Project design document form for CDM project activities

(Version 05.0)

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	SSE1 Solar PV 1 – 10 Power Plant Project
Version number of the PDD	1
Completion date of the PDD	25/05/2015
Project participant(s)	Siam Solar Energy 1 Co.,Ltd.
Host Party	Thailand
Sectoral scope and selected methodology(ies), and where applicable, selected standardized baseline(s)	Sectoral scope 01 : Energy Industries (renewable/non-renewable sources) Methodology : ACM0002 version 16.0
Estimated amount of annual average GHG emission reductions	80,487 tCO2e/year

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

>> The proposed project activity entails the installation of ten solar power plants, separated in two phases. The project activity is based on solar photovoltaic technology bundled with a total installed capacity of 104.7 MW. Each project activity has different installed electricity generation capacity and an individual connection to the grid (subject to individual Power Purchase Agreements (PPA) with the Provincial Electric Authority (PEA) of Thailand). The project activities are located in Kanchanaburi and Suphanburi provinces of Thailand. The total expected electricity exported to the grid is about 148,477 MWh per year. The bundled project activity is expected to reduce 80,487 tCO_2e per annum, which would have been otherwise emitted to the atmosphere by fossil fuel based power plants connected to the Thai national grid.

The project activities are developed in parallel by the same mother company Siam Solar Energy 1 Co.,Ltd. (SSE). This entity is responsible for implementation and operation of the Solar Photovoltaic (PV) power plants. The details of each project activities are presented in Table 1 and Table 2.

Table 1 : SSE PV plant phase 1

Site	Location	Install Capacity (MW)
SSE1-PV1-05	Kanchanaburi	10.5
SSE1-PV2-06	Suphanburi	10.4
SSE1-PV3-07	Suphanburi	10.5
SSE1-PV4-08	Suphanburi	10.4
SSE1-PV5-09	Suphanburi	10.4

Table 2 : SSE PV plant phase 2

Site	Location	Install Capacity (MW)
SSE1-PV6	Kanchanaburi	10.504
SSE1-PV7	Kanchanaburi	10.510
SSE1-PV8	Kanchanaburi	10.506
SSE1-PV9	Suphanburi	10.504
SSE1-PV10	Suphanburi	10.505

The bundled project activity will contribute to the sustainable development in Thailand as follows:

Environmental benefits
By generating electricity through solar power, the project activities displace fossil fuel based electricity from the Thai national grid. Thereby, the bundled project activity contributes to the reduction of pollutants such as NO_x, SO_x and particles as well as greenhouse gas (GHG) emissions.

Social benefits
The project activity leads to alleviation of poverty by establishing direct and indirect employment related to the manufacturing of local components, the civil construction of the solar power plants

and operation of the same. The infrastructures in and around the project area will also be improved due to the presence of the project activities.

Economic benefits

The bundled project activity leads to significant investments in a rural and underdeveloped region, which would rarely occur in the absence of the project activities. The project activities will reduce fossil-fuel imports (improving Thailand's trade balance), support Thailand's transformation to a low carbon economy, expand the reach of Thailand's renewable energy development policy and make better use of Thailand's natural resources. The project activities provide also job opportunities and fosters income generation in Thailand related to the construction, operation and maintenance of the solar power plants.

Technological benefits

The solar PV based electricity generation systems implemented under the bundled project activity represents a cutting-edge, environmentally safe and sound technology. The project activities contribute to technology transfer, the promotion of clean energy technologies and foster the creation of a local renewable energy industry in Thailand.

A.2. Location of project activity

A.2.1. Host Party

>> Thailand

A.2.2. Region/State/Province etc.

>>
PV-1 : Kanchanaburi Province
PV-2 : Suphanburi Province
PV-3 : Suphanburi Province
PV-4 : Suphanburi Province
PV-5 : Suphanburi Province
PV-6 : Kanchanaburi Province
PV-7 : Kanchanaburi Province
PV-8 : Kanchanaburi Province
PV-9 : Suphanburi Province
PV-10: Suphanburi Province

A.2.3. City/Town/Community etc.

>>
PV-1 : Boploy District
PV-2 : Donjaedee District
PV-3 : Nongyasai District
PV-4 : Doem Bang Nang Buad District
PV-5 : Doem Bang Nang Buad District
PV-6 : Danmakhamtia District
PV-7 : Tamuang District
PV-8 : Panomtuan District
PV-9 : U thong District
PV-10: Samchuk District

A.2.4. Physical/Geographical location

>>

PV1- N: 14 19'52.24" E: 099 28'27.00"
PV2- N: 14 38'09.57" E: 099 53'29.27"
PV3- N: 14 46'27.09" E: 099 57'05.56"
PV4- N: 14 52' 04.90" E: 099 49' 46.96"
PV5- N: 14 52' 04.90" E: 099 49' 46.96"
PV6- N 13 49’ 33.48” E 99 25’ 23.89”
PV7- N 13 55’ 2.9” E 99 24’ 0.8”
PV8- N 14 13’ 01.74” E 99 44’ 10.89”
PV9- N 14 24’ 9.48” E 99 49’ 53.44”
PV10- N 14 44’ 33.22” E 100 08’ 10.81

