameter	$FC_{i,y}$
Unit	Ton, litre or $1000m^3$
Description	Amount of fuel type I consumed by power plants/units in year y
Source of data	Energy Balances in Taiwan
Value(s) applied	Step 4 Table in Appendix 4
Choice of data or Measurement methods and procedures	Fuel consumption breakdown by power plant/unit is unavailable, total consumption amounts are published annually.
Purpose of data	Calculation of baseline emissions
Additional comment	

Data / Parameter	$NCV_{i,y}$
Unit	GJ/mass or volume unit
Description	Net calorific value (energy content) of fuel type I in year y
Source of data	GHG Emission Factor Inventory- Industrial Development Bureau, Ministry of Economic Affairs, Taiwan
Value(s) applied	Please refer to the table in Appendix 4
Choice of data or Measurement methods and procedures	Numbers are adopted from the reference document.
Purpose of data	Calculation of baseline emissions
Additional comment	

Data / Parameter	$EF_{C02,i,y}$
Unit	t CO2/GJ
Description	CO2 emission factor of fuel type i in year y
Source of data	GHG Emission Factor Inventory– Industrial Development Bureau, Ministry of Economic Affairs, Taiwan R.O.C.
Value(s) applied	Please refer to the table in the Appendix 4

Choice of data or Measurement methods and procedures	Publicly available data from Bureau of Energy, Ministry of Economic Affairs
Purpose of data	Calculation of baseline emissions
Additional comment	

Data / Parameter	$EF_{coal, Adv}$ $EF_{gas,Adv}$ $EF_{oil,Adv}$
Unit	tCO2/MWh
Description	Emission factor of commercialized coal-fired, oil-fired and gas-fired power plant
Source of data	Equipment energy efficiency benchmark from Energy Information Network by Industrial Technology Research Institute, Bureau of Energy , Ministry of Economic Affairs
Value(s) applied	Step 5 in Appendix 4
Choice of data or Measurement methods and procedures	Publicly available data from Bureau of Energy, Ministry of Economic Affairs
Purpose of data	Calculation of baseline emissions
Additional comment	

Data / Parameter	$CAP_{source,y}$
Unit	MW
Description	Installed capacity by different sources from 2013 to 2015
Source of data	Statistic data of power generation capacity and total generation published by Bureau of Energy, Ministry of Economic Affairs
Value(s) applied	Step 5 in Appendix 4
Choice of data or Measurement methods and procedures	Publicly available data from Bureau of Energy, Ministry of Economic Affairs
Purpose of data	Calculation of baseline emissions
Additional comment	

Data / Parameter	$EF_{grid,CM,y}$
Unit	tCO2e/MWh
Description	Combined Emission factor
Source of data	Calculated
Value(s) applied	0.660
Choice of data or Measurement methods and procedures	The Baseline Emission Factor is calculated as a Combined Margin, using the weighted average of the Operating Margin and Build Margin.
Purpose of data	Calculation of baseline emissions
Additional comment	

B.6.3. Ex ante calculation of emission reductions

>>

Project Emissions

In according to ACM0002, the project emission for most renewable energy (including wind farm) project activities is zero (PEy=0).

Leakage

Based on ACM0002, there is no need of leakage calculation or monitoring for this kind of activity, thus leakage is considered to be zero (0 tCO_2e).

Baseline Emissions

Based on ACM0002, baseline emissions (BEy) include only CO_2 emissions from electricity generation in fossil fuel fired power plants that are displaced due to the proposed project activity, which is calculated as follows:

$BE_y=EG_{PJ,y}*EF_{grid,CM,y}$

Where:

BE_y: Baseline emissions in year y (tCO_2/yr)

$EG_{PJ,y}$: Quantity of net electricity generation that is produced and fed into the grid as a result of the implementation of the CDM project activity in year y (MWh/yr)

$EF_{grid,CM,y}$: Combined margin CO_2 emission factor for grid connected power generation in year y calculated using the latest version of the "Tool to calculate the emission factor for an electricity system" (tCO_2e/MWh)

According to Section B.6.1, the final result for calculating this project's emission reduction is the following:

ER= BE_y- PE_y= 142,866 MWh *0.660 tCO2e/MWh-0 tCO_2e =94,291 tCO_2e

B.6.4. Summary of ex ante estimates of emission reductions

Year	Baseline emissions (t CO_2e)	Project emissions (t CO_2e)	Leakage (t CO_2e)	Emission reductions (t CO_2e)
Year 1	94,291	0	0	94,291
Year 2	94,291	0	0	94,291
Year 3	94,291	0	0	94,291
Year 4	94,291	0	0	94,291
Year 5	94,291	0	0	94,291
Year 6	94,291	0	0	94,291
Year 7	94,291	0	0	94,291

Total	660,037	0	0	660,037
Total number of crediting years	7			
Annual average over the crediting period	94,291	0	0	94,291

B.7. Monitoring plan

B.7.1. Data and parameters to be monitored

Data / Parameter	$EG_{e,y}$
Unit	MWh
Description	Quantity of electricity generation supplied by the project plant/unit to the grid
Source of data	Electricity meter
Value(s) applied	
Measurement methods and procedures	Continuous measurement and at least monthly recording. Data from the electricity meters will be collected and monitored by both, the project owner and Taipower. The confirmed electricity supplied to the grid is then recorded in the electricity receipts obtained from Taipower every month.
Monitoring frequency	8 years
QA/QC procedures	Meter reading records will be crosschecked with the electricity receipts. The electricity meters will undergo maintenance/calibration according to Taiwan national standards (based on The Weight and Measures Act, Regulation no. CNMV 46, 'Technical Specification for Verification and Inspection of Electricity Meters'). In addition, electricity receipt is kept for cross reference as per ACM0002
Purpose of data	
Additional comment	

