COMPONENT PROJECT ACTIVITY DESIGN DOCUMENT FORM (F-CDM-CPA-DD)
Version 02.0

COMPONENT PROJECT ACTIVITIES DESIGN DOCUMENT (CPA-DD)

SECTION A. General description of CPA

A.1. Title of the proposed or registered PoA

Standard Bank Renewable Energy Programme
Current version number of the PoA-DD: 3.0
Date the PoA-DD was completed: 27/09/2012

A.2. Title of the CPA

Standard Bank Renewable Energy Programme – Navrongo solar CPA001
Current version number of the CPA-DD: 3.0
Date the CPA-DD was completed: 27/09/2012

A.3. Description of the CPA

The proposed CPA to be implemented under the PoA framework consists in a grid-connected electricity generation plant/unit from renewable energy according to the following matrix scenario:

	Type of implementation scenario		
Type of renewable energy	Greenfield	Retrofit or replacement of an existing plant	Capacity addition to an existing plant
Hydropower			
Wind power			
Solar power	**X**		

The purpose of proposed CPA is to implement and operate a solar power plant.
The CPA's installed capacity is 1.92 MWp. The net annual electricity generation is estimated at 3,183 MWh. The power output is exported to the national grid of Ghana.

Volta River Authority acts as a CPA implementer for the proposed CPA.

A.4. Entity/individual responsible for CPA

Volta River Authority, hereafter referred to as "VRA", is the responsible project owner and implementer of CPA.

The Volta River Authority (VRA) was established on April 26, 1961 under the Volta River Development Act, Act 46 of the Republic of Ghana, as a body corporate with the mandate to operate mainly as a power generation, transmission and distribution utility. In 2005, following the promulgation of a major amendment to the VRA Act in the context of the Ghana Government Power Sector Reforms, the VRA's mandate has now been largely restricted to generation of electricity. The transmission function has been hived off into a separate entity, designated National Grid Company to perform the transmission activities. During this process of transition, the VRA is planning to operate its distribution agency, the Northern Electricity Department (NED) as a subsidiary company to merge with the Electricity Company of Ghana into a single distribution utility after the transmission period. The amendment has a key function of creating the requisite environment to attract independent power producers (IPPs) onto the Ghana energy market. VRA has other responsibilities in furtherance of its corporate mandate. These include Lake

Transportation, Tourism, Maritime administration of the Volta Lake, Lakeside Health and Management of the Akosombo Township.

VRA as an electrical power producer does not have any particular obligations or incentives regarding the construction and operation of renewable energy power plant. Even though the first two major power plants in Ghana were hydroelectric plants (Akosombo and Kpong), since the 1980s all new power plants have been fossil fuel fired. Indeed it is more profitable now to operate such plants, especially natural gas fired, since important amounts of natural gas have been discovered offshore Ghana.

A.5. Technical description of the CPA

Project technology (Solar Photovoltaic)

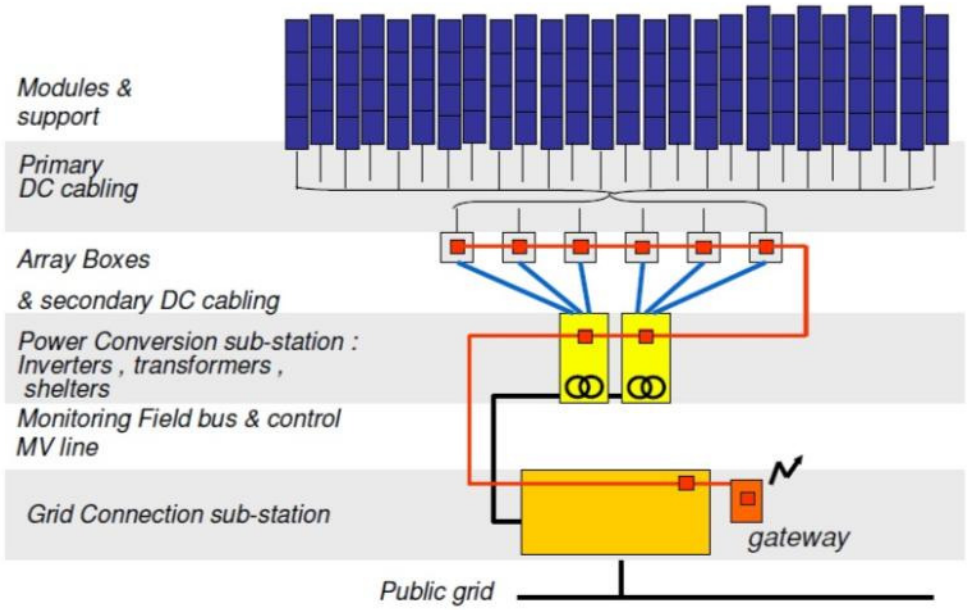

Figure 1 : *Solar PV power plant system overview*

The Solar PV electricity generation unit will constitute the following equipment:

- PV modules and support.
- Primary DC cabling
- Array Boxes & Secondary DC cabling
- Power Conversion sub-station: inverters, transformers, shelters
- Monitoring Field bus & Control MV line
- Grid Connection sub-station

Table 1: *Project equipment manufacturer's specifications*[1]

	Unit	*Specification*
Annual solar irradiation in optimal plane of modules without any shadow	kWh/m²/y	5.53 (kWh/m$^{2/}$day)
Installed capacity of the plant	MWp	1.92
Grid connection distance	km	10
Net electricity generation measured at the output substation	MWh / year	3,183
Diesel Generator utilization	-	none

[1] Source: Technical information provided to the DOE / "Load factor of solar projects in Upper East and upper West Region.pdf" page 10

Performance ratio	-	78
Number of PV modules	-	6,930
Watt-peak of one PV module	Wp	280
Number of inverters	-	4
Power of inverters	kW	500
PV array	(fixed or tracking)	fixed
Monitoring equipment	-	Electricity meters at substation
Average lifetime	years	20-25

Baseline Scenario

As justified in section D.4, the baseline scenario is a continuation of the current practise, i.e. 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.

The facilities, systems and equipment generating electricity in the existing/baseline scenario compose the National Interconnected Transmission System (NITS) as detailed in D.6.1 and reflected in the corresponding calculation of the the combined margin (CM) emission factor.

The existing scenario prior to the implementation of the CPA does not need to be described as identical to the baseline scenario.

A.6. Party(ies)

Name of Party involved (host) indicates a host Party	**Private and/or public entity(ies) CPA implementer(s) (as applicable)**	**Indicate if the Party involved wishes to be considered as CPA implementer (Yes/No)**
Republic of Ghana (host)	Volta River Authority (Public entity)	No

A.7. Geographic reference or other means of identification

Table 2: *Location of the project activity implemented under the CPA*

Administrative Region	**Administrative District**	**Administrative Town**	**Site address**	**GPS coordinates[2]**
Upper East	Kassena Nankana East	Navrongo	Pungu Telania (4.77 ha size of land)	10°55'28.10"N 01° 03'24.90"W 10°55’ 36.50 N 01°03’ 16.80”W 10° 55’ 28.50” N 01° 03’ 10.60” W

[2] Source: PV Power Plant Layout Plan-Navrongo.pdf

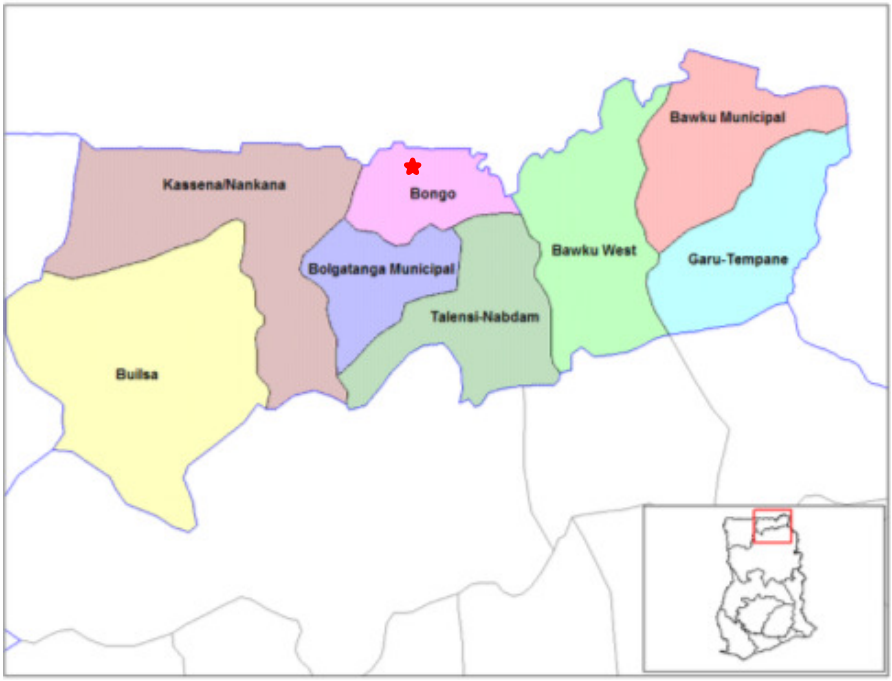

Figure 2 : *Location of the solar PV electricity generation unit*

A.8. Duration of the CPA
A.8.1. Start date of the CPA

22/05/2012

The starting date of the CPA has been determined as the date of order of the equipment, which is after the start of PoA validation in accordance with the *Glossary of CDM terms*.