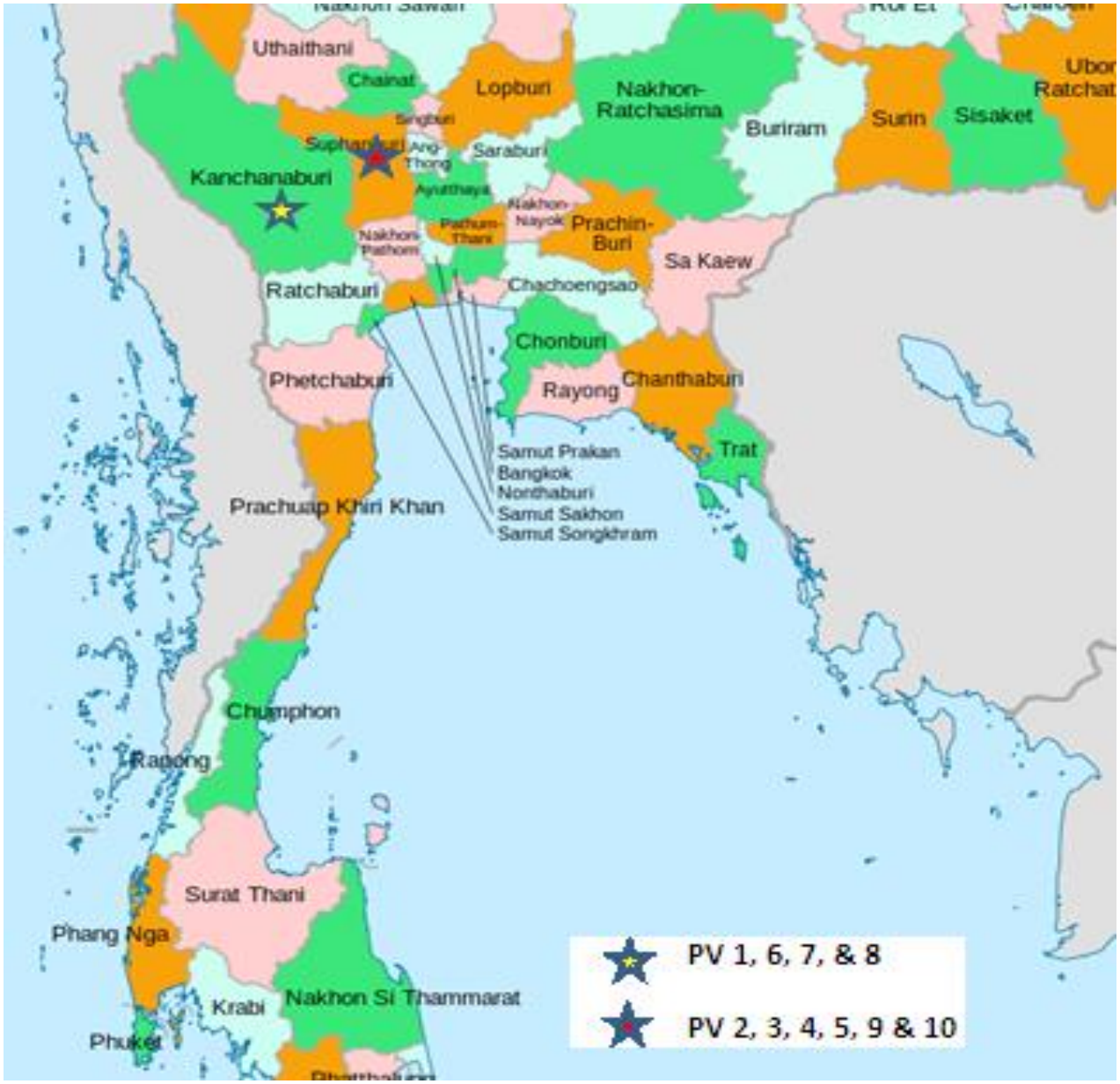
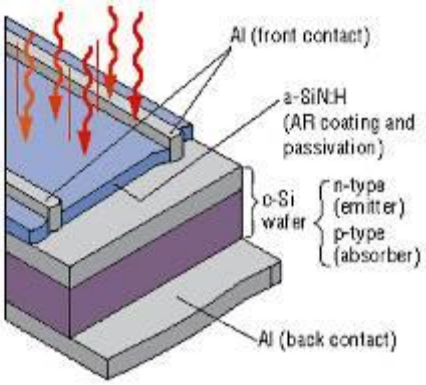


Figure 1 : Project Locations

A.3. Technologies and/or measures

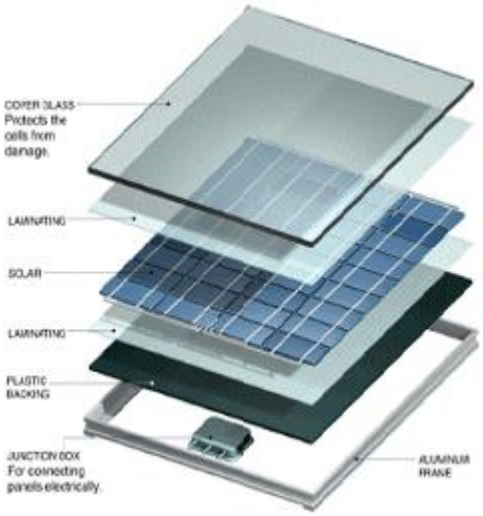
>> The technology applied in the project activities is the solar thin film photovoltaic or PV technology. This type of PV solar modules employ a very thin layer of semiconductor—usually just a couple of millionths of a meter (microns) thick—in place of a traditional silicon wafer.



Crystalline Silicon (c-Si) Photovoltaic Cell Construction

Source: SST Pennant.com

A typical thin-film solar panel consists of the semiconductor and several other thin films bonded to a sheet of glass, covered by another sheet of glass and sealed in with an industrial laminate.



The array of PV module will convert the solar radiation into direct current electricity or DC by using semiconductors, which exhibit the photovoltaic effect. The grid-controlled solar inverter transforms the DC into Alternating Current electricity or AC for exporting to the National Grid.

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)
Thailand	Siam Solar Energy 1 Co.,Ltd.	No
Switzerland	Swiss Carbon Value Ltd.	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

>> ACM0002: Grid-connected electricity generation from renewable sources, version 16.0

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

a) "Tool to calculate the emission factor for an electricity system";
b) "Tool for the demonstration and assessment of additionality";
c) "Combined tool to identify the baseline scenario and demonstrate additionality";
d) "Tool to calculate project or leakage CO2 emissions from fossil fuel combustion";
e) "Tool to determine the remaining lifetime of equipment"
f) "Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period".

Above tools and methodologies can be found on the following site:
http://cdm.unfccc.int/methodologies/index.html

B.2. Applicability of methodology and standardized baseline

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

a) Install a Greenfield power plant;
b) Involve a capacity addition to (an) existing plant(s);
c) Involve a retrofit of (an) existing operating plants/units;
d) Involve a rehabilitation of (an) existing plant(s)/unit(s); or
e) Involve a replacement of (an) existing plant(s)/unit(s).

Of the above-mentioned applicability conditions, the project activity falls under (a) and therefore the methodology is applicable to the project activity.

The methodology is also applicable under the following conditions ;

	Methodology Requirements	Project Applicability
1	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;	The proposed project activity is the installation of solar power plants in Thailand and hence meets this criterion.
2	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	Not relevant to the project activity as the project does not involve the capacity additions, retrofitting or replacements.

	undertaken between the start of this minimum historical reference period and the implementation of the project activity.	
3	In case of hydro power plants, one of the following conditions shall apply: (a) The project activity is implemented in existing single or multiple reservoirs, with no change in the volume of any of the reservoirs; or (b) The project activity is implemented in existing single or multiple reservoirs, where the volume of the reservoir(s) is increased and the power density calculated using equation (3), is greater than 4 W/m2 ; or (c) The project activity results in new single or multiple reservoirs and the power density, calculated using equation (3), is greater than 4 W/m2 ; or (d) The project activity is an integrated hydro power project involving multiple reservoirs, where the power density for any of the reservoirs, calculated using equation (3), is lower than or equal to 4 W/m2 , all of the following conditions shall apply: (i) The power density calculated using the total installed capacity of the integrated project, as per equation (4), is greater than 4 W/m2 ; (ii) Water flow between reservoirs is not used by any other hydropower unit which is not a part of the project activity; (iii) Installed capacity of the power plant(s) with power density lower than or equal to 4 W/m2 shall be: a. Lower than or equal to 15 MW; and b. Less than 10 per cent of the total installed capacity of integrated hydro power project.	Not relevant as the project does not involve the implementation of hydro power plants.
4	In the case of integrated hydro power projects, project proponent shall: - Demonstrate that water flow from upstream power plants/units spill directly to the downstream reservoir and that collectively constitute to the generation capacity of the integrated hydro power project; or - Provide an analysis of the water balance covering the water fed to power units, with all possible combinations of reservoirs and without the construction of reservoirs. The purpose of water balance is to demonstrate the requirement of specific combination of reservoirs constructed under CDM project activity for the optimization of power output. This demonstration has to be carried out in the specific scenario of water availability in different seasons to optimize the water flow at the inlet of	Not relevant as the project does not involve the implementation of hydro power plants.

