CLEAN DEVELOPMENT MECHANISM

CDM-SSCWG48-A09

Draft Small-scale Methodology

AMS-XX: Solar power for domestic aircraft at-gate operations

Version 01.0

Sectoral scope(s): 01,07

DRAFT

United Nations Framework Convention on Climate Change

COVER NOTE

1. Procedural background

1. The Executive Board of the clean development mechanism (CDM) (the Board) at its eighty-first meeting (EB81) agreed under the 2015 CDM management plan (MAP 2015) to include the "Top down development of Methodologies/Standardized baselines and tools" covering, among others, aviation sector.[1]

2. The secretariat in close collaboration with experts from the International Civil Aviation Organization (ICAO) and in consultation with the small scale working group (SSC WG) members developed draft methodology covering application of solar PV for at-gate operations involving domestic aircraft.

3. Following the consultation with the methodology panel (MP) at its sixty-seventh meeting, the SSC WG at its 48th meeting agreed to launch a call for public input on the draft methodology "AMS-XX: Solar power for domestic aircraft at-gate operations"

2. Purpose

4. It aims to develop a new methodology based on the objective of CDM MAP 2015 to improve the existing regulation by broadening the coverage of CDM in aviation sector.

3. Key issues and proposed solutions

5. Emissions from aviation activities represent approximately 2 per cent of global anthropogenic CO_2 emissions. The magnitude of forecasted traffic growth, however, suggests that the future contribution of aviation activities to climate change will be significantly higher in the coming decades.

6. Emissions from international aviation activities (i.e. flights between countries) are being addressed by the ICAO, which has established an aspirational goal of carbon-neutral growth beyond 2020 and is pursuing a basket of measures, including aircraft-related technology development, alternative fuels, improved air traffic management and infrastructure, more efficient operations, and market-based measures.

7. In contrast, emissions from domestic aviation activities (i.e. flights within a country), are a matter for each Party to address. Significant growth in emissions from domestic aviation activities in non-Annex I Parties is expected as these markets mature, and measures to mitigate these emissions are eligible to be credited under the CDM.

[1] See EB82 Annex 11 (Paragraph 18-22) , Concept note: Development of new methodologies to broaden the applicability of CDM" available at http://cdm.unfccc.int/Meetings/MeetingInfo/DB/C1REFM4G0ZT6K8P/view and Annex 2, EB82 (Page 32) "Work-plan of panels and working groups for 2015 (version 01.0) available at http://cdm.unfccc.int/EB/index.html

8. Based on the input received from ICAO, there is limited evidence of widespread implementation of GHG mitigation measures in non-Annex I Parties, hold immediate potential for CDM projects.

9. At-gate aircraft require power to operate electrical systems as well as heating, ventilation, and air conditioning systems. Current practice involves the generation of power from carbon intensive on-board auxiliary power units (APUs) ground power units (GPUs).The proposed methodology aims for displacement of carbon intensive electricity with renewable electricity.

4. Impacts

10. The proposed draft methodology would expand its portfolio of methodologies expansion into a fast-growing sector that remains largely untapped by crediting mechanisms.

5. Subsequent work and timelines

11. After receiving public inputs on the document, the SSC WG will continue working on the methodology, at its 49th meeting, for recommendation to the Board at a future meeting.

6. Recommendations to the Board

12. Not applicable (call for public input).

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1. Introduction

1. The following table describes the key elements of the methodology.

Table 1. Methodology key elements

Typical project(s)	Production of electricity using solar photovoltaic that supply electrical energy for aircraft at-gate operations in airports
Type of GHG emissions mitigation action	Renewable energy. Displacement of energy that would be provided to the airports for at-gate operation by more-GHG-intensive means (grid, fossil fuel)

2. Scope, applicability, and entry into force

2.1. Scope

2. This methodology comprises renewable energy generation units from solar photovoltaic that supply electrical energy to airports for aircraft at-gate operations. The methodology is only applicable to domestic flights and flights that operate on international routes are not included in this methodology.