A.8.2. Expected operational lifetime of the CPA

The expected operational lifetime of the CPA is about 20 – 25 years.

A.9. Choice of the crediting period and related information

Renewable crediting period

A.9.1. Start date of the crediting period

01/01/2013 (expected implementation date), or on the date of inclusion of the CPA in the PoA, whichever is later.

A.9.2. Length of the crediting period

7 years (i.e. 120 months), renewable twice.

A.10. Estimated amount of GHG emission reductions

Emission reductions during the crediting period	
Years	**Annual GHG emission reductions (in tonnes of CO_2e) for each year**
2013	1,074
2014	1,074
2015	1,074
2016	1,074
2017	1,074
2018	1,074
2019	1,074
Total number of crediting years	7
Annual average of the estimated reductions over the crediting period (tCO2)	1,074
Total estimated reductions (tonnes of CO_2e)	7,515

A.11. Public funding of the CPA

No public funding is involved - according to the OECD definitions for Official Development Assistance (ODA).

A.12. Confirmation for CPA

The CME review has confirmed that the CPA is not registered or under validation under the Clean Development Mechanism of the UNFCCC or any voluntary scheme as a single CDM project activity or as a CPA under another PoA.

CPA implementer has confirmed to the CME that the CPA is uniquely identified and defined in an unambiguous manner by amongst other aspects providing geographic information (GPS coordinates).

SECTION B. Environmental analysis

B.1. Analysis of the environmental impacts

The environmental regulations that the solar power projects have to comply with are set out in the Environmental Assessment Regulations 1999 (paragraph 5. (1) and 6)).

Therefore a Preliminary Environmental Assessment will be carried out for the proposed project activity in compliance with the laws of Ghana. This procedure has started in March 2012 with the selection of an Environmental Consulting firm by the project proponent to undertake the study in accordance with the adequate terms of reference. The Preliminary Environmental Report has been submitted to the EPA on August 18th 2012.[3]

[3] The letter confirming the receipt of the Preliminary Environmental Report has been provided to the DOE.

B.2. Environmental impact assessment

It is expected that the conclusions of EIA will confirm that there are no significant negative impacts related to the construction and operation of the solar power plant except landownership and land-use. Other impacts will be minimal and temporary[4].

The issuance of the Environmental Permit by the Ministry of Environment is expected on October 2012.

SECTION C. Local Stakeholders comments

C.1. Solicitation of comments from local stakeholders

Procedure followed to invite stakeholder comments

The stakeholder consultation consisted of a public meeting with the identified stakeholders at Navrongo on 18/01/2012.

Local stakeholders were invited through post mailing addressed to:

- Paramount Chiefs
- Districts assemblies
- Local committees
- Members of Parliament
- Neighbour institutions and industries
- Media

Radio announcements were also performed in English and in the local language over 5 days prior to the meeting date.

Program of the public meetings

Venue	**Navrongo**
Date	18/01/2012
Attendance	75
Language	English
Meeting procedure	- Introduction - Objectives of public consultation - Project description - Environmental/CDM and socio-economic impacts - Questions and answers from participants - Conclusion - *Refreshment*

[4] The Preliminary Environmental Report submitted to the EPA in August 2012 has been provided to the DOE.

Figure 3: *Picture of the public meeting*

Lists of participants:

The original attendance sheets are available for the DOE.

C.2. Summary of comments received

Navrongo - Compilation of the Comments Received	
Local stakeholder hearing held on 18 January 2012 in Navrongo	
Questions asked	**Answers provided**
1. Comment on the use of electricity generated by the solar power plant: The participant was referring to a project which was introduced in the region in the late 90's / early 2000. The project was based on solar home systems and was not implemented successfully. His concern was mainly how the replacement of materials in the household would be assured in the future in order to enable the households to use electricity generated from Navrongo PV Plant.	VRA could assure the participants that the technology sought to be implemented differs from the approach mentioned in this concern. Whereas solar home systems (isolated) require additional equipment like batteries in the homes, Navrongo PV Plant will be directly connected to the grid. Since the customers already receive their electricity from the grid, they will continue to receive their electricity as usual also in the future. The PV plant will contribute to improved electricity supply and more grid stability in the Upper East Region. If a product ever fails due to a manufacturing defect, we will repair the product, without charge, or replace it, at our discretion. This warranty does not cover damage caused by accident, improper care, negligence, normal wear and tear, or the natural breakdown of colors and materials over

Navrongo - Compilation of the Comments Received	
Local stakeholder hearing held on 18 January 2012 in Navrongo	
Questions asked	**Answers provided**
	extended time and use. Damage not covered under warranty will be repaired for a reasonable rate and return shipping will be charged.
2. Comment on the sustainability of the project: The participant had concerns regarding the sustainability of the project with regard to the maintenance of the project. He was also referring to the solar home system project that was not successfully implemented in the late 90's / early 2000.	VRA informed the participants that the Navrongo PV Plant will be under the operation of VRA. VRA will be responsible for the maintenance and will train staff accordingly in order to assure reliable operation and maintenance of the Navrongo PV Plant.
3. Comment on grid reliability and climate change mitigation due to the solar power plant: The Dean of the Engineering University of Development Studies raised several concerns. On the one hand, he stated concerns regarding the reliability of the grid which will provide the electricity generated from the PV plant and would thus prefer an individual off-grid solution for each home. On the other hand, he doubted the positive climate impact due to only marginal savings from the combustion of fossil fuels. Moreover, he asked why VRA is not focusing on electricity generated from biofuels.	The participants were informed that improvements on the grid are already on-going in order to strengthen the network for the connection of the PV plant and according reliable energy supply. [Linus] Regarding the preference for solar home systems, the participants were informed that solar home systems require batteries as storage in order to supply electricity when no sun is shining, e.g. during the night. This is not the case if a PV plant is grid-connected. The same amount of electricity which will be provided from the PV plant would have to be provided otherwise from a fossil-fuelled power plant. Purchase of fossil fuel is expensive and fuel combustion causes high greenhouse gas emissions which are causing climate change. This will be avoided with the PV plant. Moreover, since Navrongo PV plant is amongst the first generation stations in the North of the country, it provides stability to the grid. It will also lead to a significant reduction in transmission losses, since the electricity does not have to be transmitted any more via long distances from the South to the North. Moreover, the specific losses related to the consumed amount of electricity are reduced which is furthermore a climate-friendly effect considering that a significant share of the electricity sent-out is being contributed by thermal power stations.

Navrongo - Compilation of the Comments Received	
Local stakeholder hearing held on 18 January 2012 in Navrongo	
Questions asked	**Answers provided**
4. Comment on local employment opportunities: A university representative considers the project as a good project. It is pleaded that the sustainability aspect is taken seriously. The university is working on a project in applied physics and encourages VRA to consider graduates from the University for Training and employment on the Navrongo PV Plant.	VRA confirms that it is envisaged to consider staff from the region. Integration in technical know-how transfer and local employment shall be achieved by the project activity.
5. Comment on the benefit of capacity addition to the grid by means of the solar power plant: The participants learned in the stakeholder hearing that the PV plant is grid connected and the electricity will come from the grid as it is currently the case. One participant asked for the actual benefit of the capacity addition.	There are several benefits of the capacity addition from the PV plant in the context of electricity supply. The generation capacity will contribute to a more reliable electricity supply for the customers in the Navrongo Region. Moreover, the plant will contribute to the stability of the grid which facilitates to reduce transmission losses. In addition to this, there will still be the possibility to feed electricity generated from the PV plant into the grid if there are certain power plant outages down in the South. Without the PV plant, there would also be no electricity in the Navrongo Region under these circumstances.
6. Comment on the technical lifetime of the solar power plant: The participants learned that the lifetime of the Navrongo PV Plant is 25 years. One participant asked what happens thereafter.	It is common practice that power plants are rehabilitated after the end of their technical lifetime. In the case of a PV plant, e.g. the PV modules and other parts of the equipment are exchanged. This is also anticipated from the current point of view for Navrongo PV plant, i.e. it is expected that it is operating much longer than 25 years.
7. Comments on site selection criteria for a solar power plant, off-grid power plants and weather station equipment: One participant was asking what will be the benefit from the PV plant for citizens living further away from the centre of Navrongo and are not connected to the grid. Moreover, he asked why no off-grid power plant will be implemented instead. Furthermore, he asked if there was a weather station already installed in order to collect data for the planning of the PV plant.	VRA informed that the site of the PV plant was chosen according to its suitability in terms of (i) solar resource, (ii) site/soil conditions, (iii) grid connection as well as (iv) access to road infrastructure. Hence, the site was chosen in order to achieve the highest output from the resource, i.e. the solar irradiation, if all the prerequisites are fulfilled. This provides in the first place an advantage for citizens close to the PV plan due to more reliable electricity supply. Further, the implementation of PV plant in the national electricity system constitutes a system expansion from additional generation. Additional generation is required to satisfy the electricity demand. This