Data / Parameter	$EGi_{,y}$
Unit	MWh
Description	Quantity of electricity consumption of the project plant/unit from the grid
Source of data	Electricity meter
Value(s) applied	
Measurement methods and procedures	Continuous measurement and at least monthly recording. Data from the electricity meters will be collected and monitored by both, the project owner and Taipower. The confirmed electricity consumption is then recorded in the electricity receipts obtained from Taipower every month.
Monitoring frequency	
QA/QC procedures	Meter reading records will be crosschecked with the electricity receipts. The electricity meters will undergo maintenance/calibration according to Taiwan national standards (based on The Weight and Measures Act, Regulation no. CNMV 46, 'Technical Specification for Verification and Inspection of Electricity Meters'). In addition, electricity receipt is kept for cross reference as per ACM0002
Purpose of data	
Additional comment	

Data / Parameter	$EG_{PJ,y}$
Unit	MWh
Description	Quantity of net electricity generation supplied by the project plant/unit to the grid
Source of data	Calculated by the difference of EGe-EGi
Value(s) applied	Ex-ante estimation of net electricity delivered annually to grid: 142,866 MWh
Measurement methods and procedures	Calculated by the difference of EGe and EGi, which are measured continuously and at least monthly recording.
Monitoring frequency	8 years
QA/QC procedures	Meter reading records of EGe and EGi will be crosschecked with the electricity receipts, and calculation will be double checked and verified.
Purpose of data	
Additional comment	

B.7.2. Sampling plan

>>

(1) Monitoring Objectives:

As per ACM0002, the emission reductions achieved by the project activity will be determined ex-post through direct measurement of the amount net electricity supplied to the grid multiplied by the combined margin emission:

$ER_y = EF_{grid,CM,y} * EG_{PJ}$

Where :

$EF_{grid,CM,y}$ Combined Margin Emission Factor in year y

EG_{PJ} Net electricity delivered to grid by the Project in year y

ER_y Emission reduction in year y

As the emission factor is fixed for the whole crediting period, the aim of the monitoring is therefore only to monitor the net electricity generated using energy meters. The project proponent may use electricity from the grid for start up purpose so both electricity consumption and generation will be monitored:

$EG_{PJ,y} = EGe_{,y} – EGi_{,y}$

$EG_{PJ,y}$ Net electricity delivered to grid by the Project

$EGe_{,y}$ Electricity delivered to grid by the Project

$EGi_{,y}$ Electricity imported from grid

(2) Electricity meters:

Electricity generation ($EGe_{,y}$)

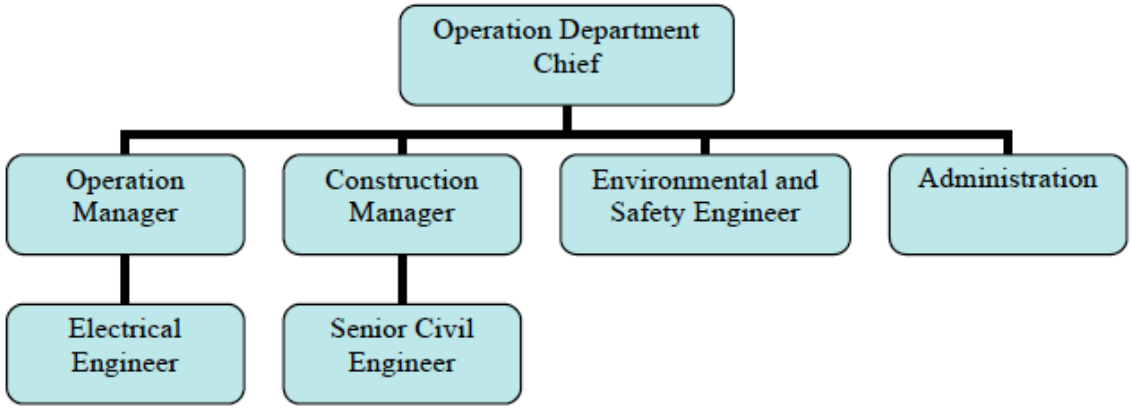
The electricity generated by the wind turbines will be transmitted to Taipower's substation in which an electricity meter is installed to record the transmitted electricity.

Electricity consumption ($EGi_{,y}$)

The wind farm needs to use electricity from grid during the turbines start up. Electricity consumptions are also recorded by Taipower.

(3) Monitoring Management

In InfraVest, the operation department is in charge of overall monitoring and operation of Guanyin project. It is the authority of project operation, maintenance, monitoring, training and report. The team will appoint specific civil engineer, electric engineer, environmental and safety experts for relevant work of proposed project. The organization chart for monitoring the meters is shown in the following:



Name	Organization	
Dr. Karl Eugen Feifel	InfraVest	Dr. Feifel is the president of InfraVest Taiwan and is responsible for overall project management.
Mr. Nils Casemir	InfraVest	Mr. Casemir is the chief of operation department of Guanyin wind farm. He is in charge of data recording

		processing and reporting for the project. The data will be either automatically recorded or manually recorder by operators. All data will be imported to Excel for validation or verification.
South Pole Carbon	South Pole	South Pole Carbon Asset Management Ltd. will provide review of reported data before they are submitted to DOE for validation or verification.

(4) Monitoring Procedures

Procedures for monitoring electricity meter

The monitoring is done according to the following procedure:

• Meter of Facility (MOF): Electricity generation and consumption are measured continuously by the Meter of Facility, which is owned by grid.

