Component project activity design document form

(Version 08.1)

Complete this form in accordance with the instructions attached at the end of this form.

BASIC INFORMATION	
Title of the CPA	ASYV 8.5MW Solar PV Project (CPA-001)
Scale of the CPA	☐ Large-scale ☒ Small-scale
Version number of the CPA-DD	Version 07
Completion date of the CPA-DD	14/11/2017
Title and UNFCCC reference number of the registered CDM PoA	Gigawatt Global Programme of Activities PoA 10202 :
Title and reference number of the corresponding generic CPA	ASYV 8.5MW Solar PV Project (CPA-001) CPA 10202-0001
Coordinating/managing entity	Gigawatt Global Coöperatief U.A.
Host Party	Rwanda
Applied methodologies and standardized baselines	AMS-I.D Grid connected renewable electricity generation (version 18.0).
Sectoral scopes linked to the applied methodologies	Scope 1: Energy industries (renewable- / non-renewable sources)
Estimated amount of annual average GHG emission reductions	10,081 tCO_2e

1. Description of component project activity (CPA)

A.1. General description of CPA

The ASYV 8.5MW Solar PV project (CPA-001) forms part of the Gigawatt Global Programme of Activities, which seeks to promote grid connected renewable energy projects in Rwanda. The CPA falls under CPA type I "Greenfield small-scale solar PV power plants/units in Rwanda applying automatic additionality", which is one of the five CPA types eligible for inclusion under the PoA.

The proposed CPA will install a new renewable energy power plant at a site where none existed prior to the implementation of the project activity (Greenfield plant). The CPA is located in Rwamagana District, Rubona Sector, Karambi cell at the Agahozo-Shalom Youth Village (ASYV), approximately nine kilometres from the main Kigali-Kagitumba highway. The site is about 50km from Kigali, Rwanda's capital.

The CPA will use solar photovoltaic (PV) modules with a single axis tracking system. The CPA is expected to have a peak output capacity of 8.5 MWp consisting of 28.360 solar PV modules and covering 16 hectares.[1] The project is expected to have an annual average net electricity generation of 15,275 MWh for the first crediting period and 15,552 MWh for the first year of operation. A plant load factor of 20.88 % is expected during the first year of operation.

Electricity generated will be evacuated to the Rwandan national electricity grid via the utility company owned transmission lines. The CPA will therefore achieve CO_2 emission reductions by displacing electricity generated by fossil fuel powered plants connected to the national electricity grid. The project is expected to achieve average annual emission reductions of about 10,081 tCO_2e during the first crediting period, and a total of 70,567 tCO_2e for the first crediting period.

The implementation of the CPA under the Gigawatt Global programme of Activities, is expected to contribute to sustainable development in the following ways:

- The project is expected to provide reliable electricity to the national electricity grid. This is in line with Rwanda's Vision 2020, which places infrastructural advancement and energy generation as one of the pillars that are necessary in transforming Rwanda to a middle income earning economy.[2]
- The project is expected to provide local employment opportunities during the construction and operation phase.
- The project will improve the hydrocarbon trade balance through reduction of oil imports used for electricity generation.
- The project will result in the transfer of state-of-the art technology in utility scale power generation from solar PV sources to the Rwandan population. The transfer of technology and know-how will be directly replicable to other future solar PV energy projects.

A.2. Location of CPA

The project is located in Rwamagana District, Rubona Sector, Karambi cell at the Agahozo-Shalom Youth Village (ASYV), approximately nine kilometres from the main Kigali-Kagitumba highway and about 50 km from Kigali.

[1] Feasibility Study for Solar PV power plant in Rwanda (2012)

[2] Republic of Rwanda (2000), Rwanda Vision 2020

The table and diagram below shows the geo-coordinates and location of the project site respectively.

Table 1: Project location coordinates

Latitude	Longitude
- 2.024050°	30.377978°
- 2.027697°	30.379181°
- 2.028694°	30.375042°
- 2.026692°	30.374444°

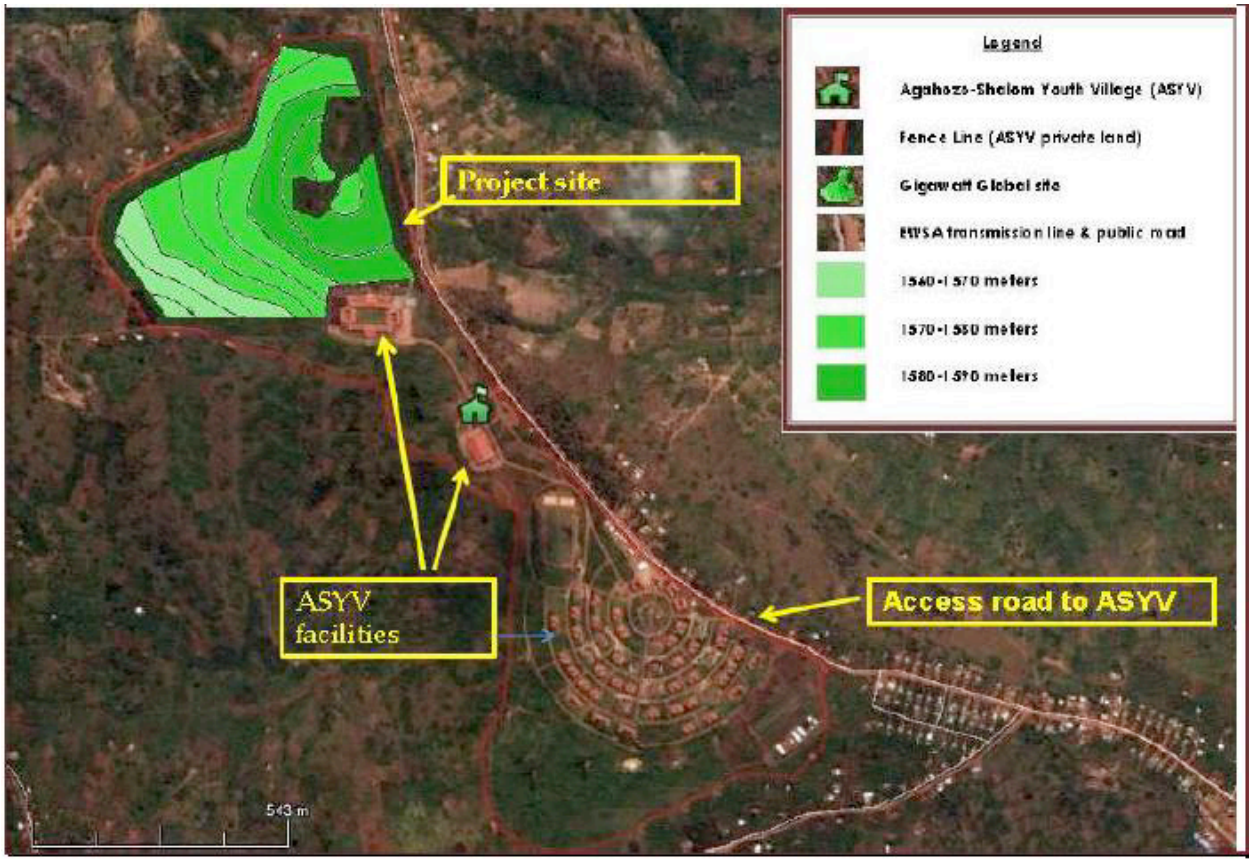

Figure 1: Location of the CPA

A.3. Technologies/measures

The purpose of the project is the installation of an 8.5MWp solar PV power plant in ASYV that will supply an annual average of 15,275 MWh of clean electricity to the Rwandan national grid.

The major milestones achieved during the implementation of the project activity are summarized in the table below.

Milestone	Date	Documentary Evidence
Agreement reached between the Government of Rwanda and Gigawatt Global Rwanda Ltd.	5 November 2012	MoU with the Government of Rwanda
Conclusion of the Environmental Impact Assessment	November 2012	Environmental Impact Assessment Report
Feasibility Studies for the project is finalized	28 December 2012	Feasibility Studies Report.
Approval of the Environmental Impact Assessment	9 January 2013	EIA Licence from Rwanda Development Board

CDM and Gold Standard Local Stakeholder Consultation	10 February 2014	LSC report
Financial close (CDM Start Date)	14 February 2014	Financial close documents

An overview of the energy and mass flows and balances of the systems and equipment included in the CPA can be introduced with the conversion of radiation from the sun into electrical energy in direct current (DC) form, by the solar modules. The DC electricity is then collected via the DC distribution network comprising of an interconnection of solar modules in series and parallel. Inverters receive the DC current from the distribution network and convert it to an alternating current (AC), which is grid compatible. The resulting current is fed into transformers for a step-up to the required voltage for evacuation to the Rwandan National Grid. Measurement of electricity supplied to the Rwandan National Grid is done using electricity meters located at the interconnection point and remotely monitored continuously by the utility company through a supervisory control and data acquisition (SCADA) system.

A more detailed description of the systems and equipment together with the energy and mass flows and balances is given as follows:

Solar PV technology

The solar photovoltaic cells, also known as the solar cells, are used to convert solar energy into electrical energy. The solar cells, which are the basic elements of a solar module, are made of a special class of materials called semiconductors. Solar PV modules are typically composed of solar cells in series, parallel or a combination of series and parallel, in order to obtain a desired final power, current, and voltage. The number of solar cells in crystalline modules varies typically between 36 and 72 cells. The output current of a solar cell directly relates to the incoming irradiation: The higher the irradiation, the more electron-hole pairs are produced and therefore the current increases and more electricity is produced. These cell connections comprise of positive and negative wiring terminals allowing for the electricity generated to be channelled to end-users. As long as sunlight is available, the electrons will keep flowing and can deliver electrical energy to a load that's connected to the circuit.

Technical specifications of the main equipment

According to the Energy Yield Assessment report, the CPA will comprise of polycrystalline silicon PV modules, of the BYD 300P6C-36 type, rated 300Wp at STC[3] conditions. 28,360 of such modules will be connected in series consisting of 20 PV modules to form 1,417 strings of parallel connections and produce a nominal capacity 8,502 kWp.[4] The single axis tracking system design is used to minimize the angle of incidence between the incoming sunlight and a photovoltaic panel thereby increasing the amount of electricity generated per fixed amount of nominal installed capacity. The P50 forecast of electricity generation for the first year of production is 15,552 MWh. A degradation factor of 0.60%[5] is afterwards used to approximate the amount of electricity generated in subsequent years.

The table below highlights the solar PV module characteristics:

Table 2. Solar PV module specifications

Parameter	Value
PV Module type	Si-Poly

[3] STC: Standard Test Conditions

[4] In the context of this CPA, nominal capacity is determined in accordance with the nameplate manufacturer specifications (DC). The capacity therefore excludes any related losses related to conversion of the power to AC.

[5] See Light Induced Degradation under **Table 5: Energy Yield**

PV Model	BYD 300P6C-36
Manufacturer	BYD
Rated Nominal Capacity	300Wp
Number of modules	28,360
Operating Voltage	600-850 V
Array Efficiency (STC)	15.47%
Array Nominal Capacity	8,502 kWp
Array operating characteristics	646 V, 11812 A
Lifetime	25 years

Source: Energy Yield Assessment Report

Direct solar radiation constitutes the major source of solar energy that can be captured by solar photovoltaic modules. Since the sun keeps changing its relative position during the day, the angle by which the direct sun rays hit the solar panels also keeps changing resulting in energy losses especially in the morning and evenings. Rotating the panels by use of solar trackers help to minimize the angle of incidence between the incoming sunlight and a photovoltaic panel thereby increasing the amount of energy produced from a fixed amount of installed power generating capacity. A single axis tracker system, rotating from East to West depending on the position of the sun will be used for this CPA.

The table below highlights the characteristics of the tracking system:

Table 3. Tracking system specifications

Tracking plane, tilted Axis	Axis tilt 0°	Axis azimuth 0°
Minimum limitations	Minimum Phi: -45°	Maximum Phi: -45°
Backtracking strategy	Tracker Spacing: 950 m	Collector width: 3.92m
Inactive band	Left: 0.10 m	Right: 0.10 m

Source: Energy Yield Assessment Report

The figure below shows the schematic mounting structure of the proposed CPA:

Figure 2: Mounting structure of the CPA

Apart from the module technology, the other vital component of the power plant is the DC distribution system. The DC distribution system is comprised of cabling, connectors, fuses, switches, over voltage and lightning protection, current sensing devices and enclosures. The distribution system is critical since it determines the final electrical output from the PV modules. The CPA DC distribution system has been designed to keep losses arising from cabling to a maximum of 1.5% at Standard Test Conditions. This is reached by using proven design topography for cable routing and box design.