Navrongo - Compilation of the Comments Received	
Local stakeholder hearing held on 18 January 2012 in Navrongo	
Questions asked	**Answers provided**
	comprises also the connection of more citizens to the grid under the currently on-going rural electrification program. The site selection has been accomplished based on already existing solar map data by the means of a planning software. Hence, no additional weather station is erected for data collection. Moreover it was again highlighted that a solar based off-grid solution is not able to generate electricity if there is a lack of the resource, i.e. solar irradiation, e.g. during the night.
8. Comment on potential health implications from the operation of the solar power plant: A participant asked if health implication from the operating PV plant may be expected (e.g. from electromagnetic fields).	VRA's environmental specialist informed the stakeholders that no health implications may be expected.
9. Comment on negative environmental impacts of the solar power plant: A participant asked if negative environmental and health impacts from the decommissioning of the PV plant may be expected.	VRA's environmental specialist informed the stakeholders that no negative environmental and health impacts from the decommissioning of the PV plant may be expected.
10. Comment on the competitiveness of solar based power generation: A participant asked about the competitiveness of power generation cost from solar power when compared to fossil fuels and hydropower.	The stakeholders were informed that the power generation cost of solar power are in general competitive to fossil fuel based power generation cost, but higher than hydropower generation cost. It is noted however that this always has to be considered and assessed on a case-to-case basis. In the long term, it is expected that solar power generation cost will be lower than fossil fuel based power generation due to steadily increasing prices for fossil fuels.
11. Comment on additional benefits of the project: A participant asked if additional benefits are envisaged in the framework of the PV power plant project under VRA's corporate social responsibility.	VRA informed the stakeholders that the project already provides a number of benefits to the local community and the contribution to a sustainable socio-economic development. Hence, no additional efforts are foreseen.
12. Comment on tariff reductions for electricity generated by the solar power plant:	VRA informed the stakeholders that no price reductions may be expected since the PV Plant is

Navrongo - Compilation of the Comments Received	
Local stakeholder hearing held on 18 January 2012 in Navrongo	
Questions asked	**Answers provided**
A participant asked if tariff reductions for the electricity generated from the Navrongo PV power plant may be expected.	generating grid-connected electricity. Moreover, although the resource which is harnessed, i.e. solar irradiation is available for free, there are still significant costs for the investment and operation of the plant. Hence, VRA will not be able to offer the electricity at a reduced price.
13. Comment from the Deputy Regional Minister of Upper East Region on security measures: The Minister explicitly welcomed the project and stated that the Upper East Region would be privileged to host such a project. The Minister further asked whether there are security measures planned for the operation of the PV power plant, in particular with regard to seasonal bush fires in the region.	VRA informed the Minister that fences and security guards are envisaged to ensure the operation of the PV power plant. Moreover, fire belts will surround the area of the PV plant to ensure that no local bush fire may destroy the technical equipment.
14. Comment on the liberalisation of the Ghanaian power sector: The perception of one participant is that VRA acts rather on a monopoly basis and asked the consultants if the power sector should rather be liberalised.	LI informed the stakeholders that a liberalised power market has pros and cons. In general, competition allows for the engagement of private electricity providers to supply reliable electricity in order to facilitate that it is sold. However, it has to be ensured that all of the electricity providers are also capable to supply the amount of electricity which is basically required – especially when there is suppressed demand which is the case for Ghana. Hence, it may also be an advantage if the power sector is run by an experienced utility and under the auspices of a responsible Government in order to ensure reliable power supply which is very important for the whole society.

C.3. Report on consideration of comments received

Neither negative comments nor opposition opinions were received from the consulted public and the personal interviews. Besides, the project initiative was widely praised during the questions & answers closing the public consultations, both for its innovative environmental characteristics and for its local employment potential.

As guaranteed to all participants, all recommendations were humbly and responsibly taken into account by VRA and included in their Project development and monitoring plan.

SECTION D. Eligibility of CPA and estimation of emissions reductions

D.1. Title and reference of the approved baseline and monitoring methodology(ies) selected:

The approved baseline and monitoring methodology selected for to the proposed CPA is: ACM0002 - Consolidated baseline methodology for grid-connected electricity generation from renewable sources (Version 12.3.0).

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

- "Tool for the demonstration and assessment of additionality" (Version 06.1.0);
- "Combined tool to identify the baseline scenario and demonstrate additionality" (Version 04.0.0);
- "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion" (Version 02);
- "Tool to calculate the emission factor for an electricity system" (Version 02.2.1).

"Guidelines for demonstrating additionality of microscale project activities" (Version 04.0) are also applied.

D.2. Application of methodology(ies)

The choice of the ACM0002 methodology is accurate since the proposed CPA respects all the applicability conditions required.

Table 3: *Compliance of the CPA project activity regarding ACM0002 applicability conditions*

§	Applicability conditions of the methodology	CPA specifications
1	This methodology is applicable to grid-connected renewable power generation project activities that: (a) install a new power plant at a site where no renewable power plant was operated prior to the implementation of the project activity (greenfield plant); (b) involve a capacity addition; (c) involve a retrofit of (an) existing plant(s); or (d) involve a replacement of (an) existing plant(s).	The CPA will consist of a grid-connected renewable electricity generation project falling under option (a). Indeed, the proposed CPA is a new solar electricity generation unit i.e. a Greenfield plant as described in section A.
2	The project activity is the installation, capacity addition, retrofit or replacement of a power plant/unit of one of the following types: ▪ hydro power plant/unit (either with a run-of-river reservoir or an accumulation reservoir), ▪ wind power plant/unit, ▪ solar power plant/unit.	The CPA will consist of a renewable power unit project falling under the solar power type. Indeed, the proposed CPA is a new solar electricity generation unit i.e. a Greenfield plant as described in section A.
3	In the case of capacity additions, retrofits or replacements (except for capacity addition projects for which the electricity generation of the existing power plant(s) or unit(s) is not affected): ▪ the existing plant 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 addition or retrofit of the plant	Not applicable to the proposed CPA.

§	Applicability conditions of the methodology	CPA specifications
	has been undertaken between the start of this minimum historical reference period and the implementation of the project activity	
4	In case of hydro power plants, one of the following conditions must apply: ▪ The project activity is implemented in an existing single or multiple reservoirs, with no change in the volume of any of the reservoirs; or ▪ The project activity is implemented in an existing single or multiple reservoirs, where the volume of any of reservoirs is increased and the power density of each reservoir, as per the definitions given in the Project Emissions section, is greater than 4 W/m^2 after the implementation of the project activity; or ▪ The project activity results in new single or multiple reservoirs and the power density of each reservoir, as per the definitions given in the Project Emissions section, is greater than 4 W/m^2 after the implementation of the project activity.	Not applicable to the proposed CPA.
5	The methodology is not applicable to the following: ▪ 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; ▪ Biomass fired power plants; ▪ A hydro power plant that results in the creation of a new single reservoir or in the increase in an existing single reservoir where the power density of the reservoir is less than 4 W/m^2.	The CPA does not consist in (i) switching from fossil fuels to renewable energy sources at the site of the project activity, neither (ii) biomass fired power plants, nor (iii) a hydro power plant that results in the creation of a new single reservoir or in the increase in an existing single reservoir where the power density of the reservoir is less than 4 W/m^2.
6	In the case of retrofits, 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, i.e. 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 applicable to the proposed CPA.

D.3. Sources and GHGs

The main emission sources and type of GHGs in the proposed CPA boundary are listed in the table below:

Table 4: *Emissions sources and greenhouse gases included in the proposed CPA boundary*

Source		Gas	Included?	Justification/Explanation
Baseline	CO_2 emissions from electricity generation in fossil fuel fired power plants that are displaced due to the project activity	CO_2	Yes	Main emission source
		CH_4	No	Minor emission source
		N_2O	No	Minor emission source
Project Activity	CO_2 emissions from combustion of fossil fuels for electricity generation in solar thermal power plants	CO_2	No	Main emission source *(Only for CSP)*
		CH_4	No	Minor emission source
		N_2O	No	Minor emission source
	For hydro power plants, emissions of CH_4 from the reservoir	CO_2	No	Minor emission source
		CH_4	No	Main emission source *(Only for specific hydro)*
		N_2O	No	Minor emission source

According to ACM0002 methodology, the spatial extent of the project boundary includes the project power plant and all power plants connected physically to the electricity system[5] that the CDM project power plant is connected to.

The project boundary is therefore determined as:

- The CPA site, where the electricity is being produced,
- The Ghanaian grid with the power plant connected to.

