ICAO Supporting Tools
States' Action Plan

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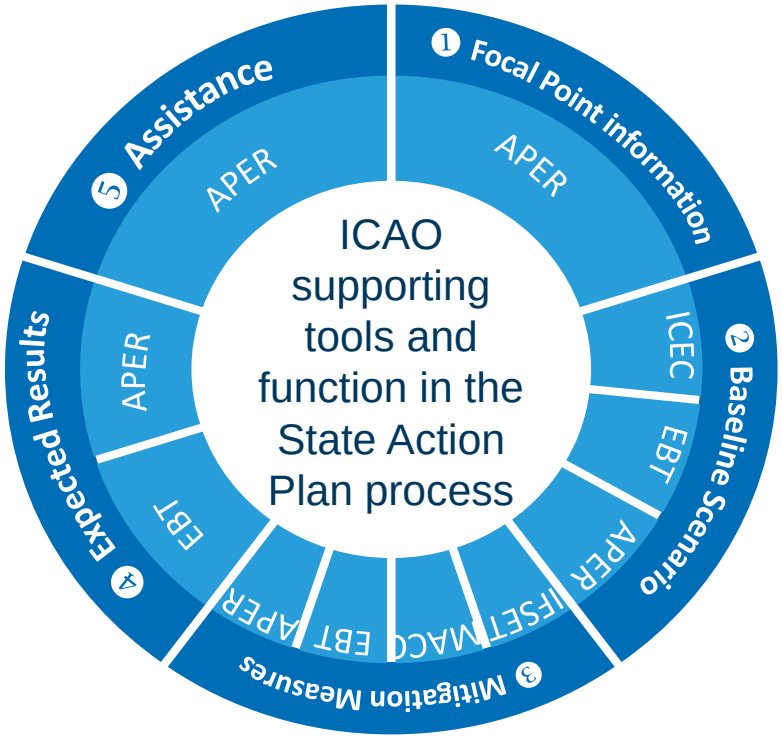
ICAO Environmental Tools



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ICAO Environmental - ENV Tools Suite

ICAO Carbon Emissions Calculator – for States

Allows passengers to estimate CO_2 emissions from their air travel

ICAO Fuel Savings Estimation Tool (IFSET)

To assist States in estimating fuel savings from operational improvements

ICAO CORSIA CO2 Estimation and Reporting Tool (CERT)

To assist States and aeroplanes operators - monitoring and reporting requirements

ICAO E-Learning Course – Module 1. State Action Plan

ICAO Green Meetings Calculator

To support decision making in minimizing CO_2 emissions from air travel to attend meetings

ICAO EBT – Environmental Benefit Tool

ICAO MAC Curves

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Baseline scenario

Mitigation Measures

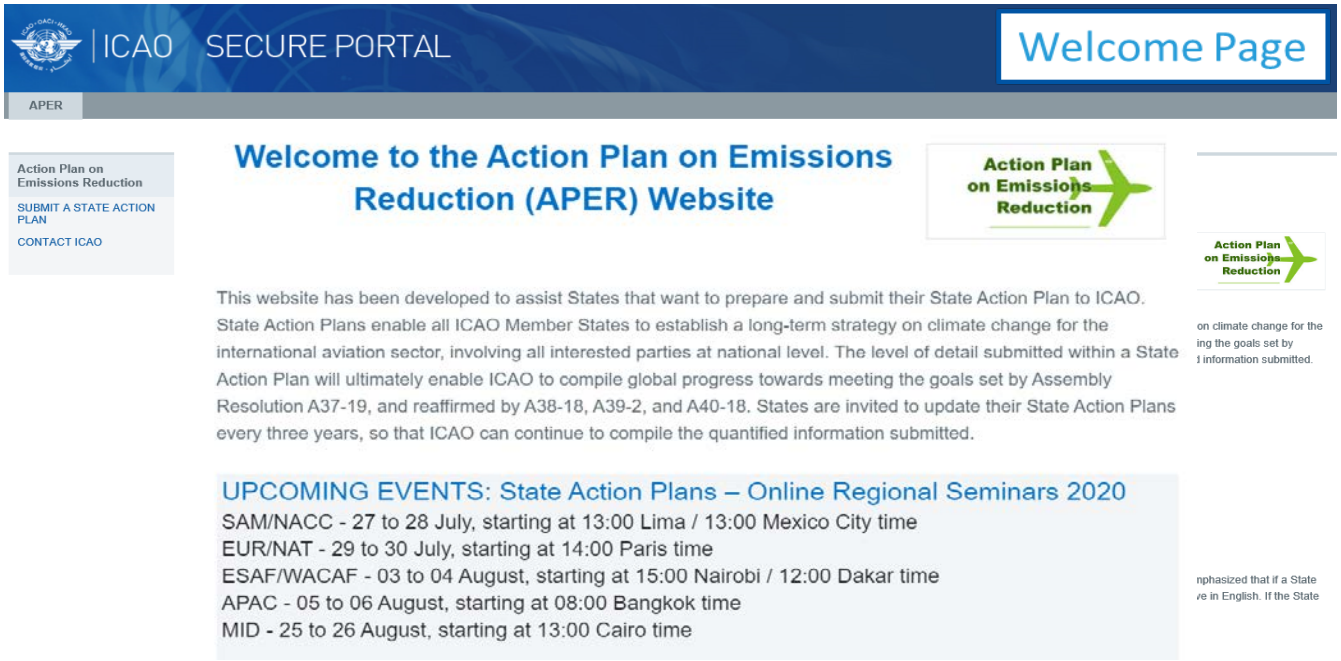
Expected Results

EBT

MAC CURVES

© ICAO 2019

Action Plan Emissions Reduction (APER) Website



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Action Plan Emissions Reduction (APER) Website

- **Resources**
  - Document 9988 - Guidance Material for the Development of States' Action Plans
  - Document 10031 - Guidance on Environmental Assessment of Proposed Air Traffic Management Operational Changes
  - Transforming Global Aviation Collection
  - Feasibility Studies

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Action Plan Emissions Reduction (APER) Website

- **Tool links & guidance**
  - Environmental Benefit Tool (EBT)
  - ICAO e-learning course on Action Plans
  - ICAO Carbon Emissions Calculator for States
  - Marginal Abatement Cost (MAC) Curve Tool
  - ICAO Fuel Savings Estimation Tool
  - Eco-Airport Toolkit e-collection

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Action Plan Emissions Reduction (APER) Website

- **Miscellaneous**
  - Assembly Resolution A40-18 – Climate Change
  - International RTK by State
  - Fuel burn and RTK by State
  - Form M
  - Seminar Material

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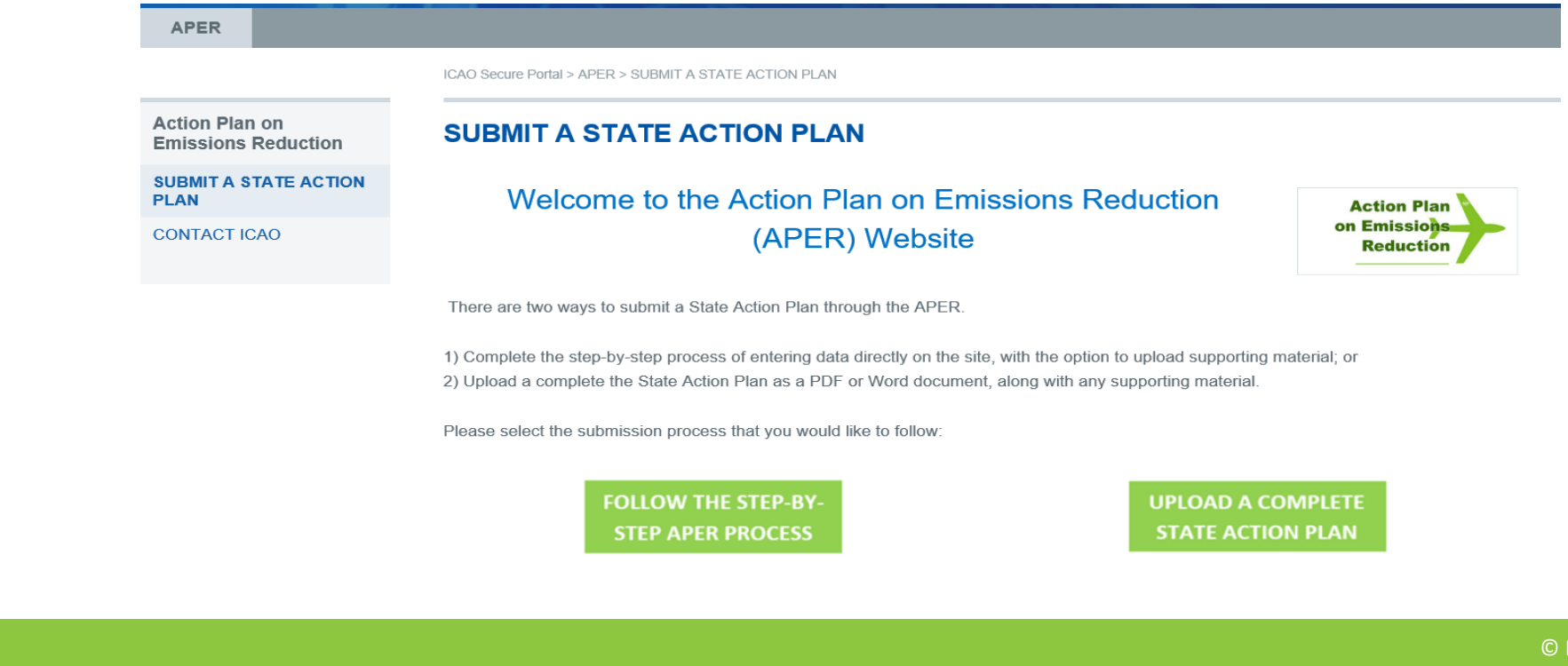
Action Plan Emissions Reduction (APER) Website



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Baseline scenario

Mitigation Measures

Expected Results

EBT

MAC CURVES

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ICAO E-Learning Training Tutorial

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ICAO UNITAR Online Training Tutorial

UN CC:e-Learn
Think, Talk, Act Climate

www.icao.int/environmental-protection

https://unccelearn.org

This e-tutorial aims to build an understanding of the importance of States' Action Plans in the civil aviation sector.
It shows how, by adopting the right "basket of measures" in the aviation sector, according to their own contexts, States can mitigate the Greenhouse Gas Emissions from international aviation .