• Monthly report: the operation department of InfraVest is responsible of the followings:

1. Electricity meter reading at Taipower's substation (Meter of Facility, MOF) together with Taipower's personnel;

2. Confirmation of the bill amount;

3. Monthly generation report;

4. Invoice sending to Taipower.

• Annually, the operation department of InfraVest is responsible of:

1. Making annual report;

2. Generating the next two year's plan to Taipower.

Procedures for maintenance of monitoring equipment and installations Taipower is in charge of the

electricity meter (MOF). The electricity meters undergo maintenance/calibration according to Taiwan national standards (based on The Weight and Measures Act, Regulation no. CNMV 46, 'Technical Specification for Verification and Inspection of Electricity Meters').

Procedures for Training the staffs:

• In construction phase, the following trainings will be carried out:

1. The introduction of driven pile and planted pile.

2. The introduction for safety regulations and procedures

• In operation and maintenance phase, the following trainings will be carried out:.

1. The introduction of climbing system for windmills

2. The introduction of wind energy.

3. The introduction for SCADA operation

4. The introduction for control of wind turbines

Emergency management procedures:

Since Taipower is in charge of all electricity meter, in case of emergency, it follows management procedures as stated in the Power Supply and Engineering Regulations clause 33[16], and recalculates the amount of electricity dispatched by InfraVest based on Electricity Tariff Regulations clauses 84-88[17] and section 4 clauses 58-63.

Moreover, all emergency and disputes management procedures related to the electricity meter are regulated by Bureau of Standards, Metrology and Inspection, M.O.E.A., R.O.C. [19].

(5) Quality Assurance and Quality Control

Internal audit will be carried out to check compliance with operational procedures outlined in this monitoring plan. This internal audit will also identify potential possible adjustments for operational procedures to improve monitoring and reporting in future years.

(6) Data Storage and Filing

Electricity data from the Meter of Facility (MOF) in Taipower's substation will be recorded on paper and downloaded using the electronic device by Taipower's monitoring staff. The MOF measures

both electricity generation and consumption, both data will be recorded in the monthly and annual report. Subsequent to meter reading sessions, Taipower sends separate confirmations to InfraVest regarding amount of both generation and consumption. MOF data copies and the confirmation records will be archived for at least two years after the end of the crediting period by InfraVest.

(7) Calibration

Taipower's calibration procedures are in accordance to The Weight and Measures Act, Regulation no. CNMV 46, 'Technical Specification for Verification and Inspection of Electricity Meters'[20], governed by the Bureau of Standards, Metrology and Inspection, Ministry of Economic Affairs, Taiwan. According to Taiwan government's regulation CNMV46, the official period of validity for the electronic electricity meter in this project is defined as 8 years. However, Taipower has agreed on meter calibration in every 3 years period.

Furthermore, the accuracy class of the electricity meter (MOF) is 0.5S, which is in line with the official standarderror for this type of meter (ranging ±0.5%)

B.7.3. Other elements of monitoring plan

>>
N/A

B.8. Date of completion of application of methodology and standardized baseline and contact information of responsible persons/ entities

>>
Date of completion of application of methodology and standardized baseline:

10/03/2017

Responsible persons/ entities:

Ms.Fang Qun

South Pole Carbon Asset Management Ltd.

SECTION C. Duration and crediting period

C.1. Duration of project activity

C.1.1. Start date of project activity

>>

09/01/2009 (the date when construction contract was signed)

C.1.2. Expected operational lifetime of project activity

>>
20 years

C.2. Crediting period of project activity

C.2.1. Type of crediting period

>>
Second period of renewable crediting period

C.2.2. Start date of crediting period

>>

The first crediting period is from 18/01/2010 to 17/01/2017
The start date of second crediting period is 18/01/2017.

C.2.3. Length of crediting period

7 years

SECTION D. Environmental impacts

D.1. Analysis of environmental impacts

>>

The assessment of Environmental Impacts (EIA) of the project activity was carried out by InfraVest and was supervised by the Environmental Protection Agency (EPA). As every requirement set by the EPA was completed for the project, the project activity will start to take place.

Requirements and main conclusions of the EIA

Requirement of the EPA		Conclusion		
Physics and Chemical Environment Assessment	1. Terrain, Geology and Earth	Construction stage	No liquefaction and no other negative effects result from the wind farm construction.	
		Operation stage	No negative effects rise from the wind farm operation.	
	2. Water Quality	Construction Stage	The project is not in the water quality protection area and is in a safe distance of any source of drinking water. No pumping takes place during the operation. The waste water due to the construction will be well managed and stored in the	

			construction stage. Thus EIA reported that the construction activities will not give any negative impacts on the water quality.	
		Operation Stage	Wind farm will not produce waste water during its operation. Thus no negative effects are reported in EIA.	
	3.Waste from projects	Construction Stage	Wind farm produce few wastes during its construction. The waste management company will be commissioned to well manage these wastes. The impacts therefore considered very limited.	
		Operation Stage	During the operation phases, only 3 persons are needed to maintain 34 turbines. The impact on the waste is thus considered negligible.	
	4.Noise and Vibration	Construction Stage	The noise generated due to transportation and construction is below the standard requirement 74dB. It thus can be negligible.	
		Operation Stage	Wind turbines produce low frequency noises, but the measured values are blew the standard requirement. No vibration takes	

			place during the operation. The impact is thus considered very limited and can be negligible.	
	5. Air Quality	Construction Stage	Concerns over dust that might fly in the air during the construction phase are raised. Another impact on the air quality might be the SO2and NO2 emissions during construction. However, the emissions reported by EIA are blew the standard. Thus the impacts on air quality are very limited.	InfraVest responded that they will water the land (dust is emitted when moisture content of land is insufficient) during construction to minimize the on the air quality InfraVest commits to adopt low sulphur diesel engines to reduce the pollution during construction.
		Operation Stage	No emissions take place during the operation phase.	
	6. Animals	Construction Stage	The construction areas are not located in protected and sensitive regions. Thus,construction activities do not increase the burden of environment.	
		Operation Stage	Concerns regarding the impact of the wind farm on birds' activity is raised, but the turbines' height are below the birds' migration (flying) altitude. During landing, birds will dodge these wind turbines. Thus bird's issues are considered very limited in EIA report.	

