GHG Emission reduction analysis

17880: Resilience to hurricanes in the building sector in Antigua and Barbuda

1) Calculation of installed PV capacity

A precise calculation of the project's avoided CO2 emissions cannot be calculated without the specifications of the PV arrays for each selected building. In lieu of these specifications, an estimate of the total solar PV capacity to be installed for this project was developed utilizing information from another DOE project. That project, titled "Sustainable Pathways, Protected Areas, and Renewable Energy" (SPPARE) is installing 433kW of solar PV on 23 separate buildings which fit the profile of critical infrastructure. These buildings include health clinics, pharmacies, schools, the Ministry of Health, and the National Office of Disaster Services. The PV systems for these buildings are designed and sized to allow for autonomous operation of each facility in the event of prolonged grid failure. As critical infrastructure, they are analogous to the PV systems that will be deployed on selected buildings of the *Resilience to hurricanes in the building sector in Antigua and Barbuda* (GCF Build) project and can be used to estimate the total installed PV capacity of all interventions.

Reports generated for the SPPARE project determined that solar PV systems deployed in Antigua and Barbuda will produce approximately 1,927.2kWh per kW of installed capacity per year

1.1. Key Assumptions and Facts

The key assumptions and facts employed to determined approximate installed PV capacity for the GCF Build project are as follows:

- GCF Build project sites selected for solar PV systems share similar electrical needs and similar durations of autonomy as SPPARE project interventions
- Total area for SPPARE project sites is 357.086m^2
- Total area for GCF Build sites selected for solar PV systems is 27331m^2
- Average installed PV capacity per SPPARE project site is 18.82kW
- Average kW per square meter for SPPARE project sites is 0.052704kW/m^2

1.2. Methodology for calculating installed PV capacity

The following methodology was utilized to estimate the total installed solar PV capacity and approximate annual energy production for the proposed project:

1. The average area in square meters of all 23 buildings in the SPPARE RFP1 and RFP2 was calculated (357.086m^2).
2. The average solar PV capacity per building for each of the 23 buildings in SPPARE was calculated using the designs for each structure (18.82kW). Note, all designs are finalized, and total solar PV capacity in this project is known.
3. Average building area and average installed PV capacity were used to determine the average kW of installed PV capacity per square meter for each building targeted by SPPARE (0.052704 kW/m^2).

4. The average kW per square meter was then multiplied by the total area in square meters of all buildings selected by the GCF Build project for solar PV (0.052704 kW/m^2 * 27331m^2). This value is the total estimated installed solar PV for all buildings selected for GCF build (1,440.453 kW).
5. Total PV capacity for the GCF Build (1,440.453kW) was then multiplied by the annual energy production per kW (1,927.2kWh per kW). The resulting value is the estimated annual energy production for all solar PV installations undertaken for the GCF Build project.

2) Climate additionality of the project

The project is located in Antigua and Barbuda, which is a SIDS. According to CDM methodological tool for demonstration of additionality of microscale project activities (Version 09.0), paragraph 11(a), project activities that are located in SIDS, employ renewable energy and have total installed capacity equal to or less than 5 MW are considered automatically additional.

Therefore, the presented project is considered to meet the climate additionality requirements.

3) Applied methodology

The proposed project activity involved the installation of PV generation systems in buildings that are connected to the grid. The PV system supplies electricity to the end users and does not supply electricity to the grid.

Therefore, the emission reduction for the project can be calculated using CDM methodology AMS – I.F.: Renewable electricity generation for captive use and mini-grid (Version 3.0).

2.1 Baseline emissions

In the baseline, the users will use the same amount of grid electricity as the amount supplied by the PV system. Baseline emissions are calculated using the following formula:

$$BE_y = EG_{BL,y} \times EF_{CO_2,y} \qquad \text{Equation (1)}$$

Where:

BE_y	=	Baseline emissions in year *y* (tCO_2)
$EG_{BL,y}$	=	Quantity of net electricity displaced as a result of the implementation of the CDM project activity in year *y* (MWh)

$EF_{CO2,y}$ = Emission factor (tCO_2/MWh)

- Emission factor of the grid uses the default values for Antigua and Barbuda of the IFI TWG for Harmonization of GHG Accounting (0.693 tCO_2/MWh)

2.2 Project emissions and leakage emissions

Project emissions and leakage emissions are considered to be 0 tCO_2/MWh for solar projects.

2.3 Emission reductions

Emission reductions are calculated using the following formula.

$$ER_y = BE_y - PE_y - LE_y$$ Equation (2)

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)

3. Emission reduction calculations

$$BE_y = EG_{BL,y} \times EF_{CO_2,y}$$

BE_y = 1,923 t CO_2/yr

$EG_{BL,y}$ = 2,776 MWh/yr [Calculated based on Section 1 above]

$EF_{CO2,y}$ = 0.693 tCO_2eq/MWh [IFI TWG default grid emission factors]

<u>$ER_y = BE_y$ = 1,923 tCO_2/yr</u>

Key Assumptions for Energy Production:

Annual energy production per kW of installed solar PV was determined from information gathered by the Department of Environment for its application to the International Renewable Energy Agency (IRENA) and Abu Dhabi Fund for Development (ADFD) third project cycle. Average annual daily horizontal insolation levels were determined to be 6.16kWh/m^2/per day. Annual energy production per kW was determined using 300W mono- SI solar PV modules with an efficiency of 18.33%.