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Tutorial

Tutorial

© ICAO 2019

E-Learning Training Course on States Action Plan

MODULE 1

STATES' ACTION PLANS ON CO_2 EMISSIONS REDUCTION FROM INTERNATIONAL AVIATION

This module describes the main components of the States' Action Plans on CO_2 Emissions Reduction from International Aviation. By the end of this module, you will be able to:

- Define the activities to carry out for the development of a State Action Plan
- Explain why it is important to develop a State Action Plan
- Describe the main information which should be included in a State Action Plan

MODULE 2

BASELINE SCENARIO CALCULATION

This module aims to provide the necessary information to enable the States to calculate their baseline. By the end of this module, you will be able to:

- Define the baseline scenario of CO_2 emissions from international aviation
- Estimate international aviation fuel burnt, CO_2 emissions, and International Revenue Tonnes Kilometer (RTK)
- Calculate the baseline using the ICAO Environment Benefits Tool (EBT)

UN CC:e-Learn
Think, Talk, Act Climate

MODULE 3

MITIGATION MEASURES

This module provides an overview of mitigation measures to limit or reduce CO_2 emissions from international aviation and case-studies of low emissions aviation measures implemented in States. By the end of this module, you will be able to:

- Understand the elements of ICAO's Basket of Measures to reduce CO_2 emissions
- Identify relevant measures that can be taken by a State to reduce CO_2 emissions from the international aviation sector

MODULE 4

SELECTION, PRIORITIZATION AND IMPLEMENTATION OF MITIGATION MEASURES

This module aims to provide the necessary information to enable States to select, prioritize and implement mitigation measures. By the end of this module, you will be able to:

- Analyse the benefits and effectiveness of mitigation measures in relation to the costs involved
- Analyse the additionality of projects
- Carry out a risk analysis in the process of implementing mitigation measures

MODULE 5

TOOLS AND EXPECTED RESULTS

This module presents the tools that allow the Civil Aviation Authorities (CAA) to calculate, as well as to monitor CO_2 emissions from international aviation at the State level. By the end of this module, you will be able to:

- Use the ICAO tools to calculate CO_2 emissions reduction and fuel savings
- Use the ICAO Environmental Benefits Tool (EBT) to calculate the expected results from the selected mitigation measures
- Use the Aviation Environmental System (AES) to monitor CO_2 emissions from the aviation sector, if available in the State

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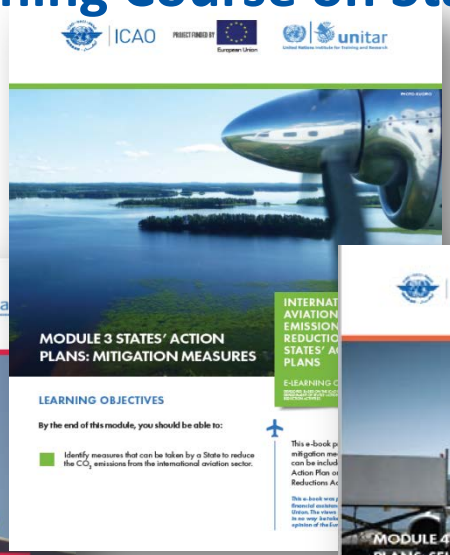
E-Learning Training Course on States Action Plan



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Estimating aircraft fuel burn and CO_2 emissions:

ICAO Carbon Emissions Calculator

© ICAO 2019

ICAO Carbon Emissions Calculator

Description:

ICAO has developed a methodology to calculate the carbon dioxide emissions from air travel for use in offset programmes.

One Way/Round Trip	Cabin Class	Number of Passengers
One Way	Economy	1

Leg	From City/Airport	To City/Airport
1	GVA	YUL

Delete All Location(s) | Delete Leg | Add New Leg

Reset | Compute

Metric (KG / KM) | **Standard** (LBS / MI)

Total

Dep Airport	Arr Airport	Number of passengers	Cabin Class	Trip	Aircraft Fuel Burn/journey (KG)[ab]	Total passengers' CO2/journey (KG)[c]
GVA	YUL	1	Economy	One Way	46048.4	318.2

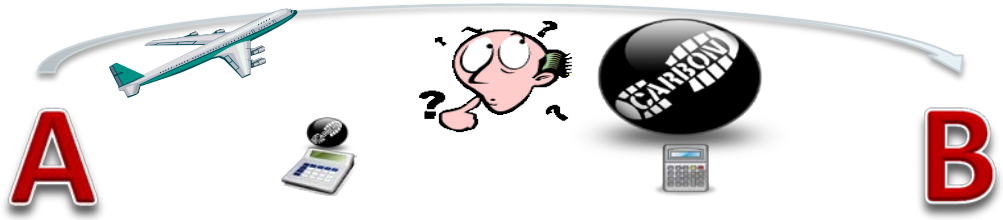
Flight Stage Detail

Dep Airport	Arr Airport	Distance (KM)	Aircraft	Aircraft Fuel Burn/leg (KG)[a]	Passenger CO_2/pax/leg (KG)
GVA	YUL	5901.0	333	46048.4	318.2

© ICAO 2019

ICAO Carbon Emissions Calculator Background

- Proliferation of tools for calculating “carbon footprint” from aviation
  - Results differ by factor of 4 or more!
  - Unknown data sources and methodologies (black box)
  - Inconsistent basis for offsetting



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ICAO Carbon Emissions Calculator Methodology

- **Objectives**
  - User-friendly, unbiased, tool to compute carbon emissions from air travel
  - Suitable for use with voluntary offsetting programmes
  - Best publicly available data (**transparency**)
  - Fully documented

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ICAO Carbon Emissions Calculator Methodology (cont.)

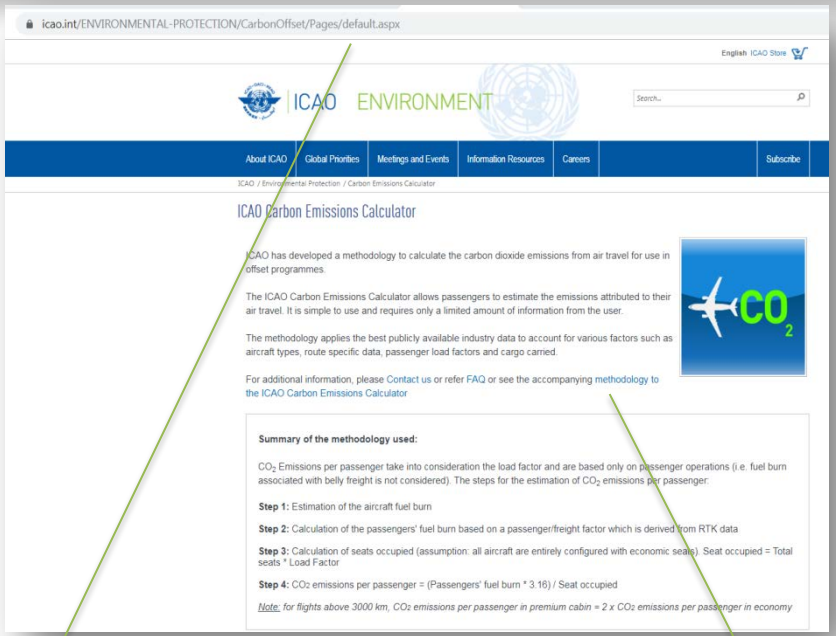
- **Methodology Developed through CAEP**
- **Expert input provided from**
  - ICAO Secretariat
  - ICAO Member States
  - Universities
  - NGOs
  - International Air Transport Association – IATA (Airlines)
  - International Coordinating Council of Aerospace Industries Associations – ICCAIA (Manufacturers)
- **Methodology is internationally recognized and accepted**
- **All UN air travel GHG inventories are prepared using the ICAO Calculator**