	7. Plants	Construction Stage	By investigating, no protected or rare plants are found in the construction areas. The impacts on the plants can be negligible.	
		Operation Stage	The wind turbines and blades are higher than the plants. They will not impede the growth of plants.	
Sociology and Economy	8. Residents Characteristics	Construction Stage	The project activity will make the second industry (manufacturing) and third industry (services) more prosperous by bringing almost 50 job opportunities	
		Operation Stage		
	9.Economic Environment	Job opportunities are increased and the service industry and income of the local residents will be promoted as well		
	10. Industry Structure	The wind-farm is expected to promote tourist activities in the area and increase opportunities to the local industries. Farming will not be influenced by the project activity.		
	11. Usage of Land	Concerns over the usage of land arise from. However, the project is to develop in terms of dots not facets, meaning the distance between every turbine is considered significant and there is plenty of room for other purpose of land, if any. Basically there will be no severe impact on the usage of land. Furthermore, the turbines are built on public land, managed by the government, and it is not dedicated for agrarian or residential purposes.		
	12. Infrastructure	The employment will be mainly offered to local residents that there would not be extra demand for existing infrastructure.		
	13. Transportation: overview and traffic analysis	Impact on traffic depends on the service quality of the road during the transportation of staff, machine and material. The projectderived		

		one way traffic is 16 p.c.u[23]/hr. However, the construction period is short and the transportation will avoid the heavy hours in such extent that generally the overall impact on traffic is very limited	
Tourism Impact	14. Scenery Study and Entertainment Study	The location of these wind turbines are far from the residential areas. No any specific scenery is sited around or within these locations. Thus the impacts on the scenery and entertainment places are very limited.	
Cultural Environment	15.Excavation	No excavation found.	
	16. Ancient Buildings	No ancient buildings in the designated site have been reported.	
	17. Cultural Customs and Religions	No impact on close cultural customs and religions activities	

D.2. Environmental impact assessment

>>

There is no significant impact deriving from the project activity, to the surrounding environment.

SECTION E. Local stakeholder consultation

E.1. Solicitation of comments from local stakeholders

>>

In concern of the interests of the local stakeholders, the project owner collected opinions from the local residents during the EIA review process, and in various occasions and forms, including:

1. Local Stakeholder Consultation for Guanyin wind farm project

South Pole Carbon Asset Management Co., Ltd. invited international stakeholders through emails on 03/10/2008. Recipients of invitation included Gold Standard, local supporters of Gold Standard, Climate Group, Mercy Crops, Greenpeace and WWF in Hong Kong. Meanwhile, plant owner invited the local residents near plant site and representatives of plant staff through the invitation letters. Invitations to the local stakeholders were sent on 01/10/2008. Public Consultation Meeting was held on 17th Oct. 2008, introduction of the project was made and comments were collected. The list of the recipients is shown below:

Organisation (if relevant)	Name of invitee	Way of invitation	Date of invitation	Confirmation received?Y/N
Guan Yin Residents Representatives Association	Ou, Dao-Xin	Invitation Letter sent via Post	01-10-2008	Y

Guan Yin Township Office	Mai-Lv, Guo-Zhi	Invitation Letter sent via Post	01-10-2008	Y
Local Residents	Xu,Xiu-Bin	Invitation Letter sent via Post	01-10-2008	Y
Local Residents	Xie, Chun-Wen	Invitation Letter sent via Post	01-10-2008	Y
Local Residents	Chen, Shun-Lang	Invitation Letter sent via Post	01-10-2008	Y
Local Residents	Liao,Zhen-Jian	Invitation Letter sent via Post	01-10-2008	Y
Local Residents	Zeng, Xian-Long	Invitation Letter sent via Post	01-10-2008	Y
Local Residents	Zhuo, Sheng-Shen	Invitation Letter sent via Post	01-10-2008	Y
Local Residents	Ni, Yong-Quan	Invitation Letter sent via Post	01-10-2008	Y
Local Residents	Huang, Yuan-Ri	Invitation Letter sent via Post	01-10-2008	Y
Local Residents	Zhang, Zhao-Mei	Invitation Letter sent via Post	01-10-2008	Y
Local Residents	Peng, Shi-Gao	Invitation Letter sent via Post	01-10-2008	Y
Environmental Quality Education Foundation		Invitation Letter sent via Post	01-10-2008	Y
The Climate Group	Josh Harris	Email Invitation	03-10-2008	N
Grean Peace	Steve Sawyer	Email Invitation	06-10-2008	N
Mercy Corps	Dorothy McIntosh	Email Invitation	06-10-2008	N
WWF Hong Kong	Lim Salter	Email Invitation	06-10-2008	N
Secretariat of Gold Standard		Email Invitation	06-10-2008	N

2.Stakeholder Feedback Round

The Stakeholder Feedback Round started at the 15th of March 2009 ended and on 14th of May 2009. Invitations are sent via emails and post (for local stakeholders who attended the Local Stakeholder Consultation), and the documents related to the project are published on South Pole Carbon Asset Management Ltd., as well as SGS (DOE) official websites[25]. No comment was received via the Stakeholder Feedback Round.

