



ICAO

ENVIRONMENT

NO COUNTRY LEFT BEHIND



ICAO CAPACITY BUILDING SEMINAR ON LOW EMISSIONS AVIATION MEASURES

Supporting SIDS and their aviation stakeholders in selecting measures for the State Action Plan

Neil Dickson, Chief, Environmental Standards Section, ICAO





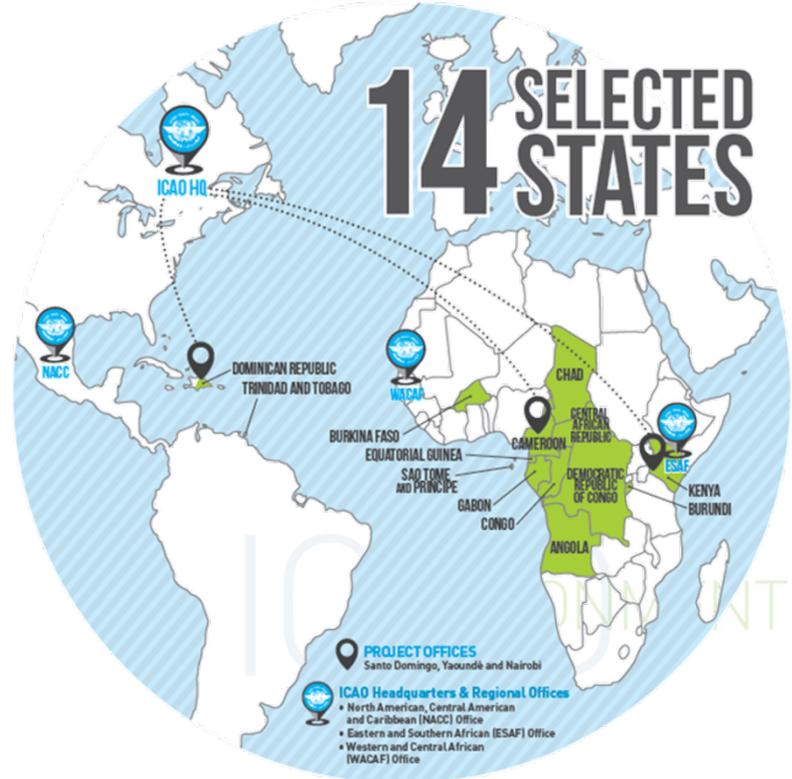
ICAO

ENVIRONMENT

NO COUNTRY LEFT BEHIND



CAPACITY BUILDING FOR CO2 MITIGATION FROM INTERNATIONAL AVIATION



14 SELECTED STATES

ICAO HQ

NACC

WACAF

DOMINICAN REPUBLIC
TRINIDAD AND TOBAGO

BURKINA FASO
EQUATORIAL GUINEA
SAO TOME AND PRINCIPE

GABON
CONGO

CHAD
CENTRAL AFRICAN REPUBLIC

DEMOCRATIC REPUBLIC OF CONGO

ANGOLA

ESAF

KENYA
BURUNDI

PROJECT OFFICES
Santo Domingo, Yaoundé and Nairobi

- ICAO Headquarters & Regional Offices
- North American, Central American and Caribbean (NACC) Office
- Eastern and Southern African (ESAF) Office
- Western and Central African (WACAF) Office



