CLEAN DEVELOPMENT MECHANISM

CDM-MP67-A11

Draft Large-scale Methodology

AM00XX: Electric taxiing systems for airplanes

Version 01.0 - Draft

Sectoral scope(s): 07

United Nations
Framework Convention on
Climate Change

COVER NOTE

1. Procedural background

1. At its eighty-first meeting, the Board requested the Meth Panel to conduct a gap analysis with a view to identifying methodologies needed for the aviation and other transport sectors that are currently not available and to develop top-down methodologies based on the outcome of this gap analysis.

2. At its eighty-second meeting, the Board considered the concept note and agreed on the development of methodologies in the areas of aviation, renewable energy, electrification and household energy supply.

2. Purpose

3. Developed top-down in collaboration with the International Civil Aviation Organization, the methodology aims to cover project activities that implement and operate electric-taxiing (e-taxi) systems in commercial airplanes.

3. Key issues and proposed solutions

4. The panel would like to receive inputs from the public on the draft methodology, including those relating to the following issues:

   (a) The applicability of the Radiative Force Index (RFI) to the leakage emissions due to transporting the extra weight of the e-taxi systems;

   (b) Whether such an energy efficiency measure may be considered automatically additional for three years, taking into account that the project activity is a fuel-saving measure but not yet in commercial use;

   (c) The applicability of the methodology to the type of flights, relating to the two options as presented in paragraph 3 of the draft methodology.

4. Impacts

5. The draft methodology, if approved, would widen the coverage of CDM into the aviation sector.

5. Subsequent work and timelines

6. The Meth Panel, at its sixty-seventh meeting, agreed on the draft version of the methodology. After receiving public inputs on the document, the Meth Panel will continue working on the draft methodology, at its next meeting, for recommendation to the Board at a future meeting of the Board.

6. Recommendations to the Board

7. Not applicable (call for public inputs).

TABLE OF CONTENTS **Page**

1. Introduction

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

Table 1. Methodology key elements

Typical projects	Implementation and operation of e-taxi systems in commercial airplanes
Type of GHG emissions mitigation action	Energy efficiency. Switch to energy-efficient technology

2. Scope, applicability, and entry into force

2.1. Scope

2. The methodology applies to project activities that implement and operate electric-taxiing (e-taxi) systems in commercial airplanes.

2.2. Applicability

3. (Option 1) Domestic flights of commercial airplanes operating e-taxi systems on either/or both of the airports in the host country are eligible to claim emission reductions using this methodology.

4. (Option 2) Operational cycles of commercial airplanes operating e-taxi systems on domestic flights in the host country are eligible to claim emission reductions using this methodology.

5. The applicability conditions included in the tools referred to below also apply.

2.3. Entry into force

6. Not applicable (call for public inputs).

3. Normative references

7. The methodology also refers to the latest approved version of the following methodological tools:

   (a) The methodological tool “Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period”;

   (b) Combined tool to identify the baseline scenario and demonstrate additionality”.

8. For more information regarding the approved methodologies and the tools as well as their consideration by the Executive Board (hereinafter referred to as the Board) of the clean development mechanism (CDM) please refer to <http://cdm.unfccc.int/methodologies/PAmethodologies/approved>.

4. Definitions

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

10. For the purpose of this methodology following definitions applies

(a) **Auxiliary power unit (APU)** - a device on an airplane that provides energy for functions other than propulsion, including proving power to start the main airplane engines, running accessories while the engines are shut down;

(b) **Commercial airplane** - an airplane used to carry cargo or passengers for payment;

(c) **Electric taxiing (e-taxi) system** - a system that moves an airplane along the ground before take-off or after landing with electric motors powered by APU instead of requiring airplane engines;

(d) **Operational cycle**- a operational cycle for a project activity is defined as two periods:

(i) from switching e-taxi equipment on for vacating runway after landing until switching e-taxi equipment off at arriving at a gate; and

(ii) from switching e-taxi equipment on for leaving the gate until switching e-taxi equipment off at at a holding point of runway for the next take off.

(e) **Taxiing time** - The total time during an operational cycle.

	Taxi in		**Taxi out**	
	Baseline/e-taxi	e-taxi	Baseline	e-taxi
Start of taxiing	Vacating runway by engine thrust	Vacating runway by e-taxi	Start of movement by engine thrust or by tractor	Start of movement by e-taxi
End of taxiing	Stop at gate/stand		Arrival at holding point to runway for the take-off	

(f) **Domestic flight** - a flight stage operated within the boundaries of a country by an air carrier in that country or between the territories of a country including those accessed through international waters or flying over the territory of another country.