3.EIA review board meetings

EPA is responsible for EIA review of the proposed project. A review board is formed, consisting of representatives from related governing departments, academia experts, and local community offices. During the small group meetings, the stakeholder comments are welcomed through inviting the local representatives, to express their opinions regarding the project. Detailed invitation record and meeting minutes are available in the latest version of EIA report (dated July 2009).

E.2. Summary of comments received

>>

1. Local Stakeholder Consultation for Guanyin wind farm project

Mr. Yong-Quan Ni, a local resident from Fu-Lin Village, Guanyin Township questioned:

InfraVest's productivity and technical maintenance plan for the proposed wind farm

Possible impact of the turbine towards signal reception for televisions

2. Stakeholder Feedback Round

No comment was received via the Stakeholder Feedback Round

3. EIA review board meeting (2009-04-07)

Guanyin Township Community Office Representative commented, the project owner has obtained approval from most of the residents in the area. He warmly welcomed the project owner to install wind turbines in Guanyin Township area.

E.3. Report on consideration of comments received

>>

The summary of the comments are list in blew:

Stakeholder Comment	Response to comment
Question on InfraVest's productivity and technical maintenance plan for the wind farm	The project owner thanked the stakeholder for the question. The proposed project applies advanced, automated monitoring system for the wind farm. Safety precautions regarding the operation are also considered to better maintain performance of the turbines, including different approach in various weather conditions, etc. Furthermore, a periodical maintenance would also be done by the experts. Reference: Local Stakeholder Consultation Report Section G
Possible impact of the turbine towards signal reception for televisions	The project owner thanked the stakeholder for the comment. Signal interference mostly is caused by the rotation of the metal rotor blade of the turbines. Yet, the blade of the wind turbines used in the proposed project is built of Fiber Reinforced Polymer (FRP) material, to minimize this affect. In addition, the location of the wind farm is considerably far from the residential area; therefore, the signal interference effect is very minimal. Reference: Local Stakeholder Consultation Report Section G
Guanyin Township Community Office	Project owner thanked the representative for the

Representative commented, the project owner has obtained approval from most of the residents in the area. He warmly welcomed the project owner to install wind turbines in Guanyin Township area.	comment. Reference: Latest version of EIA report (July 2009)

SECTION F. Approval and authorization

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N/A

Appendix 1. Contact information of project participants and responsible persons/ entities

Project participant and/or responsible person/ entity	☒ Project participant ☐ Responsible person/ entity for application of the selected methodology (ies) and, where applicable, the selected standardized baselines to the project activity
Organization name	InfraVest GmbH
Street/P.O. Box	10-2F, No. 9, Sec. 2, Roosevelt Rd.,
Building	-
City	Taipei
State/Region	Taiwan
Postcode	10094
Country	Taiwan
Telephone	+886 2 2395 4886
Fax	+886 2 2395 1580
E-mail	info@infra-vest.com
Website	http://www.infra-vest.com/
Contact person	Karl Eugen Feifel
Title	President
Salutation	Dr.
Last name	Feifel
Middle name	
First name	
Department	
Mobile	
Direct fax	
Direct tel.	
Personal e-mail	feifel@infra-vest.com

Project participant and/or responsible person/ entity	☒ Project participant ☐ Responsible person/ entity for application of the selected methodology (ies) and, where applicable, the selected standardized baselines to the project activity
Organization name	South Pole Carbon Asset Management Ltd.
Street/P.O. Box	Technoparkstr. 1
Building	/
City	Zurich
State/Region	Zurich
Postcode	8005
Country	Switzerland
Telephone	+41 44 633 78 70
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E-mail	info@southpolecarbon.com
Website	www.southpolecarbon.com
Contact person	Renat Heuberger
Title	/
Salutation	Mr.
Last name	Heuberger
Middle name	/
First name	Renat
Department	/
Mobile	/
Direct fax	+41 44 633 14 23
Direct tel.	+41 44 633 78 70
Personal e-mail	r.heuberger@southpolecarbon.com

Appendix 2. Affirmation regarding public funding

The project does not involve any ODA financing. As confirmed with the GS[1], GS projects in Taiwan have been exempted from ODA declaration. Taiwan is not an OECD member, and it is not included in the DAC list of ODA recipients. Taiwanese projects are therefore not eligible for receiving ODA funding.
There is no public funding from Annex I countries involved in the project activity.

Appendix 3. Applicability of methodology and standardized baseline

N/A

Appendix 4. Further background information on ex ante calculation of emission reductions

According to the "Tool to calculate the emission factor for an electricity system" (Version 05.0), six steps shall be applied for calculating the emission factor:

STEP 1. Identify the relevant electric system

[1] Email correspondence with Leon Wang, GS Regional Manager of China and East Asia Region, dated October 19, 2011. Please also refer to the GS Passport of Registered Project #GS612 – InfraVest Guanyin Wind Farm Project – Taiwan. The email has been provided.

A project electricity system is defined by the spatial extent of the power plants that are physically connected through transmission and distribution lines to the project activity and that can be dispatched without significant transmission constraints.

A national connected electricity system is defined as an electricity system that is connected by transmission lines to the project electricity system. Taiwan is an island with no cable connection with the continent. Thus there is not any connected electricity system in Taiwan. The spatial extent of the Project Boundary is defined as the insular electricity grid of Taiwan operated by Taipower Company.

The source of data used in calculation of OM and BM is publicly available in Taiwan:

- Energy Balances in Taiwan (from the Bureau of Energy), which give access to electricity production and fossil fuel consumption in Taiwan by sectors.

As it will be explained below, the data will be used for calculating the operating margin and the build margin.