3. The project activity shall displace electricity to replace energy requirements for electricity and pre-conditioned air both external and internal generation that is or would have been supplied by at least one fossil fuel fired generating unit i.e. in the absence of the project activity, the users would have been supplied electricity from one of the sources listed below:

(a) Auxiliary Power Unit[2] (APU);

(b) Ground Power Unit (GPU);

(c) A national or a regional grid (grid hereafter); and/or

(d) Fossil fuel fired captive power plant(s).[3]

2.2. Applicability

4. The methodology is applicable to project activities that:

(a) install a new solar photovoltaic system (Green field plant) at an airport facility where no onsite renewable energy power is operating prior to implementation of the project activity; or

[2] [Operation of aircraft APU with its low efficiency rate of 8-14% is subject to higher carbon emissions, to mitigate emissions fixed energy systems can be designed to provide both electrical energy and pre-conditioned air to aircraft (*Aircraft Ground Energy Systems, Zurich Airport*)]

[3] Where the users of the captive electricity are also connected to the grid in the project site.

(b) supplies energy i.e. electricity and/or pre-conditioned air to the airplane at gate through use of external power sources connected to the airplane or internal power sources i.e., with only engine generator (APU) running;

5. If the unit added has both renewable and non-renewable components (e.g. solar and diesel unit), the eligibility limit of 15 MW for a small-scale CDM project activity applies only to the renewable component.

6. The methodology is only applicable to supply and displacement of electrical energy and pre-conditioned air for at-gate operations i.e. the point of use, where these services are utilized by the aircraft.

7. The methodology is not applicable to at-gate operations for supply of energy services to any other operations except for supply of energy services, electricity and pre-conditioned air, to an aircraft.

8. The methodology is not applicable to abnormal[4] and/or emergency at-gate operations.

9. Project participant should ensure through a contractual agreement with the end-user(s) of solar electricity that the end-user(s) do not claim emission reductions from using it through a separate CDM project activity. The project participants can however enter in contractual arrangements with end-users regarding sharing of emission reductions generated by this project activity.

2.3. Entry into forces

10. Not applicable (call for public input).

3. Normative references

11. Project participants shall apply the “General guidelines for SSC CDM methodologies”.

12. This methodology also refers to the latest approved versions of the following approved methodologies and tools:

(a) “ACM0002: Grid-connected electricity generation from renewable sources”;

(b) “AMS-I.A.: Electricity generation by the user”;

(c) “AMS-I.C.: Thermal energy production with or without electricity”;

(d) “AMS-I.D.: Grid connected renewable electricity generation”;

(e) “Tool to calculate baseline, project and/or leakage emissions from electricity consumption;

(f) “Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion”;

(g) “Tool to calculate the emission factor for an electricity system”.

[4] Flights with deferred APU failure i.e., aircraft operation without APU for limited days, depending on prescription under maintenance manual, are considered abnormal operations

4. Definitions

13. The definitions contained in the Glossary of CDM terms shall apply.

14. In addition, for the purpose of this methodology, the following definitions apply:

(a) **At-gate operations:** commences as soon as the aircraft engine(s) is shut-off upon landing and terminates at engine start-up. The aircraft may either be connected to passenger loading bridges or standing in the open. The at-gate ground handling operations for this methodology is limited to ground power and pre-conditioned air delivery to aircraft during its ground time.

(b) **Auxiliary power unit (APU):** small gas-turbine engine coupled to an electrical generator and used to provide electrical and pneumatic power to aircraft systems when required. It is normally mounted in the tail cone of the aircraft, behind the rear pressure bulkhead, and runs on kerosene fed from the main fuel tanks. Not all aircraft are fitted with an APU and, though their use on transport category jet aircraft is now almost universal, some turboprops and business jets do not have an APU fitted. APU are used when ground power units are not available or where ground handling operations are dependent of a short turn-around time i.e. the time from start to stop of at-gate operation for the aircraft. APU for air conditioning can operate in addition to ground power units that supply external pre-conditioned air if required indoor temperature requirement cannot be achieved by ground power units alone.

(c) **Ground power unit (GPU) or external power unit:** A GPU supplies electrical energy to an aircraft during its ground time through a connector near the nose gear. There are two types of GPUs:
(a) grid-powered GPU where the electrical energy is supplied either by (i) centralized converters that distribute electrical energy throughout the airport, or (ii) individual converters installed under the passenger loading bridges, or (iii) mobile converter vehicles; and/or
(b) Mobile fuel consumption fuel trucks

Other possible considerations as per reference listed: Ground support equipment (GSE) utilization and activity levels vary by airport type (e.g., commercial versus GA), aircraft type (e.g., wide body versus narrow body), payload (e.g., passengers versus cargo) and climatic conditions (e.g., cold versus warm). GSE emissions also vary by fuel type (e.g., diesel, gasoline, propane, electric, etc.), model year, and horsepower rating. Again, the selected emissions inventory approach (i.e., Basic, Intermediate, Advanced) determines which GSE data are necessary to compute emissions from this source.