Available on the public website

© ICAO 2019

ICAO Carbon Emissions Calculator - Public Interface

- Transparent
- Easy-to-use
- Publicly available
- Delivers consistent estimates of CO_2 – suitable for use with offset programs
- Available since June 2008



http://www.icao.int/ENVIRONMENTAL-PROTECTION/CarbonOffset/Pages/default.aspx

Link to Methodology

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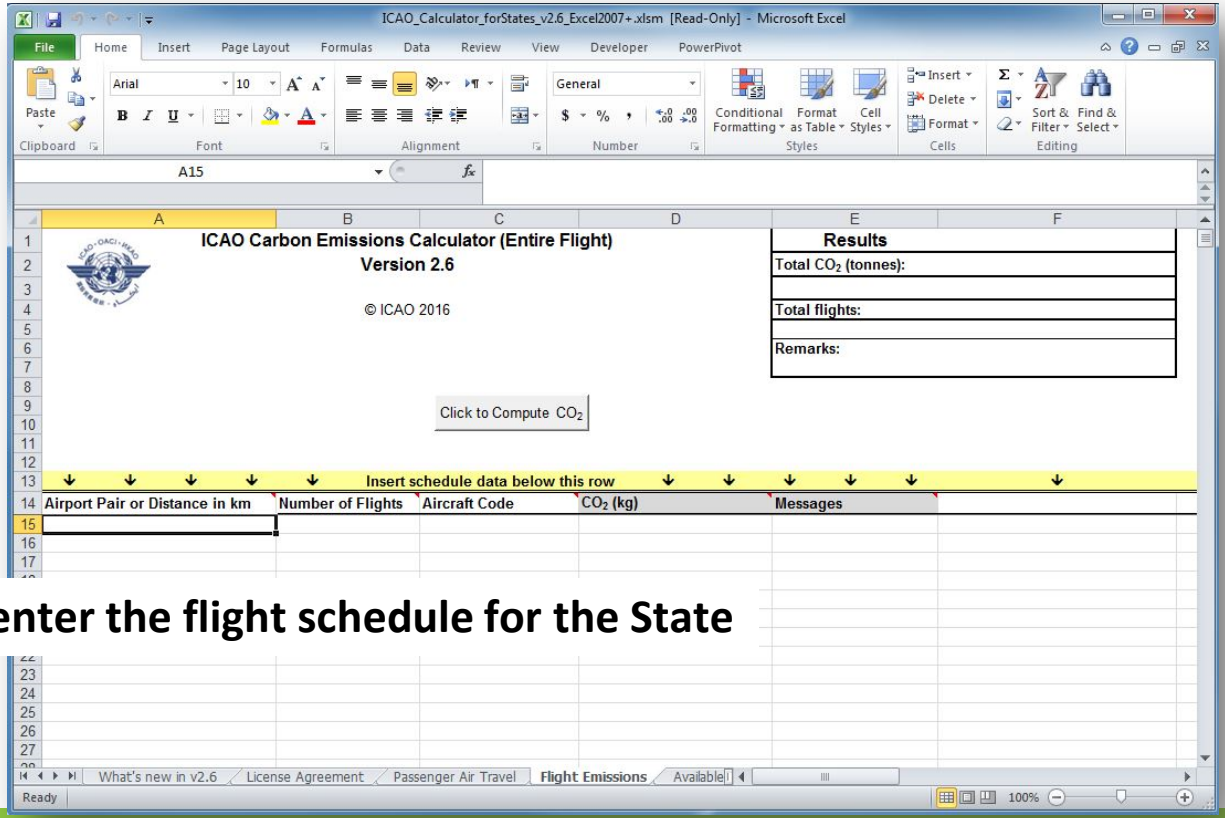
ICAO Carbon Emissions Calculator User Interface for Action Plans

Action Plan on Emissions Reduction

Available on the APER Website



Simply enter the flight schedule for the State

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Baseline scenario

Mitigation Measures

Expected Results

EBT

MAC CURVES

© ICAO 2019

Estimating Fuel Savings from Operational Changes:

ICAO Fuel Savings Estimation Tool (IFSET)

© ICAO 2019

ICAO Fuel Savings Estimation Tool

Input

ID	Action	From Alt (ft)	To Alt (ft)	Distance (nm)	Time (sec)
1	Taxi				1200
2	Climb	3000	20000	37	
3	Level	20000	20000	20	
4	Climb	20000	25000	20	

Add Delete

New Procedure Definition

ID	Action	From Alt (ft)	To Alt (ft)	Distance (nm)	Time (sec)
1	Taxi				1000
2	Climb	3000	25000	57	
3	Level	25000	25000	20	

Add Delete

Output

Estimated Fuel Changes Report

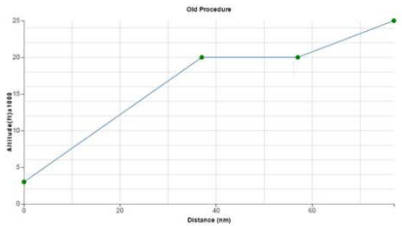
Scenario Name	Old Fuel Consumption (KG)	New Fuel Consumption (KG)	Savings (KG)	Savings (%)
Example	1337600	1283000	-54500	-4.10

Estimated Detailed Fuel Changes Report

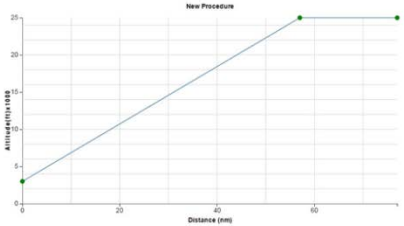
Old Climb Fuel (KG)	New Climb Fuel (KG)	Climb Savings (KG)
923000	921000	-2100
Old Descent Fuel (KG)	**New Descent Fuel (KG)**	**Descent Savings (KG)**
0	0	0
Old Level Fuel (KG)	**New Level Fuel (KG)**	**Level Savings (KG)**
155800	146400	-9400
Old Taxi Fuel (KG)	**New Taxi Fuel (KG)**	**Taxi Savings (KG)**
258800	215600	-43100

Graphics

Distance (nm)	Altitude (ft)
0	3000
37	20000
57	20000
77	25000



Distance (nm)	Altitude (ft)
0	3000
57	25000
77	25000



Description:

Operational measures are one of the instruments available to States to improve fuel efficiency and reduce CO_2 emissions.

The ICAO Fuel Savings Estimation Tool (IFSET) has been developed by the Secretariat with support from States and international organizations to assist the States to estimate fuel savings in a manner consistent with the models approved by CAEP and aligned with the Global Air Navigation Plan.

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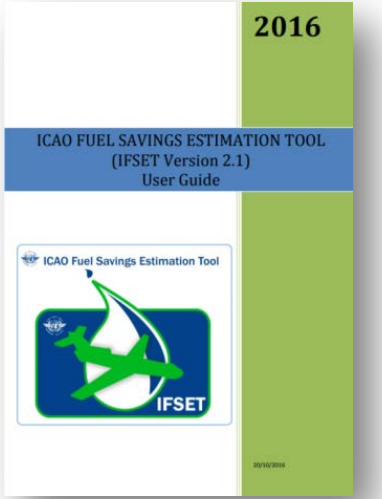
The tool can estimate:

- Effects of shortening / eliminating level segments on departure and approach
- Effects of shorter routes (either in time or distance)
- Effects of cruising at different altitudes
- Effects of reduced taxi times



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- The tool **does not**:
  - Replace detailed modelling or measurement of fuel consumption
  - Estimate fuel consumption from airborne holding
  - Compute other elements than fuel consumption / CO_2 emissions

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IFSET
How it Works: User Input

- Fleet mix defined for baseline and post-implementation scenario
  - Aircraft category
  - Aircraft remaining trip distance (optional parameter that will increase accuracy for departures)
- User selects “elements” to define the baseline and “new” procedure
- Tool estimates the change in total fuel consumption between the 2 scenarios

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IFSET
Example

Objective

Operational measures are one of the instruments available to States to improve fuel efficiency and reduce CO2 emissions. The ICAO Fuel Savings Estimation Tool (IFSET) has been developed by the Secretariat with support from States and international organizations to assist the States to estimate fuel savings in a manner consistent with the models approved by CAEP and aligned with the Global Air Navigation Plan.
The ICAO Fuel Savings Estimation Tool (IFSET) is not intended to replace the use of detailed measurement or modelling of fuel savings, where those capabilities exist. Rather, it is provided to assist those States without such facilities to estimate the benefits from operational improvements in a harmonized way.

User Guide: IFSET Ver 2.1 User Guide

Please note that all the information saved in this web tool can be seen by the public. Therefore you should delete the event when you have finished using the tool.

New Scenario | Saved Scenario

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Example (cont.)

Step 1 - Define New Scenario

Scenario Name Example

ID	Aircraft	Base Flights	New Flights	Continuing Old Flights	Remaining Trip (nm)
1	Single Aisle Jet	1000	1000	0	1160
2	Turboprop	500	500	0	740

Back | Aircraft Category Map | Add | Delete | Save | Next Step

Save any change on the page by clicking "Save" before clicking "Next Step".

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Example (cont.)

Step 2 - Saved Old/New Procedure Definition

Scenario Name: Example

Old Procedure Definition

ID	Action	From Alt (ft)	To Alt (ft)	Distance (nm)	Time (sec)
1	Taxi				1200
2	Climb	3000	20000	37	
3	Level	20000	20000	20	
4	Climb	20000	25000	20	

Add Delete

New Procedure Definition

ID	Action	From Alt (ft)	To Alt (ft)	Distance (nm)	Time (sec)
1	Taxi				1000
2	Climb	3000	25000	57	
3	Level	25000	25000	20	

