CLEAN DEVELOPMENT MECHANISM

CDM-SSCWG50-A01

Draft Small-scale Methodology

SSC-I.x: Solar power for domestic aircraft at-gate operations

Version 01.0

Sectoral scope(s): 01 and 07

United Nations
Framework Convention on
Climate Change

COVER NOTE

1. Procedural background

1. In 2014 the secretariat received a request from International Civil Aviation Organization (ICAO), to jointly develop two aviation methodologies under the CDM.

2. 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.

3. 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 a methodology covering the application of a solar power system for at-gate operations involving aircraft operating on domestic routes.

4. The first version of the recommendation was send to the Board, at its eighty-seventh meeting (EB87), and it requested the Secretariat to prepare a revised draft of the –"SSC-I.X: Solar power for domestic aircraft at-gate operations", expanding the scope of the methodology to cover international aircrafts and to seek input from ICAO on the draft methodology.

5. The Board considered the revised version prepared by the secretariat, at its eighty-eighth meeting (EB88), requested the SSC WG to propose further revisions to the draft methodology: (a) taking into account the feedback provided by the Board on technical issues during the meeting, (b) limiting the application of the methodology to domestic aircrafts as proposed by the International Civil Aviation Organization (ICAO), and (c) seeking inputs from ICAO on the draft revised methodology. The Board requested the secretariat to continue to consult with ICAO to explore if there are options to expand the applicability of the methodology to cover international aircrafts.

6. The SSC WG at its 50th meeting agreed to the Board's proposal to further revise the methodology taking into account the above mentioned feedback provided by the Board at its 88th meeting.

2. Purpose

7. To further revise the draft methodology taking into account the feedback provided by the Board at its eighty-eighth meeting.

3. Key issues and proposed solutions

8. Emissions from all aviation activities represent approximately 2 per cent of global anthropogenic CO2 emissions (with domestic aviation representing approximately 0.7 per cent). 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.

9. Emissions from international aviation activities (i.e. aircrafts 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 such as aircraft-related technology development, alternative fuels, improved air traffic management and infrastructure, efficient operations, and market-based measures.

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

4. Impacts

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

5. Subsequent work and timelines

12. The methodology is recommended by the SSC WG for consideration by the Board at its eighty-ninth meeting. No further work is envisaged.

6. Recommendations to the Board

13. The SSC WG recommends that the Board adopt this final draft methodology, to be made effective at the time of the Board’s approval.

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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 technology 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 GHG-intensive means (grid, fossil fuel)

2. Scope, applicability, and entry into force

2.1. Scope

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

3. The project activity reduces the consumption of fossil fuels used to provide electricity and/or pre-conditioned air to domestic aircrafts. In the absence of the project activity, the electricity and/or pre-conditioned air may be generated from both external and internal generation or would have been supplied by at least one fossil fuel generating unit, i.e. the electricity provided to the users and electricity used to generate pre-conditioned air would have been supplied from one of the sources listed below:

   (a) Auxiliary Power Unit (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).[1]

2.2. Applicability

4. The methodology is applicable to project activities that:

   (a) Install a new solar photovoltaic system (Greenfield plant) at an airport facility where no onsite renewable energy power generation capacities existed prior to the implementation of the project activity that supplied power to the airport's at-gate operations; and

[1] Where the users of the captive electricity may also be connected to the grid in the project site.

(b) Supply electricity and/or pre-conditioned air to domestic aircrafts, at-gate through use of new solar photovoltaic system installed at an airport facility that partially or fully replaces the following baseline power sources:

(i) Auxiliary Power Unit (APU);

(ii) Ground Power Unit (GPU);

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

(iv) Fossil fuel fired captive power plant(s); and[2]

(c) Supply the electricity generated by the new solar photovoltaic system installed at an airport facility to an airport electricity distribution system (AEDS) that services at-gate operations. This AEDS supplied by the project is not connected to grid and/or captive generation other than the new solar photovoltaic system.