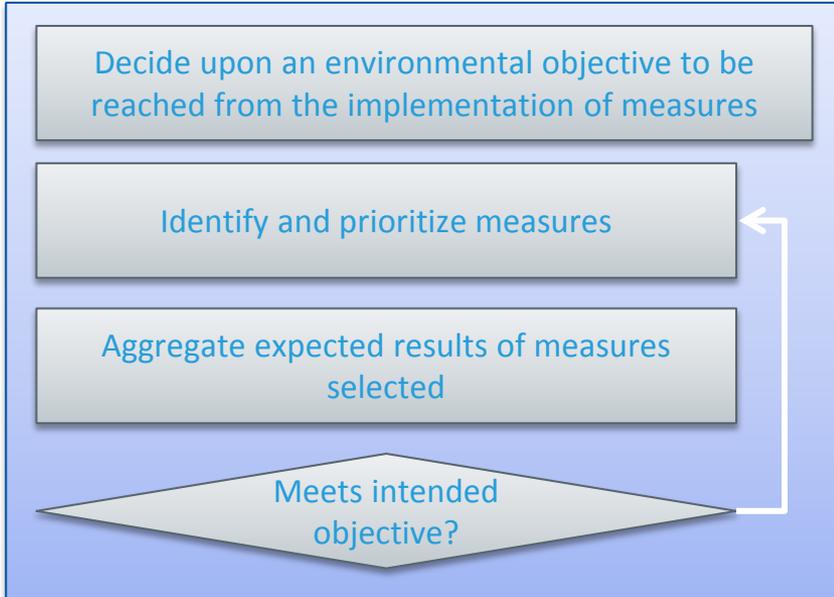
Background

- A State Action Plan comprises 5 elements:
 1. Contact information of the Focal Point
 2. Baseline
 - 3. Mitigation Measures**
 4. Expected Results
 5. Assistance needs (if any)
- The selection of Mitigation Measures can be challenging
 - Cost associated?
 - CO₂ abated?
- To facilitate the selection, ICAO has developed a Marginal Abatement Cost (MAC) Curve

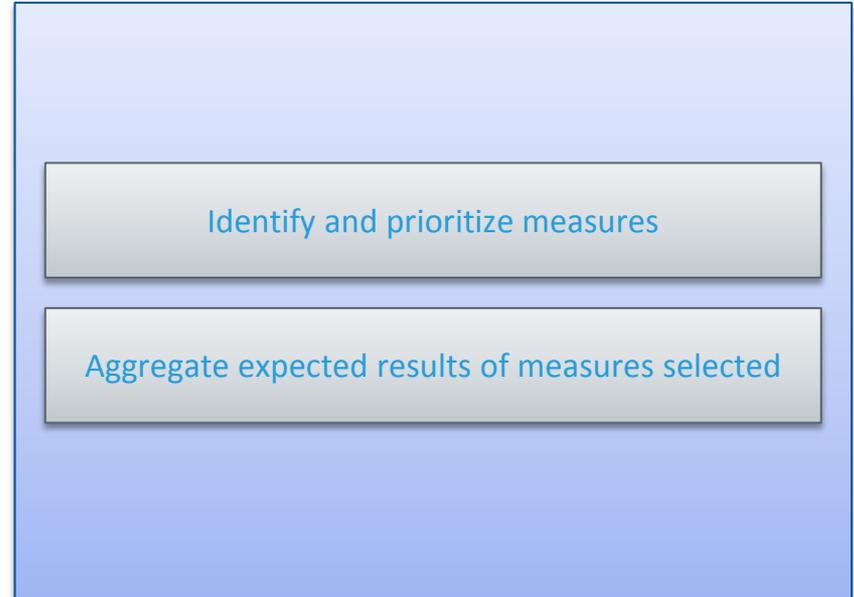


Selection of mitigation measures

Top-down approach



Bottom-up approach



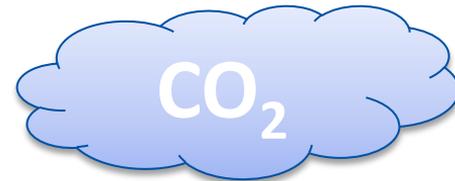


Prioritization of mitigation measures

- The prioritization of mitigation measures consists to rank the selected mitigation measures based on criteria, such as
 - Emissions reductions;
 - Economic feasibility;
- **Example** (for economic feasibility):