Add Delete

Back Reset Save Calculate

© ICAO 2019

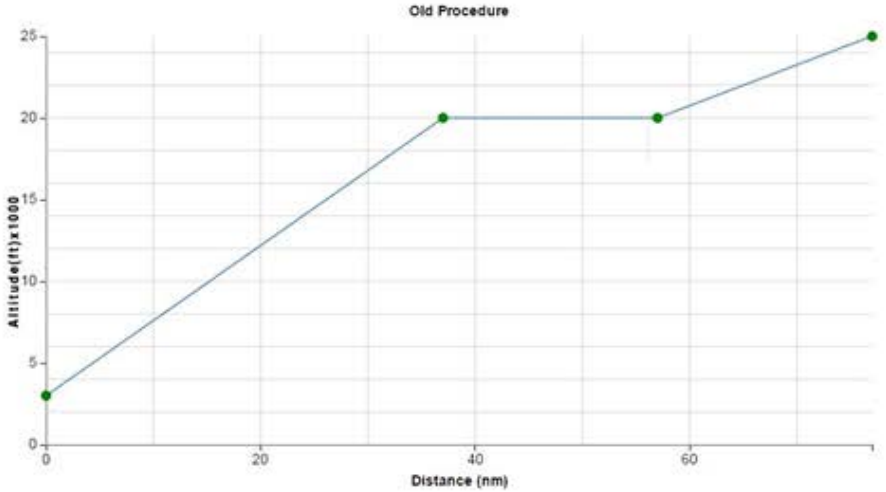
Sample Graphical View

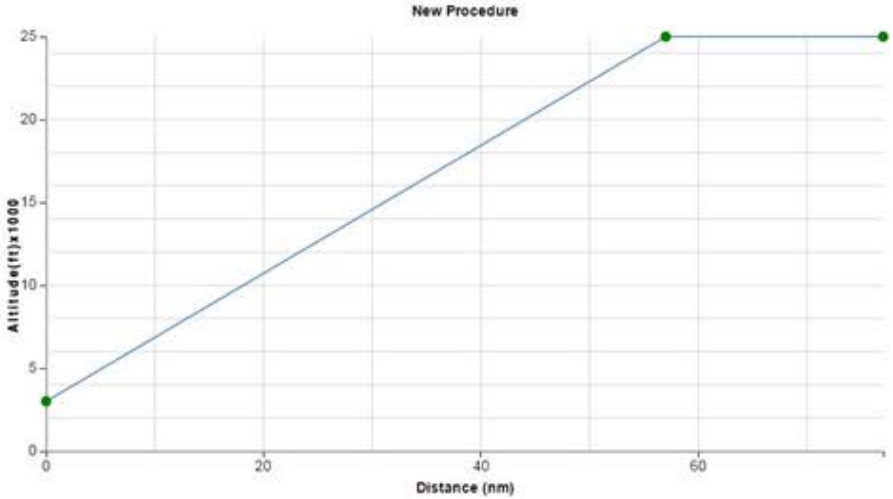
Step 3 - Estimated Fuel Changes Report

Scenario Name: Example

Distance (nm)	Altitude (ft)
0	3000
37	20000
57	20000
77	25000

Distance (nm)	Altitude (ft)
0	3000
57	25000
77	25000





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Example Results

Estimated Fuel Changes Report

Scenario Name	Old Fuel Consumption (KG)	New Fuel Consumption (KG)	Savings (KG)	Savings (%)
Example	1337600	1283000	-54500	-4.10

Estimated Detailed Fuel Changes Report

Old Climb Fuel (KG)	New Climb Fuel (KG)	Climb Savings (KG)
923000	921000	-2100

Old Descent Fuel (KG)	New Descent Fuel (KG)	Descent Savings (KG)
0	0	0

Old Level Fuel (KG)	New Level Fuel (KG)	Level Savings (KG)
155800	146400	-9400

Old Taxi Fuel (KG)	New Taxi Fuel (KG)	Taxi Savings (KG)
258800	215600	-43100

Back

Export to Excel

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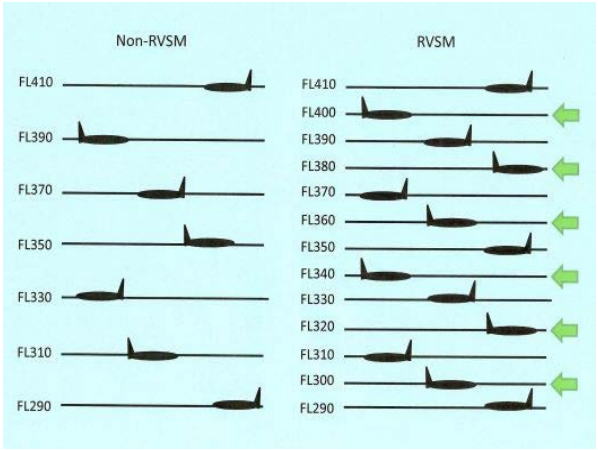
IFSET - In Summary



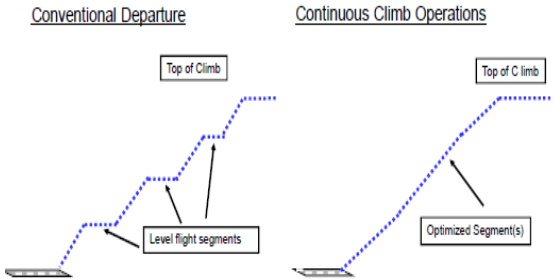
Operational Measure Implementation (planned or post)

+

Need to quantify change in fuel consumption, but don't have the tools?

=

USE IFSET



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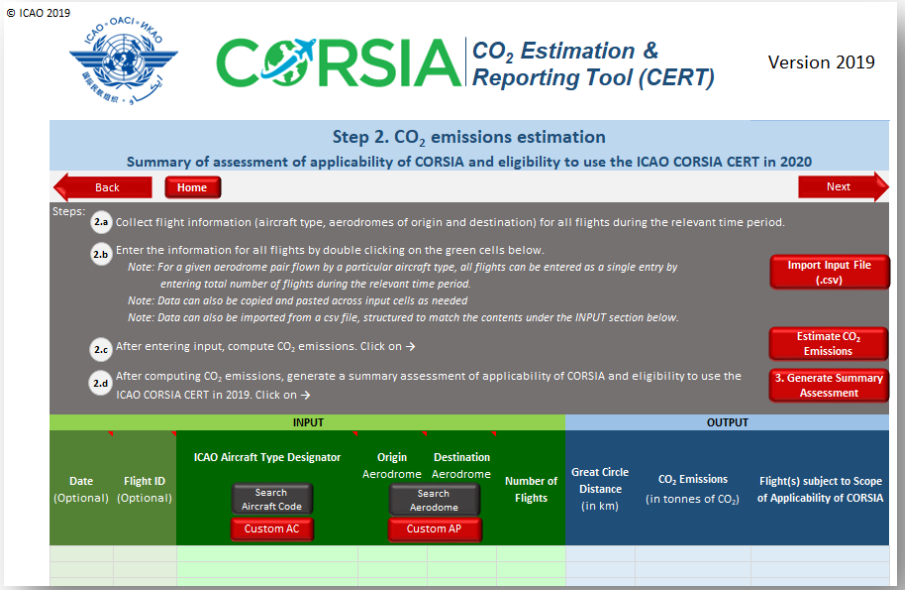
ICAO CO_2 Estimation and Reporting Tool CERT



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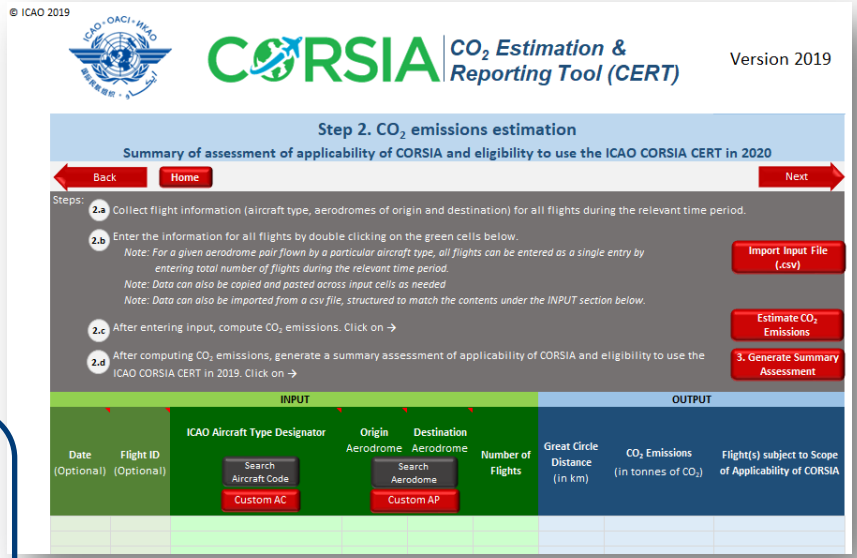
ICAO CORSIA CO_2 Estimation and Reporting Tool (CERT)

Description:

The ICAO CORSIA CERT is one of the five ICAO CORSIA Implementation Elements and is reflected in the ICAO document entitled "ICAO CORSIA CO_2 Estimation and Reporting Tool", referenced in Annex 16, Volume IV.

The ICAO CORSIA CERT supports aeroplane operators in fulfilling their monitoring and reporting requirements in CORSIA by populating the standardized Emissions Monitoring Plan and Emissions Report templates.



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Baseline scenario

Mitigation Measures

Expected Results

?

?

?

?

?

?