5. The methodology is only applicable to claim emission reductions for supplying electrical energy and pre-conditioned air to domestic aircrafts for its at-gate operation services.

6. The methodology is not applicable where the output of the project activity is supplied to a grid. For projects involving grid connected renewable electricity supply, project proponents may choose to apply the latest version of the approved methodology of “AMS-I.D: Grid connected renewable electricity generation”.

7. The methodology is not applicable to abnormal[3] and/or emergency at-gate operations.

8. The project participants should ensure through a contractual agreement with the end-user(s) of solar electricity, i.e. the aircraft operators, that the end-user(s) do not claim emission reductions from using it through a separate CDM project activity. The steps undertaken to avoid double counting shall be documented in the PDD.

2.3. Entry into force

9. The date of entry into force is the date of the publication of the EB 89 meeting report on the 13 May 2016.

2.4. Applicability of sectoral scopes for DOE :

10. For validation and verification of project and programme of activities using this methodology sectoral scope 01 and 07 are mandatory.

3. Normative references

11. Project participants shall apply the “General guidelines for SSC CDM methodologies, information on additionality (attachment A to Appendix B) provided at <http://cdm.unfccc.int/methodologies/SSCmethodologies/approved.html> mutatis mutandis.

[2] Where the users of the captive electricity may also be connected to the grid in the project site.

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

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

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

(b) “Methodological tool: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation”;

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

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’s 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 an aircraft during its time on the ground;

(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. APUs are used when ground power units are not available or where ground handling operations are dependent on a short turn-around time, i.e. the time from start to stop of at-gate operation for the aircraft. APUs operate in addition to externally supplied pre-conditioned air if the required indoor temperature cannot be achieved by through the external source 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 of the aircraft. There are two types of GPUs:

(i) Grid-powered GPU where the electrical energy is supplied either by:

a. Centralized converters that distribute electrical energy throughout the airport, or

b. Individual converters installed under the passenger loading bridges, or

c. mobile converter vehicles; and

(ii) Mobile units that supply power using fossil fuel based power generators;

(d) **Pre-conditioned air (PCA):** pre-conditioned air, either warm or cold air depending on ambient climatic conditions, could be supplied by APU or by mobile air conditioning units or from hook-ups at the passenger loading bridge. Mobile air conditioning units powered through fuel consumption, whereas PCA supplied

by hook-ups at the passenger loading bridge are powered by means of a grid-supplied centralized system;

(e) **Airport electricity distribution system (AEDS):** consists of a centralized electrical power distribution network that caters both the services (electrical energy and PCA) from a centralized location or from equipment provided to the aircraft at-gate or with modifications[4] to supply larger sized aircraft.

5. Baseline methodology

5.1. Project boundary

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

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 including all domestic aircrafts serviced by the airport facility. The boundary also extends to all power plants connected physically to the project electricity system[5] that the airport 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 through the airport electrical distribution system (AEDS). Supply of electrical energy through the AEDS in the baseline is illustrated in Figure 1, whereas supply of electrical energy through a dedicated AEDS in the project is illustrated in Figure 2 below.

[4] 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.

[5] 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. Airport facility supplied by grid and/or captive power generation in the baseline