(d) **Pre-conditioned air (PCA):** pre-conditioned air, either warm or cold depending on ambient climatic conditions, is a gate provided alternative to APU supplied either by mobile air conditioning units or from hook-ups at the passenger loading terminal gate. Mobile air conditioning units are fuel consumption PCA trucks whereas PCA supplied by hook-ups at the passenger loading terminal gates are by means of a grid supplied centralized system.

(e) **Airport electricity distribution system:** consists of a centralized electrical power distribution network that distribute electrical energy to energy demand centres within the airport facility and whose individual consumption is measured

that also measure the supply of electrical energy to meet demands for at-gate operations.

(f) **At-gate electrical systems:** Depending on the type of aircraft different types of GPUs can be used. Centralized ground power systems generate aircraft compatible electrical energy in one location, from where it is distributed to each gate. For example, smaller aircraft require 28 Volt direct current GPU systems, whereas larger aircrafts require 400 hertz power supply, which can be supplied from a centralized location or from equipment provided at gate. [Converters and distribution of 115V/400Hz alternating current (AC) to the aircraft at-gate or with modifications[5] to supply larger sized aircrafts e.g. new A380.]

5. Baseline methodology

5.1. Project boundary

15. The spatial extent of the project boundary includes the solar photovoltaic arrays, the existing captive energy generation facilities, facilities generating pre-conditioned air and the facilities at gate consuming energy generated by the system.

16. The project boundary also includes the entire geographical reach of fuel consuming mobile generation units that generate electrical energy and pre-conditioned air within the airport facility. The boundary also extends to the project power plant and all power plants connected physically to the project electricity system[6] that the CDM project power plant is connected to.

5.2. Baseline scenario

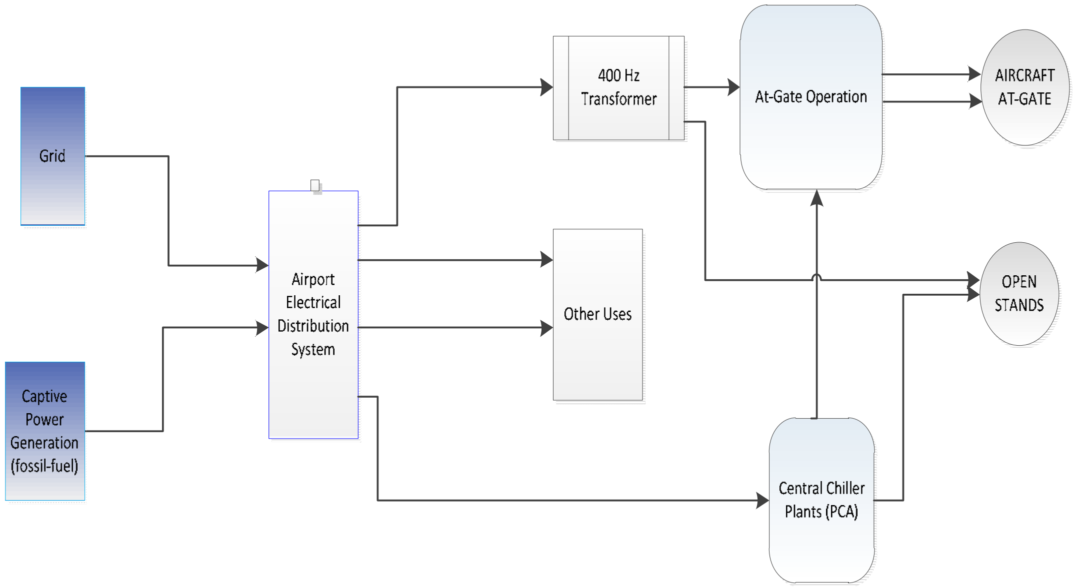
17. Electrical energy supplied by sources listed in paragraph 3 (b), (c) and (d) above are distributed to the “point of use” for both electrical energy and PCA requirements.

18. The electrical energy is supplied to the point of use either through the airport electrical distribution system (AEDS) or directly. Supply of electrical energy through the AEDS is illustrated in Figure-1 below.

[5] When an airport gets approval of being capable of operating a new aircraft model all ground handling services of the airport have been considered. Therefore the relevant GPU/PCA output parameters should meet requirements of aircraft operating manuals issued by aircraft manufacturers.