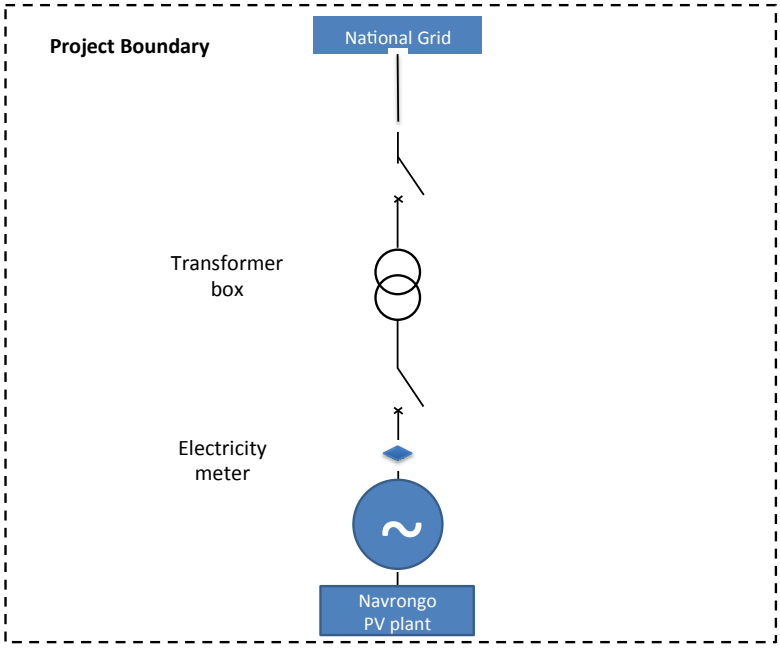

Figure 4 : *CPA boundary*

[5] Refer to the "Tool to calculate the emission factor for an electricity system" for definition of an electricity system.

D.4. Description of the baseline scenario

Assessment and demonstration of additionality will follow the "Tool for the demonstration and assessment of additionality" (Version 06.1.0) for Greenfield and Capacity Addition projects and the "Combined tool to identify the baseline scenario and demonstrate additionality" (Version 04.0.0) for CPAs involving a Retrofit or Replacement of existing grid-connected renewable power plant/unit(s) at the CPA project site. However for projects with an installed capacity up to 5 MW, "Guidelines for demonstrating additionality of microscale project activities" (Version 04.0) can also be applied as detailed in eligibility criteria (f) and (k).

"Guidelines on additionality of first-of-its-kind project activities" version 02.0 may be applied to demonstrate additionality.

The proposed CPA consists in the installation of a new grid-connected renewable power unit (Greenfield); therefore, 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".

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 described in section B.6.1. equation (9).

Step 1. Identification of alternatives to the project activity consistent with current laws and regulations

Define realistic and credible alternatives to the project activity(s) through the following Sub-steps:

Sub-step 1a: Define alternatives to the project activity:

For Greenfield project, realistic and credible alternatives available to the project participants or similar project developers that provide outputs or services comparable with the proposed CDM project activity are:

1) The proposed project activity undertaken without being registered as a CDM project activity;
2) The continuation of the current situation (no project activity or other alternatives undertaken).

Sub-step 1b: Consistency with mandatory laws and regulations:

	Regulatory analysis	Consistency with laws & regulations?
1	The proposed project activity undertaken without being registered as a CDM project activity; This alternative is in compliance with the National Energy Policy, 2010 and also with the Renewable Energy Bill 2011.	YES
2	The continuation of the current situation (no project activity or other alternatives undertaken). This alternative is in compliance with the National Energy Policy, 2010 and also with the Renewable Energy Bill 2011.	YES

The alternative scenarios 1) and 2) are consistent with mandatory laws and regulations.

Step 2: Investment analysis

Not applied.

Step 3.Barrier analysis

Not applied.

The installed capacity of the proposed project is less than 5 MW. The "Guidelines for demonstrating additionality of microscale project activities" (Version 04.0) is applied in accordance with eligibility criteria (f) and (k).

As mentioned in Section A.7 of the CPA-DD, the project is located in the Upper East Region of Ghana.

As explained in Section B.1 (part I) of the PoA-DD, Upper East Region of Ghana can be considered as a special underdeveloped zone (SUZ) of the country. Therefore, the project is automatically additional.

Step 4. Common practice analysis

Not applicable.

D.5. Demonstration of eligibility for a CPA

To be included in the PoA, the CPA proposed should verify all applicability assessments below.

Eligibility criteria		Tick when met	Mean of proof / Evidence / Document
§	**Description**		
(a)	The proposed CPA is developed within the borders of Ghana and is connected to the national grid.	☒	- GPS coordinates indicated in the document "PV Power Plant Layout Plan-Navrongo.pdf" - Preliminary Environmental Report.
(b)	The CPA implementer complies with the procedure established by the CME as specified in PoA-DD Section C Part I to avoid double accounting.	☒	- The review of UNFCCC and DNA registries/portfolios did not detect any similar activities; and - The CME project assessment and interview confirmed that: o the proposed CPA is not registered or under validation under the Clean Development Mechanism of the UNFCCC or any voluntary scheme as a single project activity or as a component activity under another program, and o the proposed CPA is uniquely identified and defined in an unambiguous manner by amongst other aspects providing geographic information (GPS coordinates).
(c)	The proposed CPA is one of the following: install a new power plant at a site where no renewable power plant was operated prior to the implementation of the project activity (greenfield plant); or involve a capacity addition; or involve a retrofit of (an) existing plant(s); or involve a replacement of (an) existing plant(s).	☒ ☐ ☐ ☐	- GPS coordinates, indicated in the document "PV Power Plant Layout Plan-Navrongo.pdf" - Preliminary Environmental Report

Eligibility criteria		Tick when met	Mean of proof / Evidence / Document
§	**Description**		
	In the case of capacity additions, retrofits or replacements (for hydro projects), the proposed CPA consist of an: ▪ existing plant that started commercial operation prior to the start of a minimum historical reference period of five years; and ▪ no capacity expansion or retrofit of the plant will have been undertaken between the start of this minimum historical reference period and the implementation of the project activity. If the proposed CPA is a grid-connected hydropower plant: ▪ the CPA will be implemented in an existing single or multiple reservoir, with no change in the volume of any of the reservoir; or ▪ the CPA will be implemented in an existing single or multiple reservoir, where the volume of any of reservoirs is increased and the power density of each reservoir, as per the definitions given in the Project Emissions section, will be greater than 4 W/m^2 after the implementation of the CPA; or ▪ the CPA will result in new single or multiple reservoirs and the power density of each reservoir, as per definitions given in the Project Emissions section, will be greater than 4 W/m^2 after the implementation of the CPA.	☐ and ☐ ☐ and ☐ and ☐	

Eligibility criteria		Tick when met	Mean of proof / Evidence / Document
§	**Description**		
(d)	In accordance with the CDM Glossary, the starting date of the proposed CPA is the date on which CPA implementer commits to expenditures related to the implementation or the construction of the grid-connected renewable electricity generation project. The CME has verified that no significant financial commitment for project implementation or construction has been done yet at the time of validation.	☒ ☒	- Purchase orders related to the implementation or the construction of the grid-connected renewable electricity generation project
(e)	The proposed CPA-DD complies and applies the baseline and monitoring methodology ACM0002 "Consolidated baseline methodology for grid-connected electricity generation from renewable sources" (Version 12.3.0)	☒	- As demonstrated in Section D.2, the proposed CPA meets the criteria of ACM0002 "Consolidated baseline methodology for grid-connected electricity generation from renewable sources" (Version 12.3.0).
(f)	The proposed CPA-DD meets the relevant requirements pertaining to the demonstration of additionality: *Guidelines for demonstrating additionality of microscale project activities* (when applicable) for CPAs up to five megawatts; or *Tool for the demonstration and assessment of additionality*; and/or *Combined tool to identify the baseline scenario and demonstrate additionality* in case of retrofit or replacement of existing grid-connected renewable power plant/unit(s).	☒ or ☐ and/or ☐	- Since the CPA consists in a solar photovoltaic electricity generation plant with a capacity under 5 MW and located in recognized underdeveloped areas of Ghana, it is **automatically defined as additional**, according to the *Guidelines for demonstrating additionality of microscale project activities.*
(g)	Local stakeholder consultation has been conducted prior to the inclusion of the proposed CPA-DD. The proposed CPA-DD complies with the Ghanaian Environmental Assessment Regulations 1999 in terms of	☒ and ☒	- Minutes of the meeting, summary of concerns raised and clarification provided thereof, attendance sheet, photographs and or video, etc. - Letter from EPA confirming receipt of EIA (18th August 2012)

Eligibility criteria		Tick when met	Mean of proof / Evidence / Document
§	**Description**		
	environmental impact analysis as specified in Section E.1. Part II.		- Preliminary Environmental Report
(h)	Confirmation that the proposed CPA does not involve any public funding from Annex I Parties or that in case public funding is used, it does not result in diversion of Official Development Assistance (ODA)	☒	- Statement in CPA-DD section A.11 "Public funding of the CPA"
(k)	As per requirements pertaining to the demonstration of additionality as specified in Section B.1. Part I., some CPA may fall under the microscale threshold criteria as following: CPA total installed capacity is below or equal to 5MW AND The geographic location of the project activity is • In one of the least developed countries (LDCs) or • In one of the small island developing States (SIDS) or • In a special underdeveloped zone (SUZ). identified by the Government in official notifications for development assistance including for planning, management, and investment satisfying any one of the following conditions using most recent available data: • The proportion of population with	☒ and ☒	As stated in section A.3, the installed capacity of the CPA is 1.92 MWp[9], thus below the 5 MW threshold. The proposed CPA is undertaken in a special underdeveloped zone (SUZ) of the host country according to the Savannah Accelerated Development Authority (SADA). As stated in section B.1. of the PoA-DD, according to a recent study conducting conducted by the World Bank, the poverty rate of Northern Ghana and adjacent districts was estimated to 58.3% in 2006[10]. (World Bank, 2011).