The inverter receives the direct current (DC) from the DC distribution and converts it to alternating current (AC) utility grade electricity and feeds it to the grid. The inverter model to be used in the

CPA is the Sunny Central 900CP XT_25degree type with characteristics as shown in the table below:

Table 4: Inverter specifications

Parameter	Value
Inverter Model	Sunny Central 900CP XT_25degree
Manufacturer	SMA
Operating voltage	600-850 V
Number of inverters	8
Unit nominal capacity	990 kW AC
Total nominal capacity	7,920 kW AC

Source: Energy Yield Assessment Report

Energy Yield Assessment

The following data is a summary of the data used for the calculation of the energy delivered to the national grid:

Table 5: Energy Yield

Annual global incident in collector plane	1,860 kWh/m2
Collector area	54,990 m2
Horizontal global irradiation global incident in coll. plane	+21.8%
Near shading: irradiance losses	-2.4%
IAM factor on global	-1.8%
Array soiling losses	-1.5%
Effective irradiance on collectors	2,136 kWh/m2 * 54,990 m2 coll.
Efficiency at STC	15.47%
PV loss due to irradiance level	-0.2%
PV loss due to temperature	-7.9%
Shadings: Electrical Loss acc. to strings	-2.0%
Module quality loss	+0.5%
Light Induced Degradation	-0.6%
Module array mismatch loss	-0.5%
Ohmic wiring loss	-1.2%
Inverter loss during operation	-1.8%
Inverter Loss over nominal inv. power	0.0%
Inverter Loss due to power threshold	0.0%
Inverter Loss over nominal inv. voltage	0.0%
Inverter Loss due to voltage threshold	-0.2%
AC Ohmic loss	-0.3%
External transformer loss	-0.9%
Net energy yield output first year	15,552 MWh
Plant load factor for the first year	20.88%

Source: Energy Yield Assessment Report

Transmission system

The transmission system will comprise of all the transmission lines and infrastructure, which aids in the connection of the project site to the Rwandan National Grid. The project was previously designed to be connected to the existing utility owned 15 kV Karenge transmission line which connects to the Musha substation which thereafter connects to the Rwandan National Grid via a 70kV transmission line. However, in order to minimize losses due to transmission inefficiencies, the utility company has since built a new 15 kV dedicated transmission line connecting Musha substation to the project. The project will be integrated into the existing supervisory control and data acquisition (SCADA) system allowing for continuous monitoring from the utility end and

enhance communication with the utility through a cellular modem. **Figure 3** below shows the schematic diagram of the power plant.

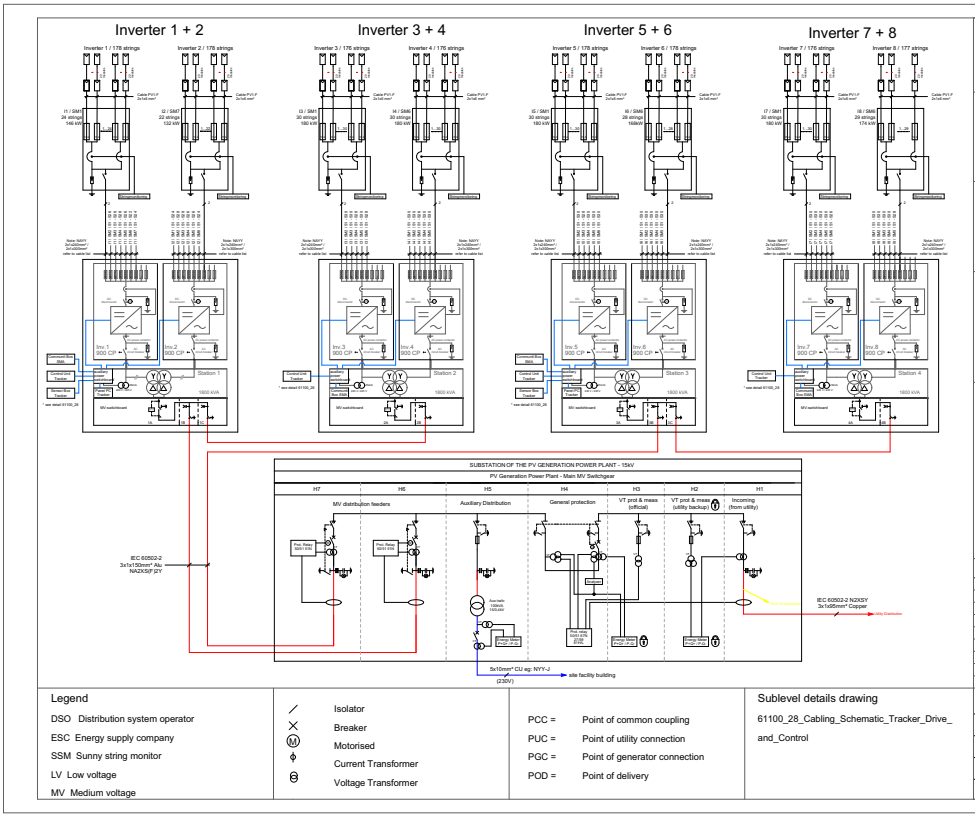

Figure 3: Schematic layout of the power plant

Metering system

The metering equipment installed at the CPA site is in line with the provisions of the Power Purchase Agreement and the Rwandan Electricity Grid Code. The Metering Installation has been installed at the Interconnection Point, at a voltage of 15 kV, and has a main electronic meter that can be remotely interrogated, which has an electronic communication link and which is connected to the metering database of the Transmission Metering Administrator (TMA) or Distribution Metering Administration (DMA).

More information on the metering equipment is found in section B.5.3.

The emissions sources and greenhouse gases involved include CO_2 emissions from electricity generation by fossil fuel fired power plants that is displaced due to the project activity. The ASYV 8.5MW solar PV project will displace 15,275MWh of electricity generated by grid-connected fossil fired plants on average during every year of the first crediting period and hence reduce 10,081 tCO_2e on average annually.

Transfer of environmentally safe and sound technology will take place through the introduction of state-of-the-art solar tracking technology and applicable inverters from Germany and the United States of America (USA) respectively, to Rwanda. Transfer of know-how will take place through the training of local engineers and other technical staff by the EPC contractor and the Operations and Maintenance contractor with the support of the manufacturer.

In accordance with simplified baseline and monitoring methodology AMS-I.D (version 18.0) *Grid connected renewable electricity generation*, the baseline scenario is “the 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 into the grid".

The scenario existing prior to the implementation of the CPA is considered the same as the baseline scenario.

By June 2013, the total installed capacity in Rwanda reached 110 MW[6]. The country's electricity generation was dominated by thermal power, accounting for about 52.08 MW of the total generation followed by hydropower at 42.13 MW. Electricity imports from the regional countries accounted for about 15.5 MW. Of this capacity, grid connected solar accounted for only 0.25MW,[7] which represents less than 0.3% of the total installed capacity. However, the available capacity fluctuated between 80MW and 92 MW.

Generation from thermal sources, accounting for more than half the national generation mix, directly translates to high cost of fuel consumption estimated at $40 million annually with an average electricity cost of diesel generation of USD 0.26/kWh compared to an overall global average of USD 0.14/kWh, [8] forcing the government to provide electricity subsidies in order to keep the tariff comparable with the regional average of about USD 0.12- USD 0.18. [9] The high costs of thermal electricity are attributed to high costs of transporting fossil fuels by road from Mombasa to Rwanda via Uganda.

This information on Rwanda energy generation mix is summarised in **Table** and Figure 4 below as follows:

Table 6: Installed capacity by type in Rwanda

Generation Type	Installed Capacity (MW)
Thermal	52.08
Hydro	42.13
Imports	15.5
Solar PV	0.25
Total	109.96

[6] RURA annual report 2012-2013

[7] Electricity data provided by EWSA for the period 2009 -2013

[8] http://www.ewsa.rw/index.php/En/products-services/energy/introduction-energy;Accessed on 18 December 2014

[9] Rapid Assessment of a National Energy and Low Carbon path for Rwanda (May 2009)

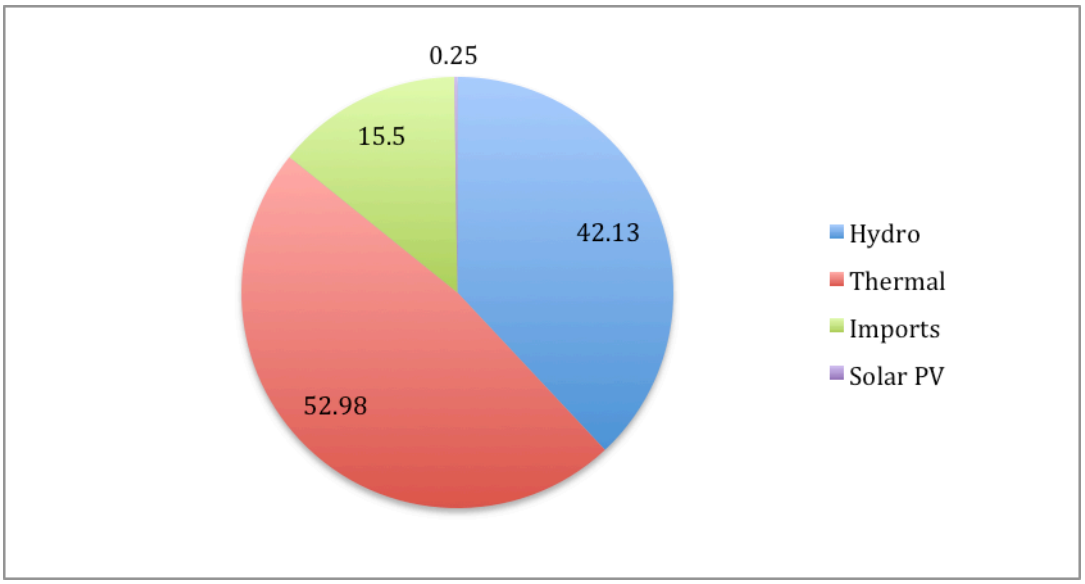

Figure 4: Rwanda's installed grid electricity capacity by type

Further information on the baseline is provided in section B.3 of the CPA-DD.

A.4. Coordinating/managing entity

Name of CPA Implementing Entity: Gigawatt Global Rwanda Ltd.
Postal Address: P.O. Box 6463, Kigali, Rwanda
Email: chaim.motzen@gigawattglobal.com
Tel: +31 (20) 893 2720

A.5. Parties and CPA implementers

Parties involved	CPA implementers	Indicate if the Party involved wishes to be considered as CPA implementer (Yes/No)
Rwanda (host)	Gigawatt Global Rwanda Ltd.	

A.6. Public funding of CPA

The CPA Implementing Entity received funding from the Energy and Environment Partnership, which is funded by public funds from the UK, Finland and Austria. However, there was no precedent condition that credits coming out of the project be transferred, directly or indirectly, to the donor country requirements. A confirmation letter from the Energy and Environment Partnership has been provided as proof that no carbon credits will be transferred to any of the Annex I countries that are providing the funding.

Therefore, it can be demonstrated that the public funding will not result into diversion of ODA funding.

A.7. History of CPA

The CPA has not been registered as a single CDM project activity nor is it part of another registered PoA. Prior to registering of the CPA, the CME has checked the CDM project database to

confirm the project has not been registered as a single CDM project. The CME has also confirmed that there is no geographical overlap between the CPA and another single CDM project or CPA of the same type as described in the management system, section C of the PoA-DD.

A.8. Debundling

The CPA is not a debundled component of a large-scale project activity or CPA as shown in the eligibility for inclusion criteria in section F of the CPA-DD

2. Application of selected methodologies and standardized baselines

2.1. Reference to methodologies and standardized baselines

Small-scale CPAs included in the PoA will apply approved baseline and monitoring methodology AMS-I.D *Grid connected renewable electricity generation* (version 18.0).

AMS-I.D (version 18.0) also refers to the latest versions of the following methodological tools:

- *Tool to calculate the emission factor for an electricity system (version 04.0)*
- *Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion (version 02)*
- *Tool to determine the remaining lifetime of equipment (version 01)*
- *Project and leakage emissions from biomass (version 02.0)*
- *Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period (version 03.0.1)*

CPAs included under this PoA will not apply the *Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion (version 02),* since no on-site fossil fuel consumption will take place. The *tool to determine the remaining lifetime of equipment* will not be applied since the project activity is of Greenfield type and the *Project and leakage emissions from biomass* is not applied since the project activity does not involve biomass cultivation. In addition, the tool for the *Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period* will not be applied since this is the first crediting period of the CPA.

Therefore, for the first crediting period, only the *Tool to calculate the emission factor for an electricity system* will be applied by the individual CPAs.

2.2. Project boundary, sources and greenhouse gases (GHGs)

According to the approved small-scale methodology AMS-I.D *Grid connected renewable electricity generation* (version 18.0), “The spatial extent of the project boundary includes the project power plant and all power plants connected physically to the electricity system that the CDM project power plant is connected to.”

The project power plant and all power plants physically connected to the Rwandan National Grid system constitute the project boundary for this project.

The greenhouse gases and emission sources included in or excluded from the project boundary are shown in the tables below. The figures below provide flow charts of the equipment and systems, emissions sources and gases included in the project boundary as well as the monitoring variables in the project boundary of the CPA.