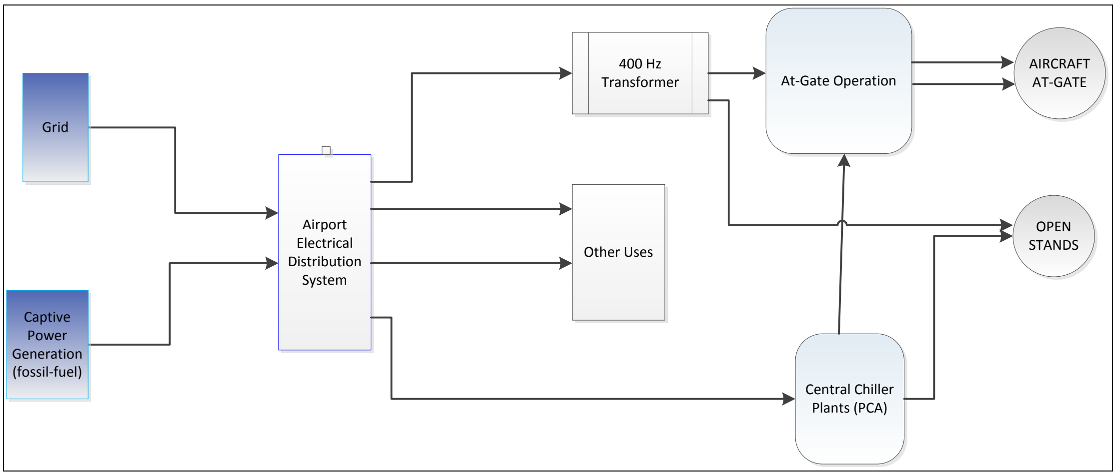
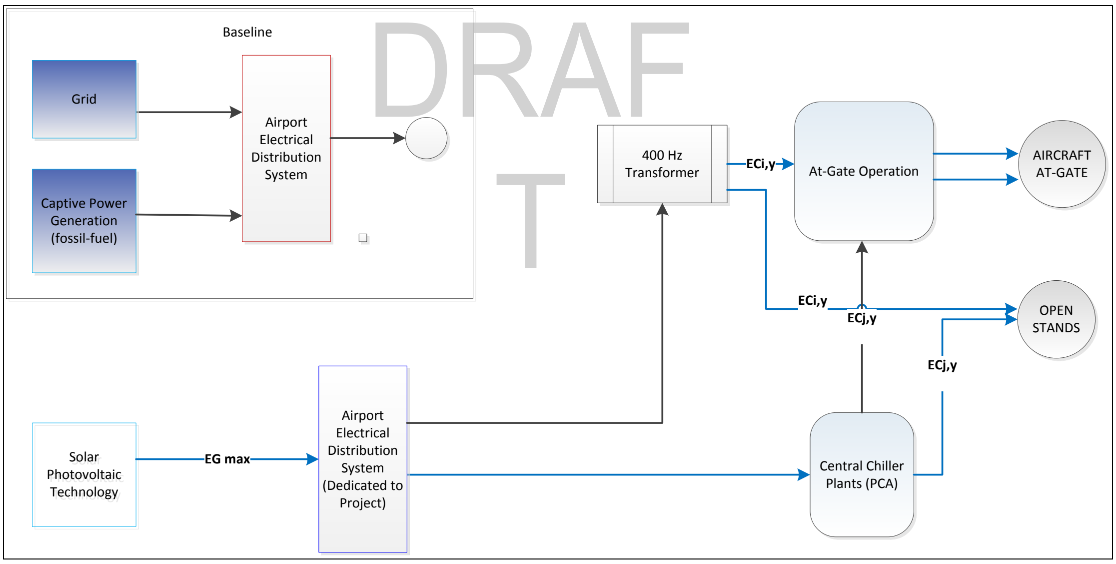


Figure 2. Airport facility supplied by grid and/or captive power generation in the project



19. Electrical energy and PCA supplied either by fuel consuming mobile units and/or by the internal source, i.e. the APU as per paragraph 3(a) above, are other sources for point of use at at-gate operations.

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

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

Point of use	Energy systems for aircraft	Aircraft built-in APU	Fixed GPUs		Mobile GPUs	
	Energy Source(s)	Jet Fuel	Grid	Fuel	Grid	Fuel
Electrical energy	✓		✓	✓	✓	✓
PCA	✓		✓	✓	✓	✓

21. Table 3 below provides the three scenarios pertaining to the means and range of servicing aircrafts for at-gate operations by airports. An airport based on its scale, can provide at-gate services with a different range of options to serve the aircrafts i.e. using fully equipped gate (i.e., scenario1), partially equipped gate (i.e., scenario 2) or APU (i.e., scenario 3)[6].