STEP 2: Choose whether to include off-grid power plants in the project electricity system (optional)

According to "Tool to calculate the emission factor for an electricity system (Version 05.0)", project participants may choose between the following two options to calculate the operating margin and build margin emission factor:

Option I: Only grid power plants are included in the calculation.
Option II: Both grid power plants and off-grid power plants are included in the calculation.

Since option II requires collecting data on off-grid power generation, while such data is not publicly available in the region, thus the off-grid power plants are excluded from the calculation and option I is chosen.

STEP 3. Select a method to determine the operating margin (OM)

In order to calculate the Operating Margin, the emission factors of fossil fuels are listed in the following table:

Table A1 Net Calorific Values ($NCV_{i,y}$) multiplied by ($EF_{co2,i,y}$) of fossil fuel used for OM and BM calculation

Fuel Type	Emission Factor	Unit
Bituminous Coal - Steam Coal	**2.22**	tCO2/t
Sub-Bituminous Coal	**1.90**	tCO2/t
Coke Oven Gas	**0.66**	$KgCO2/M^3$
Blast Furnace Gas	**0.71**	$KgCO2/M^3$
Oxygen Steel Furnace Gas	**1.13**	$KgCO2/M^3$
Diesel Oil	**2.55**	KgCO2/L

Residual Fuel oil	**3.03**	KgCO2/L
LNG	**2.05**	KgCO2/M^3
Petroleum Coke	**2.85**	KgCO2/Kg
Natural Gas	**1.82**	KgCO2/M^3
Refinery Gas	**1.82**	KgCO2/M^3

According to the experts[2], coal should not be considered as low cost/must run. Thus only nuclear, biomass, hydro, geothermal electricity, solar photovoltaic and wind power plants are included as low-cost/must-run resources, hereafter referred as lc-mr, which turns out to be between 20.32% and 21.4% of the total electricity generation on average during years 2010 and 2014:

Table A2: Gross and Net Electricity Generation in Taiwan[3]

	Units	2010	2011	2012	2013	2014	2015
Total electricity generation	MWh	250,785,847	255,733,038	253,862,468	255,875,507	256,834,324	258,496,598
Total low-cost/must-run	MWh	53,658,833	54,138,650	54,091,229	55,750,472	52,187,634	46,847,902
Total Power plant Own Use	MWh	10,628,686	10,678,208	10,556,467	10,223,738	14,078,785	10,856,028
Total LCMR power Plant Own Use	MWh	1,645,131	1,642,496	1,584,200	1,610,638	1,630,679	1,374,739
share of LCMR	MWh	21.40%	21.17%	21.31%	21.79%	20.32%	18.12%

[2] According to Dr. Chung-Huang Huang (黃宗煌教授), a professor at Department of Economics, National Tsing Hua University, coal power plants are not 'low-cost' in calculation of Operating Margin because when evaluating the total costs of the electricity generation technologies, the external costs also have to be taken into account besides the internal costs (such as the operational cost, construction cost, etc). With the external costs included in the calculation, the total social cost (internal cost + external cost) of coal power plants is proved to be higher than that of renewable power generation. Furthermore, when the grid was going to reduce power plant operation during the lower load demand period, the coal-fired power plants are prioritized to undertake such function. Thus, coal cannot be considered as 'low-cost / must-run'.

[3] Extracted from the "Energy Balances Sheet in Taiwan", Bureau of energy,

The baseline methodology allows a choice among four methods for the calculation of OM emission factor;

1. (a) Simple OM, or
2. (b) Simple adjusted OM, or
3. (c) Dispatch Data Analysis OM, or
4. (d) Average OM

Since the average share of electricity generation by lc-mr plants for five most recent years is found to be less than 50%, option (a) is chosen. The simple OM emission factor can be calculated using either of the two data vintages:

(a) Ex-ant option: if the ex ante option is chosen, the emission factor is determined once at the validation stage, thus no monitoring and recalculation of the emission factor during the crediting period is required. For grid power plants, use a 3-year generation-weighted average, based on the most recent data available at the time of submission of the CDM-PDD to the DOE for validation. For off-grid power plants, use a single calendar year within the five most recent calendar years prior to the time of submission of the CDM-PDD for validation;

(b) Ex-post option: if the ex post option is chosen, the emission factor is determined for the year in which the project activity displaces grid electricity, requiring the emissions factor to be updated annually during monitoring. If the data required to calculate the emission factor for year y is usually only available later than six months after the end of year y, alternatively the emission factor of the previous year y-1 may be used. If the data is usually only available 18 months after the end of year y, the emission factor of the year proceeding the previous year y-2 may be used. The same data vintage (y, y-1 or y-2) should be used throughout all crediting periods.

The ex-ante option is selected to calculate the operating margin for the Project. Monitoring and recalculation of the emission factor during the second crediting period is not required.

STEP 4. Calculate the operating margin emission factor according to the selected method

The Simple OM emission factor is calculated as the generation-weighted average CO2 emissions per unit net electricity generation (tCO2/MWh) of all generating power plants serving the system, not including low-cost/must-run power plants/units.

The simple OM may be calculated by one of the following two options;

- Option A: Based on data on fuel consumption and net electricity generation of each power plant/unit, or
- Option B: Based on data on net electricity generation and the average efficiency of each power unit and the fuel types used in each power unit, or
- Option C: Based on data on the total net electricity generation of all power plants serving the system and the fuel types and total fuel consumption of the project electricity system.

Complete plant-specific data required by Options A and B are unavailable, Taipower can furnish some plant specific data but only for the power plants they operate, these numbers do not comprise all IPP for which plant specific statistics are not available.