5. Baseline methodology

5.1. Project boundary

11. The spatial extent of the project boundary encompasses the geographical area of the airports where the project airplanes operate e-taxi systems.

12. The greenhouse gases and emission sources included in the project boundary are shown in Table 2.

Table 2. Emission sources included in or excluded from the project boundary

Source		Gas	Included	Justification/explanation
Baseline	Emissions from combustion of fossil fuels by airplane engines, APUs and tractors during taxiing without e-taxi	CO_2	Yes	Main emission source
		CH_4	No	Minor emission source
		N_2O	No	Minor emission source
Project activity	Emissions from combustion of fossil fuels in APUs during taxiing with e-taxi	CO2	Yes	Main emission source
Leakage	Emissions from combustion of fossil fuels in airplane engines en route due to added weight of e-taxi system	CO2	Yes	Main emission source
		CH_4	No	Minor emission source
		N_2O	No	Minor emission source

5.2. Procedure for the selection of the most plausible baseline scenario and demonstrate additionality

13. The CDM project activities are automatically additional.

14. The simplified procedures are valid for three years from the date of entry into force of Version 1.0 of the methodology on xx month 2015; before the end of this period, the CDM Executive Board will reassess the validity of these simplified procedures and extend or update them if needed. Any update of the simplified procedures does not affect the projects that request registration as a CDM project activity or a programme of activities by xx month 2018 and apply the simplified procedures contained in version 1.0 of the methodology.

5.3. Baseline emissions

15. In the absence of e-taxi, airline operators implement multi-engine taxi, single-engine with APU running taxi, and sometimes a mix of above as the standard operating procedures (SOPs) in their operation manuals. Some airline operators may use tractors to tow airplanes from gate to holding point of runway at specific airports. However, tractors are always required if the airplane needs to push backwards away from its gate.

16. The SOPs depicting the operation of airplane engine, APU or tractor during taxiing without e-taxi system, shall be identified ex ante, as applicable to each project airplane and each project airport. If the applicable SOPs are updated during the crediting period, the SOPs valid for the monitoring period shall be referenced. The inclusion of each airplane’s engine or APU for each operational cycle in the baseline emissions shall be justified accordingly.

17. If the SOP provides more than one option to include engines and APU, the most conservative combination shall be used. For example, if SOP allows to perform taxiing with two main engines or with one main engine and APU, the latter combination shall be used.

18. Baseline emissions are determined for all airplanes in the project activity and include the following sources:

(a) CO_2 emissions from combustion of fossil fuel used by engines of the project airplanes, if taxiing with any airplane engine running;

(b) CO_2 emissions from combustion of fossil fuel used by APUs of the project airplanes, if taxiing with APU running;

(c) CO_2 emissions from the tractors, if used for a pushback and/or a tow to runway.

19. The baseline emissions are calculated as follows:

$$BE_y = \sum_{1}^{i}\left[\left(\sum_{1}^{j} SFC_{BL,j,i,y}\right) \times T_{PJ,i,y} \times NCV_y \times EF_y + BE_{TR,i,y}\right] \times PF$$ Equation (1)

Where:

BE_y	=	Baseline emissions in year *y* (tCO_2e)
$SFC_{BL,j,i,y}$	=	Specific fuel consumption by engine or APU *j* without e-taxi during operational cycle *i* (t/hour)
$T_{PJ,j,i,y}$	=	Taxiing time during operational cycle *i* in year *y* (hour)
i	=	Operational cycle of the project airplane in year *y*
j	=	Engine or APU *j* of the airplane
EF_y	=	CO_2 emission factor for the fossil fuel used by commercial airplanes in year *y* (tCO_2/GJ)
NCV_y	=	Net calorific value for the fossil fuel used by commercial airplanes in year *y*(GJ/ mass or volume unit)
PF	=	Adjustment for the penetration of the e-taxiing technology at the beginning of the second crediting period and the third crediting period
$BE_{TR,i,y}$	=	Baseline emissions from using tractors during the operational cycle *i* in year *y*

20. The project taxiing time monitored during operational cycle *i* shall be shortened by five per cent for the calculation of baseline emissions. This discount factor aims to address the possible longer taxiing time in the project scenario due to the e-taxi equipment speed limitations. The discount factor of five per cent can be neglected for operational cycle *i* if any one of the following conditions is met:

(a) The speed limit of the project e-taxi system is above the taxiing speed limit of the airport relevant for operational cycle *i*; or

(b) The airplane does not reach the e-taxi speed limit while taxiing during operational cycle *i*.