	power units. Therefore this water balance will take into account seasonal flows from river, tributaries (if any), and rainfall for minimum five years prior to implementation of CDM project activity	
5	The methodology is not applicable to: (e) 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; (f) Biomass fired power plants/units	Not relevant as the project activity installed solar power plants and does not involve fuel switching.
6	In the case of retrofits, rehabilitations, replacements, or capacity additions, this methodology is only applicable if the most plausible baseline scenario, as a result of the identification of baseline scenario, is "the continuation of the current situation, that is to use the power generation equipment that was already in use prior to the implementation of the project activity and undertaking business as usual maintenance".	Not relevant as the project does not involve the retrofits, rehabilitations, replacements, or capacity additions.

B.3. Project boundary

The project boundary of the project activities is described in the figure below. The project boundary includes the renewable energy generating units and the power plants connected to the Thai national grid.

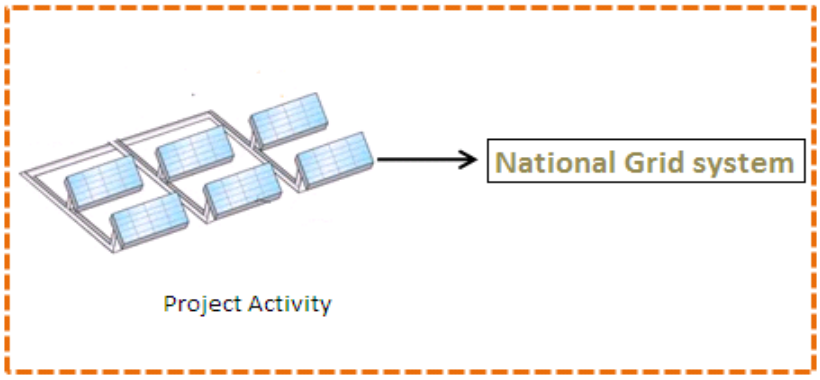


Figure 2 : Project Boundary

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	CO_2	Yes	Main emission source: substitution of electricity produced by the national grid. Electricity has been produced using mix of fossil intensive fuels.
		CH_4	No	Excluded for simplification
		N_2O	No	Excluded for simplification
Project scenario	For geothermal power plants, fugitive emissions of CH4 and CO2 from noncondensable gases contained in geothermal steam	CO_2	No	Excluded since the project does not involve geothermal thermal power plant.
		CH_4	No	Excluded since the project does not involve geothermal thermal power plant.
		N_2O	No	Excluded since the project does not involve geothermal thermal power plant.
	CO2 emissions from combustion of fossil fuels for electricity generation in solar thermal power plants and geothermal power plants	CO_2	No	Excluded since the project does not involve solar thermal power plant.
		CH_4	No	Excluded since the project does not involve solar thermal power plant.
		N_2O	No	Excluded since the project does not involve solar thermal power plant.
	For hydro power plants, emissions of CH_4 from the reservoir	CO_2	No	Excluded since the project does not involve hydro power plant.
		CH_4	No	Excluded since the project does not involve hydro power plant.
		N_2O	No	Excluded since the project does not involve hydro power plant.

B.4. Establishment and description of baseline scenario

>> As per paragraph 23 of the methodology:

> *"If the project activity is the installation of a Greenfield power plant, the baseline scenario is 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".*

Given the project activities have been implemented in Greenfield locations, the baseline scenario is the electricity delivered to the grid by the project activities that would have been installed. The details on emission factor can be found in Annex 3.

B.5. Demonstration of additionality

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The additionality of the project activity is demonstrated and assessed using the latest version of the "Tool for the demonstration and assessment of additionality".

Prior consideration

Although, there is no requirement under Gold Standard voluntary scheme on the prior consideration, the following time line of each project has been displayed for a transparency purpose.

Event	PV 1	PV 2	PV 3	PV 4	PV 5
Power Purchase Agreement (Project start date)	10/04/2012	10/04/2012	10/04/2012	10/04/2012	10/04/2012
EPC contract signing date	18/09/2012	05/11/2012	18/09/2012	05/11/2012	05/11/2012
Construction permit	12/11/2012	31/10/2012	05/09/2012	25/10/2012	25/10/2012
Service with Swiss Carbon	30/11/2012	30/11/2012	30/11/2012	30/11/2012	30/11/2012
Expected Commissioning date	10/02/2013	10/02/2013	10/02/2013	10/02/2013	10/02/2013

Event	PV 6	PV 7	PV 8	PV 9	PV 10
Power Purchase Agreement (Project start date)	25/07/2013	25/07/2013	25/07/2013	25/07/2013	25/07/2013
EPC contract signing date	04/01/2013	04/01/2013	30/05/2013	04/01/2013	30/05/2013
Construction	07/10/2013	07/10/2013	07/10/2013	07/10/2013	07/10/2013
Expected Commissioning date	10/02/2013	10/02/2013	10/02/2013	10/02/2013	10/02/2013
Service with Swiss Carbon	15/01/2014	15/01/2014	15/01/2014	15/01/2014	15/01/2014

Additionality

According to the guidance on the investment analysis, if the proposed project activity and the alternatives generate no financial or economic benefits other than CDM related income, then apply the simple cost analysis. Otherwise, use the investment comparison analysis or the benchmark analysis. Since the project generates financial and economic benefits other than CDM related income, the simple cost analysis is not appropriate. Since, the alternative to the project activity is the supply of electricity from a grid, the benchmark approach is considered appropriate and used for additional demonstration of the proposed CDM project activity as per a suggestion from paragraph 19 of the 'Guideline of investment analysis, version 5'.

Sub-step 3c: Calculation and comparison of financial indicators

Benchmark analysis

The investment analysis has been done over a period of 25 years as suggested by "Tool to determine the remaining lifetime of equipment, version 1" and the desired crediting period. The input values have been sourced from the project proponent, and all of the supportive documents will be provided to the DOE for validation.

As instructed in the paragraph 12 of the Guidelines on the Assessment of Investment Analysis, version 05, Annex 5, EB 62, "Local commercial lending rates or weighted average costs of capital (WACC) are appropriate benchmarks for a project IRR". The project activity involves both equity and debt component. Hence, the cost of financing has been derived based upon weighted average of the cost of debt and the cost of equity of the proposed project activity.