Specific Budget



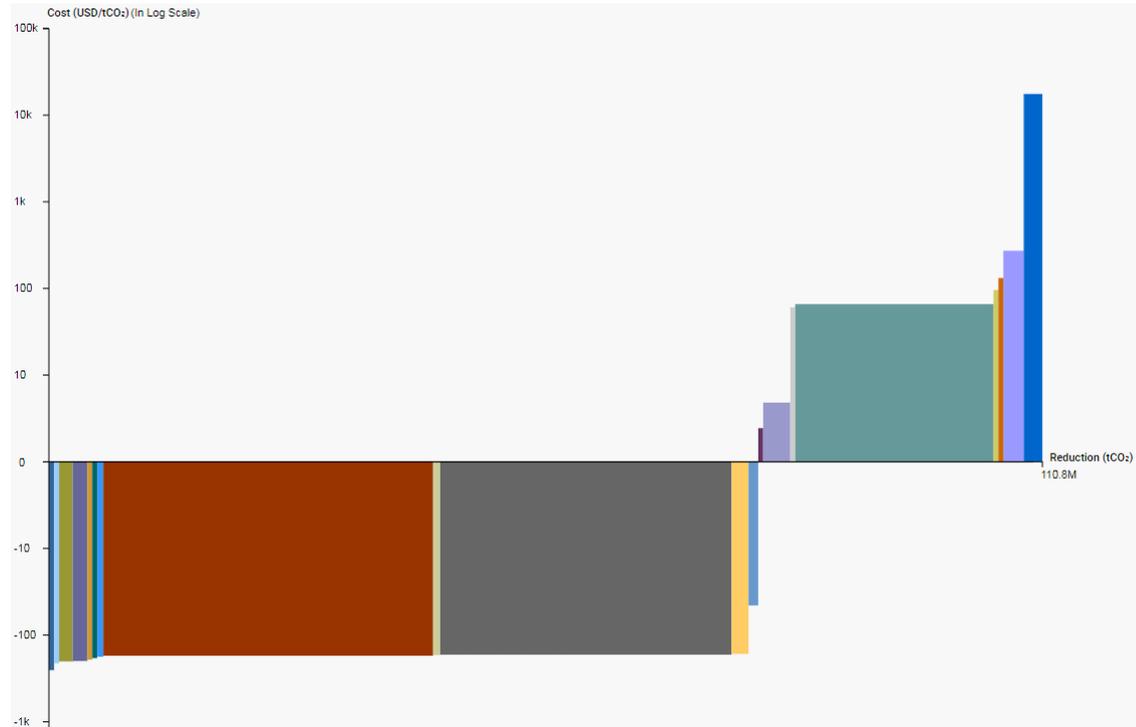
Maximize the CO₂ reduction



Function and Representation of a MAC curve

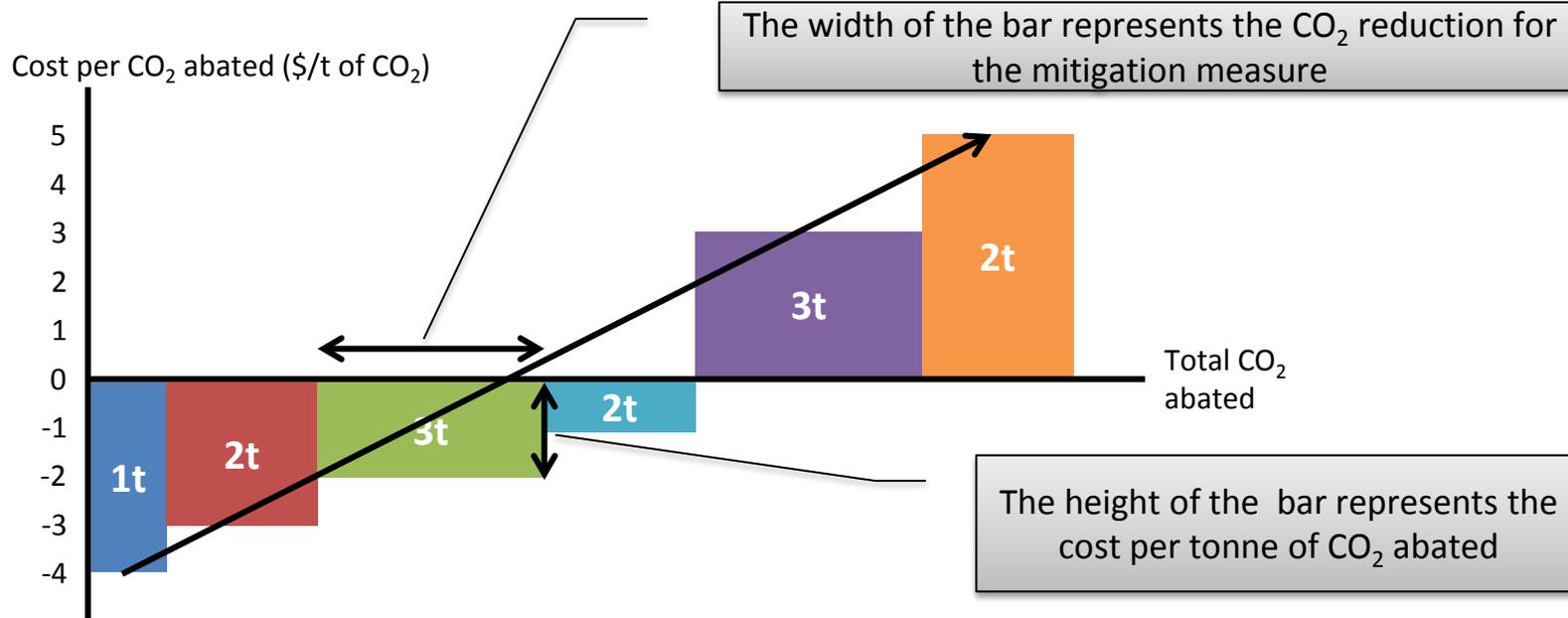
Function: A MAC curve helps to select and prioritize mitigation measures.