	Source	GHG	Included?	Justification/Explanation
Baseline	CO_2 emissions from electricity generation in fossil fuel fired power plants that are displaced due to project activity	CO_2	Yes	Main emission source as per AMS-I.D and the *Tool to calculate the emission factor for an electricity system*
		CH_4	No	Not applicable as an emission source under AMS-I.D
		N_2O	No	Not applicable as an emission source under AMS-I.D
Project activity	CO_2 emissions from combustion of fossil fuels for electricity generation in the case of a combination of non-renewable and Solar PV units/plants.	CO_2	No	No on-site fossil fuel consumption will take place. Therefore no emissions as per AMS-I.D and the *Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion*
		CH_4	No	
		N_2O	No	
	For geothermal power plants, fugitive emissions of CH_4 and CO_2 from non-condensable gases contained in geothermal steam	CO_2		Geothermal power plants are not included in this CPA. The CPA is solar PV based
		CH_4		
		N_2O		
	CO_2 emissions from biomass sourced from dedicated plantations	CO_2	No	No biomass is involved in this CPA. The CPA is solar PV based
		CH_4	No	
		N_2O	No	
	For hydro power plants, emissions of CH_4 from the reservoir	CO_2	No	No emissions since the uses solar PV technology
		CH_4	No	
		N_2O		

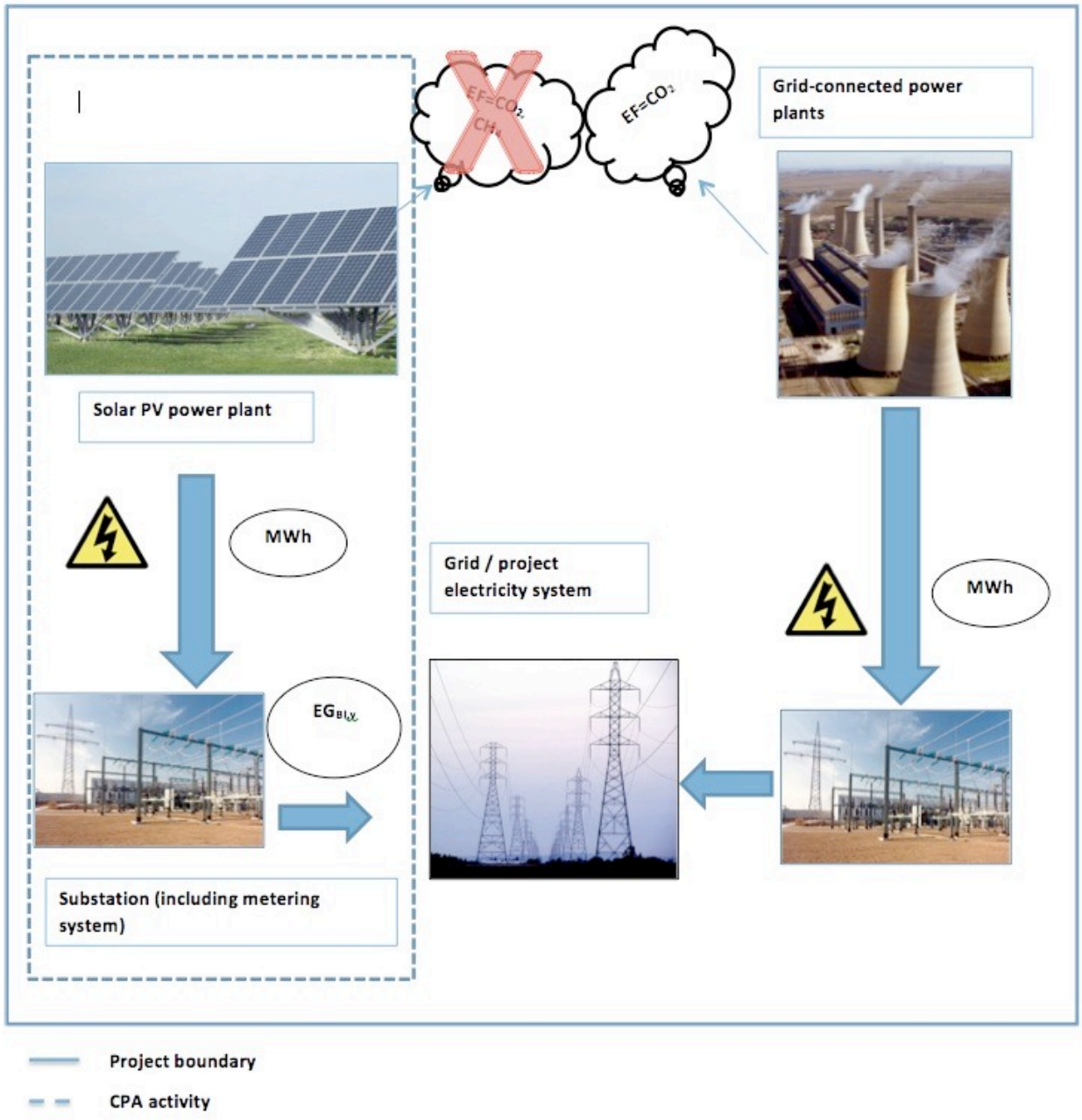

Figure 5: Flow diagram delineating the CPA boundary

2.3. Establishment and description of baseline scenario

In accordance with the simplified baseline and monitoring methodology AMS-I.D (version 18.0) *Grid connected renewable electricity generation*, the baseline scenario is "the 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 into the grid".

Structure of the Rwanda Power sector

The power sector in Rwanda lies under the Ministry of Infrastructure (MININFRA), which has the primary responsibility of policy formulation and strategy setting for the energy sector, and for

coordinating developments in the electricity sub-sector.[10] The Government of Rwanda (GoR) launched the Economic Development and Poverty Reduction Strategy II (EDPRS II), 2013 - 2018, with an aim to boost economic growth.[11] Increasing the supply, access and stability of electricity have been identified as some of the core pillars for achieving this stated objective and increasing electricity generation from renewables has been particularly emphasized.[12]

The Rwanda Utilities Regulatory Authority (RURA) is the body that is tasked to oversee the energy sector together with other sectors in telecommunications, water, waste and transport. RURA was established on 13/01/2001 through the adoption of Law N°39/2001. This Law was further reviewed and replaced by Law Nº 09/2013 of 01/03/2013, which further amended its mission, powers, organization and functions specifically in the energy sector. RURA is mandated to control and regulate electricity generation, transmission and distribution in order to ensure efficiency and sustainability in the sector. As such, it plays a supervisory role by among other things, granting licenses for generation, transmission and distribution of electricity in Rwanda.[13]

Apart from MININFRA and the Rwanda Utilities Regulator (RURA), the utility company, the newly established utility company, the Rwanda Energy Group Limited (REG)[14] is the other key player in the energy sector. The 100% state owned company is the largest electricity generator accounting for over 90% of the total electricity generated and also responsible for transmission, distribution and supply of electricity in Rwanda.[15]

Since the early 2000, Rwanda has gradually moved towards power sector reforms focusing on deregulation and gradual reduction of government participation in the electricity sector. Power sector reforms have taken different paths but have typically involved the passing of electricity laws, the establishment of a regulatory body overseeing the power sector, some form of unbundling of the power sector and the introduction of Independent Power Producers (IPPs). Rwanda has also introduced Feed-in-Tariff policies starting with small hydro projects with the rest of renewable energy technologies to be included in future. The Renewable Energy Feed-in-Tariff (REFIT) adopted in 2012, is a direct result of the governments Green Growth Strategy adopted in 2011 to foster the uptake of renewable energy in the national grid.[16]

Previously, EWSA was responsible for providing both electricity and water thereby hindering its ability to make real progress in improving energy supply in Rwanda. As a consequence, the company was separated into two entities in July 2014, namely, Rwanda Energy Group Ltd (REG) and the Water & Sanitation Corporation Ltd (WASAC) with different and independent roles in providing energy and water services respectively. This move is expected to promote efficiency and transparency in the generation and distribution of electricity in Rwanda.

Installed Generation Capacity

Rwanda's installed capacity has increased significantly from a mere 25MW in 1994 to 110MW in 2013.[17] The five-year average[18] of the national electricity generation mix is dominated by thermal sources (58.7%), hydro (41.2%) and the remaining 0.1% for solar PV.

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[10] http://www.mininfra.gov.rw/Mission and Purpose ; Accessed on 18 December 2014

[11] Economic Development and Poverty Reduction Strategy II (EDPRS II)

[12] Republic of Rwanda (2000), Rwanda Vision 2020

[13] www.rura.rw/about-rura/; Accessed on 18 December 2014

[14] Formerly the utility company was Energy Water and Sanitation Company (EWSA)

[15] www.reg.rw/home; Accessed on 18 December 2014

[16] www.rura.rw; Accessed on 18 December 2014

[17] http://www.ewsa.rw/index.php/En/products-services/energy/introduction-energy; Accessed on 18 December 2014

By June 2013, the total installed capacity in Rwanda reached 110MW[19]. The country's electricity generation was dominated by thermal power accounting for about 52.08 MW of the total generation followed by hydropower at 42.13 MW. Electricity imports from the regional countries accounted for about 15.5 MW. However, the available capacity fluctuated between 80MW and 92 MW. Of this capacity, grid connected solar accounted for only 0.25MW,[20] which represents 0.1% of the total installed capacity.

According to the former utility company, EWSA, generation from thermal sources accounting for more than half the national generation mix, directly translated to high cost of fuel consumption estimated at USD 40 million annually and an average electricity cost of USD 0.26/kWh.[21] This average electricity costs in Rwanda is almost double the overall global average of USD 0.14/kWh.[22] The Rwandan government has consequently been forced to provide electricity subsidies in order to keep the tariff comparable with the regional average.

This information on Rwanda energy generation mix is summarised graphically as follows:

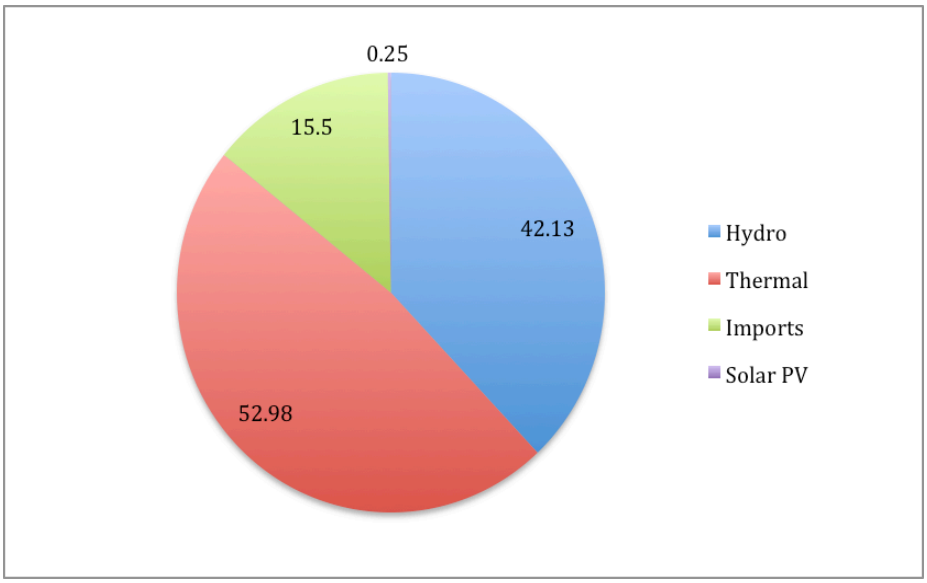

Figure 6: Installed grid electricity capacity by type in Rwanda

Future Generation

Rwanda's electricity consumption constitutes only 4% of the overall primary energy consumption with biomass forming the largest proportion at 85% and petroleum accounting for 11%.[23] On one hand, these percentages present the electricity subsector as the least developed in the energy sector while on the other hand, the figures illustrate a high dependency on wood fuel in Rwanda.

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[18] Electricity data provided by EWSA for the period 2009 -2013

[19] RURA annual report 2012-2013 reports 110MW. However electricity data from the utility company (used in the GEF spread sheet) indicates the capacity to be about 127.45 MW. The former has been used since its publicly available information while data from EWSA is not.

[20] Electricity data provided by EWSA for the period 2009 -2013

[21] http://www.ewsa.rw/index.php/En/products-services/energy/introduction-energy; Accessed on 18 December 2014

[22] Rapid Assessment of a National Energy and Low Carbon path for Rwanda (May 2009)

[23] RURA Annual Report 2012/2013, Page 77

The GoR recognizes that the availability of reliable power supply is a pre-requisite for economic growth, social prosperity, as well as human development. The government, therefore, aims at increasing and diversifying electricity generation in the country through a rollout programme that will rapidly increase supply. Already some positive results have been posted following the implementation of the initial phase of the government initiative and increasing electricity access by a remarkable 160% between the year 2008 and 2011.[24] Nonetheless, only 16% (350,000) of Rwanda's households are connected to the grid as shown in the table below. In this regard, the government has revised its target to expand electricity access to households to approximately 70% by 2017.[25] The expansion plan is aimed at increasing the electricity generation capacity by an additional 1000MW in 2017[26] and 1300MW by 2020.[27] The 1,000MW additional installed capacity in 2017 will comprise of 340 MW of hydropower, 310MW of geothermal power, 300MW of natural gas (methane-based) power, 200MW of peat-based power and 20MW of diesel thermal plants and 5 MW from solar PV.[28]

The table below shows the growth in electricity service from the year 2000 to 2012:

Table 7: Growth in electricity service (2000 - 2012)

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Peak Load (MW)								47	51	56	64	78	92
Sales (GWh)	204	209	225	235	204	194	230	249	277	308	353	417	
Losses			35				22	18	18	20	19	19	
No. of customers '000	49	49	58	67	68	70	77	86	109	140	175	280	350
Access %									4	8	13	14	16

Source: EWSA

Table 8: Target Capacity Additions in Rwanda by 2017

Generation type	Target installed capacity (MW)
Peat	200
Geothermal	310
Hydro Power	340
Methane	300
Diesel	20
Solar	5[29]
Total	1,175

[24] Rwanda Energy Sector Review and Action Plan (2013), Page 31

[25] Rwanda Energy Sector Review and Action Plan, Page 8

[26] Energy Policy and Strategy, page 54

[27] Energy Policy and Strategy, page 52

[28] The summation of these capacities yield about 1,175MW against the indicated 1000MW. Other sources indicate a capacity target of 20MW for solar PV in Rwanda. We have however chosen to stick with the capacity target as documented in the policy document.