The project participant applies the following WACC equation to estimate the required return on capital as a benchmark for the project IRR:

$$WACC = \frac{E}{V} * \mathrm{R}_e + \frac{D}{V} * \mathrm{R}_d * (1 - T_c)$$

Where:
Re : Cost of equity
Rd : Cost of debt
E : Amount of equity in the project
D : Amount of debt in the project
V : Total investment cost
Te : Average enterprise tax rate

Determining the cost of equity

In financial theory, the cost of equity is the return that required from a project on the equity portion apart from the debt, which could be determined by using the Capital Asset Pricing Model (CAPM). CAPM is one if the method to determine the return of a security or a portfolio equals the rate on a risk-free security plus risk premium. If the expected return does not meet the required return, then the investment should not be undertaken. The model takes into account the asset's sensitivity to non-diversifiable risk (also known as market risk), often represented by the quantity beta in the financial industry, as well as the expected return of the market and the expected return of a theoretical risk-free asset.

The model describes the relationship between risk and time value of money as follow:

$$R_e = R_f + \beta_L * R_{m,premium}$$

Where:
Re : Cost of equity for the same type of the project activity
Rf : Risk free rate
β : Beta of security for the same type of the project activity

Rm,premium : Market risk premium (country risk + equity market risk)

It is apparent from the above equation that the expected return from a security is the return of a risk-free investment plus Beta times the difference between the expected market return and the return from the risk-free investment (termed as market risk premium). Hence, CAPM justifies that the expected return of an investor should be commensurate with higher expected risk of the investment.

In accordance, in order to apply CAPM, the following estimations are needed

- Rf : Risk Free rate
The risk free return on a security that is considered free from default risk and is uncorrelated with returns from anything else in the economy. The rate on a long-term average returns of US treasury Bonds (nominal values) have been used.

- Rm,premium : Market Risk Premium
The market risk premium can be estimated using a base equity risk premium and a country risk premium. The total market risk premium for Thailand from Stern School of Business, New York University has been used.

- β:L : Beta
Beta, compared with the base equity risk premium, shows the amount of compensation equity investors need for taking on additional risk for the particular type of project. The total Beta for the power industry market from Stern School of Business, New York University has been used.
Hence, the Equity benchmark for the proposed project activity shall be equal to:

For PV1-5

Indicator	Value	Source
Rf	2.77%	Long-term average returns of US treasury Bonds (nominal value) for 10April 2012 (Project start date).
β	1.46	Source: Stern School of Business at New York University in 2011 for power business
Rm,premium	8.25%	Source: Stern School of Business at New York University in 2011 for Thailand
Equity IRR benchmark	14.82%	Calculation: 2.77+8.25*1.46

For PV6-10

Indicator	Value	Source
Rf	2.11%	Long-term average returns of US treasury Bonds (nominal value) for 10April 2012 (Project start date).
β	1.46	Source: Stern School of Business at New York University in 2011 for power business
Rm,premium	8.25%	Source: Stern School of Business at New York University in 2011 for Thailand
Equity IRR benchmark	14.16%	Calculation: 2.11+8.25*1.46

Determining the cost of debt

The cost of debt is the prevailing interest rate at the time of making the investment decision for a long-term loan. The cost of debt is taken as the minimum lending rate for the investment decision time period. This information is available in the public domain, as it is published rate by the public

bank of host country. Cost of debt for this case is taken as ***7.61%*** and ***7.60%*** which were the average MLR in Thailand.

Project benchmark (WACC)

WACC is calculated using the following data:

For PV 1 – PV 5

Parameters	Value
% of total investment Equity financed	50% (Default)
% of total investment Debt financed	50% (Default)
Cost of equity	14.83
Cost of debt (Average MLR 10 Apr 2012)	7.61
Cooperate tax rate	30%
WACC	10.07%

For PV 6 – PV10

Parameters	Value
% of total investment Equity financed	50% (Default)
% of total investment Debt financed	50% (Default)
Cost of equity	14.16
Cost of debt (Average MLR 10 Apr 2012)	7.60
Cooperate tax rate	30%
WACC	9.74%

Since the project IRR has been calculated on a pre-tax basis, the (post-tax) WACC benchmark has to be converted to a pre-tax figure accordingly:

$$WACC_{pre-tax} = WACC_{post-tax} / (1 - T_c)$$

Therefore,

	PV 1 - 5	PV 6 - 10
WACC pre-tax	14.39%	13.91

Determining Project IRR

Project IRR calculation for each project activity has been done separately and for the projects, it is below the benchmark. The detailed calculations will be provided during the validation of the project activity.

B.6. Emission reductions

B.6.1. Explanation of methodological choices

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Approved large-scale consolidated baseline and monitoring methodology ACM 0002, version 16.0.0, sectoral scope 01 “Large Scale Consolidated baseline methodology for grid-connected electricity generation from renewable sources”. The justification of their applicability has already been demonstrated in section B.2.

According to ACM0002 version 16.0.0, emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y$$

Where:

ER_y	=	Emission reductions in year y (tCO2)
BE_y	=	Baseline emissions in year y (tCo2)
PE_y	=	Project emission in year y (tCO2)
LE_y	=	Leakage emission in year y (tCO2

Baseline emissions

Baseline emissions include only CO_2 emissions from electricity generation in fossil fuel fired power plants that are displaced due to the project activity. The methodology assumes that all project electricity generation above baseline levels would have been generated by existing grid-connected power plants and the addition of new grid-connected power plants. The baseline emissions are to be 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 calculation of $EG_{PJ,y}$ is different for Greenfield plants, capacity additions, retrofits, rehabilitations, and replacements. Since the project activity is the Greenfield solar power plans, the equation below is chosen.

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

Where:

$EG_{facility,y}$	=	Quantity of net electricity generation supplied by the project plant/unit to the grid in year *y* (MWh/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)

Project emissions

For most renewable energy power generation project activities, $PE_y = 0$. However, some project activities may involve project emissions that can be significant. These emissions shall be accounted for as project emissions by using the following equation:

$$PE_y = PE_{FF,y} + PE_{GP,y} + PE_{HP,y}$$

Where:

PE_y = Project emissions in year *y* (tCO_2e/yr)

$PE_{FF,y}$ = Project emissions from fossil fuel consumption in year *y* (tCO_2/yr)

$PE_{GP,y}$ = Project emissions from the operation of geothermal power plants due to the release of non-condensable gases in year *y* (tCO_2e/yr)

$PE_{HP,y}$ = Project emissions from water reservoirs of hydro power plants in year *y* (tCO_2e/yr)

Given that the project activity is a solar power plant and there is no use of any fossil fuels, project emissions are assumed to be zero.

Leakage emissions

No leakage emissions are considered.