Option C can be used, as only renewable sources and nuclear are considered as lc-mr power sources and the quantity of electricity supplied to the grid by these sources is known. According to the “Tool to calculate the emission factor for an electricity system”;

$$EF_{grid,OMsimple,y} = \frac{\sum_i FC_{i,y} * NCV_{i,y} * EF_{CO2,i,y}}{EG_y}$$

Where:

$EF_{grid,OMsimple,y}$	Simple operating margin CO2 emission factor in year y (tCO2/MWh)
$FC_{i,y}$	Amount of fuel type i consumed in the project electricity system in year y (mass or volume unit)
$NCV_{i,y}$	Net calorific value (energy content) of fuel type i in year y (GJ/mass or volume unit)
	EFco2,i,y: CO2 emission factor of fuel type i in year y (tCO2/GJ)
EG_y	Net electricity generated and delivered to the grid by all power sources serving the system, not including low-cost /must-run power plants /units, in year y (MWh)
i	All fuel types combusted in power sources in the project electricity system in year y
y	The relevant year as per the data vintage chosen in Step 3

Table A3: The total CO2 emissions by fuels of 2012, 2013 and 2014

Total Emission in 2013	tCO2	133,783,653
Total Emission in 2014	tCO2	133,471,489
Total Emission in 2015	tCO2	135,587,886

Thus the results of OM:

EF_{OM} 2012	tCO_2/MWh	0.699
EF_{OM} 2013	tCO_2/MWh	0.683
EF_{OM} 2014	tCO_2/MWh	0.670
Average EF_{OM}	tCO_2/MWh	0.690

The result of Operating Margin emission factor calculation is **0.690** tCO2e/MWh

STEP 5. Calculate the build margin (BM) emission factor

In accordance to the calculation method proposed by the Chinese NDRC[4] which was approved by CDM EB[5], since it is impossible to separate the different generation technology capacities based on coal, oil or gas fuel etc from the generic term “thermal power” in the present energy statistics, the following calculation measures is taken:

First, according to the energy statistics of the selected period in which approximately 20% capacity has been added to the grid, the ratio of CO2 emissions produced by solid, liquid, and gas fuel consumption for power generation is determined; then multiply this ratio by the respective emission factors based on commercially available best practice technology in terms of efficiency. Finally, this emission factor for thermal power is multiplied with the ratio of thermal power identified within the approximation for the latest 20% installed capacity addition to the grid. The sample group of power units chosen to calculate the build margin is therefore the set of power capacity additions in the electricity system that comprise 20% of the system capacity (in MW) that have been built most recently[6]. In terms of vintage of data, Option 1 is chosen:

For the second crediting period, build margin emission factor is updated based on the most recent information available on units already built at the time of submission of the request for renewal of the crediting period to the DOE.

The result is the BM emission factor of the grid is calculated as follows:

Sub-step 1

All emission factors of fossil fuels used in calculation of the emissions of fossil fuels are referred to the table “the emission factors of fossil fuels in Taiwan” in Step 2.

Calculate the proportion of CO2 emissions related to consumption of coal, oil and gas fuel used for power generation as compared to total CO2 emissions from the total fossil fueled electricity generation (sum of CO2 emissions from coal, oil and gas).

[4] The build margin calculations is derived from the "Bulletin on the baseline emission factor of the Chinese Electricity Grid”, which has been published by the Chinese DNA (Office of National Coordination Committee on Climate Change) on Oct. 16. 2006.
[5] This is in accordance with the request for guidance: Application of AM0005 and AMS-I.D in China, a letter from DNV to the Executive Board, dated 07/10/2005, available online at: http://cdm.unfccc.int/UserManagement/FileStorage/6POIAMGYOEDOTKW25TA20EHEKPR4DM. This approach has been applied by many registered CDM projects using methodology ACM0002 so far.
[6] Note: According to the Tool to calculate the emission factor for an electricity system (version 04.0) "If 20% falls on part of the generation of a unit, the generation of that unit is fully included in the calculation."

$$\lambda_{Coal,y} = \frac{\sum_{i \in COAL,j} F_{i,j,y} \times NCV_{i,y} \times EF_{CO2,i,j,y}}{\sum_{i,j} F_{i,j,y} \times NCV_{i,y} \times EF_{CO2,i,j,y}}$$

$$\lambda_{Oil,y} = \frac{\sum_{i \in OIL,j} F_{i,j,y} \times NCV_{i,y} \times EF_{CO2,i,j,y}}{\sum_{i,j} F_{i,j,y} \times NCV_{i,y} \times EF_{CO2,i,j,y}}$$

$$\lambda_{Gas,y} = \frac{\sum_{i \in GAS,j} F_{i,j,y} \times NCV_{i,y} \times EF_{CO2,i,j,y}}{\sum_{i,j} F_{i,j,y} \times NCV_{i,y} \times EF_{CO2,i,j,y}}$$

Fi,j,y	The amount of fuel i (in a mass or volume unit) consumed by power sources j in year y
NCVi,y	the net calorific value of fuel i in year y (GJ/t for solid and liquid fuels, GJ/m^3 for gas fuels)
EF co2,i,j,y	the CO2 emission coefficient of fuel i (tCO2/GJ)

Coal, Oil and Gas stands for solid, liquid and gas fuels respectively.