5.3.1. Baseline emission from using tractors (optional)

21. Determination of emissions occurring from using the tractor in the baseline is optional, i.e. the project participants may exclude this source as it is conservative. If emissions occurring from the use of the tractor in the baseline are included, the following guidance shall be used.

22. For the fuel-powered tractors, there are two options to calculate baseline emissions from using the tractor:

$$BE_{TR,i,y} = \sum_{1}^{i} SFC_{TR,i,y} \times T_{TR,i,y} \times NCV_{TR,y} \times EF_{TR,y}$$ Equation (2)

$$BE_{TR,i,y} = \sum_{1}^{i} FC_{TR,i,y} \times NCV_{TR,y} \times EF_{TR,y}$$ Equation (3)

Where:

$SFC_{TR,i,y}$	=	Specific fuel consumption rate of the tractor during the operational cycle *i* in year *y* (t/hour)
$T_{TR,i,y}$	=	Time the tractor was used during the operational cycle *i* in year *y* (hour)
$FC_{TR,i,y}$	=	Fuel consumption of the tractor during the operational cycle *i* in year *y* (t)
$NCV_{TR,y}$	=	Net calorific value of the fuel used by the tractor in year *y* (GJ/mass or volume unit)
$EF_{TR,y}$	=	CO_2emission factor of the fuel used by the tractor in year *y* (tCO_2/GJ)

23. For the electricity-powered tractors baseline emissions should be calculated by applying the latest version of the “Tool to calculate baseline, project and/or leakage emissions from electricity consumption”. Total electricity consumption of the tractor during all the applicable operational cycles in year *y* should be assigned to the parameter $EC_{BL,k,y}$while applying the tool.

5.4. Project emissions

24. Project emissions are the emissions associated with consumption of fossil fuel to run APU during taxiing within each operational cycle.

25. Project emissions are given by:

$$PE_y = \sum_{1}^{i}\left[\left(\sum_{1}^{j} SFC_{PJ,j,i,y}\right) \times T_{PJ,i,y}\right] \times NCV_y \times EF_y$$ Equation (4)

Where:

PE_y	=	Project emissions in year *y* (tCO_2e)
$SFC_{PJ,j,i,y}$	=	Specific fuel consumption by APU *j* with e-taxi during operational cycle *i* (t/hour)
$T_{PJ,j,i,y}$	=	Taxiing time during operational cycle *i* in year *y* (hour)
i	=	Operational cycle of the project airplane in year *y*
j	=	APU *j* of the airplane
EF_y	=	CO_2emission factor for the fossil fuel used by commercial airplanes in year *y* (tCO_2/GJ)
NCV_y	=	Net calorific value for the fossil fuel used by commercial airplanes in year *y* (GJ/ mass or volume unit)

5.5. Leakage

26. Installing the e-taxiing devices will increase the weight of the airplane, which would lead to slightly greater fuel consumption en route. The emissions due to added weight from engines en route should be considered as a leakage.

27. Leakage emissions are calculated as follows:

$$LE_y = W \times \mu \times T_y \times NCV_y \times EF_y$$ Equation (5)

Where:

LE_y	=	Leakage emissions en route in the year *y*, due to the extra weight of e-taxiing devices (tCO_2e)
W	=	The total weight of e-taxiing devices equipped in the plane (t)
μ	=	Additional fuel consumption en-route factor, due to the extra weight of e-taxiing devices, (t fuel/t extra weight - hour)
T_y	=	Total time of the project airplane en route in the year *y* (hour)
EF_y	=	CO_2e emission factor for the fossil fuel used by the airplane in year *y* (tCO_2/GJ)
NCV_y	=	Net calorific value for the fossil fuel used by the airplane in year *y* (GJ/ mass or volume unit)

5.6. Emissions reduction

28. The emission reduction achieved by the project activity shall be calculated as the below:

$$ER_y = BE_y - PE_y - LE_y \quad \text{Equation (6)}$$

Where:

ER_y	=	Emission reductions in year y (tCO2e)
BE_y	=	Baseline emissions in year *y* (tCO_2e)
PE_y	=	Project emissions in year *y* (tCO_2e)
LE_y	=	Leakage emissions en route in the year y, due to the extra weight of e-taxiing devices (tCO_2e)

5.7. Data and parameters not monitored

Data / Parameter table 1.