Eligibility criteria		Tick when met	Mean of proof / Evidence / Document
§	Description		
	income less than USD 2 per day (PPP)[6] in the region is greater than 50%; • The GNI per capita in the country is less than USD 3000 [7] and the population of the region is among the poorest 20% in the poverty ranking of the host country as per the applicable national policies and procedures[8]. CPA implementer has demonstrated that the CPA-DD remains within this threshold throughout the corresponding crediting period.	and ☒	CPA implementer confirms that the CPA-DD remains within this threshold throughout the corresponding crediting period.
(l)	If the proposed CPA is microscale project activities, CPA implementer has demonstrated that the CPA is not a debundled component of a small scale activity as described in the latest "Guidelines for demonstrating additionality of microscaleproject activities".	☒	- Since this CPA is the 1st CDM Project Activity implemented by the CPA implementer VRA and since this CPA will be the 1st CPA to be ever registered under Standard Bank's unique renewable energy PoA whose boundaries encompass Ghana, this proposed micro-scale CPA is not deemed to be a debundled component of a small-scale activity according to "Guidelines for demonstrating additionality of microscaleproject activities". (Version 04).
(m)	The proposed CPA is implemented by an entity who has signed a binding agreement with the CME which ensures that they are aware and agree that their activity is subscribed to a	☒	- Agreement letter between the CME and the CPA implementer

[9]Page 10 of the document " Load factor solar project-Engineering services Department-VoVRA-03-08-2012.pdf""
[10] Measured with an international poverty line of PPP $1.25 a day. Data 2006 (most recent available data).
[6] Purchasing Power Parity.
[7] PPP or the World Bank atlas method or another comparable method
[8] Information on per capita income or other economic indicators used for the ranking purposes shall be provided in USD.

Eligibility criteria		Tick when met	Mean of proof / Evidence / Document
§	**Description**		
	PoA and that their carbon rights have to be relinquished to the CME.		
(n)	The proposed CPA-DD has been reviewed by the CME and submitted to a DOE for inclusion into the PoA.	☒	- Letter from the CME to the DOE (cc/ CPA implementer) submitting the proposed CPA-DD for inclusion into the PoA.

The CPA Inclusion Procedure that encompasses all provisions and procedures related to pre-inclusion due diligence has been used as the foundation of compliance team activities.

D.6. Estimation of emission reductions
D.6.1. Explanation of methodological choices

According to the approved methodology ACM0002, emission reductions are calculated as follows:

$$\mathbf{ER_y = BE_y - PE_y}$$

Where:

ER_y = Emission reductions in year y (t CO_2e)

BE_y = Baseline emissions in year y (t CO_2)

PE_y = Project emissions in year y (t CO_2e)

Project emissions

No project emissions are expected as the CPA only involves renewable power generation from a solar PV unit without fossil fuel consumption[11], therefore $PE_y = 0$.

Baseline emissions

Baseline emissions include only CO_2 emissions from electricity generation in fossil fuel fired power plants that are displaced due to the CPA. 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 calculated as follows:

$$\mathbf{BE_y = EG_{PJ,y} * EF_{grid,CM,y}} \quad \textbf{(9)}$$

Where:

BE_y = Baseline emissions in year y (tCO_2)

$EG_{PJ,y}$ = 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)

$EF_{grid,CM,y}$ = 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)

Calculation of $EG_{PJ,y}$

Since the CPA consists in the installation of new grid-connected renewable power plant at site where no renewable power plant was operated prior to the implementation of the project activity, it verifies the case of Greenfield renewable energy power plant, whereby:

$$\mathbf{EG_{PJ,y} = EG_{facility,y}} \quad \textbf{(10)}$$

Where:

$EG_{PJ,y}$ = 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)

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

[11] No back-up generators will be installed

and $\mathbf{EG_{facility,y} = G_{output,y} - C_y}$ **(10')**

Where:

$G_{output,y}$ = Annual gross electricity generation measured at the output stations of the solar PV unit in year y (MWh)

C_y = Annual electricity consumption measured of the solar PV unit imported from the grid in year y (MWh)

$EG_{facility,y}$ is the quantity of net electricity delivered to the Ghanaian electricity grid by the solar PV unit.

Calculation of $EF_{grid,CM,y}$

The grid emission factor ($EF_{grid,CM,y}$) is calculated ex-ante as per the "Tool to calculate the emission factor for an electricity-system" (Version 02.2.1). The emission factor is not monitored during the crediting period of each CPA but shall be updated at the renewal of the crediting period of the CPA.

This methodological tool determines the CO_2 emission factor for the displacement of electricity generated by power plants in an electricity system, by calculating the "combined margin" emission factor (CM) of the electricity system. The CM is the result of a weighted average of two emission factors pertaining to the electricity system: the "operating margin" (OM) and the "build margin" (BM). The operating margin is the emission factor that refers to the group of existing power plants whose current electricity generation would be affected by the CPA. The build margin is the emission factor that refers to the group of prospective power plants whose construction and future operation would be affected by the CPA.

This tool provides procedures to determine the following parameters:

Parameter	SI Unit	Description
$\mathbf{EF_{grid,CM,y}}$	tCO_2/MWh	Combined margin CO_2 emission factor for the project electricity system in year *y*
$\mathbf{EF_{grid,BM,y}}$	tCO_2/MWh	Build margin CO_2 emission factor for the project electricity system in year *y*
$\mathbf{EF_{grid,OM,y}}$	tCO_2/MWh	Operating margin CO_2 emission factor for the project electricity system in year *y*

The tool indicates six steps for the calculation of the combined margin (CM) emission factor:

STEP 1. Identify the relevant electricity systems.

The following map shows that electrical Ghana's electric power system has one national Grid the "National Interconnected Transmission System (NITS)" with transmission lines to Côte d`Ivoire, Togo/Benin and Burkina Faso.

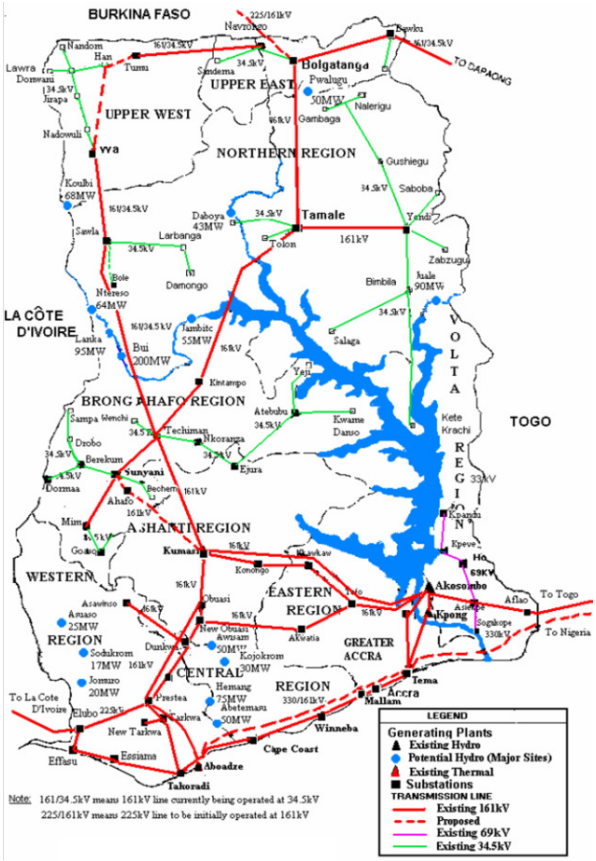

Figure 5: *Map of Ghana showing Transmission Grid (as of 07/08/2010)*

No other electricity system is located within the country, thus no internal imports take place. Therefore, the relevant electric power system is the national grid.

The following power plants are connected to the National Interconnected Transmission System:

Power plants	Type	Commissioning date	Capacity(MW)
TAPCO	*Thermal*	1997/98	330
TICO	*Thermal*	2000/01	220
Tema Diesel Reserve Plant*	*Thermal*	April 2007	50
Emergency R. Power Plant	*Thermal*	May 2007	55.2
AGGREKO*	*Thermal*	July 2007	25
Kumasi Res. Power Plant*	*Thermal*	August 2007	20
Mines Reserve Power Plant	*Thermal*	October 2007	80
TT1PP - VRA	*Thermal*	2009	110
TT2PP	*Thermal*	2010	49.5
Sunon Asogli	*Thermal*	2010	200
Akosombo	*Hydro*	1966	1,020
Kpong	*Hydro*	1982	160

** Decommissioned as of 2009*

Ghana imported the following amount of electricity from other countries:

Imports	GWh
2008	274.8
2009	198.0
2010	106.3

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

The tool allows selecting one of the following two options to calculate the operating margin and build margin emission factor:

Option 1: Only grid power plants are included in the calculation.

Option 2: Both grid power plants and off-grid power plants are included in the calculation.

Because off-grid power plants are not considered, **Option 1** is selected for the calculation of both the operating and build margin emission factors.

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

The calculation of the operating margin emission factor ($EF_{grid,OM,y}$) is based on one of the following methods:

(a) Simple OM, or
(b) Simple adjusted OM, or
(c) Dispatch data analysis OM, or
(d) Average OM.