B.6.2. Data and parameters fixed ex ante

Data / Parameter	The percentage share of total installed capacity of the specific technology
Unit	%
Description	The percentage share of total installed capacity of the specific technology in the total installed grid connected power generation capacity in the host country.
Source of data	National statistics or other official data
Value(s) applied	2.9
Choice of data or Measurement methods and procedures	The National's published data : Energy in Thailand facts & Figures Q1-Q3 / 2014 (http://www4.dede.go.th/dede/images/stories/stat_dede/sit_57/Fact&Figure%20Q1-Q3_2014.pdf) The install capacity of Solar is 1,287.85 MW from 4,485 MW of all renewable power generation capacity. The renewable part is accounting for 10.1% of total power capacity in Thailand.
Purpose of data	-
Additional comment	

B.6.3. Ex ante calculation of emission reductions

>>

The baseline emissions are to be 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 detailed calculations are provided in the emission reduction calculations excel sheets.

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	8,624	0	0	8,624
Year 2	67,779	0	0	67,779
Year 3	81,527	0	0	81,527
Year 4	80,962	0	0	80,962
Year 5	80,725	0	0	80,725
Year 6	79,880	0	0	79,880
Year 7	79,339	0	0	79,339
Total	**478,836**	**0**	**0**	**478,836**
Total number of crediting years	**7**			
Annual average over the crediting period	**80,847**	**0**	**0**	**80,487**

B.7. Monitoring plan

B.7.1. Data and parameters to be monitored

Data / Parameter	$EG_{facility,y}$
Unit	MWh/y
Description	Quantity of net electricity generation supplied by the project activities to the national grid in year y
Source of data	Electricity invoices
Value(s) applied	For ex-ante estimation
Measurement methods and procedures	The net electricity will be measured continuously with electricity meters recording both the amount of electricity exported and imported to/from the grid by the project plant. Net electricity will be calculated by subtracting total imported electricity from total exported electricity.
Monitoring frequency	Electricity will be measured continuously and recorded monthly.

Project Site	Output MWh/y	2013 1	2014 2	2015 3	2016 4	2017 5	2018 6	2019 7
PV1-05	14,740	4,913	14,549	14,432	14,302	14,174	14,046	13,920
PV2-06	15,060	5,647	14,984	14,909	14,815	14,761	14,687	14,614
PV3-07	14,740	2,457	14,549	14,432	14,302	14,714	14,046	13,920
PV4-08	15,062	1,255	14,987	14,912	14,837	14,763	14,689	14,616
PV5-09	15,062	1,255	14,987	14,912	14,837	14,763	14,689	14,616
PV6	14,795		8,630	14,691	14,588	14,486	14,385	14,284
PV7	14,793		11,095	14,689	14,586	14,484	14,383	14,282
PV8	14,740		8,598	14,585	14,483	14,382	14,282	14,181
PV9	14,746		11,059	14,643	14,540	14,438	14,337	14,237
PV10	14,740		8,598	14,584	14,482	14,380	14,280	14,180
Total	**148,477**	**15,528**	**122,037**	**146,789**	**145,773**	**145,346**	**143,824**	**142,850**

QA/QC procedures	Electricity meters shall be calibrated according to the manufacturing standard or as per the regulation.
Purpose of data	For baseline emission calculation
Additional comment	Data shall be kept 2 years further at the end of the crediting period.

Data / Parameter	$EF_{grid,CM,y}$
Unit	tCO_2/MWh
Description	Combined margin CO2 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"
Source of data	Thai Greenhouse Gas Organization http://www.tgo.or.th/english/index.php?option=com_content&view=article&id=178:thailand-grid-emission-2010-report&catid=50:tgos-research-projects&Itemid=40
Value(s) applied	0.5554
Measurement methods and procedures	The combined margin CO2 emission factor for the Thailand grid is published by the DNA of Thailand.
Monitoring frequency	To be updated for every verifications
QA/QC procedures	Cross-checked with the latest version of National Published Data available
Purpose of data	Baseline emission calculation
Additional comment	

B.7.2. Sampling plan

>> N/A

B.7.3. Other elements of monitoring plan

>> N/A

B.7.4. Date of completion of application of methodology and standardized baseline and contact information of responsible persons/ entities

>>
25 May 2015, Ms. Nattaya Lonawan
n.lonawan@thesouthpolegroup.com

SECTION C. Duration and crediting period

C.1. Duration of project activity

C.1.1. Start date of project activity

>> 18th September 2012 , the date that EPC contracts were signed for SSE-PV01 and PV03.

C.1.2. Expected operational lifetime of project activity

>> 25 years

C.2. Crediting period of project activity

C.2.1. Type of crediting period

>> Renewal

C.2.2. Start date of crediting period

>> 17th July 2013 – date when SSE1-PV02 commissioned and started exporting electricity to the grid.

C.2.3. Length of crediting period

>> 7 years

SECTION D. Environmental impacts

D.1. Analysis of environmental impacts

>> In accordance with the Ministry of Science and Technology "Notification on type and size of project or enterprise that must report an environmental impact assessment" dated 16 June 2009 and published in the Government Gazette dated 31 August 2009; solar PV projects are not designated as a project type required to complete an Environmental Impact Assessment (EIA).

However, according to the Code of Practice in applying for operating license under Factory Act 1992 , the power plant with install capacity between 5 to 10 MW , has to submit the Environmental & Safety Assessment (ESA). The project has conducted the ESA of each sub-project by following the Notification from Department of Industry Work on Reporting of Environmental & Safety Assessment 2009 and the same have been submitted and approved by government agency as well.

D.2. Environmental impact assessment

>> If environmental impacts are considered significant by the project participants or the host Party, the project shall provide conclusions and all references to support documentation of an environmental impact assessment undertaken in accordance with the procedures as required by the host Party. The environmental impact of using solar energy is varied. The main concern with a Solar Farm involves the adverse effects on surrounding wildlife and the ecosystem. With solar energy farms in generally arid regions, plants and animals must adapt to very specific harsh environments. However, all of the solar farms are not located in the natural sensitive area otherwise it would not have secured the permit from both local and national authority. Therefore, it is not required an extensive environmental impact assessment according the regulation.

SECTION E. Local stakeholder consultation

E.1. Solicitation of comments from local stakeholders

>> The stakeholder consultation has been conducted separately for each sub-project of the bundle at the local as follows:

Project Site	Date	Meeting Location Subdistrict , District , Province
PV01	6th , 10th and 17th Sep 2012	Chongdhan , Bo Ploy District , Kanchanaburi
PV02	11th Sep , 10th Oct , 14th Oct and 25th Oct 2012	Srakrajome , Donchedi , Suphanburi
PV03	8th Aug , 10th Aug and 15th Aug 2012	Nongyasai , Nongyasai , Suphanburi
PV04	23rd Sep , 27th Sep (site visit at L-Solar Project) , 30th Sep and 5th Oct 2012	Nongkratoom , Dermbangnangboud , Suphanburi
PV05	23rd Sep , 27th Sep (site visit at L-Solar Project) , 30th Sep and 5th Oct 2012	Nongkratoom , Dermbangnangboud , Suphanburi
PV06	28th Jan and 4th Feb 2013	Nongpai , Dhan Makamtia , Kanchanaburi
PV07	16th and 17th Dec 2012	Rangsali , Tha Muong , Kanchanaburi
PV08	4th Apr and 3rd May 2013	Rangwhai , Panomtuon , Kanchanaburi
PV09	20th Dec 2012 and 18th Jan 2013	Nhong Aong , U-Thong , Suphanburi
PV10	18th and 20th Mar 2013	Wang Luek , Samchuke , Suphanburi

Sample of meeting evidence is provided below.