EBT

MAC CURVES

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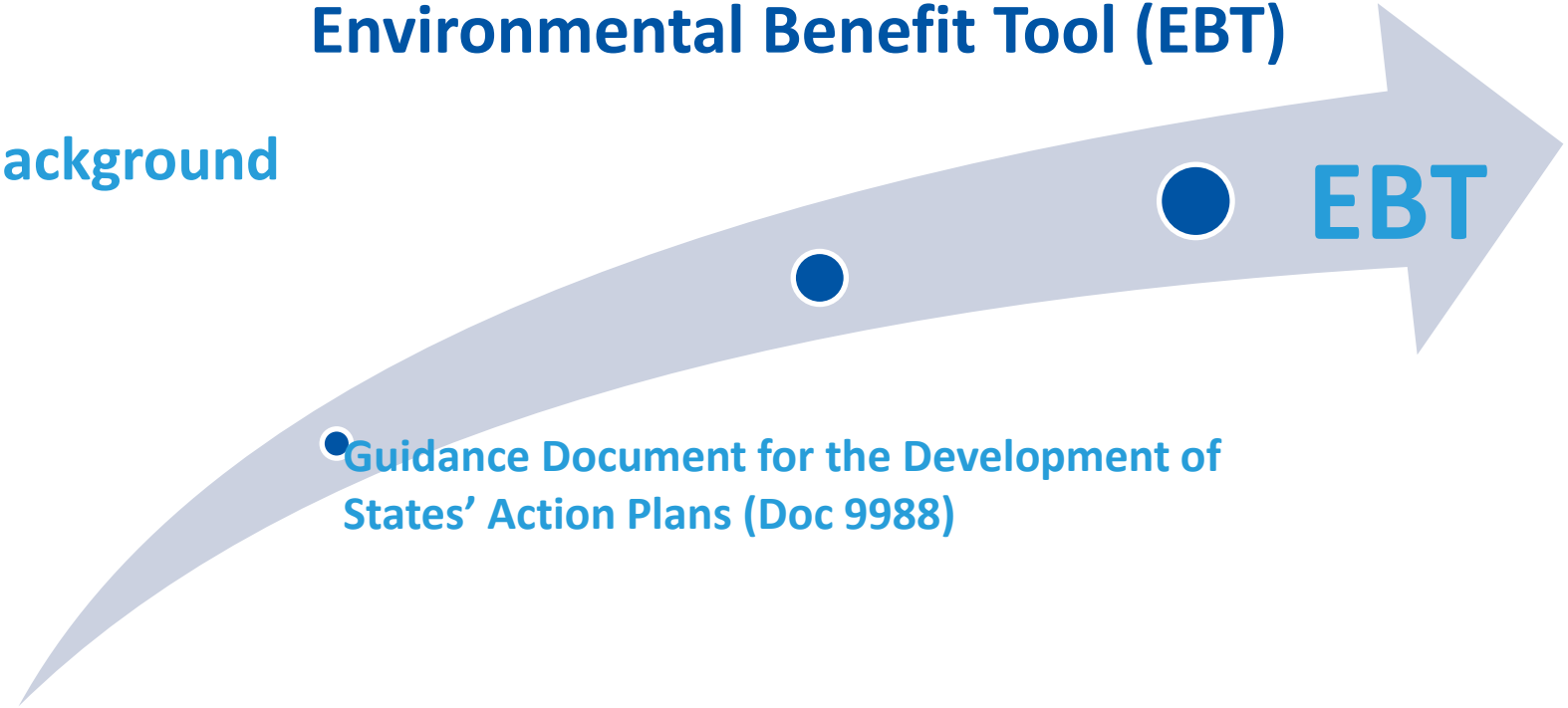
Environmental Benefit Tool (EBT)

- **Background**



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Environmental Benefits Tool

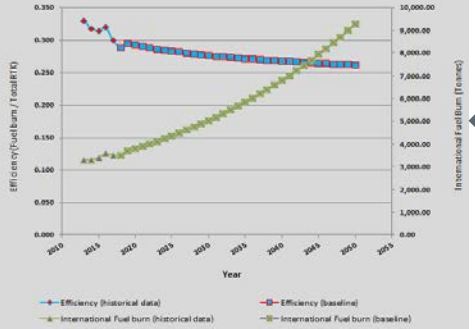
(EBT)

Baseline Scenario

Expected Results

BASELINE

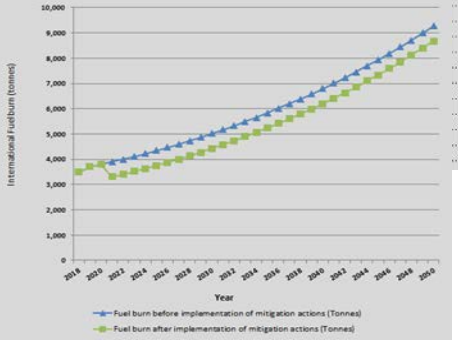
Year	International RTK ('000)	International Fuel burn (Tonnes)	Efficiency (Fuel burn / RTK)
2018	12,166.53	3,500.00	0.288
2019	12,580.19	3,708.36	0.295
2020	13,007.92	3,800.40	0.292
2021	13,450.19	3,898.57	0.290
2022	13,907.49	4,002.40	0.288
2023	14,380.35	4,111.62	0.286
			0.284
			0.283
			0.281
			0.280
			0.279
			0.277
			0.276
			0.275
			0.274
			0.273
			0.272
			0.271
			0.271
			0.270
			0.269
			0.268



EXPECTED RESULTS : FUEL SAVINGS

Year	Annual Fuel burn before implementation of mitigation actions (Tonnes)	Annual Fuel burn after implementation of mitigation actions (Tonnes)	Annual Fuel savings (Tonnes)	Change Fuel savings (%)
2018	3,500.00	3,500.00	0.00	0.00
2019	3,708.36	3,708.36	0.00	0.00
2020	3,800.40	3,800.40	0.00	0.00
2021	3,898.57	3,303.82	594.74	-15.26
2022	4,002.40	3,407.65	594.74	-14.86
2023	4,111.62	3,516.87	594.74	-14.46
2024	4,226.05	3,631.31	594.74	-14.07
2025	4,345.62	3,750.88	594.74	-13.69
2026	4,470.28	3,875.54	594.74	-13.30
2027	4,600.04	4,005.30	594.74	-12.93
2028	4,734.94	4,140.20	594.74	-12.56
2029	4,875.05	4,280.30	594.74	-12.20
2030	5,020.44	4,425.70	594.74	-11.85
2031	5,171.22	4,576.48	594.74	-11.50
2032	5,327.51	4,732.77	594.74	-11.16
2033	5,489.43	4,894.69	594.74	-10.83
2034	5,657.13	5,062.39	594.74	-10.51
2035	5,830.76	5,236.02	594.74	-10.20
2036	6,010.48	5,415.74	594.74	-9.90
2037	6,196.47	5,601.72	594.74	-9.60

Annual Fuel efficiency improvement before implementation of mitigation actions : 0.30%
Annual Fuel efficiency improvement after implementation of mitigation actions : 0.50%



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Environmental Benefits Tool (EBT)

- Description:
  - The EBT is a tool developed for supporting States in the development of their State Action Plan.
  - This tool allows easily generating a baseline scenario, estimating the impact of mitigation measures and finally generating expected results.

Welcome Page

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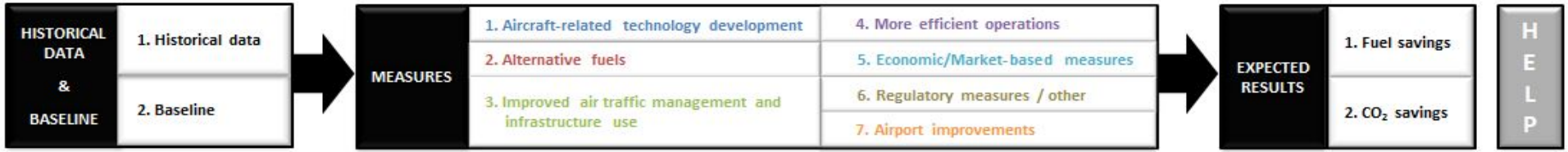
Environmental Benefit Tool (EBT)



Part 1 : Historical Data & Baseline

1. Select baseline methodology:
   - *Method A* – The main national air carrier of the State has a fleet of no more than 10 aircraft
   - *Method B* – The State has access to data for 5 years or more
   - *Method C* – The State only has data available for a single year
2. Generate the baseline up to 2050

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Part 2 : Mitigation Measures

Calculate the impacts of the mitigation measures based on Rules of Thumb, IFSET or State data

Part 3 : Expected Results

Generate the expected results by combining baseline and mitigation measures information

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Environmental Benefit Tool (EBT)

HISTORICAL DATA & BASELINE		MEASURES			EXPECTED RESULTS		HELP
	1. Historical data		1. Aircraft-related technology development	4. More efficient operations		1. Fuel savings	
	2. Baseline		2. Alternative fuels	5. Economic/Market-based measures		2. CO_2 savings	
			3. Improved air traffic management and infrastructure use	6. Regulatory measures / other			
				7. Airport improvements			

Input | **Next** (Baseline)

HISTORICAL DATA

Year	International RTK ('000)	International Fuel burn (Tonnes)	Efficiency (Intl. Fuel burn / Intl. RTK)
2007	500,000.00	200,000.00	0.400
2008	550,000.00	215,000.00	0.391
2009	650,000.00	250,000.00	0.385
2010	700,000.00	260,000.00	0.371
2011	850,000.00	325,000.00	0.382
2012	900,000.00	345,000.00	0.383
2013	1,100,000.00	415,000.00	0.377
2014	1,100,000.00	414,000.00	0.376
2015	1,350,000.00	490,000.00	0.363