[6] Refer to the latest approved version of the “Tool to calculate the emission factor for an electricity system” for definition of project electricity system.

Figure 1. Fully equipped Airport facility supplied by grid and/or captive power generation



19. Electrical energy and PCA supplied either by fuel consuming mobile units and/or by the internal source listed in paragraph 3 (a) above.

20. Table 2 below provide a relation between the sources available to provide the services of electrical energy and PCA to aircraft for at-gate operations.

Table 2. Means of providing energy to aircraft at-gate operations

	Energy systems for aircraft	**Aircraft built-in APU**	**Fixed+ GPUs**		**Mobile GPUs**	
	Energy Source(s)	**Jet Fuel**	**Grid**	**Fuel****	**Grid**	**Fuel****
Electrical energy (400Hz)		✓	✓	✓	✓	✓
PCA		✓	✓	✓	✓	✓

+ Fixed GPUs supplied by electricity include passenger bridges
** Fuel includes both fossil-fuel drive for electricity generation as well as captive generation e.g. onsite diesel generation sets

21. Table 3 below provides the three scenarios pertaining to the means of servicing aircrafts for at-gate operations by airports. The airport service for a large airport can provide aircrafts at-gate a fully equipped gate that provides a full range of options to service the aircrafts. For small airports services may only be provided by aircrafts own internal generation.

Table 3. Three baseline situations/scenarios are envisaged

Scenario 1	Scenario 2	Scenario 3
▪ Fully Equipped Gate: Electricity: (i) for aircraft electrical equipment by grid/captive generation; and PCA: (ii) from conditioned air heater/Chiller utility plant	▪ Partially equipped gate ▪ Mobile/Fixed GPU (grid/captive power): Separate Electricity and separate PCA supply and/or ▪ Mobile GPU (fossil fuel consuming) Separate electrical energy and separate PCA supply	▪ Only APU: Supplying both electrical energy and PCA requirements

Large Scale of Airport *Small* →

22. The selection of the baseline scenario should be explained and transparently documented in the CDM-PDD.

5.2.1. Baseline emissions

23. Baseline emission where electrical energy is supplied by grid to meet the requirements of both aircraft electrical equipment and PCA.

$$BE_y = \min\left(\left(\sum_{i=1}^{l} EG_{i,y} + \sum_{j=1}^{m} EG_{j,y}\right), \left(EG_{i,\max,y} + EG_{j,\max,y}\right)\right) \times EF_{CO2}$$ Equation (1)

Where:

BE_y	=	Baseline emissions in year *y* (t CO_2)
$EG_{i,y}$	=	Quantity of net electricity produced as a result of the CDM project activity and supplied for use by aircraft electrical components *i* for the domestic aircraft at-gate operation for the type and size of aircraft in year *y* (kWh)
l	=	Total number of gates and/or open spaces which are supplied by electrical energy by the CDM project activity in year y
$EG_{j,y}$	=	Quantity of net electricity produced as a result of the CDM project activity and supplied for use by aircraft pre-conditioned air *j* for domestic aircraft at-gate operation for the type and size of aircraft in year *y* (kWh)
m	=	Total number of gates and/or open spaces which are supplied by pre-conditioned air by the CDM project activity in year y
EF_{CO2}	=	Emission factor (tCO_2/MWh) determined in accordance with paragraph 25 below

$EG_{i,\max,y}$	=	Maximum quantity of electricity generated by the Solar photovoltaic installation at project site that was supplied for use by aircraft electrical components *i* for the domestic aircraft at-gate operation for the type and size of aircrafts in year *y* (kWh)
$EG_{j,\max,y}$	=	Maximum quantity of electricity that can be generated by the Solar photovoltaic installation at project site that was supplied for use by aircraft pre-conditioned air *j* for the domestic aircraft at-gate operation for the type and size of aircrafts in year *y* (kWh)

24. Total electricity generated by the CDM project activity shall be compared with the total electricity consumption for at-gate operations by domestic aircrafts in year y, and the eligible quantity of electricity for claiming emission reductions should always be the minimum between the electricity generated by the renewable energy system to that of the total electricity consumed for all applications (i.e. electricity and PCA).

5.2.2. Determination of EF_{CO2}

25. Table 4 below illustrates the various means to determine the baseline emission factor compared to the baseline sources for each of the two services provided by airport to aircrafts at-gate (i.e. electricity and PCA).