การศึกษาผลกระทบสิ่งแวดล้อมเบื้องต้น

โครงการโรงผลิตไฟฟ้าพลังงานแสงอาทิตย์ขนาด 8 เมกะวัตต์

สิงหาคม 2555

รายชื่อผู้เข้าร่วมรับฟังการบรรยาย ประชาสัมพันธ์และสร้างความรู้ความเข้าใจ "โครงการโรงผลิตไฟฟ้าพลังงานแสงอาทิตย์ขนาด 8 เมกะวัตต์ "

วันที่ 6 **เดือน** ก.ย. **พ.ศ.** 2555 10 ก.ย. 2555

ลำดับ	รายชื่อ	ตำแหน่ง	ที่อยู่	ลายมือชื่อ	เบอร์โทรศัพท์
1	วรรณพร [illegible]	กรรมการ	23 หมู่ 4 ต.ช่องด่าน		
2	[illegible]	-	268/1 หมู่ 4 ต.ช่องด่าน	กรรณพร	081-1334126
3	[illegible]	[illegible]	254/1 ม.4 ต.ช่องด่าน	[illegible]	081-2205961
4	[illegible]	ผู้ช่วย	16/2 ม.4 ต.ช่องด่าน	[illegible]	080-0212899
5	[illegible]			[illegible]	086-1765942
6	[illegible]		281/1 ม.4 ต.ช่องด่าน		
7.	[illegible]	[illegible]	74 ม.4 ต.ช่องด่าน	[illegible]	089-9131651
	[illegible]	ผู้ช่วยผู้ใหญ่บ้าน	27/1 ม.4 ต.ช่องด่าน	[illegible]	081-9218035
	[illegible]	จ.อบต.	268/1 ม.4 ต.ช่องด่าน	[illegible]	
				[illegible]	

ขอรับรองว่าการลงลายมือชื่อข้างต้น เข้าร่วมรับฟังการบรรยายด้วยความสมัครใจ

(ลงชื่อ) [illegible] (จนท.อบต.) (ลงชื่อ) [illegible] (ผู้ใหญ่บ้าน/ผู้ประสานงาน)

(..................................) (..................................)

Nature Nine

1-

E.2. Summary of comments received

>> Please refer to GS passport for further details.

E.3. Report on consideration of comments received

>> Please refer to GS passport for further details.

SECTION F. Approval and authorization

>>

All the projects have received operation licences and are currently under operation.

- - - - -

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	Siam Solar Energy 1 Co.,Ltd.
Street/P.O. Box	
Building	Maleenont Tower 16th Floor
City	Bangkok
State/Region	Klongtan/Klongtoey
Postcode	10110
Country	Thailand
Telephone	662 661-2701
Fax	662 661-2705
E-mail	
Website	
Contact person	
Title	Director
Salutation	
Last name	Maleenont
Middle name	
First name	Cathleen
Department	
Mobile	
Direct fax	
Direct tel.	
Personal e-mail	

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	Swiss Carbon Value Ltd.
Street/P.O. Box	Technoparksrasse 1
Building	
City	Zurich
State/Region	
Postcode	8005
Country	Switzerland
Telephone	+41 43 501 35 50
Fax	+41 43 501 35 99
E-mail	registration@southpolecarbon.com
Website	www.thesouthpolegroup.com
Contact person	

Title	
Salutation	
Last name	Heuberger
Middle name	
First name	Renat
Department	
Mobile	
Direct fax	
Direct tel.	
Personal e-mail	

Appendix 2. Affirmation regarding public funding

No public funding is used under the proposed project activities

Appendix 3. Applicability of methodology and standardized baseline

Not required. The information given in section B above is sufficient.

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

The emission factor of electricity generation can be calculated by Methodological Tool (Version 02.2.1) "Tool to calculate the emission factor for an electricity system" that was approved by the CDM Executive Board on 29 September 2011 (EB 63, Annex 19).
The parameters of this methodological tool are listed below

Parameter SI Unit Description	EF y,CM,grid	tCO2
/MWh Combined margin CO2 emission factor for the project electricity system	in year y	EFy,OM,grid
tCO2	/MWh Operating margin CO2 emission factor for the project electricity system	in year y
EF y,BM,grid	tCO2	/MWh Build margin CO2 emission factor for the project electricity system in

The calculated emission factor can be used for the calculation of emission reductions of CDM projects that generate and transmit electricity to the Thai national grid or replace electricity consumption from the Thai national grid.

Identification of the electricity system

In Thailand, the electricity transmission line system is considered as a single grid system due to the transmission lines are networked all of the country area. Electricity Generating Authority of Thailand (EGAT) regulate electricity generation and main transmission system, meanwhile Metropolitan Electricity Authority (MEA) is responsible for electricity distribution system in Bangkok and vicinity area, and Provincial Electricity Authority (PEA) is responsible for electricity distribution system in the rest of country.

Method to determine the operating margin emission factor

The calculation of the operating margin (OM) emission factor (EFgrid,OM,y) is based on the one of the following methods:

1) Simple OM
2) Simple adjusted OM
3) Dispatch Data Analysis OM
4) Average OM

According to Thailand's data, the Simple OM method (ex ante option) is the most appropriate method that requires the latest 3 years data including the quantity of electricity generation, fuel types and fuel consumption of each fuel type. In this study, used the electricity statistic data in the years 2008 – 2010 due to as the following:

1. In Thailand, the electricity data that generate and transmit to the national grid system are available. While, the off-grid electricity data are not available.
2. The low-cost-must-run (LCMR) power plants include hydropower and renewable power plants. The quality of electricity that was generated by LCMR, constitute less than 50% of the total grid generation in average of the 5 most recent years (in the years 2006 – 2010_. Therefore, LCMR data are not included in the OM calculation.

The operating margin emission factor can be calculated by the equation (1), follows with the Simple OM (option B)

$$EF_{grid,OMsimple,y} = \frac{\sum_i \left(FC_{i,y} \times NCV_{i,y} \times EF_{CO_2,i,y}\right)}{EG_y} \quad (1)$$

$EF_{grid,OMsimple,y}$	=	Simple operating margin CO_2 emission factor in year *y* (tCO_2/MWh)
$FC_{i,y}$	=	Amount of fossil 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 fossil fuel type *i* in year *y* (GJ/mass or volume unit)
$EF_{CO_2,i,y}$	=	CO_2 emission factor of fossil fuel type *i* in year *y* (tCO_2/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 fossil fuel types combusted in power sources in the project electricity system in year *y*
y	=	The relevant year as per the data vintage chosen

The Net Calorific Value (NCV) is obtained from data that provided by Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy. The CO2 emission factor of fossil fuel follows IPCC default values in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. The values of CO2 emission from combustion of fossil fuel (per unit of fossil fuel) are shown in Table 1.