Representation: ----->





How to read a MAC curve?

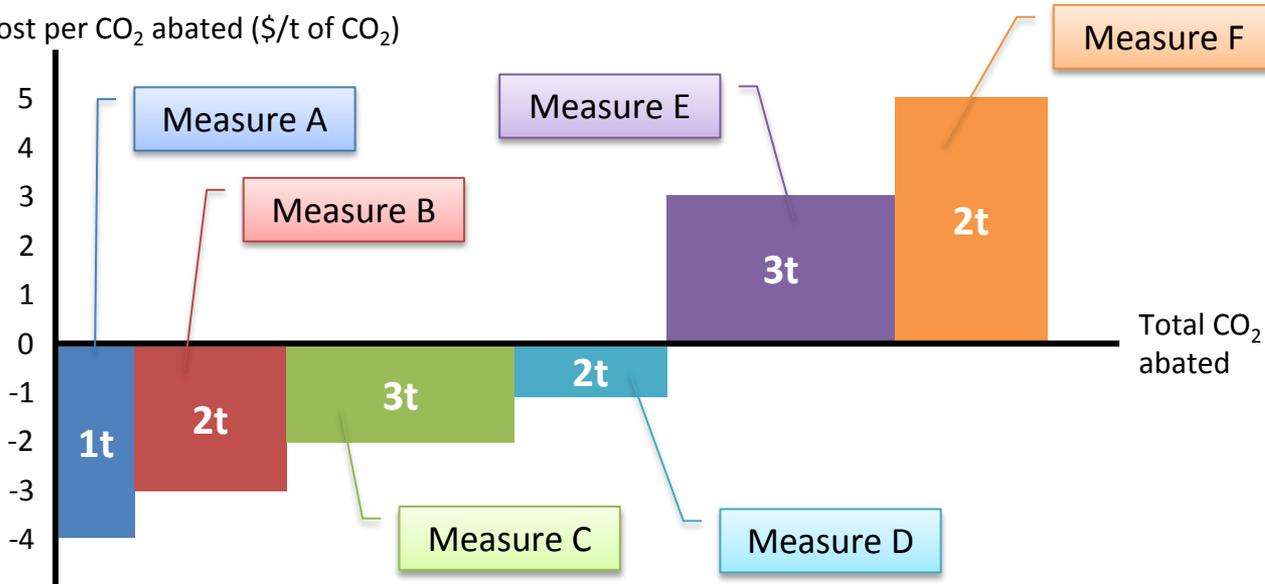




How to use a MAC curve – Example

Scenario Maximize the CO₂ abated by setting the total cost at 0\$ or lower

Cost per CO₂ abated (\$/t of CO₂)