Table 4. Emission factor based on baseline energy systems that service the aircraft

Source of emission	**Emission factor based on energy systems that service the aircraft**	
	Electricity consumed at-gate (400 Hz)	**PCA consumed at-gate**
Jet fuel	APU	APU
Diesel	Mobile fuel consumption GPU	Mobile fuel consumption air conditioning unit
Grid	• Mobile GPU (underground cable/open stands) • Fully supported Passenger bridge	• Central chiller/Heat facility • Mobile air conditioning units (extendable cables to supply PCA for open stands)
Captive generation	• Mobile GPU (underground cable/open stands) • Fully supported Passenger bridge	• Central chiller/Heat facility • Mobile air conditioning units (extendable cables to supply PCA for open stands)

26. The baseline emission shall be determined for the historical [one][three] year at-gate operations for domestic flights at the airport where the CDM project activity is implemented.

27. Based on the scenario that applies the baseline emissions for the at-gate operations for domestic flights would be determined by the operating time at the gate, the type of fuels consumed to supply electricity and pre-conditioned air to the aircrafts.

28. The estimation of baseline emission factor of the baseline source *i* of electricity supplied to domestic aircrafts and the baseline source of electricity for pre-conditioned air *j* that would be supplied by the CDM project activity is explained below.

5.2.2.1. Baseline scenario 1 – a fully equipped gate

29. For a fully equipped gate the emission factor could consist of a combination of proportion of electrical energy consumed by domestic flights separately for electricity and pre-conditioned air supplied by grid and/or captive generation, mobile fuel consuming units or auxiliary power units.

30. The emission factor of a grid shall be calculated as per the procedures provided in AMS-I.D

31. Emission factor for captive electricity generation shall be calculated as per the procedures described in the latest version of the “Tool to calculate baseline, project and/or leakage emissions from electricity consumption”

32. [Option 1] For mobile fuel consuming units and APUs the emission factor should be separately estimated for the at-gate operation time for supply of electricity and/or preconditioned air, the associated fuel and efficiency of the motor/generator.

33. The baseline emission factor should reflect the proportional distribution of the respective sources with the emissions intensity of the grid, captive power plant, mobile consumption units and APU usage for [one][three] year period prior i.e. the weighted average emission factor for the displaced electricity is calculated using values based on the historical consumption of electricity used from grid, captive plants, mobile consuming units and APU.[7]

34. [Option 2] In case if the project proponent wishes not to use historical data, The baseline emission factor shall be the minimum between the respective sources of emission intensity between the grid, captive power plant, mobile consuming units and APU. The emission factor for mobile consuming units and APU can be gathered from the optimum design values.

5.2.2.2. Baseline scenario 2 – partially equipped gate (grid/captive powered GPUs and/or Mobile fuel consumption GPU/PCA)

35. Where airports are catered by both mobile units and mobile fuel consuming units, the emission factor for mobile units that supply either grid and/or captive generated power to at-gate operations shall be calculated as described above. This includes situations where mobile units of GPU and PCA are used to replace APU.

[7] For example if in the baseline the annual electricity requirement for at-gate operations was met by grid import (30 per cent), captive generation (30 per cent), mobile fuel consuming units (30 per cent) and the remaining by APUs the weighted average emission factor (EF_{CO2}) would be 0.3 EF_{grid} + 0.3 $EF_{captive}$.+ 0.3 $EF_{mobile\text{-}units}$.+ 0.1 EF_{APU}.

36. For mobile fuel consuming units the emission factor should be separately estimated for the at-gate operation time for supply of electricity and/or preconditioned air, the associated fuel and efficiency of the motor/generator.

37. [Option 1] The baseline emission factor should reflect the proportional distribution of the respective sources with the emissions intensity of the grid, captive power plant, mobile fuel consumption units for [one][three] year period prior

38. [Option 2] The baseline emission factor shall be the minimum between the respective sources of emission intensity between the grid, captive power plant, mobile consuming units and APU.

5.2.2.3. Baseline scenario 3 – APU running to supply both electricity and PCA

39. The APU can supply either electricity or PCA or both for the duration of time the domestic flight is at the gate at airports where the gate infrastructure is not available or is limited.

40. The [duration of time that the APU is in operation, the fuel consumption rate,] type of fuel and the type of aircraft, should be determined for the historical [one][three] year prior.