Data / Parameter:	$SFC_{BL,j,i,y}$
Data unit:	t/hour
Description:	Specific fuel consumption by engine or APU *j* without e-taxi during operational cycle *i*
Source of data:	Engine or APU design fuel consumption provided by manufacturer
Measurement procedures (if any):	
Monitoring frequency:	At the start of the crediting period
QA/QC procedures:	
Any comment:	Fuel consumption for the idle mode of an engine should be used by default.

Data / Parameter table 2.

Data / Parameter:	$SFC_{TR,i,y}$
Data unit:	t/hour
Description:	Specific fuel consumption rate of the tractor during the operational cycle *i* in year *y*
Source of data:	Design fuel consumption provided by manufacturer
Measurement procedures (if any):	
Monitoring frequency:	At the start of the crediting period
QA/QC procedures:	
Any comment:	Fuel consumption for the idle mode of an engine should be used by default.

Data / Parameter table 3.

Data / Parameter:	W
Data unit:	T
Description:	The total weight of e-taxiing devices equipped in the plane

Source of data:	Data provided by manufacturer
Measurement procedures (if any):	
Monitoring frequency:	At the start of the crediting period
QA/QC procedures:	
Any comment:	

Data / Parameter table 4.

Data / Parameter:	***μ***
Data unit:	t fuel/t extra weight - hour
Description:	Additional fuel consumption en-route factor, due to the extra weight of e-taxiing devices
Source of data:	
Measurement procedures (if any):	The value μ shall be selected according to the classified airplane size according to ICAO. 2013. Assessment of the Feasibility of ICAO Climate Goals (CAEP/10-MDG/3-WP/20, 27/8/13)
Monitoring frequency:	At the start of the crediting period
QA/QC procedures:	
Any comment:	(a) μ = 1.95, for turboprop airplane (b) μ = 3.35, for narrow body airplane (c) μ = 3.87, for wide body airplane

6. Monitoring methodology

6.1. Data and parameters monitored

Data / Parameter table 5.

Data / Parameter:	**NCV_y**
Data unit:	GJ/mass or volume unit
Description:	Net calorific value (energy content) of fuel type in year *y*

<table>
<tr><td>Source of data:</td><td>The following data sources may be used if the relevant conditions apply:
<table>
<tr><th>Data source</th><th>Conditions for using the data source</th></tr>
<tr><td>Values provided by the fuel supplier in invoices</td><td>If data is collected from airlines</td></tr>
<tr><td>Regional or national average default values</td><td>If values are reliable and documented in regional or national energy statistics/energy balances</td></tr>
<tr><td>IPCC default values at the lower limit of the uncertainty at a 95 per cent confidence interval as provided in Table 1.2 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories</td><td></td></tr>
</table></td></tr>
<tr><td>Measurement procedures (if any):</td><td>-</td></tr>
<tr><td>Monitoring frequency:</td><td></td></tr>
<tr><td>QA/QC procedures:</td><td>-</td></tr>
<tr><td>Any comment:</td><td>The gross calorific value (GCV) of the fuel can be used, if gross calorific values are provided by the data sources used. Make sure that in such cases also a gross calorific value basis is used for CO_2 emission factor</td></tr>
</table>

Data / Parameter table 6.

Data / Parameter:	EF_y
Data unit:	tCO_2/GJ
Description:	CO_2e emission factor for the fossil fuel used by the airplane in year *y*

<table>
<tr><td>Source of data:</td><td>The following data sources may be used if the relevant conditions apply:
<table>
<tr><th>Data source</th><th>Conditions for using the data source</th></tr>
<tr><td>Values provided by the fuel supplier in invoices</td><td>If data is collected from airlines</td></tr>
<tr><td>Regional or national average default values</td><td>If values are reliable and documented in regional or national energy statistics/energy balances</td></tr>
<tr><td>IPCC default values at the lower limit of the uncertainty at a 95 per cent confidence interval as provided in table 1.4 of Chapter1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories</td><td></td></tr>
</table></td></tr>
<tr><td>Measurement procedures (if any):</td><td></td></tr>
<tr><td>Monitoring frequency:</td><td></td></tr>
<tr><td>QA/QC procedures:</td><td></td></tr>
<tr><td>Any comment:</td><td></td></tr>
</table>

Data / Parameter table 7.