The hydro power plants of Akosombo and Kpong represent low cost/must run resources and constitute more than 50% of the total grid generation, based on the average of the five most recent years 2006 - 2010 (68.6%). Therefore method (a), simple OM, is not applicable.

The simple adjusted OM requires the detailed operation and hourly dispatch data of each power plant in the grid, which are not available to date for the Ghanaian grid. Therefore, method (b) is not applicable.

For identical reasons of data availability, method (c) dispatch data analysis OM is not applicable.

The method (d), average OM, will be used as low-cost/must run resources constitute more than 50% of the total amount of power generation on the grid.

According to the Energy Commission, the total electric power generation of the Ghanaian grid in 2010 is 10,126 GWh, in which fossil fuel based power generation is 3,135 GWh, accounting for 31 % and hydropower generation represents 6,991GWh accounting for 69 %.

As the table below shows, hydropower represents all of the low-cost/must run resources with an average share over the past 5 years of 68.6 %.

Table 5: *Net production and share of low cost/must run power plants.*

	2006	**2007**	**2008**	**2009**	**2010**
Hydropower gross production (GWh)	5,615	3,724	6,192	6,871	6,991
Share of hydropower [%]	66.6%	52.9%	74.3%	76.9%	69.0%

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

According to the tool, the average OM emission factor ($EF_{OM,ave,y}$) is calculated as the average emission rate of all power plants serving the grid, using the guidance for the simple OM calculation, but also including the low-cost/must-run power plants in all equations.

Option A is applied:

Under this option, the simple OM emission factor is calculated based on the net electricity generation of each power unit and an emission factor for each power unit, as follows:

$$EF_{grid,OM\ simple,y} = \frac{\sum_m EG_{m,y} \times EF_{EL,m,y}}{\sum_m EG_{m,y}}$$

Where:

$EF_{grid,OMsimple,y}$	=	Simple operating margin CO_2 emission factor in year y (tCO_2/MWh).
$EG_{m,y}$	=	Net quantity of electricity generated and delivered to the grid by power unit m in year y (MWh).
$EF_{EL,m,y}$	=	CO_2 emission factor of power unit m in year y (tCO_2/MWh)
m	=	All power units serving the grid in year y except low-cost/must-run power units.
y	=	The relevant year as per the data vintage chosen in STEP 3.

Since data on fuel consumption and electricity generation is available, the emission factor ($EF_{EL,m,y}$) should be determined as follows (**option A1** of the tool):

$$EF_{EL,m} = \frac{\sum_i FC_{i,m,y} \times NCV_{i,y} \times EF_{CO2,i,y}}{EG_{m,y}}$$

Where:

$EF_{EL,m,y}$	=	CO_2 emission factor of power unit *m* in year *y* (tCO_2/MWh)
$FC_{i,m,y}$	=	Amount of fossil fuel type *i* consumed by power unit *m* 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)
$EF_{CO2,i,y}$	=	CO_2 emission factor of fossil fuel type *i* in year *y* (tCO_2/GJ)
$EG_{m,y}$		Net quantity of electricity generated and delivered to the grid by power unit *m* in year *y* (MWh)
m	=	All power units serving the grid in year *y* except low-cost/must-run power units
i	=	All fossil fuel types combusted in power unit *m* in year *y*
y	=	The relevant year as per the data vintage chosen in Step 3.

For the calculation of the OM emission factor, the consumption data for each fossil fuel used to power the different power plants are taken from the certified data provided by the Energy Commission. The Energy Commission holds data on annual fuel consumption, electricity generation by sources and electricity imports/exports.

The calculation of the OM is based on the years 2008, 2009 and 2010.

If available, local values of $NCV_{i,y}$ and $EF_{CO2,i,y}$ shall be used. If not, country-specific values are preferable to IPCC default values. In this proposed CPA:

- $NCV_{i,y}$ of all fossil fuels come from IPCC default value at the lower limit of the uncertainty at a 95% confidence interval as provided in table 2.2 of Chapter 2 Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories.
- $EF_{CO2,i,y}$ of all fossil fuels come from IPCC default value at the lower limit of the uncertainty at a 95% confidence interval as provided in table 1.2 of Chapter 1 Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories.

Based on 2008, 2009 and 2010, the calculated Operating Margin is: **0.2015 tCO_2/MWh.**

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

Option 1: For the first crediting period, project participants calculate the build margin emission factor ex ante based on the most recent information available on units already built for sample group m at the time of the proposed PoA-DD submission to the DOE for validation (year 2010). This option does not require monitoring the emission factor during the crediting period.

Capacity additions from retrofits of power plants are not included in the calculation of the build margin emission factor.

The sample group of power units *m* used to calculate the build margin are determined as per the following procedure, consistent with the data vintage selected above:

(a) Identify the set of five power units, excluding power units registered as CDM project activities, that started to supply electricity to the grid most recently ($SET_{5\text{-units}}$) and determine their annual electricity generation ($AEG_{SET\text{-}5\text{-}units}$);

- The set of five power units that started to supply electricity to the grid most recently represents a net electricity production (in year 2010) $\mathbf{AEG_{SET\text{-}5\text{-}units} = 763\ GWh.}$

(b) Determine the annual electricity generation of the project electricity system, excluding power units registered as CDM project activities (AEG_{total}). Identify the set of power units, excluding power units registered as CDM project activities, that started to supply electricity to the grid most recently and that comprise 20% of AEG_{total} (if 20% falls on part of the generation of a unit, the generation of that unit is fully included in the calculation) ($SET_{\geq 20\%}$) and determine their annual electricity generation ($AEG_{SET\text{-}\geq 20\%}$);

- The set of power capacity additions in the electricity system that comprise 20% of the system generation (i.e. 2,205 GWh in year 2010) and that started to supply electricity to the grid most recently corresponds to a total set of $\mathbf{AEG_{SET\text{-}\geq 20\%} = 3{,}135\ GWh.}$

(c) From $SET_{5\text{-units}}$ and $SET_{\geq 20\%}$ select the set of power units that comprises the larger annual electricity generation (SET_{sample});

- The set of power units that comprises the larger annual generation is $\mathbf{SET_{sample} = SET_{\geq 20\%}}$.

Identify the date when the power units in SET_{sample} started to supply electricity to the grid. If none of the power units in SET_{sample} started to supply electricity to the grid more than 10 years ago, then use SET_{sample} to calculate the build margin.

Otherwise (d), (e); which are irrelevant since there is no power units registered as CDM project activity in Ghana.

(f) The sample group of power units m used to calculate the build margin is the resulting set $\mathbf{SET_{sample\text{-}CDM\text{->}10yrs} = SET_{sample} = SET_{\geq 20\%}}$.

Table 6: *Set of power units under consideration.*

Name of power plants included in the build margin (interconnected grid)	Date of operation	Fuel Type	Net power generation in 2010 (GWh)	Cumulated share (%)
TAPCO	1997	LCO/DO/NG	1,213	30.96%
TICO	2000	LCO/DO	1,159	18.99%
Tema Reserve Power Plant	Apr-07	Diesel	0	7.54%
Emergency R. Power Plant	May-07	Diesel	0	7.54%
AGGREKO	Jul-07	Diesel	0	7.54%
Kumasi Res. Power Plant	Aug-07	Diesel	0	7.54%
Mines Reserve Plant	Oct-07	Diesel	18	7.54%
TT1PP - VRA	2009	LCO/DO/NG	587	7.36%
TT2PP	2010	DO	21	1.57%
Sunon Asogli	2010	NG	138	1.36%

The build margin emissions factor is the generation weighted average emission factor (tCO_2/MWh) of all power units *m* during the most recent year y for which electricity generation data is available, calculated as follows:

$$EF_{grid,BM,y} = \frac{\sum_m EG_{m,y} \times EF_{EL,m,y}}{\sum_m EG_{m,y}}$$

Where:

$EF_{grid,BM,y}$	=	Build margin CO_2 emission factor in year *y* (tCO_2/MWh)
$EG_{m,y}$	=	Net quantity of electricity generated and delivered to the grid by power unit *m* in year *y* (MWh)
$EF_{EL,m,y}$	=	CO_2 emission factor of power unit *m* in year *y* (tCO_2/MWh)
m	=	Power units included in the build margin
y	=	Most recent historical year for which electricity generation data is available.

As there is no specific guidance or data from the host country, the carbon Emission Factor values[12] of fossil fuel used for the calculations are:

- EF Light Crude Oil (LCO) = 71,100 $kgCO_2/TJ$;
- EF Distillate Oil (DO) = 71,100 $kgCO_2/TJ$;
- EF Diesel = 72,600 $kgCO_2/TJ$.
- EF Natural Gas (NG) = 54,300 $kgCO_2/TJ$.

As there is no specific guidance or data from the host country, the Net Calorific Values[13] of fossil fuel used for the calculations are:

- NCV Light Crude Oil (LCO) = 40.1TJ/Gg;
- NCV Distillate Oil (DO) = 40.1 TJ/Gg;
- NCV Diesel = 41.4 TJ/Gg;
- NCV Natural Gas (NG) = 46.5 TJ/Gg.