[29] The Electricity policy and strategy indicates 5 MW although other sources indicate 20MW. The later has been picked since its more realistic. Besides, the Rwanda development Board lists two solar PV projects of 10MW each to be under development.

Year	Based on EDPRS and Vision 2020			Based on Targets Set in 2010 by the New Government		
	Access (%)	Installed Capacity (MW)	Energy (GWH)	Access (%)	Installed Capacity (MW)	Energy (GWH)
2008	6.0	45	225.0	6.0	45	225
2010	11.0	85	353	11.0	85	353
2015	22	200	965.5	35.0	800	1200
2017	28.0	300	1,200.0	50.0	1000	1400
2020	32	400	1,478.0	90	1200	1950
2025	40.0		2,148.4	94.0	1500	3300

Figure 7: Vision 2020 vs. New Electricity generation targets

Source: Electricity Master Plan (2011), Seven-Year Electricity (2011)

2.4. Estimation of emission reductions

2.4.1. Explanation of methodological choices

>>

This CPA will focus on grid-connected renewable electricity generation from solar power. This CPA will include project activities that install a new power plant at a site where there was no renewable energy power plant operating prior to the implementation of the CPA (Greenfield plant).

This CPA will not include the combination of both renewable and non-renewable components (e.g. a solar PV/diesel unit).

The emission factor of the grid is calculated in a transparent and conservative manner using the combined margin (CM) consisting of the operating margin (OM) and build margin (BM) according to the procedures described in the *Tool to calculate the emission factor for an electricity system* (version 04.0).

Baseline emissions

The baseline emissions for small-scale solar PV CPAs are the product of electrical energy baseline $EG_{PJ,y}$ expressed in MWh of electricity produced by the renewable generating unit multiplied by the grid emission factor.

The baseline emissions (BE_y) are calculated using **equation (1)** of AMS-I.D version 18.0:

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

Where:

BE_y	=	Baseline Emissions in year y (t CO_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)

$EF_{grid,y}$ = 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" (t CO_2/MWh)

As per AMS-I.D (version 18.0):

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

Where:

$EG_{facility,y}$ = 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)

Calculation of $EF_{grid,y}$

The emission factor is calculated in a transparent and conservative manner using option (a), the combined margin (CM), consisting of the combination of operating margin (OM) and build margin (BM) according to the procedures described in the *Tool to calculate the emission factor for an electricity system* (version 04.0). Therefore:

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

The grid emission factor is calculated for the Rwandan electricity system. Equations and source of data to calculate the grid emission factor for Rwanda are provided below.

Step 1. Identify the relevant electric power system

For calculating the grid emission factor, the project activity has identified the Rwandan national grid as the relevant project electricity system.

The identification of the Rwandan national grid as the relevant project electricity system is based on the following arguments:

- The Rwandan DNA has not published a delineation of the project electricity system and connected electricity system.
- There are no spot markets in the Rwandan grid system
- Although the Rwandan grid is connected to a number of its neighbouring countries' grids including Uganda, Burundi and DRC Congo, there is no data available to provide proof of the existence of significant transmission constraints by means of the application criteria, therefore the application criteria does not result in a clear grid boundary. Those countries will however be considered as connected electricity systems and the electricity imported into the Rwandan grid (project electricity system) will be included as imports.
- Finally, Rwanda does not have a layered dispatch system and the country has only one grid system that serves the entire country. Therefore, and in line with version 04.0 of the *Tool to calculate the emission factor for an electricity system*, the national grid definition is used by default.

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

The project activity has selected Option I; only grid power plants are included in the calculation.

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

The *Tool to calculate the emission factor for an electricity system* provides for the following methods to determine the operating margin (OM):

a) Simple OM
b) Simple adjusted OM
c) Dispatch data analysis OM
d) Average OM

In Rwanda, low-cost/must-run resources, which are mainly hydro, constitute less than 50% of total grid generation; therefore, simple OM method is used.

The CPA has used the *ex-ante* option and the OM will be calculated once at the validation stage using a three years generation-weighted average.

Step 4: Calculate the operating margin emission factor according to the selected method

The simple OM emission factor is calculated as the generation-weighted average CO_2 emissions per unit net electricity generation (t CO_2/MWh) of all generating power plants serving the system, not including low-cost/must-run power plants/units. The OM emission factor calculation includes electricity imports from the connected grid systems and the OM emission factors of the respective exporting grid systems. According to the data from the Rwandan government[30], about 97% of the imports are derived from DRC while the rest is derived from other grid systems. Since DRC is part of the South African Power Pool (SAPP), the OM emission factor from the approved SAPP Standardised Baseline has been applied by default for DRC's grid while the other grids apply an emission factor of 0 in accordance with the tool and as a conservative approach.

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

Option A: Based on the net electricity generation and a CO_2 emission factor of each power unit; or,
Option B: Based on the total net electricity generation of all power plants serving the system and the fuel types and total fuel consumption of the project electricity system.

Option A has been chosen to calculate the operating margin emission factor of power plants serving the grid.

The Simple OM emission factor is calculated using equation 1 as follows:

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

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 grid 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

Determining $EF_{EL,m,y}$

[30] Refer to the 4th submission to the UNFCCC for Rwanda's Grid Emission Factor dated 18 June 2015.

For the calculation of the emission factor for each power plant *m*, option A1 has been selected as fuel consumption is normally provided. Therefore, equation 2 will be used as follows:

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

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 fuel type *i* consumed by power unit *m* in year *y* (Mass or volume unit)
$NCV_{i,y}$	=	Net calorific value (energy content) of fuel type *i* in year *y* (GJ/mass or volume unit)
$EF_{CO2,i,y}$	=	CO_2 emission factor of 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 fuel types combusted in power unit *m* in year *y*
y	=	The relevant year as per the data vintage chosen in Step 3

However, there were instances where there was missing data on the fuel consumption amounts, and therefore, option A.2 was also selected and therefore equation 3 used as follows:

Where several fuel types are used in the power unit, the fuel type with the lowest CO_2 emission factor for $EFCO_2,m,i,y$ is required to be used. In the case of the CPA, only one fuel type is used.

$$EF_{EL,m,y} = \frac{EF_{co2,m,i,y} \times 3.6}{\eta_{m,y}}$$

Where:

$EF_{EL,m,y}$	=	CO_2 emission factor of power unit *m* in year *y* (t CO_2/MWh)
$EF_{CO2,m,i,y}$	=	Average CO_2 emission factor of fuel type *i* used in power unit *m* in year *y* (t CO_2/GJ)
$\eta_{m,y}$	=	Average net energy conversion efficiency of power unit *m* in year *y* (ratio)
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

Determination of $FC_{i,m,y}$

Amount of fuel type *i* consumed by power unit *m* in year *y* (Mass or volume unit) was based on published records from EWSA and IPP power plants.

Name	Type	Fuel Consumption data (litres/year)		
		2011	2012	2013

Jabana	Diesel	2,988,840	1,675,624	1,413,304
Jabana II	HFO	18,850,392	24,498,642	20,348,141
Jabana II	Diesel	3,361,018	230,306	2,958,461
Gatsata	Diesel	-	-	-
Aggreko I Gikondo	Diesel	20,953,916	22,346,911	22,259,941
Aggreko II Mukungwa	Diesel	-	1,929,305	17,237,416
Methane Gas	Methane gas	-	-	-

Determination of $EG_{m,y}$

For grid power plants, $EG_{m,y}$ is based on published records and data obtained directly from EWSA and IPP power plants together with publicly available data from the government entities. The grid emission factor calculations are based on the publicly available data in Rwanda, i.e. EWSA and IPP power plants which represents the total electricity generated in the Rwandan grid.

		Generation data (MWh)		
Name	**Type**	**2011**	**2012**	**2013**
Jabana I	Thermal	11,506.71	6,373.20	5,041.39
Methane Gaz	Thermal	6,110.21	8,826.16	9,937.59
Jabana II	Thermal	97,794.96	106,122.91	97,451.52
Gatsasa	Thermal	-	-	-
Aggreko I Gikondo		80,458.07	82,222.77	85,629.86
Aggreko Mukungwa (old)	Thermal	-	7,682.80	67,759.45
Aggreko Mukungwa (new)	Thermal	-	-	-
Imports – DRC	Imports	72,870.02	88,120.17	90,486.81
Imports – Other grids	Imports	2,253.71	2,725.372	2,798.56

Name	**Type**	**$EG_{m,y}$ (MWh/y)**				
		2009	**2010**	**2011**	**2012**	**2013**
Gihira	Hydro	5,666.00	4,652.50	2,860.22	10,546.20	9,330.22
Gisenyi	Hydro	1,219.63	0.00	991.52	3,691.48	4,850.37
Ntaruka	Hydro	29,413.00	39,849.20	30,840.64	45,904.52	23,323.00
Mukungwa	Hydro	62,599.70	67,073.52	68,466.77	77,928.03	71,468.15
Murunda	Hydro	0.00	435.48	1,183.39	554.30	624.87
Rukarara	Hydro	0.00	0.00	34957.14	34556.30	3,2870.36
Rugezi	Hydro	0.00	0.00	4395.78	2007.78	834.73
Keya	Hydro	0.00	0.00	4043.80	503.20	682.68
Nkora	Hydro	0.00	0.00	1245.21	2770.00	1,442.40
Cyimbili	Hydro	0.00	0.00	342.89	1002.30	260.70
Mazimeru	Hydro	0.00	0.00	0.00	1987.10	2,764.75
Musarara	Hydro	0.00	0.00	0.00	0.00	2,747.57
Mukungwa II	Hydro	0.00	0.00	0.00	0.00	2565.96
Nshiri	Hydro	0.00	0.00	0.00	0.00	0.00

Jali Solar	Solar	362.92	323.87	298.79	305.86	298.39
Jabana I	Thermal	16325.77	12334.89	11506.71	6373.20	5041.39
Methane Gaz	Thermal	3311.59	8972.56	6110.21	8826.16	9937.59
Jabana II	Thermal	73866.95	74216.29	97794.96	106122.91	97451.52
Gatsata	Thermal	0.00	0.00	0.00	0.00	0.00
Aggreko I Gikondo	Thermal	42820.81	68421.68	80458.07	82222.77	85629.86
Aggreko Mukungwa (old)	Thermal	12732.12	0.00	0.00	7682.80	67759.45
Aggreko Mukungwa (new)	Thermal	0.00	0.00	0.00	0.00	0.00
Imports (DRC+Other grids)	Imports	62,386.31	79,754.58	75,123.73	90,845.53	93,285.37

Step 5: Calculate the build margin (BM) emission factor

For the calculation of the build margin (BM) emission factor, **Option 1** data vintage has been chosen. Hence, for the first crediting period, the build margin emission factor shall be calculated, *ex ante* based on the most recent information available on units already built for sample group *m* at the time of CPA-DD submission to the DOE for validation. For the second crediting period, the build margin emission factor will be updated based on the most recent information available on units already built at the time of submission of the request for renewal of the crediting period to the DOE. For the third crediting period, the build margin emission factor calculated for the second crediting period should be used. This option does not require the emission factor to be monitored during the first crediting period.

The build margin emission factor is thus calculated using **equation 13** of the "*Tool to calculate the emission factor for an electricity system"*, as shown below:

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

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 power generation data is available

The CO_2 emission factor of each power unit *m* ($EF_{EL,m,y}$) has been determined as per the guidance in section 6.4.1 for the simple OM, using both equation (2) under option A1 and equation 3 under option A2, and using for *y* the most recent historical year for which grid power generation data is available, and using for *m* the power *units* included in the build margin.