Table 1 Net Calorific Value and CO_2 emission per unit of each type of fossil fuel

Fuel type [A]	Unit	Net Calorific Value [1] (MJ/Unit)	CO_2 Emission [2] (tCO_2/TJ)	CO_2 Emission ($kgCO_2$/Unit)
Natural Gas	scf.	1.02	54.30	0.0554
Lignite	ton	10,470.00	90.90	951.7230
Bituminous	ton	26,370.00	89.50	2,360.1150
Bunker	liter	39.77	75.50	3.0026
Diesel	liter	36.42	72.60	2.6441

[1] Electric Power in Thailand 2010, Department of Alternative Energy Development and Efficiency, Ministry of Energy

[2] IPCC default values at the lower limit as provide in Table 1.4 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories

[A] See Table: Comparison of name of fuel type

The quantity of electricity was generated and transmitted to the national grid can be obtained from the Electricity Statistic Annual Report 2008 – 2010 that provided by EGAT. The quantity of electricity generation data is categorized by electricity generation system, group of power producer (EGAT, IPP and SPP) and type of power plant (LC/MR and Non LC/MR) as shown in Table 2. And the data of type and quantity of fossil fuel consumption in electricity generation are categorized by type of power producer (EGAT, IPP and SPP) as shown in Table 3.
VSPP is the renewable power plant such as biogas, biomass, hydropower, wind power and solar power which install the capacity equal or less than 10 MW and is considered as LC/MR power plant. However, VSPP power plants are non-firm and can supply only a small quantity of electricity to the national grid compared to other power plants. In year 2010, the quantity of electricity was generated by VSPP power plants, was supplied to the distribution system of PEA was 1,155.10 GWh (0.72% of the total electricity was generated in 2010)

Thus, this study does not include quantity of electricity that was generated an supplied by VSPP in the calculation. The total quantity of electricity was transmitted to the national grid (only Non LC/MR) in the years 2008 – 2010 was 424,913.67 GWh.

Table 2 Quantity of electricity was generated and transmitted to the national grid [4]

Generation System	Grid Generation (GWh)				
	EGAT	IPP	SPP	Total	%
2010					
Summary	78,517.70	67,775.98	13,897.27	160,190.96	100.00
Non LC/MR	73,185.41	67,775.98	11,642.33	152,603.73	95.26
LC/MR [5]	5,332.30	–	2,254.94	7,587.23	4.74
Thermal	27,289.03	15,408.42	2,162.89	44,860.34	
Combined-Cycle	38,338.71	52,367.56	8,655.76	99,362.04	
Gas Turbine	276.30	–	823.67	1,099.97	
Diesel Engine	3.98	–	–	3.98	
Hydropower	5,325.20	–	23.64	5,348.84	
Renewable Energy	7.10	–	2,231.30	2,238.40	
Electricity Import	7,277.39	–	–	7,277.39	
2009					
Summary	66,488.10	64,840.72	13,971.37	145,300.19	100.00
Non LC/MR	59,541.66	64,840.72	11,811.42	136,193.80	93.73
LC/MR	6,946.44	–	2,159.95	9,106.39	6.27
Thermal	23,463.69	12,388.03	2,225.63	38,077.35	
Combined-Cycle	33,164.46	52,452.69	8,752.19	94,369.35	
Gas Turbine	309.63	–	833.60	1,143.23	
Diesel Engine	1.44	–	–	1.44	
Hydropower	6,941.74	–	23.97	6,965.71	
Renewable Energy	4.70	–	2,135.98	2,140.68	
Electricity Import	2,602.43	–	–	2,602.43	
2008					
Summary	63,719.02	67,420.14	14,092.83	145,232.00	100.00
Non LC/MR	56,791.19	67,420.14	11,904.81	136,116.14	93.72
LC/MR	6,927.83	–	2,188.03	9,115.86	6.28
Thermal	26,778.89	14,398.34	1,996.83	43,174.06	
Combined-Cycle	26,449.20	53,021.80	9,029.90	88,500.90	
Gas Turbine	659.33	–	878.07	1,537.41	
Diesel Engine	2.30	–	–	2.30	
Hydropower	6,926.02	–	28.77	6,954.79	
Renewable Energy	1.81	–	2,159.26	2,161.07	
Electricity Import	2,901.47	–	–	2,901.47	

[4] Electricity Statistic Annual Report 2008 – 2010, Electricity Generating Authority of Thailand

[5] LC/MR power plants include hydropower and renewable energy (including biomass, solar and geothermal power)

Table 3 Amount of fossil fuel consumed by power plants [6]

Fuel type	Unit	Fuel Consumption			
		EGAT	IPP	SPP	Total
2010					
Natural Gas	scf.	430,662,249,446	491,131,955,423	151,290,468,150	1,073,084,673,019
Lignite	ton	16,043,174	–	–	16,043,174
Bituminous	ton	–	3,646,898	1,855,262	5,502,160
Bunker	liter	140,084,467	87,347,782	5,797,497	233,229,746
Diesel	liter	11,865,427	10,853,795	1,307,336	24,026,558
2009					
Natural Gas	scf.	369,146,214,392	459,228,417,361	140,550,086,056	968,924,717,809
Lignite	ton	15,818,265	–	–	15,818,265
Bituminous	ton	–	3,645,721	1,840,527	5,486,248
Bunker	liter	111,039,065	38,180,874	8,797,506	158,017,445
Diesel	liter	12,140,891	–	1,685,046	13,825,937
2008					
Natural Gas	scf.	340,739,529,461	490,866,999,785	145,410,364,035	977,016,893,281
Lignite	ton	16,407,465	–	–	16,407,465
Bituminous	ton	–	3,711,791	1,866,776	5,578,567
Bunker	liter	247,441,682	93,212,260	9,555,452	350,209,394
Diesel	liter	6,792,039	43,698,832	1,451,087	51,941,958

[6] Electricity Statistic Annual Report 2010, Electricity Generating Authority of Thailand

Table 4 shows the calculated CO2 emission from electricity generation in the years 2008 - 2010 categorized by type of fossil fuel. The total emissions during the 3-years period were 254,714,130 tCO2. The OM emission factor was calculated by the equation (1) and follows with the Simple OM method option B (ex ante option) that is shown in Table 5. The OM emission factor is 0.5994 tCO2/MWh.