41. The baseline emission factor for captive electricity generation shall be calculated as per the procedures described in the latest version of the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" and for PCA it would be calculated based on the duration of time that the APU is in operation, the fuel consumption rate.

5.3. Project emissions

42. For solar PV project activities, $PE_y = 0$.

43. CO_2 emissions from on-site consumption of fossil fuels due to the project activity shall be calculated using the latest version of the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion".

5.4. Leakage

44. No leakage considered.

5.5. Emission reductions

45. Emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y - LE_y \qquad \text{Equation (2)}$$

Where:

ER_y	=	Emission reductions in year *y* (t CO_2e/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)

6. Monitoring methodology

6.1. Data and parameters monitored

Data / Parameter table 1.

Data / Parameter:	EF_{CO2}
Data unit:	t CO_2/MWh
Description:	CO_2 emission factor for the three year historical average based on the appropriate baseline scenario
Measurement procedures (if any):	As prescribed in procedure under section 5.2.2 of this methodology
Monitoring frequency:	[one][three] year historical average
Any comment:	-

Data / Parameter table 2.

Data / Parameter:	$EG_{i,y}$
Data unit:	kWh
Description:	Quantity of net electricity produced as a result of the CDM project activity and supplied for use by aircraft electrical components *i* for the domestic aircraft at-gate operation for the type and size of aircraft in year y
Measurement procedures (if any):	Measurements are undertaken using meters located at point of use. Calibration should be undertaken as prescribed in the relevant paragraph of the “General guidelines for SSC CDM methodologies”. In the case of electricity sold to a third party, measurement results shall be cross-checked with records of sold/purchased electricity (e.g. invoices/receipts). The net electricity displaced is the gross energy generation by the project activity power plant minus the auxiliary/station electricity consumption
Monitoring frequency:	Continuous monitoring, hourly measurement and at least monthly recording and aggregated for the year
Any comment:	-

Data / Parameter table 3.

Data / Parameter:	$EG_{j,y}$
Data unit:	kWh
Description:	Quantity of net electricity produced as a result of the CDM project activity and supplied for use by aircraft pre-conditioned air *j* for domestic aircraft at-gate operation for the type and size of aircraft in year y

Measurement procedures (if any):	Measurements are undertaken using meters located at point of use. Calibration should be undertaken as prescribed in the relevant paragraph of the "General guidelines for SSC CDM methodologies". In the case of electricity sold to a third party, measurement results shall be cross-checked with records of sold/purchased electricity (e.g. invoices/receipts). The net electricity displaced is the gross energy generation by the project activity power plant minus the auxiliary/station electricity consumption
Monitoring frequency:	Continuous monitoring, hourly measurement and at least monthly recording and aggregated for the year
Any comment:	-

Data / Parameter table 4.

Data / Parameter:	$EG_{i,\max,y}$
Data unit:	kWh
Description:	Maximum quantity of net electricity generated by Solar Photovoltaic installation at project site that was supplied for use by aircraft electrical components i for the domestic aircraft at-gate operation for the type and size of aircrafts in year y
Measurement procedures (if any):	Measurements are undertaken using meters located at point of use. Calibration should be undertaken as prescribed in the relevant paragraph of the "General guidelines for SSC CDM methodologies". In the case of electricity sold to a third party, measurement results shall be cross-checked with records of sold/purchased electricity (e.g. invoices/receipts). The net electricity displaced is the gross energy generation by the project activity power plant minus the auxiliary/station electricity consumption
Monitoring frequency:	Continuous monitoring, hourly measurement and at least monthly recording and aggregated for the year

Data / Parameter table 5.

Data / Parameter:	$EG_{j,\max,y}$
Data unit:	kWh
Description:	Maximum quantity of electricity that can be generated by the Solar photovoltaic installation at project site that was supplied for use by aircraft pre-conditioned air *j* for the domestic aircraft at-gate operation for the type and size of aircrafts in year y
Measurement procedures (if any):	Measurements are undertaken using meters located at point of use. Calibration should be undertaken as prescribed in the relevant paragraph of the "General guidelines for SSC CDM methodologies". In the case of electricity sold to a third party, measurement results shall be cross-checked with records of sold/purchased electricity (e.g. invoices/receipts). The net electricity displaced is the gross energy generation by the project activity power plant minus the auxiliary/station electricity consumption

Monitoring frequency:	Continuous monitoring, hourly measurement and at least monthly recording and aggregated for the year

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Document information

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