Option A1, $EF_{EL,m,y}$ is calculated in accordance with equation 2 as follows:

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

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 fuel type *i* consumed by power unit *m* in year *y* (Mass or volume unit)
$NCV_{i,y}$	=	Net calorific value (energy content) of fuel type *i* in year *y* (GJ/mass or volume unit)
$EF_{CO2,i,y}$	=	CO_2 emission factor of 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	=	The power units included in the build margin
i	=	All fuel types combusted in power unit m in year y
y	=	The relevant year as per the data vintage chosen in Step 3

Option A2, $EF_{EL,m,y}$ is calculated in accordance with equation 3 as follows:

$$EF_{EL,m,y} = \frac{EF_{co2,m,i,y} \times 3.6}{\eta_{m,y}}$$

Where:

$EF_{EL,m,y}$	=	CO_2 emission factor of power unit *m* in year *y* (t CO_2/MWh)
$EF_{CO2,m,i,y}$	=	Average CO_2 emission factor of fuel type *i* used in power unit *m* in year *y* (t CO_2/GJ)
$\eta_{m,y}$	=	Average net energy conversion efficiency of power unit *m* in year *y* (ratio)
m	=	Power plants included in the build margin
y	=	The relevant year as per the data vintage chosen in Step 3

The sample group of power units *m* used to calculate the build margin has been determined in accordance with the "*Tool to calculate the grid emission factor for an electricity system"*.

Below is a table with select power plants in the project electricity system used for the build margin determination (Source: Energy, Water and Sanitation - EWSA). The power plants are ranked according to commissioning date.

#	Name of power plant	Commissioning date	Electricity generation 2009-2011 (MWh)	%
1	Mukungwa II	Apr-13	2,565.96	0.66%
2	Musarara	Feb-13	2,747.57	1.36%
3	Nshiri	Dec-12	-	1.36%
4	Aggreko Mukungwa (new)	Oct-12	-	1.36%
5	Mazimeru	May-12	2,764.75	2.06%
6	Keya	Jul-11	682.68	2.24%
7	Nkora	Jul-11	1,442.40	2.60%
8	Cyimbili	Jul-11	260.70	2.67%
9	Rugezi	Mar-11	834.73	2.88%
10	Rukarara	Dec-10	32,870.36	11.28%
11	Murunda	Apr-10	624.87	11.44%

12	Jabana II	Jan-09	97,451.52	36.31%
	Total (AEG SET≥20%)		142,245.54	

Step 6: Calculate the Combined Margin

Option (a) i.e. the weighted average combined margin is used.

The combined margin emissions factor is calculated as follows:

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

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 (tCO_2/MWh)
W_{OM}	=	Weighting of operating margin emissions factor (%)
W_{BM}	=	Weighting of build margin emissions factor (%)

For solar power generation projects the following default values are used for W_{OM} and W_{BM}:

W_{OM} = 0.75
W_{BM} = 0.25

Project emissions

In accordance with paragraph 39 of the simplified baseline and monitoring methodology AMS-I.D version 18.0, most renewable energy projects except for hydro and geothermal technology types, PE_y = 0. Since the CPA is of solar PV type, PE_y = 0.

Leakage emissions

No leakage emissions are considered since the CPA is not a biomass project activity.

Emission reductions

In line with AMS-I.D (version18.0) the emission reductions are calculated using (equation 9) as follows:

$$ER_y = BE_y - PE_y - LE_y$$

Where:

ER_y	=	Emission reductions in year *y* ($t\ CO_2/y$)
BE_y	=	Baseline Emissions in year *y* ($t\ CO_2/y$)
PE_y	=	Project emissions in year *y* ($t\ CO_2/y$)
LE_y	=	Leakage emissions in year *y* ($t\ CO_2/y$)

2.4.2. Data and parameters fixed ex ante

Data/Parameter	$NCV_{i,y}$

Data unit	GJ/kg
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
Value(s) applied	Fuel Type: NCV Heavy Fuel oil[31]: 0.0398 Diesel Oil: 0.0414
Choice of data or measurement methods and procedures	IPCC default values are used, as there is no specific data from the fuel suppliers of the power plants and also not regional default values.
Purpose of data	Calculation of baseline emissions
Additional comment	Applicable only to grid emission factor calculations

Data/Parameter	$EF_{CO2,i,y}$ / $EF_{CO2,m,i,y}$
Data 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 1.4 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories
Value(s) applied	Fuel Type: Effective CO_2 Emission factor Heavy Fuel oil[32]: 0.0755 Diesel Oil: 0.0726
Choice of data or measurement methods and procedures	IPCC default values are used as there is no specific data from the fuel suppliers of the power plants and also not regional default values.
Purpose of data	Calculation of baseline emissions
Additional comment	Applicable only to grid emission factor calculations

Data/Parameter	$EG_{m,y}$
Data unit	MWh
Description	Net electricity generated by power plant/unit *m*in year *y*
Source of data	Energy Water and Sanitation Company, Rwanda
Value(s) applied	See section B.4.2
Choice of data or measurement methods and procedures	Data on electricity generation has been obtained from EWSA, the utility company in Rwanda and owner of the power plants.
Purpose of data	Calculation of baseline emissions
Additional comment	Applicable only to grid emission factor calculations

[31] The description of Residual Fuel Oil in the IPCC guidelines has been considered to closely match the description of Heavy Fuel Oil. Therefore, the NCV value for Residual Fuel Oil has been considered to be the same as that of Heavy Fuel Oil.

[32] The description of Residual Fuel Oil in the IPCC guidelines has been considered to closely match the description of Heavy Fuel Oil. Therefore, the CO_2 emission factor for Residual Fuel Oil has been considered to be the same as that of Heavy Fuel Oil.

Data/Parameter	$FC_{i,m,y}$
Data unit	Kg/year
Description	Amount of fossil fuel type *i* consumed by power plant / unit *m* in year *y*
Source of data	Energy Water and Sanitation Company, Rwanda
Value(s) applied	See section B.4.2
Choice of data or measurement methods and procedures	Data on fuel consumption for electricity generation has been obtained from EWSA, the utility company in Rwanda and owner of the power plants.
Purpose of data	Calculation of baseline emissions
Additional comment	Applicable only to grid emission factor calculations

Data/Parameter	$\eta_{m,y}$
Data unit	Percentage
Description	Average net energy conversion efficiency of power unit *m* in year *y (ratio)*
Source of data	Defaults from the tool for average net energy of combined cycle engines.
Value(s) applied	60%
Choice of data or measurement methods and procedures	Publicly available sources suggest that the Methane Gaz power plant comprises gas engines of the otto cycle technology and therefore a combined cycle technology is applied. (http://www.wartsila.com/en/references/lake-kivu)
Purpose of data	Calculation of baseline emissions
Additional comment	Applicable only to grid emission factor calculations For the Methane Gaz power plant, only data on electricity generation and fuel type used was available from the utility company. Therefore, In accordance with the Tool to calculate the emission factor of an electricity System version 4, if only data on electricity generation and fuel types is available, then option A2 can be used to calculate the emission factor of an electricity system (EFel,m,y.). This parameter is part of the equation applied in these calculations.

2.4.3. Ex ante calculation of emission reductions

Baseline Emissions

The baseline emissions for CPAs involving solar PV power are to be calculated as follows:

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

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

Parameter	Value	Unit	Source
$EG_{facility,y}$ *(Year 1)*	15,552	MWh	Energy yield assessment

Calculation of $EF_{grid,y}$

The combined margin emission factor for the grid is calculated using the following equations:

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

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

Values to determine $EF_{grid,CM,y}$ for this solar PV CPA:

Parameter	Value	Unit	Source
$EF_{grid,BM,y}$	0.45	tCO_2/MWh	GEF calculations
w_{BM}	0.25		Default value
$EF_{grid,OM-DD,y}$	0.73	tCO_2/MWh	GEF calculations
w_{OM}	0.75		Default value
$EF_{grid,CM,y}$	0. 66	tCO_2/MWh	GEF calculations

Therefore, for the first year of crediting, the following values apply:

$EF_{grid,y}$ = 0.66 tCO_2/MWh

BE_y = 15,552 * 0.66= 10,264 tCO_2/year

Project emissions

PE_y = 0

Leakage emissions

No leakage emissions are considered since the CPA is not a biomass project activity.

Emissions Reductions

$$ER_y = BE_y - PE_y - LE_y$$

Therefore, emission reductions for the first year of crediting is equal to:

10,264 - 0 - 0 = 10,264 tCO_2/year

2.4.4. 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)
2016	10,264	0	0	10,264
2017	10,202	0	0	10,202
2018	10,141	0	0	10,141
2019	10,080	0	0	10,080
2020	10,020	0	0	10,020
2021	9,960	0	0	9,960
2022	9,900	0	0	9,900
Total	70,567	0	0	70,567
Total number of crediting years	7			

Annual average over the crediting period	10,081	0	0	10,081

2.5. Monitoring plan

2.5.1. Data and parameters to be monitored

Data/Parameter	$EG_{PJ,facility,y}$
Data unit	MWh/year
Description	Quantity of net electricity generation supplied by the project plant/unit to the grid in year *y*
Source of data	Electricity meter(s
Value(s) applied	Year 1: 15,552 Year 2: 15,459 Year 3: 15,366 Year 4: 15,274 Year 5: 15,182 Year 6: 15,091 Year 7: 15,000
Measurement methods and procedures	The metering equipment installed at the CPA site is in line with the provisions of the Power Purchase Agreement and the Rwandan Electricity Grid Code. The metering installation consists of a Metering System (operated and maintained by the Project Implementer) and a Backup Metering System (operated and maintained by the Purchaser) (together, the "Metering Installation"). The Metering Installation has been installed at the Interconnection Point, at a voltage of 15 kV, and has a main electronic meter that can be remotely interrogated, which has an electronic communication link and which is connected to the metering database of the Transmission Metering Administrator (TMA) or Distribution Metering Administration (DMA). The Metering Installation measures the amount and direction of Active Power/Energy and Reactive Power/Energy. The commissioning, maintenance, auditing and testing of the Metering Installation is done in accordance with the Rwanda Grid Code. A third meter is also present as a backup meter of the Metering System operated by the Project Implementer. A third meter operated by the utility company formerly known as EWSA is also present to account for the electricity imported from the electricity grid to operate the power plant. The net electricity exported/supplied to the Rwandan grid is then calculated as the difference between the measured quantities of the grid electricity supplied to the grid and delivered from the grid to the project. Therefore, two separate metering installations are in place to measure the following: (a) The quantity of electricity supplied by the project plant/unit to the grid; and (b) The quantity of electricity delivered to the project plant/unit from the grid

Monitoring frequency	The quantity of electricity supplied to the grid will be monitored continuously, measured hourly and recorded at least monthly. The basic measurement period shall be carried out in line with the PPA and the relevant industry levels.
QA/QC procedures	Records from the main meter of the quantity of electricity supplied by the project plant/unit to the grid will be cross-checked against billing records of electricity to the utility company (Rwanda Energy Group). If necessary, records can also be crossed checked with those of the two backup meters. Records of electricity consumed by the project plant/unit will be derived from the billing records sent to the CPA implementing entity from the utility company. Calibration of the main meter will be done according to the appropriate standard SANS 474:2008, NRS 057:2011, IEC 62056. This standard sets for projects between 10MVA and 100MVA an accuracy class for the meters of 0.2S for active meter and 0.5 for reactive meter. The frequency of the testing/calibration of the meter will be done according to the requirements stipulated in the PPA.
Purpose of data	Calculate baseline emissions
Additional comment	The PPA was signed with the then utility company EWSA which has since been replaced with Rwanda Energy Group. Further information is provided in the baseline description.

2.5.2. Sampling plan

The PoA and CPAs do not involve sampling.

2.5.3. Other elements of monitoring plan

Overall authority and responsibility for monitoring will rest with the CME, who will also be responsible for managing the emission reduction monitoring and verification process.

In order to enable verification of emission reductions the CPA must maintain credible, transparent and adequate data measurement, collection, estimation and tracking systems. The following monitoring procedures and responsibilities will apply.

CPA implementing entity

Each CPA implementing entity under the PoA will be responsible for the technical aspects related to on- site monitoring such as:

- Employment and training of personnel responsible for gathering and recording monitoring data
- Continuous measurement of electricity generated by the project activity
- Collecting metering information
- Storage of data
- Calibration and maintenance of main metering equipment, the Facility Metering Installation, according to the standards described in section 2.5.1 above..
- Submission of monitoring data to the CME

The CPA implementing entity will appoint a monitoring officer who will be in charge of the CPAs monitoring responsibilities as described above.

The table/diagram below shows an overview of the organizational structure for the operation and data monitoring of the CPA.

Title	Reports to	Roles and Responsibilities
Managing Director	Board of Directors	• Overall guidance and management • Receive information of decisions by the managers. • Provide final quality control of documents and contracts • Sign off final approval on documents and contracts • Be accountable for results, omissions, errors, etc • Lead the management system improvement process • Supervise manager-level staff
Project Manager	Managing Director	• Operations and maintenance the power plant/CPA for the duration of the project • Record keeping of electricity generation and provide quality control. • Employment and training of personnel responsible for gathering and recording monitoring data • Supervision on the continuous measurement of electricity generated by the CPA • Supervision on the collection of metering information • Supervision on the calibration and maintenance of main metering equipment, according to appropriate standards or manufacturer specifications. • Provide supervision to the site manager
Site Manager	Project Manager	• Employment and training of personnel responsible for gathering and recording monitoring data • Provide supervision on the continuous measurement of electricity generated by the CPA • Provide supervision on the collection of metering information • Provide supervision on the calibration and maintenance of main metering equipment, according to appropriate standards or manufacturer specifications. • Maintenance of all equipment and machinery during the lifetime of the power plant • Ensure compliance with day-to-day tasks of the power plant e.g. inspections • Ensure adherence with the HSE regulations • Ensure adherence with the onsite emergency an evacuation procedures • Address any concerns from the local community in consultation with the local government and the project manager. • Provide supervision to the technical officers
Monitoring Officer	Site Manager	• Continuous measurement of electricity generated by the CPA • Collection of metering information • Calibration and maintenance of main metering equipment, according to appropriate standards or manufacturer specifications.