Table 3. Three baseline situations/scenarios are envisaged

Scenario 1: **Fully Equipped Gate**	**Scenario 2:** **Partially equipped gate**	**Scenario 3:** **APU**
▪ Electricity: ○ for aircraft electrical equipment by grid/captive generation *and/or* ▪ PCA: ○ from conditioned air heater/Chiller utility plant	▪ Electricity: ○ By Mobile/Fixed GPU (grid/captive power): *and/or* ▪ PCA: ○ Mobile GPU (fossil fuel consuming)	▪ <u>Electricity:</u> ○ APU operation *and/or* ▪ <u>PCA:</u> ○ APU operation

Large Scale of Airport *Small*

22. The selection of the applicable baseline scenario and their combination, if any, should be explained and transparently documented in the CDM-PDD.

[6] For small airports services may only be provided by aircrafts own internal generation, i.e. APU

5.2.1. Baseline emissions

23. Baseline emissions where electrical energy would have been supplied by baseline sources to meet the requirements of aircraft electrical equipment and/or PCA is calculated as follows[7]:

$$BE_y = \left[EC_{PCA,y} + EC_{Electricity,y}\right] \times EF_{CO2}$$ Equation (1)

Where:

BE_y	=	Baseline emissions in year y (t CO2)
$EC_{Electricity,y}$	=	Quantity of electricity consumed by aircraft electrical components for the domestic aircraft's at-gate operation which is supplied by the solar power in year y (kWh)
$EC_{PCA,y}$	=	Quantity of electricity consumed by the aircraft to obtain aircraft pre-conditioned air for a domestic aircraft's at-gate operation which is supplied by the solar power in year y (kWh)
EF_{CO2}	=	Baseline emission factor (t CO2/kWh) determined in accordance with section 5.2.2 below

5.2.2. Determination of the baseline emission factor (*EF_{CO2}*)

24. 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. Baseline energy systems (with emission source) that serve the aircraft

Baseline source of emission	Baseline energy systems that service the aircraft	
	Electricity	PCA
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 loading 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)

25. The estimation of baseline emission factor of the baseline source of net electricity consumed by aircraft electrical components and the baseline source of net electricity

[7] The electricity and PCA supplied to individual domestic aircraft in each monitoring period shall be measured, monitored, recorded and used for emission reduction calculation.

consumed by aircraft PCA that would be supplied by the CDM project activity is explained below.

5.2.2.1. Baseline scenario 1 – a fully equipped gate

27. The emission factor could consist of a combination of electricity consumed by electrical components and pre-conditioned air for the domestic aircrafts which is supplied by grid and/or captive generation, including GPUs or APUs, as and where applicable.

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

27. The emission factor for captive electricity generation shall be calculated as per the procedures described in the latest version of the “Methodological tool: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation For GPUs and APUs (refer to section 5.2.2.3 below for APU) the emission factor should be separately estimated for the at-gate operation time for the supply of electricity and/or pre-conditioned air, based on the associated fuel and efficiency of the motor/generator.

28. The baseline emission factor shall be calculated using one of the following options:

    (a) Option 1: The baseline weighted average emission factor for the displaced electricity is calculated using historical share[8] of electricity used from grid, captive power plant, GPU and APU. At least a one-year period of historical data shall be available prior to the start date of the project activity;

    (b) Option 2: The baseline emission factor shall be the minimum between the respective sources of emission intensity between the grid, captive power plant, GPU and APU. The emission factor for GPU should be gathered from the optimum manufacturer design values. The information to arrive at the most conservative emission intensity between these sources shall be transparently documented in the PDD.

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

29. Where airports serve aircraft by mobile/fixed GPUs using grid/captive power, the emission factor for mobile/fixed GPUs that supply either grid and/or captive generated power to at-gate operations shall be calculated as using the provision provided under the baseline scenario 1. This includes situations where GPU and PCA mobile units are used to replace the use of the APU.

30. For mobile GPUs that supply power to PCA using fossil fuel based power generators, the emission factor should be separately estimated for the at-gate operation time for supply of electricity and/or preconditioned air, based on the associated fuel and efficiency of the motor/generator.