<table>
<tr><th>Data / Parameter:</th><th>$NCV_{TR,y}$</th></tr>
<tr><td>Data unit:</td><td>GJ/mass or volume unit</td></tr>
<tr><td>Description:</td><td>Net calorific value (energy content) of fuel used by the tractor in year y</td></tr>
<tr><td>Source of data:</td><td>The following data sources may be used if the relevant conditions apply:
<table>
<tr><th>Data source</th><th>Conditions for using the data source</th></tr>
<tr><td>Values provided by the fuel supplier in invoices</td><td>If data is collected from airlines</td></tr>
<tr><td>Regional or national average default values</td><td>If values are reliable and documented in regional or national energy statistics/energy balances</td></tr>
<tr><td>IPCC default values at the lower limit of the uncertainty at a 95 per cent confidence interval as provided in Table 1.2 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories</td><td></td></tr>
</table></td></tr>
</table>

Measurement procedures (if any):	-
Monitoring frequency:	
QA/QC procedures:	-
Any comment:	The gross calorific value (GCV) of the fuel can be used, if gross calorific values are provided by the data sources used. Make sure that in such cases also a gross calorific value basis is used for CO_2 emission factor

Data / Parameter table 8.

<table>
<tr><td>Data / Parameter:</td><td>$EF_{TR,y}$</td></tr>
<tr><td>Data unit:</td><td>tCO_2/GJ</td></tr>
<tr><td>Description:</td><td>CO_2e emission factor for the fuel used by the tractor in year y</td></tr>
<tr><td>Source of data:</td><td>The following data sources may be used if the relevant conditions apply:
<table>
<tr><th>Data source</th><th>Conditions for using the data source</th></tr>
<tr><td>Values provided by the fuel supplier in invoices</td><td>If data is collected from airlines</td></tr>
<tr><td>Regional or national average default values</td><td>If values are reliable and documented in regional or national energy statistics/energy balances</td></tr>
<tr><td>IPCC default values at the lower limit of the uncertainty at a 95 per cent confidence interval as provided in table 1.4 of Chapter1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories</td><td></td></tr>
</table></td></tr>
<tr><td>Measurement procedures (if any):</td><td></td></tr>
<tr><td>Monitoring frequency:</td><td></td></tr>
<tr><td>QA/QC procedures:</td><td></td></tr>
<tr><td>Any comment:</td><td></td></tr>
</table>

Data / Parameter table 9.

Data / Parameter:	$FC_{TR,i,y}$
Data unit:	T
Description:	Fuel consumption [rate] of the tractor during the operational cycle *I* in year *y*
Source of data:	
Measurement procedures (if any):	
Monitoring frequency:	

QA/QC procedures:	
Any comment:	

Data / Parameter table 10.

Data / Parameter:	$T_{TR,i,y}$
Data unit:	Hour
Description:	Time the tractor was used during the operational cycle *i* in year *y*
Source of data:	
Measurement procedures (if any):	
Monitoring frequency:	
QA/QC procedures:	
Any comment:	

Data / Parameter table 11.

Data / Parameter:	$SFC_{PJ,j,i,y}$
Data unit:	t/hour
Description:	Specific fuel consumption by APU *j* with e-taxi during operational cycle *i*
Source of data:	Quick Access Recorder
Measurement procedures (if any):	
Monitoring frequency:	Continuously
QA/QC procedures:	
Any comment:	

Data / Parameter table 12.

Data / Parameter:	$T_{PJ,j,i,y}$
Data unit:	Hour
Description:	Taxiing time during operational cycle *i* in year *y*
Source of data:	Quick Access Recorder or airlines records
Measurement procedures (if any):	
Monitoring frequency:	Continuously
QA/QC procedures:	
Any comment:	Switching on and switching off e-taxi equipment shall be used as a control points

Data / Parameter table 13.

Data / Parameter:	PF
Data unit:	Fraction

<table>
<tr><td>Description:</td><td>Adjustment for the penetration of the e-taxiing technology at the beginning of the second crediting period and the third crediting period</td></tr>
<tr><td>Source of data:</td><td>Industry statistics</td></tr>
<tr><td>Measurement procedures (if any):</td><td></td></tr>
<tr><td>Monitoring frequency:</td><td>Continuously</td></tr>
<tr><td>QA/QC procedures:</td><td></td></tr>
<tr><td>Any comment:</td><td>The following values of the adjustment factor shall be applied:
<table>
<tr><th>Penetration rate</th><th>Adjustment factor</th></tr>
<tr><td>Up to 5 per cent</td><td>0.9</td></tr>
<tr><td>5 to 10 per cent</td><td>0.5</td></tr>
<tr><td>10 to 20 per cent</td><td>0.3</td></tr>
<tr><td>More than 20 per cent</td><td>0</td></tr>
</table>
</td></tr>
</table>

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Document information

Version	*Date*	*Description*
Draft 01.0	1 July 2015	MP 67, Annex 11 A call for public input will be issued on this new methodology.

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