Technical Officers	Site Manager	• Under supervision of the site manager, ensure the maintenance of the all equipment and machinery during the lifetime of the power plant. • Under supervision of the site manager, ensure adherence to the HSE procedures.

The following parameters will be monitored:

Parameter	Description	Type of CPA
$EG_{PJ,facility,y}$	Quantity of net electricity supplied to the grid as a result of the implementation of the CDM project activity in year *y*	All

CPA implementing entity will monitor and keep records of the quantity of net electricity supplied to the grid as a result of the implementation of the CDM CPA in year *y* ($EG_{facility,y}$). The CPA implementing entity will be responsible for preparing invoices for the sales of electricity to the electricity off-taker. The quantity of electricity supplied to the grid will be reported to the CME on a quarterly basis for the previous three months and will be accompanied by supporting evidence for cross-checking purposes. CPA implementing entity will keep electronic copies of all CDM related data at its headquarters, at least until two years after the end of the last crediting period or the last issuance of CERs, whichever occurs later.

Metering will be conducted with calibrated measurement equipment in accordance to relevant industry standards. The Rwandan Utilities Regulatory Authority (RURA) has adopted the metering standards (SANS 474:2008, NRS 057:2011, IEC 62056) as outlined in the *Metering Code*, part of the Rwandan Grid Code. This code of practice specifies the procedures and standards to be adhered to by electricity licensees and their agents in operating and servicing new and existing metering installations, which are to be used for billing purposes. The code of practice is applicable to metering installations in their entirety, including all measuring transformers, wiring, cabling, metering panel construction, active and reactive meters, data loggers and associated test facilities.

The CPA will be responsible for the Metering Installation procurement, installation, testing, commissioning and its operation and maintenance including:

- Calibration and maintenance of equipment
- Physical reading and day-to-day handling
- Quality Control and Quality assurance measures

The Metering Installation would be preferable installed at the Point of Supply, which is defined as the commercial boundary between customer (CPA implementer) and the Transmitter organization.

Calibration of meters will be performed according to the precision level stipulated in the Power Purchase Agreement.

The meter(s) readings will be readily accessible for the Designated Operational Entity (DOE) carrying out the verification of monitoring data.

Gigawatt Global Coöperatief U.A. - Coordinating/managing entity

The CME will be responsible for the following:

- Training of CPAs on CDM monitoring requirements;
- Receiving monitored data from the CPA Implementer;
- Storage of data for at least two years after the end of the last crediting period or the last issuance of CERs, whichever occurs later;
- Crosscheck of monitored data with a copy of invoices and the proof of payment of those invoices;
- Confirm that the CPA has operated the metering system in line with relevant regulations

- Preparation of monitoring report;

The CME will carry out a quality control on the data received as described below and store them in the electronic database. The CME will prepare monitoring reports for submission to the DOE for verification on a regular basis.

Data will be stored electronically by the CME in a centralized database system for at least two years following the end of the last crediting period or the last issuance of CERs, whichever occurs later. The CPAs will need to provide a copy of the documentation, such as electricity sales invoices, proof of payment of those invoices, and meter readings to the CME that will verify those.

The database contains the following information:

- Name of the CPA
- CPA implementing entity and contacts
- GPS coordinates
- Technical description
- Installed capacity
- Number of verifications and associated monitoring periods
- Monitored data/parameters and relevant evidence
- Emission reductions monitored

Training

Before the start of the crediting period of a CPA, the CME will provide training and guidance regarding the implementation of the monitoring plan. The training will include:

- CDM project cycle and the significance of monitoring
- Management structure and work scope
- Components of the monitoring plan
- QA/QC procedures
- Monitoring report template
- Preparation for verification
- Questions and answers

3. Start date, crediting period type and duration

3.1. Start date of CPA

In accordance with the CDM Project Standard (version 09.0), the start date of a project activity is the date when real action occurred. The start date of the CPA is 14/02/2014,which is the date that financial close was reached.

3.2. Expected operational lifetime of CPA

25 years

3.3. Crediting period of CPA

3.3.1. Type of crediting period

Renewable crediting period

3.3.2. Start date of crediting period

23/10/2015

3.3.3. Duration of crediting period

First crediting period will be 7 years (84 months), which can be renewed 2 times for a maximum length of 21 years

4. Environmental impacts

4.1. Analysis of environmental impacts

In accordance with the requirements of the Rwandan National Policy on Environment (November 2003) [33] , and relevant ministerial order relating to the requirements and procedure for Environmental Impact Assessment (EIA) regulations (2008)[34], the CPA type requires a full Scoping and Environmental Impact Assessment (EIA). To this end, the CPA carried out an Environmental Impact Assessment in line with Rwandan regulations and submitted an EIA report in 2012 with regard to the 10MW[35] solar PV project.

The Rwanda Development Board has since issued a certificate of Approval to the Environmental Impact Assessment.

4.2. Environmental impact assessment

The EIA report provides practical and rational mitigation measures to avoid, minimize or offset any negative impacts from the development. This is provided in the Environmental Management Plan (EMP). The EMP provides practical and actionable management, monitoring and institutional measures to be undertaken during the construction, operation and decommissioning of the proposed solar PV facility.

The major impacts highlighted in the Environmental impact assessment are described below.

Impact on Ecology

The project site is located in Rwamagana District, which experiences a tropical climate with mild wet episodes and average temperatures ranging from 19 to 30^0C. Average annual rainfall amounts for Rwamagana District is about 1000mm. Primary surface water sources in Rwamagana District and its environs include the Nyabarongo River, Lakes Muhazi, Gashanga, Rumira and Mugesera. Of these, the nearest to the project site is Lake Mugesera at a distance of about 2km away.

The proposed project site is non-cultivated and no other sensitive ecosystems were identified. Therefore, the overall impact of the project to the ecology is considered to be insignificant.

Impacts on Flora and Fauna

[33] National Policy on Environment, Rwanda (2003)

[34] EIA Regulations, Rwanda

[35] The CPA was intended to be 10MW but was scaled down to 8.5MW to enable accommodation by the grid.

The proposed project site mainly comprises of shrubs and other spontaneous natural vegetation. The most common planted vegetation is bananas. Only one type of plant species, *Erythrina abyssinica* (umuko) was identified as sensitive plant as it is protected by the government of Rwanda. Interference with this plant species will be avoided and in the event that this is not possible, the plant species will be relocated in accordance with the Environmental Monitoring Plan. Some of the existing vegetation onsite will be removed to enable construction and optimal operation of the solar modules. However, in order to minimize the impact on vegetation, these sections cleared of vegetation will be landscaped with natural vegetation to restore the vegetation.

Animal species that inhabited the proposed site were forced to migrate prior to the project implementation due to hunting, clearance for farming and bush fire among other reasons. There are still some clusters of bird species that inhabit tall trees and the swampy and lacustrine ecosystem in the district and other burrowing animal species such as mice. However, the study considers the impact of the project to these animal species to be minimal.

Therefore, the impacts of the project activity on the flora and fauna are considered to be insignificant.

Impacts on Geology and Soils

The impact of soil erosion and soil degradation during construction phase, through stockpiling, mixing, wetting, filling, compaction and pollution is considered the most direct impact but the potential for soil erosion is considered moderate since the site topography is favorable and the vegetation is currently aiding the stability of the soil.

The potential negative impacts can however be mitigated against to achieve a net neutral effect on the soil. Since the project will abide by the mitigation measures in the Environmental Monitoring Plan, the overall impact of the project on the geology and soils is considered to be insignificant.

Impacts on Heritage

No heritage sites are located on the proposed development site and the immediate surroundings. As such, the project will have no impact on heritage.

Visual Impacts

The construction of the solar PV facility will have no visual impact on the visual environment and the surrounding community as a result of the topography of the land. The closest ASYV building is situated at approximately 500 meters away, and the nearest community situated 1500 meters from the project site. Settlements in the vicinity are expected to experience a non-significant visual impact while those further away will be effectively shielded by topography from the facility's view.

Therefore, the anticipated visual impact as described in the EIA report is not considered to be a fatal flaw from a visual perspective, considering the low incidence of visual receptors in the area and the contained area of potential visual exposure.

5. Local stakeholder consultation

5.1. Modalities for local stakeholder consultation

Based on the definition of "stakeholder" from Glossary of CDM terms version (08.0) the following groups of people were identified as stakeholders:

- Local landowners in the project area
- Members from the wider project area and members of the general public.
- Academia

- Government departments and agencies (local, district and national)
- NGOs, community representatives and donor representatives

Local landowners: The land is privately owned by the Agahozo-Shalom Youth Village. Therefore, they are directly affected by the project activity implementation.

General Public: The general public is a stakeholder because they will be the end-consumers of the electricity generated from the project.

Academia: Higher learning institutions are considered stakeholders because of relevant data and information they might possess regarding the region that the developer may not be aware of.

Government representatives and Designated National Authority: Government representatives and the Designated National Authority are considered stakeholders because the implementation of the project is expected to impact on the achievement of a number government policies and sustainable development goals in relation to poverty reduction and energy provision.

NGOs, community representatives and donor representatives: NGOs, community representatives and donors are considered stakeholders because of their unique position as direct contact with the community members. One such NGO is Agahozo-Shalom Youth Village, which will host the project.

How stakeholder comments were solicited

Comments from the various groups of stakeholders were solicited by the use of emails, phone calls, newspaper adverts, invitation letters and word of mouth, as further described below:

Email invitations: A good number of the stakeholders identified had access to email services and therefore they were invited by the use of emails. The emails were sent approximately 2 weeks prior to the date of the meeting in order to give the stakeholders sufficient time to plan for attending the meeting. Stakeholders who confirmed that they could not attend the meeting due to other commitments were asked to send representatives if possible. As a last measure, in the event that it was impossible for the stakeholders and any of their representatives to be present, their input was solicited via email.

Phone call invitations: Some stakeholders only had phone numbers for their contacts and they were therefore invited by the use of phone calls. In addition, all invitations that were not confirmed after the first week of invitation were called up for a confirmation of their attendance. All responses were recorded in the stakeholder tracking spreadsheet.

Invitation Letters: Some stakeholders who had no access to email services were invited by the use of invitation letters. In some instances, the use of official invitation letters were considered as the best approach for inviting stakeholders who are held in high regard in the local area. One such stakeholder was the village "Umudugudu" chief.

Newspaper adverts: The general public was invited through advertisements in the local newspaper. The announcements were published twice (27 January 2014 and 7 February 2014) as per the requirements of the DNA.

Word of Mouth: Other members of the local community were invited through their local representative via word of mouth. The village chief, who is especially in close contact with the local community, was requested to invite locals for the meeting during sessions of the local meetings.

5.2. Summary of comments received

The following is a summary of the comments received by stakeholders:

Project Implementation

1. Does the project use the roofs of the village [ASYV]?
2. What are the side effects that the project has on the soil? Will it not cause soil erosion during construction?
3. Will the project serve ASYV only or the whole district?
4. How will the solar PV plant be connected to the grid? Is it as an emergency generator or is it always directly connected to EWSA?
5. Cost of selling electricity to EWSA, how does it compare with the other power plants?
6. It is very good bringing this project up. Will it reduce the cost of electricity from EWSA for Rwamagana residents?
7. Land on the roads, will Gigawatt also buy those for construction of drainage?
8. Rwanda is a small country. The use of solar PV takes up large amounts of land, which can take up the agricultural land. Other countries have optimized land usage for both agriculture and power production e.g. poultry farming. Have you though about this?

Climate change and carbon credits

1. What is the price of carbon credit in the market?
2. Which kinds of projects are eligible for carbon credits generation? For instance if you have one cookstove, can you register this for carbon credits?
3. What is the cost of acquiring carbon credits?
4. We have a cookstove project just undertaking a pilot but looking into expanding. How do we combine with Gigawatt to generate carbon credits?
5. Is there any figure that shows a limit of the level of CO_2 that we should reach?

5.3. Consideration of comments received

Project Implementation

1. No. The project area is big enough to accommodate the 30,000 solar modules although the project developer had also thought about this option initially.
2. No side effects on the soil are expected since the project will involve the insertion of a pole 3 meters into the soil. Nothing else will go into the soil (no cement, no chemicals). In addition, drainage channels will be dug to take up the water from the panels along the roads. Cases of flooding will consequently be reduced and no impact on the soil is expected.
3. The project will benefit the entire district. The project will supply electricity to local industries in the area via the national electricity grid. In fact most of the power will be used in the district.
4. The system is connected directly to EWSA via a SCADA system, whereby EWSA can see on the computer if there is a failure on the grid and locate where the problem originates.
5. Electricity cost from the plant is cheaper compared to thermal power plants that are connected to EWSA.
6. The structure of the power line is that electricity is channelled to EWSA lines. The villages around will be the first to benefit and then it goes down the line. If EWSA is buying cheaper electricity as compared to other sources, they might reduce the cost of electricity to the consumers in the end.
7. Gigawatt will only buy land on the road reserves.
8. Yes, Gigawatt at some point considered producing mushroom and pumpkin but as a power company, it is the people (entrepreneurs) to propose to power companies an idea, as they do not know about mushrooms or any other agricultural practices. Gigawatt is however working with various people including the student environmental club at ASYV to think and propose these ideas. In the future, Gigawatt may choose to implement one project on a trial basis.