[12] IPCC 2006 Volume 2 - Chapter 1 – Table 1.2 – Default CO_2 Emission Factors for Combustion at the lower limits of the 95% confidence interval.
[13] IPCC 2006 Volume 2 - Chapter 2 – Table 2.2 – Default NCV at the lower limits of the 95% confidence interval.

Table 7: *Emissions of the set of power units included in the Build Margin.*

Name of power plants included in the build margin (interconnected grid)	Fuel type	Net Power Generation	Emission factor of the power unit	CO_2 emissions
		GWh	tCO_2/MWh	tCO_2
TAPCO	LCO/DO/NG	1,213	0.6497	787,976
TICO	LCO/DO	1,034	0.8532	882,216
Tema Reserve Power Plant	Diesel	0	0.0000	0
Emergency R. Power Plant	Diesel	0	0.0000	0
AGGREKO	Diesel	0	0.0000	0
Kumasi Res. Power Plant	Diesel	0	0.0000	0
Mines Reserve Plant	Diesel	16	1.1310	18,096
TT1PP - VRA	LCO/DO	568	0.7863	446,630
TT2PP	LCO/DO/NG	21	0.6985	14,460
Suno Asogli	NG	138	0.5636	77,781
TOTAL		**2,990**	**0.7450**	**2,227,160**

From data provided in table 7, the Build Margin is calculated to be: **0.7450 tCO_2/MWh**.

STEP 6. Calculate the combined margin (CM) emission factor.

The calculation of the combined margin (CM) emission factor ($EF_{grid,CM,y}$) is based on the following method:

(a) Weighted average CM;

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

Where:

$EF_{grid,BM,y}$ = Build 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)
w_{OM} = Weighting of operating margin emissions factor (%)
w_{BM} = Weighting of build margin emissions factor (%)

According to the tool, default values for wind and solar power generation CPAs are: w_{OM} =0.75 and w_{BM} = 0.25 (owning their intermittent and non-dispatchable nature) for the first crediting period and for subsequent crediting periods.

According to the tool, default values for other CPAs are: w_{OM} = 0. 5 and w_{BM} = 0.5.

Based on 2008, 2009 and 2010 the combined margin (CM) emission factor $EF_{grid,CM,y}$ is given as follows:

$EF_{grid,CM,y}$	**0.3373**	**tCO_2/MWh**	**For wind and solar projects**
$EF_{grid,CM,y}$	0.4732	tCO_2/MWh	For other projects

Leakage

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.

D.6.2. Data and parameters that are to be reported ex-ante

Baseline emissions:

Data / Parameter	$FC_{i,m,y}$
Unit	Mass or volume unit
Description	Amount of fossil fuel type *i* consumed by power plant / unit *m* in year *y*.
Source of data	Government records / official sources.
Value(s) applied	See detailed table in Appendix 4.
Choice of data or Measurement methods and procedures	• Simple OM: once for each crediting period using the most recent three historical years for which data is available at the time of submission of the PoA-DD to the DOE for validation (*ex ante* option); • BM: For the first crediting period, either once *ex ante* or annually *ex post*, following the guidance included in Step 5. For the second and third crediting period, only once *ex ante* at the start of the second crediting period.
Purpose of data	Calculation of baseline emissions.
Additional comment	Data vintage available at validation: 2008 – 2010.

Data / Parameter	$NCV_{i,y}$
Unit	GJ/mass or volume unit
Description	Net calorific value (energy content) of fossil fuel type *i* in year *y*.
Source of data	IPCC default values at the lower limit of the uncertainty at a 95%confidence interval as provided in Table 1.2 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories, as neither local nor national values are available.
Value(s) applied	• NCV Light Crude Oil (LCO) = 40.1TJ/Gg; • NCV Distillate Oil (DO) = 40.1 TJ/Gg; • NCV Diesel = 41.4 TJ/Gg; • NCV Natural Gas (NG) = 46.5 TJ/Gg.
Choice of data or Measurement methods and procedures	• Simple OM: once for each crediting period using the most recent three historical years for which data is available at the time of submission of the PoA-DD to the DOE for validation (*ex ante* option); • BM: For the first crediting period, either once *ex ante* or annually *ex post*, following the guidance included in Step 5. For the second and third crediting period, only once *ex ante* at the start of the second crediting period.
Purpose of data	Calculation of baseline emissions.
Additional comment	Default values at the lower bound of the 95% confidence interval are selected from the aspect of conservativeness.

Data / Parameter	$EF_{CO2,i,y}$
Unit	tCO_2/GJ
Description	CO_2 emission factor of fossil fuel type *i* in year *y*.
Source of data	IPCC default values at the lower limit of the uncertainty at a 95% confidence interval as provided in Table 1.2 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories, as neither local nor national values are available.
Value(s) applied	• EF Light Crude Oil (LCO) = 71,100 $kgCO_2/TJ$; • EF Distillate Oil (DO) = 71,100 $kgCO_2/TJ$; • EF Diesel = 72,600 $kgCO_2/TJ$; • EF Natural Gas (NG) = 54,300 $kgCO_2/TJ$.

Choice of data or Measurement methods and procedures	• Simple OM: once for each crediting period using the most recent three historical years for which data is available at the time of submission of the PoA-DD to the DOE for validation (*ex ante* option); • BM: For the first crediting period, either once *ex ante* or annually *ex post*, following the guidance included in Step 5. For the second and third crediting period, only once *ex ante* at the start of the second crediting period.
Purpose of data	Calculation of baseline emissions.
Additional comment	Default values at the lower bound of the 95% confidence interval are selected from the aspect of conservativeness.

Data / Parameter	$EG_{m,y}$
Unit	MWh
Description	Net electricity generated by power plant/unit *m* in year *y*.
Source of data	Government records / official sources. Please also refer to Electricity Market Data Report 2011 on the Energy Commission website: http://new.energycom.gov.gh/pgs/newdetails.php?recordID=6
Value(s) applied	See detailed table in Appendix 4
Choice of data or Measurement methods and procedures	• Simple OM: once for each crediting period using the most recent three historical years for which data is available at the time of submission of the PoA-DD to the DOE for validation (*ex ante* option); • BM: For the first crediting period, either once *ex ante* or annually *ex post*, following the guidance included in Step 5. For the second and third crediting period, only once *ex ante* at the start of the second crediting period.
Purpose of data	Calculation of baseline emissions.
Additional comment	Data vintage available at validation: 2008 – 2010.

Data / Parameter	$EF_{grid,CM,y}$
Unit	tCO_2/MWh
Description	Combined margin CO_2 emission factor for the project electricity system in year *y*.
Source of data	As per "Tool to calculate the emission factor for an electricity system" (Version 02.2.1).
Value(s) applied	0.3373 — For solar projects
Choice of data or Measurement methods and procedures	Calculated from the above parameters as per step-by-step calculations detailed in C.6.1.
Purpose of data	Calculation of baseline emissions.
Additional comment	Ex-ante option is chosen: the emission factor is not monitored during the crediting period of each CPA but shall be updated at the renewal of the crediting period of the CPA.

D.6.3. Ex-ante calculation of emission reductions

	Value/Result	Source/reference
Total installed capacity	1.92 MW	A.1. - General Description
Net electricity delivered to the grid ($EG_{PJ,y}$)	3,183 MWh	A.1. $[EG_{PJ,y} = EG_{facility,y}]$
Baseline emission factor of Ghana grid ($EF_{grid,CM,y}$)	0.3373 tCO_2/MWh	C.6.1. $[EF_{grid,CM,y} = w_{OM} \cdot EF_{OM,y} + w_{BM} \cdot EF_{BM,y}]$
Baseline emissions (BE_y)	1,074 tCO_2/y[14]	$BE_y = EG_{PJ,y} \cdot EF_{grid,CM,y}$
Project emissions (PE_y)	0 tCO_2e/y	C.6.1.
Emission reduction (ER_y)	1,074 tCO_2e/year	$ER_y = BE_y - PE_y$

D.6.4. Summary of the ex-ante estimates of emission reductions

Year	Baseline emissions	Project emissions	Leakage	Emission reductions
	t CO_2e	t CO_2e	t CO_2e	t CO_2e
2013	1,074	0	0	1,074
2014	1,074	0	0	1,074
2015	1,074	0	0	1,074
2016	1,074	0	0	1,074
2017	1,074	0	0	1,074
2018	1,074	0	0	1,074
2019	1,074	0	0	1,074
Total	7,515	0	0	7,515
Total number of crediting years	7			
Annual average over the crediting period	1,074	0	0	1,074

D.7. Application of the monitoring methodology and description of the monitoring plan
D.7.1. Data and parameters to be monitored

Project emissions:

No project emissions are expected in this project activity.