[8] 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}.

31. The baseline emission factor shall be calculated using one of the following options:

(a) Option 1: Baseline weighted average emission factor for the displaced electricity is calculated using historical share[9] of electricity used from grid and/or captive powered GPUs and/or GPUs that supply power to produce PCA using fossil fuel based power generators . At least one year period historical data shall be available prior to the start date of the project activity.

(b) Option 2: The baseline emission factor shall be the minimum between the respective sources of emission intensity between the grid, captive power plant, GPU and APU. The information to arrive at the most conservative emission intensity between these sources shall be transparently documented in the PDD.

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

32. The baseline emission factor shall be calculated using one of the following options:

(a) Use at least one year of historical data prior to the start date of the project activity on APU usage for the aircraft types operating at the airport, including APU operating time, fuel consumption rate[10], type of fuel etc. to determine the emission factor;

(b) A default emission factor[11] value of 1.3 kgCO_2/kWh may be used. This value is established on the basis of the most conservative aviation fuel emission factor[12] and the highest efficiency of APU operation.[13]

5.3. Project emissions

33. For solar PV project activities, PE_y = 0.

5.4. Leakage

34. No leakage considered.

[9] 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 $EF_{mobile-units}$.+ 0.1 EF_{APU}.

[10] Use proprietary engine-specific values obtained from APU manufacturers.

[11] Project proponents may submit new proposals and approaches to establish the default emission factor.

[12] Table 3.6.4: CO2 emission factors, volume 2 of 2006 IPCC Guidelines for National Greenhouse Gas Inventories. The result is multiplied by a conservativeness factor selected (0.73) to account for the uncertainty range as contained within document FCCC/SBSTA/2003/10/Add.2.

[13] A highest efficiency of 14% is selected since operation of aircraft APU has a low efficiency rate of 8-14% (*Aircraft Ground Energy Systems at Zurich Airport*).

5.5. Emission reductions

35. Emission reductions are calculated as follows:

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

Where:

ER_y	=	Emission reductions in year y (t CO2)
BE_y	=	Baseline emissions in year y (t CO2)
PE_y	=	Project emissions in year y (t CO2)
LE_y	=	Leakage emissions in year y (t CO2)

6. Monitoring methodology

6.1. Data and parameters monitored

Data / Parameter table 1.

Data / Parameter:	$EC_{Electricity,y}$
Data unit:	kWh
Description:	Quantity of electricity consumed by aircraft electrical components for the domestic aircraft at-gate operation, which is supplied by the solar power in year *y*
Source of data:	
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”
Monitoring frequency:	Continuous monitoring, hourly measurement and at least monthly recording and aggregated for the year
QA/QC procedures:	
Any comment:	Each and every domestic aircraft that consumes electricity generated from the solar power system for its electrical components is monitored continuously. The DOE shall ensure that total consumption claimed is only for domestic aircrafts and that the consumption is not larger than production in the solar system

Data / Parameter table 2.

Data / Parameter:	$EC_{PCA,y}$
Data unit:	kWh
Description:	Quantity of electricity consumed by an aircraft to obtain pre-conditioned air for a domestic aircraft’s at-gate operation which is supplied by the solar power, in year *y*
Source of data:	

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”
Monitoring frequency:	Continuous monitoring, hourly measurement and at least monthly recording and aggregated for the year
QA/QC procedures:	
Any comment:	Each and every domestic aircraft that consumes PCA generated from the solar power system is monitored continuously. The DOE shall ensure that total consumption claimed is only for domestic aircrafts and that the consumption is not larger than production in the solar system

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Document information

Version	*Date*	*Description*
01.0	25 April 2016	SSC WG 50, Annex 01 To be considered by the Board at EB 89. This draft methodology was considered by the Board at EB 87 (CDM-SSCWG49-A01) and EB88 (CDM-EB88-AA-A10). It takes into account guidance by the Board and input from ICAO.

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