Climate change and carbon credits

1. Carbon credit is a commodity that is sold in various markets. Unfortunately, the price in the EU-ETS, which is the largest market, has a very low price, less than 0.5 euros. However, projects that have more sustainable development benefits can fetch higher values both in the compliance and the voluntary markets and can therefore fetch about 10 USD.
2. In principle improved cookstoves and renewable energy projects are eligible to qualify for carbon credits. However, the process is lengthy and relatively costly to pursue. Therefore, one needs to have large numbers e.g. for cookstoves distribution, one needs about 7,000 cookstoves to make economic sense. As an alternative, projects can be registered as a PoA, which reduces significantly the carbon development cost.
   Clarification: A PoA can be compared to a cooperative, which are quite common in Rwanda. The cooperative manages your transactions just the same way the PoA implementing entity will manage your carbon credits.
3. The costs of registering your project for carbon credits depends on the project type among other things. An indicative figure of 50,000-80,000 USD could be used. Most of it goes to the independent auditors who are quite expensive.
4. It is not possible to combine a cookstove project with a solar PV project because projects are guided by methodologies that cannot allow combination of these two projects. Examples that can be allowed include combining water filter and cookstoves, already being implemented in Rwanda.
5. Yes. The scientists in the IPCC, a body that brings together all the best scientists in the world, predict an increase by about 5°C in the next 50 years if no action is taken. Acceptable levels stand at 2°C increase and countries are trying to reach this.

6. Eligibility for inclusion

No.	Eligibility criterion - Category	Eligibility criterion - Required condition	Supporting evidence for inclusion	Description of this CPA in relation to the criterion and supporting evidence
1	16 a. The geographical boundary of the CPA including any time-induced boundary consistent with the geographical boundary set in the PoA	**Eligibility criteria 1:** The geographic boundary of the CPA is located in Rwanda.	The geographical boundary of the CPA will be evidenced through a description of the project location as provided by the CPA implementing entity. This could be in the form of a project area description in the EIA report, feasibility study/technical description or through an EIA license from the relevant authorities in Rwanda (an EIA license for a proposed CPA issued by the Rwandan authorities would automatically imply that the CPA is located in Rwanda).	**Documentary/Evidence:** The geographic boundary of the CPA is located in Rwanda. This has been evidenced through an EIA certificate issued to the CPA by the Rwanda Development Board.

No.	Eligibility criterion - Category	Eligibility criterion - Required condition	Supporting evidence for inclusion	Description of this CPA in relation to the criterion and supporting evidence
2	**16 b. Conditions that avoid double counting of emission reductions like unique identifications of product and end-user locations (e.g. programme logo)**	**Eligibility criteria 2.1:** The CPA implementing entity has confirmed that the CPA has not yet been included in another PoA or has been registered as a single CDM project.	This will be evidenced through the agreement between the CME and CPA or a signed confirmation letter from the CPA implementing entity	**Documentary/Evidence:** A signed confirmation letter by Gigawatt Global Rwanda Ltd., the CPA implementing entity, has been provided to prove that the CPA has not been included in another PoA or has been registered as a single CDM project. See: Signed confirmation letter from Gigawatt Global Rwanda.
		Eligibility criteria 2.2: The CME has checked and confirmed on the CDM website that the CPA has not yet been included in another PoA or been registered or applying to be registered as a single CDM project	. This will be evidenced through the confirmation letter from the CME	**Documentary/Evidence:** A signed confirmation letter by Gigawatt Global Cooperatief U.A., the CME, has been provided to prove that the CME has checked the CDM website to confirm that project has not been included in another PoA or has been registered or applying to be registered as a single CDM project. See: Signed CME confirmation letter.
		Eligibility criteria 2.3: The project proponent has provided a project area map including geographical coordinates.	This will be evidenced through a project map in the feasibility study/technical description report, EIA report, or other relevant documentation	**Documentary/Evidence:** The project proponent has provided the feasibility study to evidence the project area map including geographical coordinates. See: Feasibility study
		Eligibility criteria 2.4: The CME has checked and confirmed that the project area of the proposed CPA does not overlap with the project area of another CPA or single CDM project in Rwanda.	This will be evidenced through a signed confirmation letter from the CME.	**Documentary/Evidence:** A signed confirmation letter by the CME has been provided to prove that the CME has checked and confirmed that the CPA project area does not overlap with project area of another CPA or single CDM project in Rwanda. See: signed CME confirmation letter.

No.	Eligibility criterion - Category	Eligibility criterion - Required condition	Supporting evidence for inclusion	Description of this CPA in relation to the criterion and supporting evidence
3	**16 c. The specifications of technology/measure including the level and type of service, performance specifications including compliance with testing/certifications**	***Eligibility criteria 3.1:*** The CPA has confirmed that it's a Greenfield project.	This will be evidenced by project description reports including Feasibility Study Reports, Environmental Impact Assessment Reports or Technical Study Reports.	***Documentary Evidence:*** The Feasibility study has been provided to evidence that the CPA involves the implementation of a Greenfield 8.5 MWp solar PV power project supplying electricity to the Rwandan National Grid. See: Feasibility study report.
		Eligibility criteria 3.2: The CPA involves the implementation of a solar PV power project supplying electricity to the Rwanda National Grid..	This will be evidenced by the feasibility study/technical description, Power Purchase Agreement, EIA report or grid connection study	**Documentary/Evidence:** The Feasibility study has been provided to evidence that the CPA involves the implementation of a 8.5 MWp solar PV power project supplying electricity to the Rwandan National Grid. See: Feasibility study report.
		Eligibility criteria 3.3: The installed capacity of the CPA will not exceed 15 MW in line with paragraph 6 of AMS-I.D version 18.0. The installed capacity will be based on the installed/rated capacity as indicated by the manufacturer.	This will be evidenced by the feasibility study/technical description or Power Purchase Agreement (PPA) or EIA report or EIA license	**Documentary/Evidence:** The installed capacity of the CPA is 8.5MWp.[36] The feasibility study has been provided to evidence that the installed capacity of the CPA will not exceed 15MW in line with paragraph 6 of AMS-I.D version 18.0. See: Feasibility studies report.
		Eligibility criteria 3.4: The CPA's net load factor will be based on the P50 forecast. Net load factors are a function of solar irradiation, the type of solar module and losses in the system.	This will by evidenced by an Energy Yield Assessment	**Documentary/Evidence:** The CPA's net load factor has been based on the P50 forecast which predicts 15,552 MWh for the first year. This has been evidenced by the Energy Yield Assessment. See: Energy Yield Assessment

[36] The installed capacity was downscaled to 8.5 MWp from 10MWp as indicated in the feasibility studies and EIA report in order to accommodate the grid.

No.	Eligibility criterion - Category	Eligibility criterion - Required condition	Supporting evidence for inclusion	Description of this CPA in relation to the criterion and supporting evidence
		Eligibility criteria 3.5: The CPA will use average annual global horizontal solar irradiation data based on data reported by an independent third party, from internationally trusted sources, or onsite measurements.	This will be evidenced by using data from an independent third party, from internationally trusted sources, or onsite measurements	**Documentary/Evidence:** The CPA has used average annual global horizontal solar irradiation data from Meteonorm, an internationally trusted source, as evidenced by the Energy Yield Assessment. See: Energy Yield Assessment.
4	**16 d. Conditions to check the start date of the CPA through documentary evidence;**	***Eligibility criteria 4:*** The start of the CPA occurs after 15/01/2014.	This will be evidenced by the financial close agreements. If financial close has not yet been achieved at the time of inclusion of the CPA, the CPA start date will automatically be after 15/01/2014.	**Documentary/Evidence:** The start date of the project activity is on 14/02/2014, which is the date when Financial Close was reached. This is evidenced by financial close agreements. See: Financial Close agreement
5	**16 e. Conditions that ensure compliance with applicability and other requirements of single or multiple methodologies applied by CPAs**	***Eligibility criteria 5:*** The CPA has confirmed its compliance with the applicability of AMS-I.D (version 18.0) in Appendix 3 of the F-CDM-CPA-DD.	The CPA will confirm compliance with the applicability of AMS-I.D (version 18.0) in the relevant section of the CPA-DD	**Documentary/Evidence:** The CPA has confirmed compliance with the applicability of AMS-I.D version 18.0. See evidences in Appendix 3 of the CPA–DD.
6	**16 f. The conditions that ensure that CPAs meet the requirements pertaining to the demonstration of additionality as specified in Section A above;**	**Eligibility criteria 6.1:** The installed capacity of each CPA will not exceed 15 MW. The installed capacity will be based on the installed/rated capacity as indicated by the manufacturer.	This will be evidenced by the feasibility study/technical description or Power Purchase Agreement (PPA) or EIA report or EIA license.	**Documentary/Evidence:** The installed capacity of the CPA is 8.5MWp.[37] The feasibility study has been provided to evidence that the installed capacity of the CPA will not exceed 15MW in line with paragraph 6 of AMS-I.D version 18.0. See: Feasibility study.

[37] The installed capacity was downscaled to 8.5 MWp from 10MWp as indicated in the feasibility studies and EIA report in order to accommodate the grid.

No.	Eligibility criterion - Category	Eligibility criterion - Required condition	Supporting evidence for inclusion	Description of this CPA in relation to the criterion and supporting evidence
		Eligibility criteria 6.2: The CPA involves the implementation of a solar PV power project supplying electricity to the Rwanda National Grid..	This will be evidenced by the feasibility study/technical description, Power Purchase Agreement, EIA report or grid connection study	**Documentary/Evidence:** The feasibility study has been provided to provide proof that the CPA involves the implementation of a solar PV power project supplying electricity to the Rwandan national grid. See: Feasibility study.
7	**16 g. The PoA-specific requirements stipulated by the CME including any conditions related to undertaking local stakeholder consultations and environmental impact analysis;**	***Eligibility criteria 7.1:*** The CPA has carried out an Environmental Impact Assessment in line with Rwandan regulations.	This will be evidenced through the issuance of a certificate of approval of Environmental Impact Assessment from the Rwanda Development Board.	**Documentary/Evidence:** The CPA has carried out an Environmental Impact Assessment in line with Rwandan regulations as evidenced by the issuance of an EIA certificate from the Rwanda Development Board with date 9 January 2013. See: EIA certificate
		Eligibility criteria 7.2: The CPA has carried out a stakeholder consultation meeting according to the requirements of the CDM requirements and the DNA..	This will be evidenced through records and reports from the public participation process (as part of the EIA process) or through records and reports from the CDM stakeholder consultation	**Documentary/Evidence:** The CPA has carried out a stakeholder consultation meeting on 10 February 2014 according to the requirements of the CDM requirements and the DNA. The evidence is documented in the LSC report, which includes participant lists and pictures. See: LSC Report.
8	**16 h. Conditions to provide an affirmation that funding from Annex I parties, if any, does not result in a diversion of official development assistance;**	***Eligibility criteria 8.1:*** In case the CPA implementing entity has not received funding from Annex I parties, it has confirmed so by issuing a signed confirmation letter.	The CPA will confirm that it has not received any public funding from Annex I parties by issuing a signed confirmation letter	**Documentary/Evidence:** Not applicable since the CPA implementing entity has received public funding from Annex I countries.