[14] 1,074 tCO_2 for the first year of the crediting period

Baseline emissions:

Greenfield renewable energy power plants

Data / Parameter	$\mathbf{EG_{facility,y}}$
Unit	MWh
Description	Quantity of net electricity generation supplied by the project plant/unit to the grid in year *y*.
Source of data	Measured directly with electricity meters at CPA project site.
Value(s) applied	2013: 3,183; 2014: 3,183; 2015: 3,183; 2016: 3,183; 2017: 3,183; 2018: 3,183; 2019: 3,183
Measurement methods and procedures	Electricity outputs will be electronically stored and reading recorded on a record sheet. The net electricity exported to the grid ($\mathbf{EG_{facility,y}}$) is the basis for estimating emission reductions from the proposed CPA. Net electricity delivered to the grid will be calculated as follows: $$\mathbf{EG_{facility,y} = G_{output,y} - C_y}$$ $EG_{facility,y}$ Net electricity delivered to the grid by the project. $G_{output,y}$ Generation data measured at output substation. C_y Electricity consumption of the solar electricity generation unit.
Monitoring frequency	Continuous measurement and at least monthly recording
QA/QC procedures	Cross check measurement results with records for sold electricity
Purpose of data	Calculation of baseline emissions
Additional comments	-

Data / Parameter	$\mathbf{G_{output,y}}$
Unit	MWh
Description	Annual gross electricity generation measured at the output station of the solar electricity generation unit.
Source of data	Measured directly with electricity meters at CPA project site.
Value(s) applied	No estimated value applied.
Measurement methods and procedures	Electricity outputs will be electronically stored and reading recorded on a record sheet.
Monitoring frequency	Continuous measurement and at least monthly recording.
QA/QC procedures	Cross check measurement results with records for sold electricity.
Purpose of data	Calculation of baseline emissions.
Additional comments	The annual gross electricity production will be used to calculate the $\mathbf{EG_{facility,y}}$ electricity generation delivered to the grid).

Data / Parameter	C_y
Unit	MWh
Description	Annual electricity consumption measured of the solar electricity generation unit imported from the grid.
Source of data	Measured directly with electricity meters at CPA project site.
Value(s) applied	No estimated value applied.
Measurement methods and procedures	Electricity outputs will be electronically stored and reading recorded on a record sheet.
Monitoring frequency	Continuous measurement and at least monthly recording.
QA/QC procedures	Cross check measurement results with records for sold electricity.
Purpose of data	Calculation of baseline emissions.
Additional comments	The annual gross electricity production will be used to calculate the $EG_{facility,y}$ electricity generation delivered to the grid).

D.7.2. Description of the monitoring plan

The proposed CPA monitoring plan complies with the methodology ACM0002 - Consolidated baseline methodology for grid-connected electricity generation from renewable sources (Version 12.3.0), whereby it is stated that:
"All data collected as part of monitoring should be archived electronically and be kept at least for 2 years after the end of the last crediting period. 100% of the data should be monitored if not indicated otherwise in the tables [C.7.1.]. All measurements should be conducted with calibrated measurement equipment according to relevant industry standards".

The quantity of net electricity generation delivered to the grid by the renewable electricity generation plant/unit will be reliably monitored through calibrated electricity meters and cross-checked with sales records as follows.

Monitoring organization

The CME will establish and maintain a database for the proposed CPA. The CME will record CPA information detail delivered by CPA implementer, as follows:

- Name of the CPA,
- Name of CPA implementer,
- Contact details of CPA implementer,
- Renewable energy source : solar, wind or hydro,
- Installed capacity and other relevant technical specifications of each CPA,
- GPS coordinates of each CPA,
- Verification status (number of verification and associated monitoring period),
- Emission reductions monitored and issued each monitoring period.

The CME will be responsible for the management of records and data associated with the proposed CPA. All data collected as part of monitoring should be archived electronically and be kept at least for 2 years after the end of the last crediting period. The database will be updated using the data supplied by the CPA implementer. It will form the basis for the verification of CPA and be available for inspection by the DOE at any point in time.

For the proposed CPA, all parameters included in section C.7.1 will be monitored by the CPA implementer, recorded electronically and provided to the CME.

Data quality

CPA implementer will implement a QA/QC procedure to ensure that data provided meet the requirements of the monitoring plan.

The data and reports provided by the CPA implementer to the CME will be checked internally to ensure the accuracy and completeness of data. In case of mistakes, corrective action will be applied to avoid future similar mistakes. If applicable, the CPA implementer will have to deliver equipment calibration (following IEC standards) certificates to the CME.

The CME will crosscheck, reconcile or consolidate data with multiple sources whenever possible. At minimum, data obtained from the electricity meters is to be crosschecked with the electricity sales receipts. This kind of reconciliation activity will be recorded properly as DOE may request for such information during the verification.

Monitoring team and training

Data collection, consolidation and results analysis will be undertaken by a dedicated team adequately trained, well aware of CDM requirements and supervised by the CME. This team will not have any hierarchical relationships or dependence links with all entities involved to measure net electricity supplied to the grid and to assure the correct operation and maintenance of the measuring equipment either within the CME and/or CPA implementers. This independence shall guarantee the integrity of the work that will be done.

SECTION E. Approval and authorization

At the time of submitting the CPA-DD to the validating DOE, the letter(s) of approval from each Party that wishes to be involved in the CPA are not available yet.

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Appendix 1: Contact information on entity/individual responsible for the CPA

Organization	**Volta River Authority**
Street/P.O. Box	28th February Road P.O. Box Mb 77
Building	Electro-Volta House
City	Accra
State/Region	-
Postcode	-
Country	Ghana
Telephone	-
Fax	+233-21-662160
E-mail	-
Website	www.vra.com/
Contact person	Abdulai Khalilu-lahi
Title	Engineer
Salutation	Mr
Last name	Khalilu-lahi
Middle name	-
First name	Abdulai
Department	Renewable Energy
Mobile	-
Direct fax	-
Direct tel.	+233 (0) 20 4544074
Personal e-mail	abdulai.khalilu-lahi@vra.com

Volta River Authority is not a project participant.

CDM consultant

ecosur afrique

Jean-Félicien Banny (CDM project Manager)
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Aurélie Lepage (COO)
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ecosur afrique is not a project participant.

Appendix 2: Affirmation regarding public funding

Not applicable.

Appendix 3: Applicability of the selected methodology(ies).

No further background information on the applicability of the selected methodology(ies).

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

Table 8 : *Detailed power generation and fuel consumption of the project electricity system*

Power plant		[MW]	Comission ning date	Type of fuel used	Annual fuel consumption [m^3]				Net power generation [GWh]					
					2007	2008	2009	2010	2005	2006	2007	2008	2009	2010
THERMAL PRODUCTION	**TAPCO**	330	1997	LCO	398,718.9	248,568.9	145,888.4	67,909.9	831.0	1,416.0	1,521.0	874.0	447.4	1,212.9
				DO	5,988.7	585.1	462.7	942.2						
				NG	-	-	-	308,428,287.5	-	-	-	-	-	
	TICO	220	2000	LCO	503,356.0	360,023.7	353,530.1	412,160.1	328.0	1,395.0	1,417.0	1,062.6	1,034.0	1,159.4
				DO	683.9	847.7	968.6	849.7						
	Mines Reserve Plant	80	Oct-07	Diesel	12,995.2	19,012.3	7,613.5	7,907.3	-	-	163.0	45.2	16.0	18.0
	Emergency R. Power Plant	55.2	May-07	Diesel	21,959.5	12,541.2	-	-	-	-	79.0	44.8	-	-
	Kumasi Res. Power Plant	20	Aug-07	Diesel	8,589.3	4,420.1	-	-	-	-	31.0	15.9	-	-
	Aggreko	25	Jul-07	Diesel	17,664.2	13,171.0	-	-	-	-	63.8	29.9	-	-
	Tema Reserve Power Plant	50	Apr-07	Diesel	47,053.0	24,152.4	-	-	-	-	39.0	70.6	-	-
	TT1PP - VRA	110	2009	LCO	-	-	173,348.0	170,537.0	-	-	-	-	568.0	586.5
				DO	-	-	692.0	2,971.5						
				NG	-	-	-	22,495,564.9	-	-	-	-	-	
	Tema Thermal Plant 2	49.5	Jul-05	DO	-	-	-	5,863.2	-	-	-	-	-	20.7
	Sunon Asogli	200	Jul-05	NG	-	-	-	38,506,309.1	-	-	-	-	-	138.0
HYDRO	**Akosombo**	1,020	1966	Hydro	Not applicable				4,714.4	4,686.4	3,101.4	5,250.7	5,836.0	5,956.2
	Kpong	160	1982	Hydro					910.3	928.3	622.3	940.9	1,035.0	1,034.4

Appendix 5: Further background information on monitoring plan

Parameter	Symbol	Unit	Recording Frequency	Calibration frequency	Accuracy	Data; measured, calculated, estimated	Location	Method	Person Recording/ Calculating / Compiling Data	Person Verifying Data
Quantity of net electricity exported by the project	$EG_{facility,y}$	MWh	Continuous measurement and at least monthly recording	According to manufacturer specification	At least ± 2%	Measured directly with electricity meter	Power converter outlet	Electricity readings will be recorded weekly on a record sheet.	Solar power plant operator	Solar power plant shift supervisor

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History of the document

Version	Date	Nature of revision(s)
02.0	EB 66 13 March 2012	Revision required to ensure consistency with the "Guidelines for completing the component project activity design document form" (EB 66, Annex 16).
01	EB33, Annex42 27 July 2007	Initial adoption.
Decision Class: Regulatory **Document Type:** Form **Business Function:** Registration		