CLEAN DEVELOPMENT MECHANISM

CDM-MP69-A03

Draft Large-scale Methodology

AM0116: Electric taxiing systems for airplanes

Version 02.0

Sectoral scope(s): 07

United Nations
Framework Convention on
Climate Change

COVER NOTE

1. Procedural background

1. At its eighty-seven meeting, the Board approved the new methodology “AM0116: Electric taxiing systems for airplanes” and also requested the MP to explore the possibility of expanding the applicability of this methodology to cover non-commercial aircraft.

2. Purpose

2. The revision of the methodology aims to expand applicability to project activities that implement and operate electric-taxiing (e-taxi) systems in non-commercial airplanes.

3. Key issues and proposed solutions

3. The methodology is applicable only if the percentage share of commercial airplanes operating an e-taxi system is equal to or less than 20 per cent of the total number of commercial airplanes registered in the host country. This condition was introduced to ensure environmental integrity while allowing project activities being deemed automatically additional.

4. The non-commercial planes have a wide variety of models and applications, i.e. from small leisure propeller aircraft to special ‘flying hospitals’. The data for non-commercial sector may not be readily available or may be incomplete. If in the revised methodology the threshold of 20 per cent would also apply to non-commercial airplanes the project participants may face significant difficulties in validating the share of planes operating an e-taxi system.

5. In addition, the representative of ICAO confirms that the e-taxi systems that are currently being developed will initially only be available for narrow-body passenger or cargo aircraft. The technology does not yet exist for installation on smaller business aircraft.

6. Therefore, it is proposed to maintain the threshold of 20 per cent mandatory for commercial airplanes, while expanding the applicability and simplified procedure for additionality to any airplanes.

4. Impacts

7. The draft revision methodology, if approved, would widen the coverage of CDM into the non-commercial aviation sector.

5. Subsequent work and timelines

8. The methodology is recommended by the Meth Panel for consideration by the Board at its eighty-ninth meeting. No further work is envisaged.

6. Recommendations to the Board

9. The Meth Panel 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 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. Domestic flights of ~~commercial~~ airplanes operating e-taxi systems between two airports in the host country are eligible to claim emission reductions using this methodology.

4. In addition, the percentage share of commercial airplanes operating an e-taxi system is equal to or less than 20 per cent in the total number of commercial airplanes registered in the host country.

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

2.3. Entry into force

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

3. Normative references

7. This baseline and monitoring methodology is developed in collaboration with International Civil Aviation Organization (ICAO).

8. 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) The methodological tool “Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation ~~Tool to calculate baseline, project and/or leakage emissions from electricity consumption~~”.

9. 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

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

11. 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) **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;

(d) **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;

(e) **Operational cycle**- a operational cycle for a project activity is defined to include two periods:

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

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

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

Table 2. Operational cycle and taxiing means

	Taxi in		Taxi out	
	Baseline	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	

5. Baseline methodology

5.1. Project boundary

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

13. The greenhouse gases and emission sources included in the project boundary are shown in Table 3.

Table 3. 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	CO_2	Yes	Main emission source

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

14. The CDM project activities are automatically additional.

15. This simplified procedure is valid for three years from the date of entry into force of Version 1.0 of the methodology on 27 November 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 26 November 2018 and apply the simplified procedures contained in version 1.0 of the methodology.

5.3. Baseline emissions

16. In the absence of e-taxi, ~~airline operators implement~~ an airplane implements 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. In ~~S~~some ~~airline operators~~ cases ~~may use~~ tractors may be used 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.

17. 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.

18. 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 performing taxiing with two main engines or with one main engine and APU, the latter combination shall be used.

19. 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.