Table 4 Quantity of CO_2 emission was emitted from electricity generation in the years 2008 - 2010

Fuel type	Fuel Consumption		CO_2 Emission ($kgCO_2$/Unit)	CO_2 Emission ($kgCO_2$)
	Unit	Volume		
2010				
Total				88,452,088
Natural Gas	scf.	1,073,084,673,019	0.0554	59,433,868
Lignite	ton	16,043,174	951.7230	15,268,658
Bituminous	ton	5,502,160	2,360.1150	12,985,730
Bunker	liter	233,229,746	3.0026	700,304
Diesel	liter	24,026,558	2.6441	63,528
2009				
Total				82,178,673
Natural Gas	scf.	968,924,717,809	0.0554	53,664,864
Lignite	ton	15,818,265	951.7230	15,054,607
Bituminous	ton	5,486,248	2,360.1150	12,948,176
Bunker	liter	158,017,445	3.0026	474,469
Diesel	liter	13,825,937	2.6441	36,557
2008				
Total				84,083,369
Natural Gas	scf.	977,016,893,281	0.0554	54,113,058
Lignite	ton	16,407,465	951.7230	15,615,362
Bituminous	ton	5,578,567	2,360.1150	13,166,060
Bunker	liter	350,209,394	3.0026	1,051,551
Diesel	liter	51,941,958	2.6441	137,339

Table 5 Operating Margin Emission Factor (Ex ante option)

Year	CO_2 Emission (tCO_2)	Grid Consumption (GWh)	OM Emission Factor (tCO_2/MWh)
2010	88,452,088	152,603.73	0.5796
2009	82,178,673	136,193.80	0.6034
2008	84,083,369	136,116.14	0.6177
Summary	254,714,130	424,913.67	0.5994

Method to determine the build margin emission factor

The group of power units is used for calculating the build margin (BM) emission factor which can be determined following with the option 1 (ex ante) and condition (b):

"(b) Determine the annual electricity generation of the project electricity system, excluding power units registered as CDM project activities (AEGtotal, in MWh). Identify the set of power units, excluding power units registered as CDM project activities, that started to supply electricity to the gird most recently and that comprise 20% AEGtotal (if 20% falls on part of the generation of a unit, the generation of that unit is fully included in the calculation) (SET≥20%) and determine their annual electricity generation (AEGSET≥20%, in MWh)"

The group of power units that supply electricity to the grid most recently (sorted by the Commercial Operation Date (COD) which is the date when the power unit starts to supply electricity to the grid) and their annual quantity of electricity generation comprise larger than or equal to 20% of total annual electricity generation (in year 2010) are shown in Table 6. And fuel consumption of these power units are shown in Table 7.

Table 6 Quantity of electricity was generated by the most recently built power plants [7]

Power Unit	Grid Generation [7] (GWh)	COD
1. North Bangkok Power Plant (Unit 01)	1,584.22	19-Nov-10
2. Bangpakong Power Plant (Unit 05)	4,643.22	16-Sep-09
3. Phu Kieaw Bio Power Project 2	79.46	15-Sep-09
4. Dan Chang Bio Power Project 2	76.75	15-Sep-09
5. South Bangkok Power Plant (Unit 03)	4,431.92	1-Mar-09
6. Chana Power Plant (Unit 01)	5,090.02	15-Jul-08
7. Ratchaburi Power Company Limited (RPCL) (Unit 1&2)	7,124.72	1-Jun-08
8. Gulf Power Generation Co., Ltd. (Unit 1&2)	9,903.93	1-Mar-08
Summary	32,934.25	
Percentage as of 2010 Grid Generation (160,190.96 GWh)	20.56	

[7] Electricity Statistic Annual Report 2010, Electricity Generating Authority of Thailand

Table 7 Fuel consumptions of the most recently built power plants as listed in Table 6 [8]

Fuel type	Fuel Consumption		CO_2 Emission ($kgCO_2$/Unit)	CO_2 Emission (tCO_2)
	Unit	Volume		
Total				
Natural Gas	scf.	251,512,881,819	0.0554	13,930,292
Lignite	ton	–	951.7230	–
Bituminous	ton	–	2,360.1150	–
Bunker	liter	–	3.0026	–
Diesel	liter	1,179,772	2.6441	3,119

[8] Electricity Statistic Annual Report 2010, Electricity Generating Authority of Thailand

Table 8 Calculation of the build margin emission factor

Year	CO_2 Emission (tCO_2)	Grid Consumption (GWh)	BM Emission Factor (tCO_2/MWh)
2010	13,933,412	32,934.25	0.4231

As shown in Table 6, the annual quantity of electricity generation that generated by the most recently built power units which comprise 32,934.25 GWh (20.56% of the total electricity generated in year 2010 which is 160,190.96 GWh). As shown in Table 7, the CO2 emission of the most recently built power units is emitted from fossil fuel consumption which comprise 20,991,690 tonCO2.
As shown in table 8, the BM emission factor that calculated by the equation (1), is 0.4231 tCO2/MWh

Method to determine the combined margin emission factor

The combined margin (C) emission factor can be calculated by the equation (2):

$$EF_{grid,CM,y} = \left(EF_{grid,OM,y} \times w_{OM}\right) + \left(EF_{grid,BM,y} \times w_{BM}\right) \quad (2)$$

$EF_{grid,CM,y}$	=	Combined margin CO_2 emission factor in year y (tCO_2/MWh)
$EF_{grid,OM,y}$	=	Operating margin CO_2 emission factor in year y (tCO_2/MWh)
$EF_{grid,BM,y}$	=	Build margin CO_2 emission factor in year y (tCO_2/MWh)
w_{OM}	=	Weighting of operating margin emission factor
w_{BM}	=	Weighting of build margin emission factor

The weighting of OM emission factor and BM emission factor for calculate CM emission factor is categorized by type of CDM project, as shown in Table 9.

Table 9 Weighting of operating and build margin emissions factor for general CDM projects and wind and solar power generation CDM projects

CDM project type	W_{OM}	W_{BM}
General project	0.50	0.50
Wind and solar power generation project	0.75	0.25

The CM emission factors that were calculated by the equation (2) follow with the Methodological Tool (Version 02.2.1) “Tool to calculate the emission factor for an electricity system” are shown in Table 10. The CM emission factor of general CDM project is 0.5113 tCO2/MWh and the CM emission factor of wind and solar power generation project is 0.5554 tCO2/MWh.

Table 10 Calculation of combined margin emission factor

CDM project type	Emission Factor (tCO_2/MWh)		
	$EF_{grid,OM}$	$EF_{grid,BM}$	$EF_{grid,CM}$
General project	0.5994	0.4231	0.5113
Wind and solar power generation project	0.5994	0.4231	0.5554

Reference Table Comparison of name of fuel type from the various reports

Report [9]	DEDE [10] (Thailand)	IPCC [11]
Natural Gas	Natural Gas (Dry)	Natural Gas
Lignite	Lignite (Mae Moh)	Lignite
Bituminous	Coal Import	Other Bituminous Coal
Bunker	Fuel Oil	Residual Fuel Oil
Diesel	Diesel	Diesel Oil

[9] The study of emission factor for electricity generation of Thailand in year 2010

[10] Electric Power in Thailand 2010, Department of Alternative Energy Development and Efficiency, Ministry of Energy

[11] 2006 IPCC Guidelines for National Greenhouse Gas Inventories

Appendix 5. Further background information on monitoring plan

Not required. The information given under section B above is sufficient.

Appendix 6. Summary of post registration changes

Not applicable

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