Example based on Method B - The State has access to data for 5 years or more

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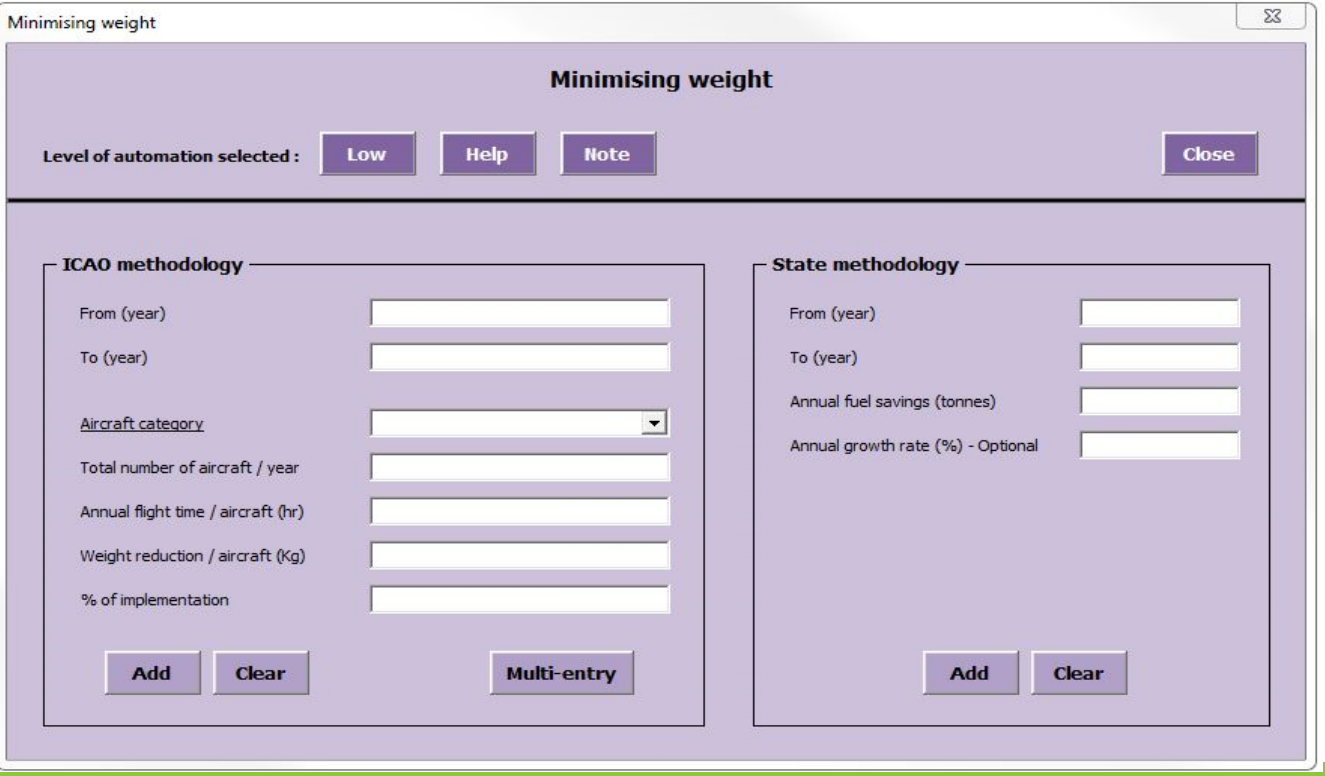
Environmental Benefit Tool (EBT)



Minimising weight

Inputs from State:

- *Time period (from, to)*
- *Aircraft category*
- *Total number of aircraft per year*
- *Annual flight time per aircraft*
- *Weight reduction per aircraft*
- *% of implementation*

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Minimising weight

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Add

Aircraft mapping

AIRCRAFT CATEGORY MAP

Click on titles to sort from A to Z

Minimising weight / Multi-entry

From (year)	To (year)	Aircraft category	Total number of aircraft / year	Annual flight time / aircraft (hr)	Weight reduction / aircraft (Kg)	% of implementation

Add Clear Close

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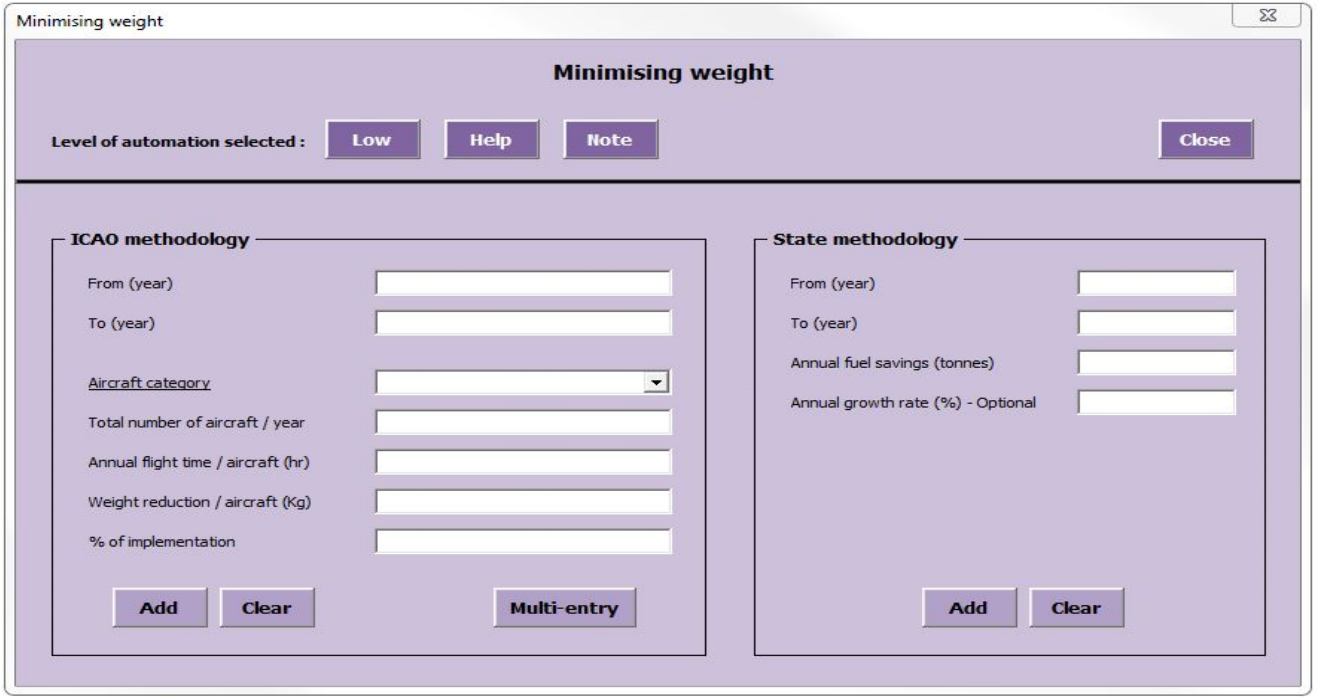
Environmental Benefit Tool (EBT)



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Inputs from State:

- *Time period (from, to)*
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- ***Total number of aircraft per year***
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- *Weight reduction per aircraft*
- *% of implementation*

Annual Fuel Savings = Weight reduction factor * Annual flight time * Weight reduction * Number of aircraft

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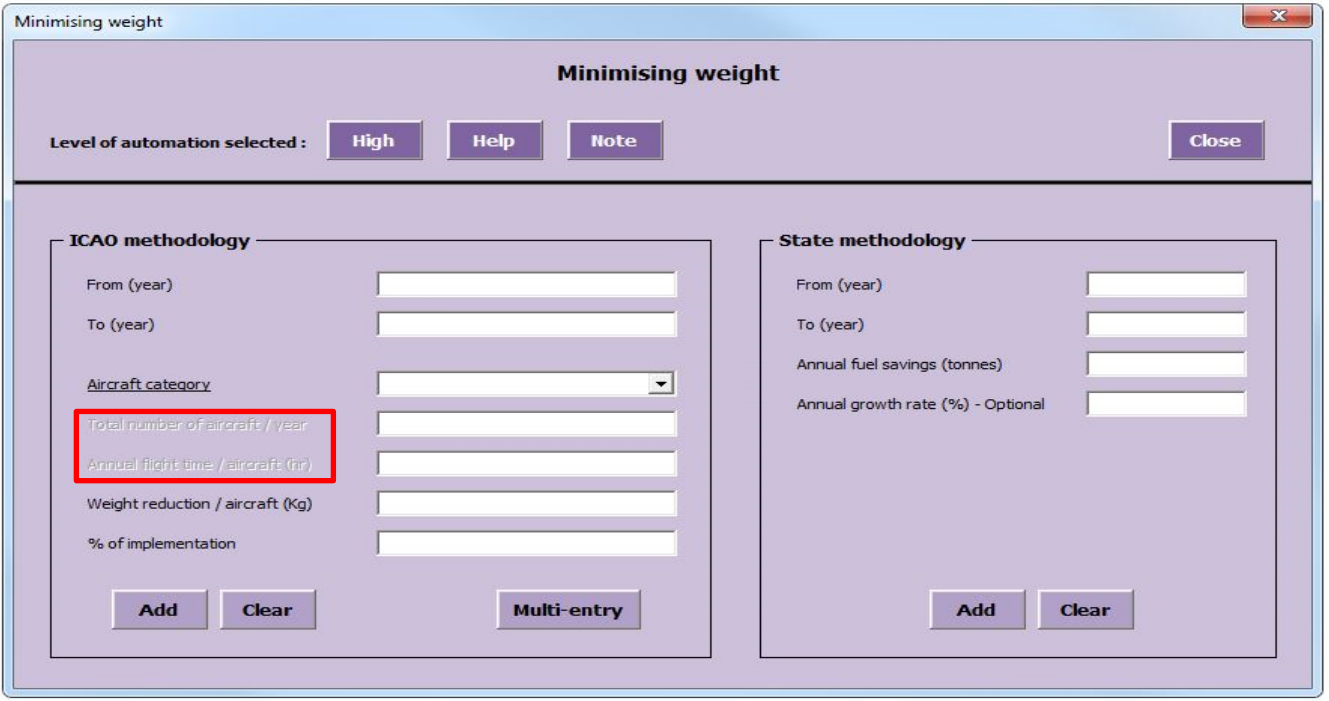
Environmental Benefit Tool (EBT)