No.	Eligibility criterion - Category	Eligibility criterion - Required condition	Supporting evidence for inclusion	Description of this CPA in relation to the criterion and supporting evidence
		Eligibility criteria 8.2: In case the CPA implementing entity has received funding from Annex I parties, a letter has been provided by the relevant national or supranational (e.g. EU) Annex I party(ies) agencies confirming that the funding does not result in a diversion of official development assistance.	The CPA will confirm that it has received public funding from Annex I parties by providing a letter confirming that the funding does not result in a diversion of official development assistance.	**Documentary/Evidence:** The CPA Implementing Entity received funding from the Energy and Environment Partnership, which is funded by public funds from the UK, Finland and Austria. However, there was no precedent condition that credits coming out of the project to transferred, directly or indirectly, to the donor country requirements. A confirmation letter from the Energy and Environment Partnership has been provided as proof that no carbon credits will be transferred to any of the Annex I countries that are providing the funding. Therefore, it can be demonstrated that the public funding will not result into diversion of ODA funding. See: Confirmation from the Energy and Environment Partnership.
9	**16 i. Where applicable, target group (e.g. domestic/commercial/ industrial, rural/urban, grid- connected/off-grid) and distribution mechanisms (e.g. direct installation);**	***Eligibility criteria 9:*** The CPA is connected to the Rwandan grid.	This will be evidenced in the feasibility study/technical description, EIA report, Power Purchase Agreement or grid-connection study.	**Documentary/Evidence:** The feasibility study has been provided to provide proof that the CPA involves the implementation of a solar PV power project supplying electricity to the Rwandan national grid. See: Feasibility study.
	16 j. Where applicable, the conditions related to sampling requirements for a PoA in accordance with the approved guidelines/standard from the Board pertaining to sampling and surveys;	The PoA and CPAs do not involve sampling.	Not applicable	Not applicable

No.	Eligibility criterion - Category	Eligibility criterion - Required condition	Supporting evidence for inclusion	Description of this CPA in relation to the criterion and supporting evidence
10	**16 k. Where applicable, the conditions that ensure that every CPA in aggregate meets the small- scale or microscale threshold criteria and remains within those thresholds throughout the crediting period of the CPA;**	***Eligibility criteria 10:*** The CPA has an installed capacity not exceeding 15 MW.	This will be evidenced in the feasibility study/technical description, EIA report, Power Purchase Agreement and or grid-connection study.	**Documentary/Evidence:** The installed capacity of the CPA is 8.5MWp.[38] The feasibility study has been provided to evidence that the installed capacity of the CPA will not exceed 15MW in line with paragraph 6 of AMS-I.D version 18.0. See: Feasibility study.
11	**16 l. Where applicable, the requirements for the debundling check, in case CPAs belong to small-scale (SSC) or microscale project categories.**	***Eligibility criteria 11.1:*** The CPA is not part of a large-scale CDM project activity. The CPA implementing entity will provide a signed document clearly stating that the CPA is not part of a large-scale project..	This will be evidenced by a signed letter from the CPA implementing entity	**Documentary/Evidence:** The CPA is not part of a large-scale CDM project activity. A signed confirmation letter from the CPA implementing entity has been provided as evidence, clearly stating that the CPA is not part of a large-scale project. See: Signed confirmation letter from Gigawatt Global Rwanda Ltd.
z		***Eligibility criteria 11.2:*** The CME has checked and confirmed on the CDM website that the CPA has not yet been included in another PoA or been registered or applying to be registered as a single CDM project.	This will be evidenced by the confirmation letter from the CME.	**Documentary/Evidence:** A signed confirmation letter by the CME has been provided to prove that the CME has checked the CDM website to confirm that project has not been included in another PoA or has been registered or applying to be registered as a single CDM project. See: Signed CME confirmation letter.
		Eligibility criteria 11.3: The project proponent has provided a project area map including geographical coordinates of the project site.	This will be evidenced through a project map in the feasibility study/technical description report, EIA report, or other relevant documentation.	**Documentary/Evidence:** The project proponent has provided the feasibility study to evidence the project area map including geographical coordinates. See: Feasibility study.

[38] The installed capacity was downscaled to 8.5 MWp from 10MWp as indicated in the feasibility studies and EIA report in order to accommodate the grid.

No.	Eligibility criterion - Category	Eligibility criterion - Required condition	Supporting evidence for inclusion	Description of this CPA in relation to the criterion and supporting evidence
		Eligibility criteria 11.4: The CME has checked and confirmed that the project area of the proposed CPA does not overlap[39] with the project area of another CPA or single CDM project of the same type in Rwanda.	This will be evidenced by a signed confirmation letter from the CME.	**Documentary/Evidence:** A signed confirmation letter by the CME has been provided to prove that the CME has checked and confirmed that the CPA project area does not overlap with project area of another CPA or single CDM project of the same technology type in Rwanda. See: signed CME confirmation letter.

[39] In the context of this CPA, overlapping boundaries would be interpreted to mean that the project boundary of the existing CPA is within 1 km of the project boundary of the proposed small-scale activity at the closest point.

Appendix 1. Contact information of CPA implementers

Organization name	Gigawatt Global Rwanda Ltd.
Country	Rwanda
Address	P.O. Box 6463 Kigali Rwanda
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E-mail	chaim.motzen@gigawattglobal.com
Website	http://gigawattglobal.com/
Contact person	Chaim Motzen

Appendix 2. Affirmation regarding public funding

MINISTRY FOR FOREIGN AFFAIRS OF FINLAND

ALI-30

23.7.2015
V 1.0

Mr. Chaim Motzen
Managing Director
Gigawatt Global Rwanda Ltd
Karamba cell, Rubona sector
Rwamagana district, Iburasirazuba province
Rwanda

UHA2011-006705, 28922801

RE: ASYV 8.5 MW Solar project in Rwanda's Eastern Province – Declaration on Public Funding

The Energy and Environment Partnership (EEP) is a programme which promotes renewable energy (RE), energy efficiency (EE), and clean technology investments in Southern and East Africa. The programme provided grant funding (project RWA5015) to Gigawatt Global Rwanda Ltd towards the development of a grid-connected utility scale solar PV project in Rwanda amounting to 245,000 EUR. EEP is funded through public funding from the governments of Finland, United Kingdom and Austria.

The public funding from EEP is considered ODA by the OECD Development Assistance Committee (OECD DAC).

This funding will not result in a diversion of official development assistance and should remain separate from and not counted towards the financial obligations of the funding host parties (Finland, the United Kingdom and Austria) under the UNFCCC.

Yours Sincerely,

Mr Jan Koivu
Desk Officer

MINISTRY FOR FOREIGN AFFAIRS

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Appendix 3. Applicability of methodologies and standardized baselines

The CPA qualifies under small-scale Type I component project activity because the maximum output capacity achieved by individual small-scale CPA will not exceed 15MW in each year of the crediting period. The CPA falls under category AMS-I.D *Grid connected renewable electricity generation* (version 18.0) because the CPA meets the applicability criteria as follows:

Applicability criteria	CPA justification
This methodology comprises renewable energy generation units, such as photovoltaic, hydro, tidal/wave, wind, geothermal and renewable biomass: a) Supplying electricity to a national or a regional grid; or b) Supplying electricity to an identified consumer facility via national/regional grid through a contractual arrangement such as wheeling.	The small-scale CPA will use grid-connected solar PV power generation that will supply electricity to the Rwandan National Grid. This is evidenced by the PPA between the project developer and utility company
This methodology is applicable to project activities that: (a) Install a Greenfield plant; (b) Involve a capacity addition in (an) existing plant(s); (c) Involve a retrofit of (an) existing plant(s); or (d) Involve a rehabilitation of (an) existing plant(s) (e) Involve a replacement of (an) existing plant(s).	The small-scale CPA will include activities that: (a) Install a Greenfield plant. This is evidenced by the feasibility studies for the project activity
Hydro power plants with reservoirs that satisfy at least one of the following conditions are eligible to apply this methodology: a) The project activity is implemented in an existing reservoir with no change in the volume of reservoir; b) The project activity is implemented in an existing reservoir, where the volume of reservoir is increased and the power density of the project activity, as per definitions given in the project emissions section, is greater than 4 W/m_2; c) The project activity results in new reservoirs and the power density of the power plant, as per definitions given in the project emissions section, is greater than 4 W/m_2.	Not applicable. This CPA includes solar PV energy projects, not hydro power plants.
If the new unit has both renewable and non-renewable components (e.g. a wind/diesel unit), the eligibility limit of 15 MW for a small-scale CDM project activity applies only to the renewable component. If the new unit co-fires fossil fuel, the capacity of the entire unit shall not exceed the limit of 15 MW.	Not applicable. The programme of activities and therefore the CPA will not use both, renewable and non-renewable components.
Combined heat and power (co-generation)	Not applicable. The programme of activities and

systems are not eligible under this category.	therefore the CPA does not include combined heat and power (co-generation) systems.
In the case of project activities that involve the capacity addition of renewable energy generation units at an existing renewable power generation facility, the added capacity of the units added by the project should be lower than 15 MW and should be physically distinct from the existing units.	Not applicable. The programme of activities and therefore the CPA does not include capacity additions.
In the case of retrofit, rehabilitation or replacement, to qualify as a small-scale project, the total output of the retrofitted or replacement unit shall not exceed the limit of 15 MW.	Not applicable. The programme of activities and therefore the CPA does not include retrofit or replacement systems.
In the case of landfill gas, waste gas, wastewater treatment and agro-industries projects, recovered methane emissions are eligible under a relevant Type III category. If the recovered methane is used for electricity generation for supply to a grid then the baseline for the electricity component shall be in accordance with procedure prescribed under this methodology. If the recovered methane is used for heat generation or cogeneration other applicable Type-I methodologies such as "AMS-I.C.: Thermal energy production with or without electricity" shall be explored.	Not applicable. The CPA only includes solar PV technologies.
In case biomass is sourced from dedicated plantations, the applicability criteria in the Tool "Project emissions from cultivation of biomass" shall apply.	Not applicable. The CPA does not involve the use of biomass.

In addition, the project meets the applicability criteria of the *Tool to calculate the emission factor for an electricity system* (version 04.0) as follows:

This tool may be applied to estimate the OM, BM and/or CM when calculating baseline emissions for a project activity that substitutes grid electricity that is where a project activity supplies electricity to a grid or a project activity that results in savings of electricity that would have been provided by the grid (e.g. demand-side energy efficiency projects).	This tool is applicable since the small-scale CPA involves the generation of electricity from solar and its supply to the Rwandan grid system. This is evidenced by the PPA between the project developer and utility company
Under this tool, the emission factor for the project electricity system can be calculated either for grid power plants only or, as an option, can include off-grid power plants. In the latter case, the conditions specified in "Appendix 2: Procedures related to off-grid power generation" should be met. Namely, the total capacity of off-grid power plants (in MW) should be at least 10 per cent of the total capacity of grid power plants in the electricity system; or the total electricity generation by off-grid power plants (in MWh) should be at least 10 per cent of the total electricity generation by grid power plants in the electricity system; and that factors which negatively affect the reliability and stability of the	The emission factor is calculated for only grid connected power plants. This is evidenced in the Grid-Emission factor spread sheet. There is no need to prove compliance with conditions specified in appendix 2 since only grid connected power plants are included in the grid emission factor calculation.

grid are primarily due to constraints in generation and not to other aspects such as transmission capacity.	
The tool is not applicable if the project electricity system is located partially or totally in an Annex-I country.	The project electricity system is located in Rwanda. Rwanda is a non-Annex I country. This is evidenced by the PPA between the project developer and utility company
The value applied to the CO_2 emission factor of biofuels is zero.	Not applicable since no biofuels are used for grid-connected electricity generation in Rwanda.

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

No further information

Appendix 5. Further background information on monitoring plan

No further information

Appendix 6. Summary report of comments received from local stakeholders

No further information

Appendix 7. Summary of post-registration changes

In accordance with section 9 of the CDM Project Standard for programmes of activities (CDM-EB93-A07-STAN, version 01.0), project participants or CME's are expected to identify and document any actual or proposed changes to the operation, implementation and or monitoring of the registered CDM PoA or included CPAs taking into account the types of changes described in the appendix 2. For this included CPA-DD four changes have been identified as suitable for approval under the issuance track in line with provisions set out under Appendix 2.

These four changes are considered as permanent changes as set out under section 9.3 of CDM-EB93-A07 STAN, version 1.0, being:

1. A correction as per section 9.3.1:

   Number of installed solar modules
   The number of solar modules indicated in the registered CPA-DD (version 05.0) is 28,340 each with a capacity of 300 W and a total peak capacity of 8.5 MW. The nameplate capacity of the modules installed on the project site remains unchanged at 300 W although the number of modules increased slightly to 28,360. Overall, the total installed peak capacity remains unchanged at 8.5 MW in accordance with the Power Purchase Agreement (PPA).

2. A change to the start date of the crediting period of the CPA as per section 9.3.2:

   The crediting period was changed to the 23/10/2015, which is the day when the CPA was included to the PoA

3. Two permanent changes to the registered monitoring plan as per section 9.3.4:

   Meter installation
   The CPA-DD (version 05.0) states that a total of four meters will be installed at the project site, the first to measure the electricity supplied to the grid and operated by the project, a backup to measure the amount of electricity supplied by the grid and operated by the utility, a third backup meter operated by the project to measure the amount of electricity delivered to the grid and a fourth meter operated by the utility measuring the amount of electricity supplied to the project from the grid.

   As opposed to the above, only three meter installations, instead of four are in place at the project site:
   1) Main meter: Operated by the CPA implementer
   2) Back-up meter: Operated by the utility, Rwanda Energy Group (REG)
   3) Auxiliary meter: Operated by the CPA implementer to meter certain electrical loads at the facility including site facility building and lighting. This meter is only used for internal management purposes but is not used for any billing purposed of electricity export to or import from the grid. This meter is thus irrelevant for calculation of emission reductions for this CPA.

   The main and back-up meters are bi-directional as they measure the electricity generation exported to the grid as well as electricity imported from the grid that is consumed by the project when the plants' electricity generation is too low to meet internal loads, e.g. during night-time.

   Accuracy of main- and back-up meter
   The registered CPA-DD (version 05.0) describes that the main-and back up meters shall comply with meters of an accuracy class of 0.5S for active and 2 for reactive power. The main and back-up meter actually installed at the project site do however belong to a more accurate class being meters complying with 0.2S for active power and 0.5 for reactive power.

   This installation is in line with the requirements of the PPA signed between the utility and the project and therefore does not affect accuracy of electricity generation metering described in the registered CPA-DD (version 05.0).