20. The baseline emissions are calculated as follows:

$$BE_y = \sum_{1}^{i} \left[\left(\sum_{1}^{j} SFC_{BL,j,i,y} \right) \times T_{PJ,i,y} \times NCV_y \times EF_y + BE_{TR,i,y} \right]$$ 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)
$BE_{TR,i,y}$	=	Baseline emissions from the use of tractors during the operational cycle *i* in year *y*

21. Index *j* is to account for the applicable combination, as prescribed in an airplane's SOP, of main engines and APU that would have been used to taxi the airplane for the operational cycle *i* in the absence of the e-taxi system. If the engine or APU is only used during part of the taxiing operation cycle, it may be excluded or the taxiing time shall be adjusted accordingly. For example, the applicable SOP may contain instructions to use one main engine and an APU for the entire operation cycle *i*. In that case, *j=1* would correspond to the main engine, while *j=2* would correspond to the APU.

22. Equation 1 is provided for one airplane. In case more than one airplane is included in the project activity, total annual baseline emissions shall be determined as the sum of baseline emissions per airplane for the same period.

5.3.1. Baseline emission from using tractors (optional)

23. Determination of emissions occurring from the use of the tractor in the baseline is optional, i.e. the project participants may consider the baseline emissions due to the use of tractor as zero if no data are available. If emissions occurring from the use of the tractor in the baseline are included, the following guidance shall be applied.

24. 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_2 emission factor of the fuel used by the tractor in year *y* (tCO_2/GJ)

25. For the electricity-powered tractors baseline emissions should be calculated by applying the latest version of the tool “Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation” ~~“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

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

27. Project emissions are given by:

$$PE_y = \sum_{1}^{i}\left[\left(\sum_{1}^{j} SFC_{PJ,j,i,y}\right) \times T_{PJ,i,y}\right] \times NCV_y \times EF_y \times AF$$ 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)
AF	=	Net to gross adjustment factor. Set as 1.08[1]

5.5. Leakage

28. No leakage is expected to occur in this type of projects

5.6. Emissions reduction

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

$$ER_y = BE_y - PE_y$$ Equation (5)

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)

[1] The net to gross adjustment factor is introduced to account for uncertainty associated with: (a) climate impact of additional emissions from the project aircrafts' engines during the landing/take-off cycle and cruise due to the increased weight of the airplane after installing the e-taxiing devices; (b) possible longer taxiing time in the project scenario due to the e-taxi equipment speed limitations; (c) possible longer taxiing time of other airplanes and associated with this additional emissions due to the congestion at taxiway caused by low taxiing speed of the project airplane.

5.7. Changes required for methodology implementation in 2nd and 3rd crediting periods

30. Refer to the tool "Assessment of the validity of the original/current baseline and to update of the baseline at the renewal of the crediting period".

31. In addition, no emission reductions can be claimed if at the beginning of the second crediting period and the third crediting period the percentage share of commercial airplanes operating an e-taxi system is high than 20 per cent in the total number of commercial airplanes registered in the host country.

5.8. 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.

6. Monitoring methodology

6.1. Data and parameters monitored

Data / Parameter table 3.

<table>
<tr><td>Data / Parameter:</td><td>NCV_y</td></tr>
<tr><td>Data unit:</td><td>GJ/mass unit</td></tr>
<tr><td>Description:</td><td>Net calorific value (energy content) of fuel type 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>
<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 4.

<table>
<tr><td>Data / Parameter:</td><td>EF_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 fossil fuel used by the airplane 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>
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</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 5.

Data / Parameter:	$NCV_{TR,y}$
Data unit:	GJ/mass unit
Description:	Net calorific value (energy content) of fuel used by the tractor 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>
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<tr><td>QA/QC procedures:</td><td>-</td></tr>
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</table>

Data / Parameter table 6.

<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>
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</table></td></tr>
</table>

Measurement procedures (if any):	
Monitoring frequency:	
QA/QC procedures:	
Any comment:	

Data / Parameter table 7.

Data / Parameter:	$FC_{TR,i,y}$
Data unit:	T
Description:	Fuel consumption 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 8.

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 9.

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 10.

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.

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Document information

Version	*Date*	*Description*
02.0	21 April 2016	MP 69, Annex 3 For the Board approval in EB 89. Revision to expand the applicability to project implementing electric-taxiing (e-taxi) systems in non-commercial airplanes.
01.0	27 November 2015	EB 87, Annex 4 Initial adoption.

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