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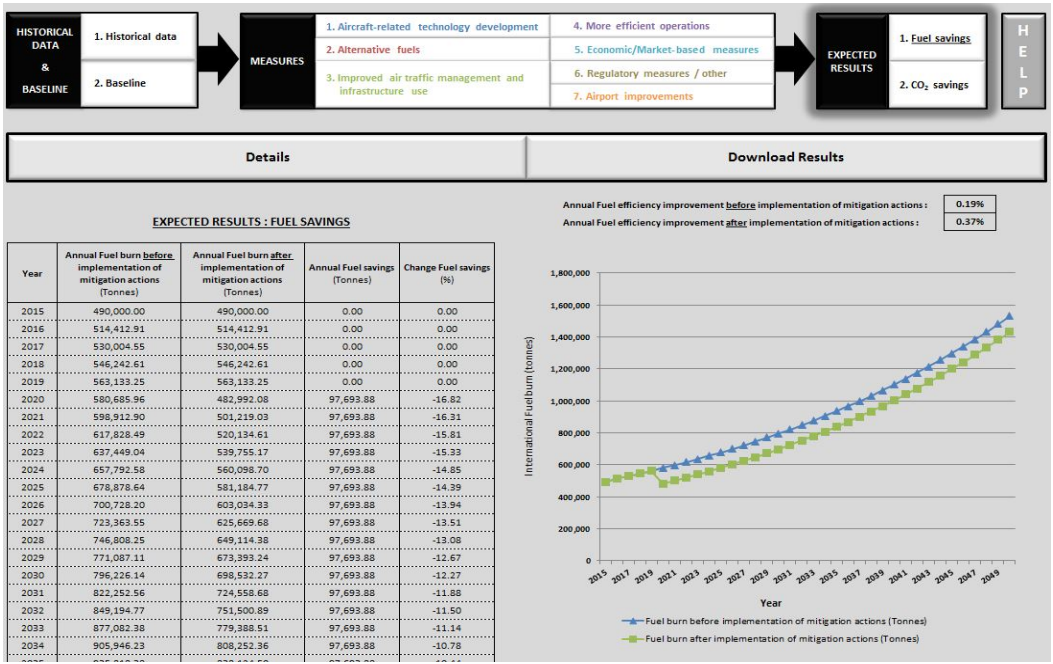
Environmental Benefit Tool (EBT)



EXPECTED RESULTS : FUEL SAVINGS

Year	Annual Fuel burn before implementation of mitigation actions (Tonnes)	Annual Fuel burn after implementation of mitigation actions (Tonnes)	Annual Fuel savings (Tonnes)	Change Fuel savings (%)
2015	490,000.00	490,000.00	0.00	0.00
2016	514,412.91	514,412.91	0.00	0.00
2017	530,004.55	530,004.55	0.00	0.00
2018	546,242.61	546,242.61	0.00	0.00
2019	563,133.25	563,133.25	0.00	0.00
2020	580,685.96	482,992.08	97,693.88	-16.82
2021	598,912.90	501,219.03	97,693.88	-16.31
2022	617,828.49	520,134.61	97,693.88	-15.81
2023	637,449.04	539,755.17	97,693.88	-15.33
2024	657,792.58	560,098.70	97,693.88	-14.85
2025	678,878.64	581,184.77	97,693.88	-14.39
2026	700,728.20	603,034.33	97,693.88	-13.94
2027	723,363.55	625,669.68	97,693.88	-13.51
2028	746,808.25	649,114.38	97,693.88	-13.08
2029	771,087.11	673,393.24	97,693.88	-12.67
2030	796,226.14	698,532.27	97,693.88	-12.27
2031	822,252.56	724,558.68	97,693.88	-11.88
2032	849,194.77	751,500.89	97,693.88	-11.50
2033	877,082.38	779,388.51	97,693.88	-11.14
2034	905,946.23	808,252.36	97,693.88	-10.78

Annual Fuel efficiency improvement before implementation of mitigation actions : 0.19%
Annual Fuel efficiency improvement after implementation of mitigation actions : 0.37%

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Environmental Benefit Tool (EBT)

- **Future developments**

1. Migrate EBT from Excel-based tool to Application (.exe)
2. Integrate the ICAO Carbon Emissions Calculator methodology and IFSET methodology into EBT
3. Provide more flexibility to users to import their own data into EBT
4. Improve connection between EBT and the APER website

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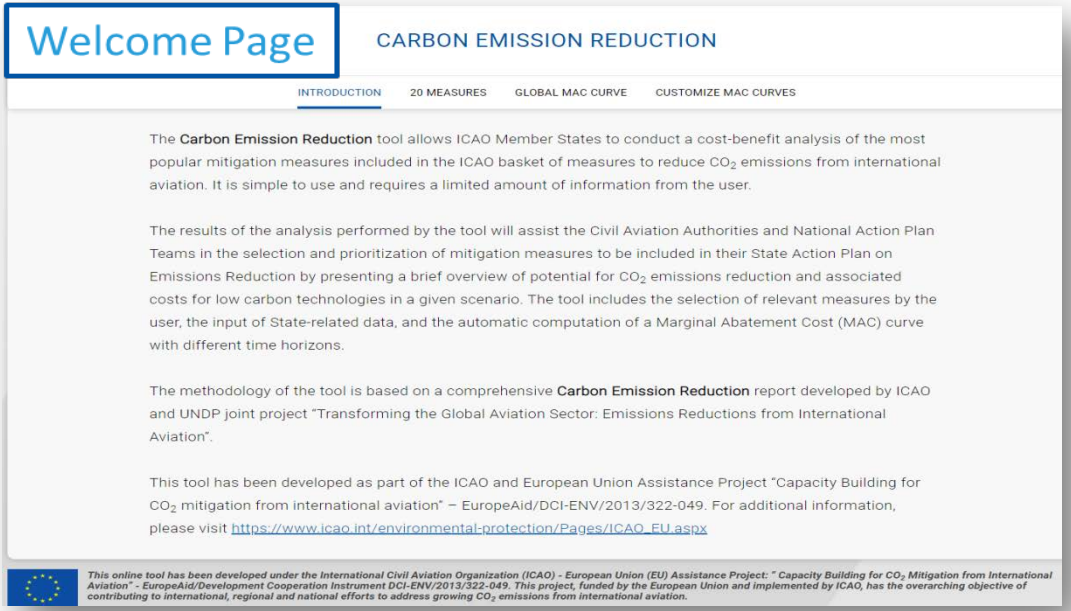
Marginal Abatement Cost Curve (MACC)

Welcome Page



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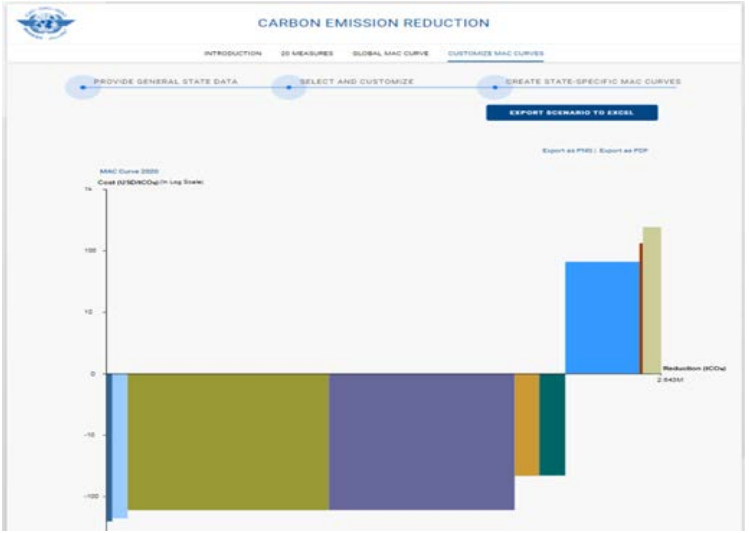
Marginal Abatement Cost Curve (MACC)

- **Description**
  - This tool offers the possibility to States to identify and rank up to 20 mitigation measures in order to facilitate decision-making.
  - The tool includes a user-friendly interface and is fully customizable to fit the State's situation



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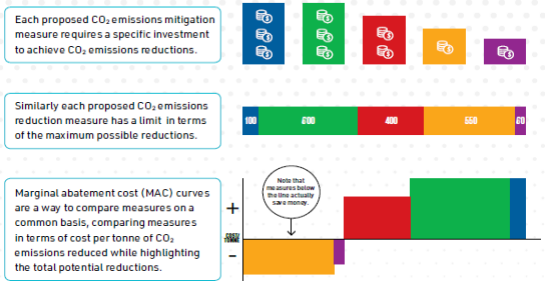
Marginal Abatement Cost Curve (MACC)

MAC CURVES

Under the framework of the ICAO-UNDP-GEF project, ICAO has designed a tool to support States and their stakeholders prioritize the most appropriate international aviation CO_2 emissions mitigation measures, in light of their respective costs and CO_2 emissions reductions. The tool is particularly focussed on developing States and Small Island Developing States (SIDS).

Numerous measures are available to States and their aviation stakeholders seeking to reduce CO_2 emissions from international aviation. Limited financial and technical resources represent a challenge for the implementation of these measures and make prioritizing a necessity. Marginal abatement cost (MAC) curves illustrate the relative CO_2 emissions reductions among possible measures on a comparative cost basis.



Based on the analysis of the mitigation measures included in the State Action Plans submitted by ICAO Member States, ICAO has developed global MAC curves, which simplify the process of assessing the CO_2 emissions reductions and the costs for individual measures and so help States and aviation stakeholders put them in priority order. A MAC Curve Tool can be tailored to the individual reality of States, allowing them to input their local data, create MAC curves and therefore prioritize the measures to be implemented in light of their own circumstances and conditions.