Table A4 The total CO2 emissions by fuel of 2014

	Fuel	Fuel Unit	Allocated Emission (tCO2e)	Emission (tCO2e)	
Solid	Bituminous Coal-Steam Coal	t	21,312,794	66,389,116	
	Sub-Bituminous Coal	t	686,589	25,407,523	-
	Coke Oven Gas	M3	478,445	478,445	
	Blast Furnace Gas	M3	1,230,658	1,230,658	-
	Oxygen Steel Furnace Gas	M3	169,211	169,211	
	Sub-total	-	-	93,674,952	-
	Refinery Gas	M3	12,688	12,688	72.38%
Liquid	Diesel Oil	L	0	212,925	-
	Residual Fuel Oil	L	1,129,685	5,893,831	-

	Petroleum Coke	t	619,431	619,431	-
	Sub-total	-	-	6,738,875	-
Gas	Natural Gas	M3	7,571	7,571	5.21%
	LNG	M3	136,791	28,994,678	-
	Sub-total	-	-	29,002,249	-
		-	25,783,863	129,416,076	22.41%

Data Source: Energy Balances in Taiwan-New Format by Taiwan's Bureau of Energy

Sub-step 2 Calculate the operating margin emission factor of fuel-based generation.

$$EF_{Thermal,y} = \lambda_{Coal,y} \times EF_{Coal,Adv,y} + \lambda_{Oil,y} \times EF_{Oil,Adv,y} + \lambda_{Gas,y} \times EF_{Gas,Adv,y}$$

Where

$EF_{Thermal,y}$	The weighted emissions factor of thermal power generation with the efficiency level of the best commercially available technology in Taiwan in the previous three years
$EF_{coal,Adv}$,$EF_{Oil,Adv}$,$EF_{Gas,Adv}$	the emission factors of coal, oil and gas-fired power generation with efficiency levels of the optimal commercially available technology in Taiwan in the previous three years.

The optimal efficiency and emission factors of commercialized coal-fired, oil-fired power plant are shown as below:

Type of power plant	Variables	Emission factor (tCO2e/MWh)
Coal fire power plant	$EF_{Coal,Adv}$	0.792
Gas fired power plant	$EF_{Gas,Adv}$	0.367
Oil fired power plant	$EF_{Oil,Adv}$	0.506

$$EF_{grid,BM,y} = \frac{CAP_{Thermal}}{CAP_{Total}} \cdot EF_{Thermal}$$

Where

CAPtotal	the total capacity addition of the selected period in which close but not lower to 20%

capacity has been added to the grid

CAPthermal the total thermal power capacity addition of the selected period in which approximately 20% capacity has been added to the grid

The below is shown the installed capacity of Taiwan Power Grid.

	Installed capacity in 2002 (MW)	Installed capacity in 2015 (MW)	Newly added installed capacity from 2002 till 2014 (MW)	Proportion against newly added installed capacity
Hydro	4,422.0	4,652.4	230.4	2.162%
Nuclear	5,144.0	5,144.0	0.0	0.000%
Thermal	27,829.0	36,638.6	8,809.6	82.662%
Renewable Energy	611.8	2,229.2	1,617.4	15.176%
Total	38,006.8	48,664.2	10,657.4	100.00%

The result of Build Margin emission factor calculation is **0.570** tCO2e/MWh.

Step 6. Calculate the combined margin emissions factor

The Baseline Emission Factor is calculated as a Combined Margin, using the weighted average of the Operating Margin and Build Margin.

$$EF_{grid,CM,y} = w_{OM} \cdot EF_{grid,OM,y} + w_{BM} \cdot EF_{grid,BM,y}$$

Where:

wOM Weighting of operating margin emissions factor (per cent)

wBM Weighting of build margin emissions factor (per cent)

The operating margin emission factor (EFgird,OM,y) of Taiwan is 0.690 tCO2e/MWh and the build margin emission factor is 0.570 tCO2e/MWh. The defaults weights for wind power are used as specified in the emission factor tool:

wOM=0.75; wBM=0.25

The result of the Baseline Emission Factor calculation is 0.660 tCO2e/MWh.

Data and parameters available at validation

Data / Parameter	EGy
Unit	MWh
Description	The net electricity generation excluding the low-cost must-run (2011-2015)
Source of data	Energy Balances in Taiwan
Value(s) applied	See Annex 2 Step 2 Table A2
Justification of the choice of data or description of measurement methods and procedures actually applied	Net electricity generated and delivered to the grid by all power sources serving the system, not including low-cost/must-run power plants/units
Any comments	

Data / Parameter	FCi,y
Unit	Ton, litre or 1000m3
Description	Total amount of fuel type I consumed by power plants/units in year y
Source of data	Energy Balances in Taiwan
Value(s) applied	
Justification of the choice of data or description of measurement methods and procedures actually applied	Fuel consumption breakdown by power plant/unit is unavailable, total consumption amounts are published annually.
Any comments	

Data / Parameter	NCVi,y
Unit	GJ/mass or volume unit
Description	Net calorific value of fuel type i in year y
Source of data	GHG Emission Factor Inventory
Value(s) applied	

Justification of the choice of data or description of measurement methods and procedures actually applied	
Any comments	The Bureau of Energy provides directly emission factor y unit of mass or volume in which is equal to the product of NCVi,y and EF co2,i,y

Data / Parameter	EFco2,i,y
Unit	tCO2/GJ
Description	CO2 emission factor of fossil fuel type i in year y
Source of data	Bureau of Energy, Ministry of Economic Affairs
Value(s) applied	See Annex 2 Step 1 Table A1
Justification of the choice of data or description of measurement methods and procedures actually applied	
Any comments	The BoE provides directly emission factor by unit of mass or volume in which is equal to the product of NCVi,y and EF co2,i,y

Data / Parameter	EFgrid,CM,y
Unit	tCO2e/MWh
Description	Combined Emission factor
Source of data	Calculated
Value(s) applied	0.660
Justification of the choice of data or description of measurement methods and procedures actually applied	The Baseline Emission Factor is calculated as Combined Margin, using the weighted average of the operating margin and build margin
Any comments	The emission of the build and operating margin are calculated according to the ex-ante option.

Appendix 5. Further background information on monitoring plan

Please refer to Sec.B.5 for more details

Appendix 6. Summary of post registration changes