ICAO IDENTIFIED MITIGATION MEASURES

- Purchase new aircraft
- Improve fuel efficiency through development or modification
- Replace engines
- Develop sustainable aviation fuel (SAF)
- Improve pre-departure planning (DMAN) and arrival planning (AMAN)
- Improve collaborative decision-making (A-CDM)
- Improve air traffic management in non-radar airspace
- Improve fuel efficiency of departure and approach procedures
- Introduce continuous climb and descent procedures
- Improve aircraft guidance on apron
- Improve taxiing
- Minimise weight
- Minimise flaps (takeoff and landing)
- Minimise reverser use
- Reduce speed
- Optimise aircraft maintenance (engine washing and zonal drying)
- Select aircraft best suited to the mission
- Install fixed electrical ground power and preconditioned air to enable auxiliary power unit switch-off
- Use cleaner alternative sources of power generation (for fixed electrical GPU and PCA)
- Construct taxiways and speed exits

MAC curves are a powerful decision-making tool. They were developed through ICAO's **Transforming the Global Aviation Sector: Emissions Reductions from International Aviation** joint assistance project with the United Nations Development Programme (UNDP), financed by the Global Environment Facility (GEF). ICAO is supporting developing States and SIDS in their efforts to reduce CO_2 emissions from international aviation, under the overarching ICAO initiative on States' Action Plans on CO_2 emissions reduction activities. The deliverables of the ICAO-UNDP-GEF project aim to increase the capacity of States and their stakeholders to take meaningful and coordinated action to address international aviation environmental issues.

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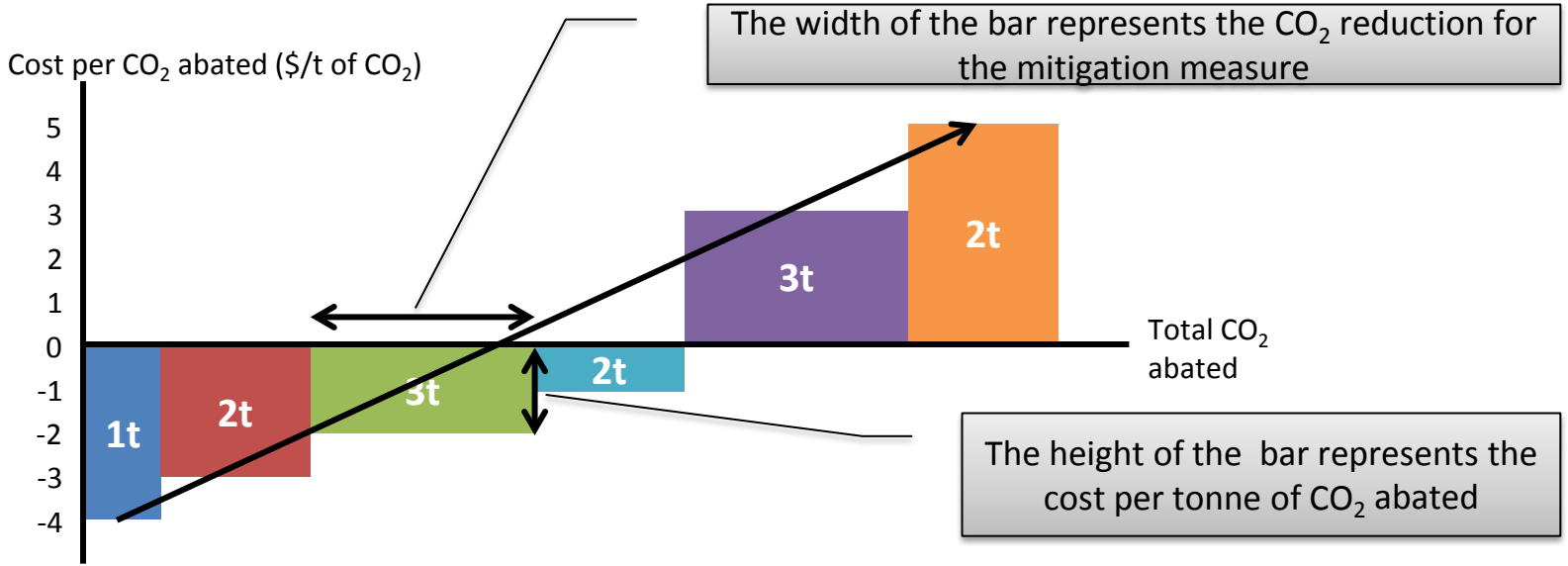
How to read a MAC curve?



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Planning Meeting Locations: ICAO Green Meetings Calculator

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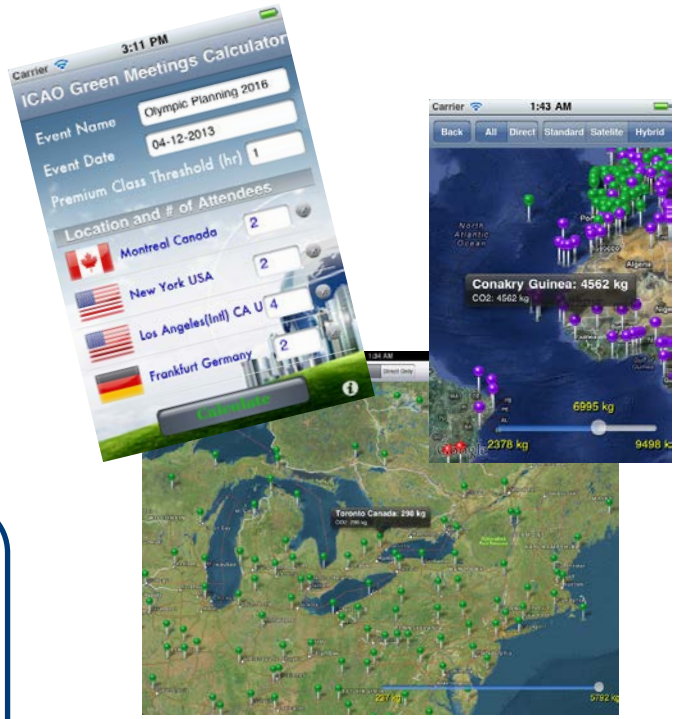
ICAO Green Meeting Calculator



(New interface and new functionalities under development)

Description:

The ICAO Green Meetings Calculator (IGMC) is a tool developed in response to request from UN Travel Offices

designed to support decision-making in reducing the carbon emissions from air travel to attend meetings.

The software generates an optimal location for a meeting in terms of CO2 emissions, taking into consideration the city of origin and the number of participants, as well as other parameters. While many factors may affect the decision for where a meeting should be held, the calculator helps facilitate the planning process.

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All of ICAO's environmental tools are available free of charge from:

http://www.icao.int/env

Designed for Windows 7, Vista, XP

Available on the App Store

Available on the Android App Store

Designed for Windows 7, Vista, XP

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Available on the App Store

Available on the Android App Store

**The special interface to the ICAO Carbon Emissions Calculator is available through the APER portal.*

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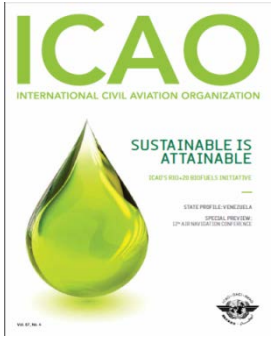
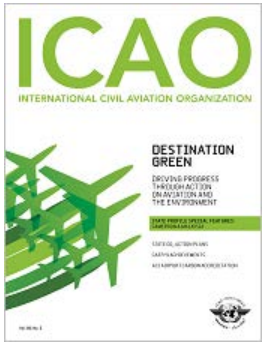
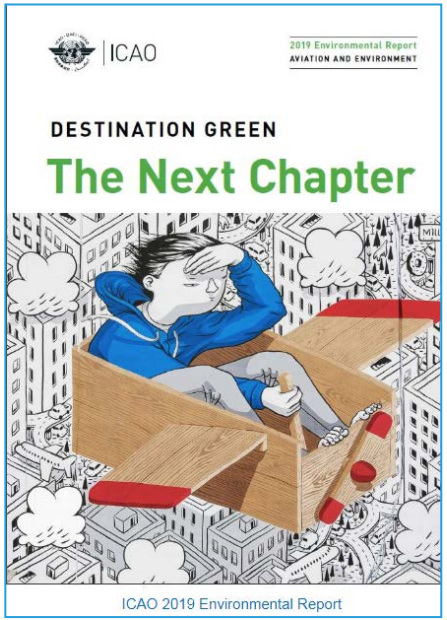
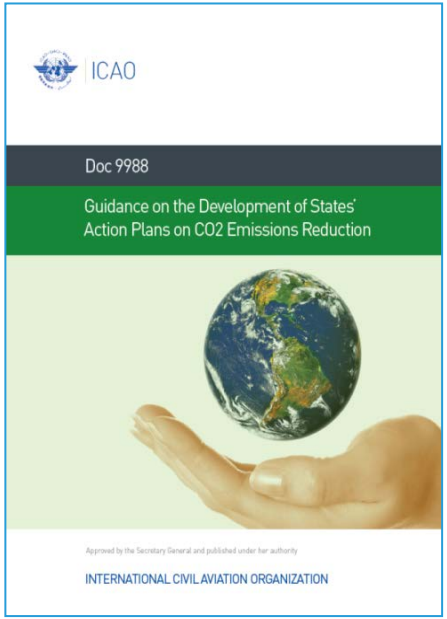
Additional Information







ICAO 2019 Environmental Report



For more information, please visit our website: **http://www.icao.int/env**

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THANK YOU

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