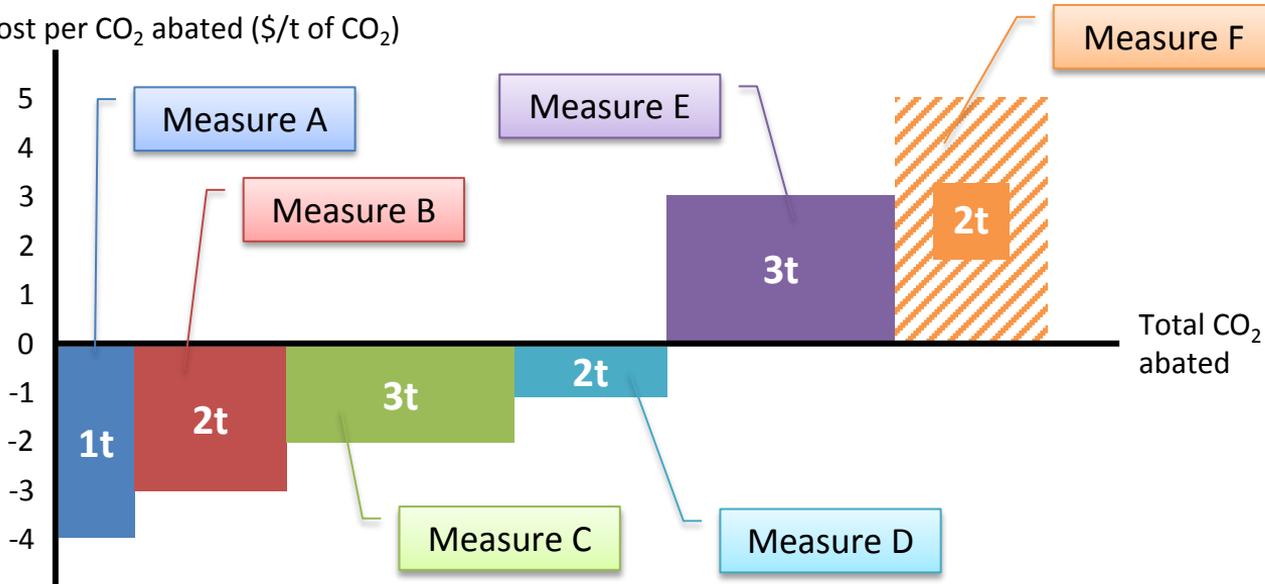
#	Cost per tonne (\$/t)	CO ₂ abated (tonne)	Total cost (\$)
A	-4	1	-4
B	-3	2	-6
C	-2	3	-6
D	-1	2	-2
E	3	3	9
F	5	2	10
Total		13	1



How to use a MAC curve – Example

Scenario Maximize the CO₂ abated by setting the total cost at 0\$ or lower

Cost per CO₂ abated (\$/t of CO₂)



#	Cost per tonne (\$/t)	CO ₂ abated (tonne)	Total cost (\$)
A	-4	1	-4
B	-3	2	-6
C	-2	3	-6
D	-1	2	-2
E	3	3	9
F	5	2	10
Total		13 --> 11	1 --> -9



ICAO

ENVIRONMENT

NO COUNTRY LEFT BEHIND



CASE STUDY

Recommendations for Small Islands Developing States and Developing States



Case Study: Parameters

In order to calibrate the model (based on 34 countries), statistics on Airport and Aircraft need to be provided.

- 34 Countries located in Latin America/Caribbean and Asia-Pacific:
 - 13 SIDS
 - 21 Developing States
- Airports:
 - Small (<25k arrivals): 45.06%
 - Medium (25k-100k arrivals): 49.59%
 - Large (>100k arrivals): 5.35%
- Aircraft:
 - TP/RJ (Turboprop/Regional Jet): 29.87%
 - NB (Narrow-body): 59.83%
 - WB (Wide-body): 10.30%
- Aircraft age:
 - 0-10 years: 81.09%
 - 10-20 years: 8.20%
 - +20 years: 10.71%



Case Study: Approach used

- Step 1:

Set the objective:

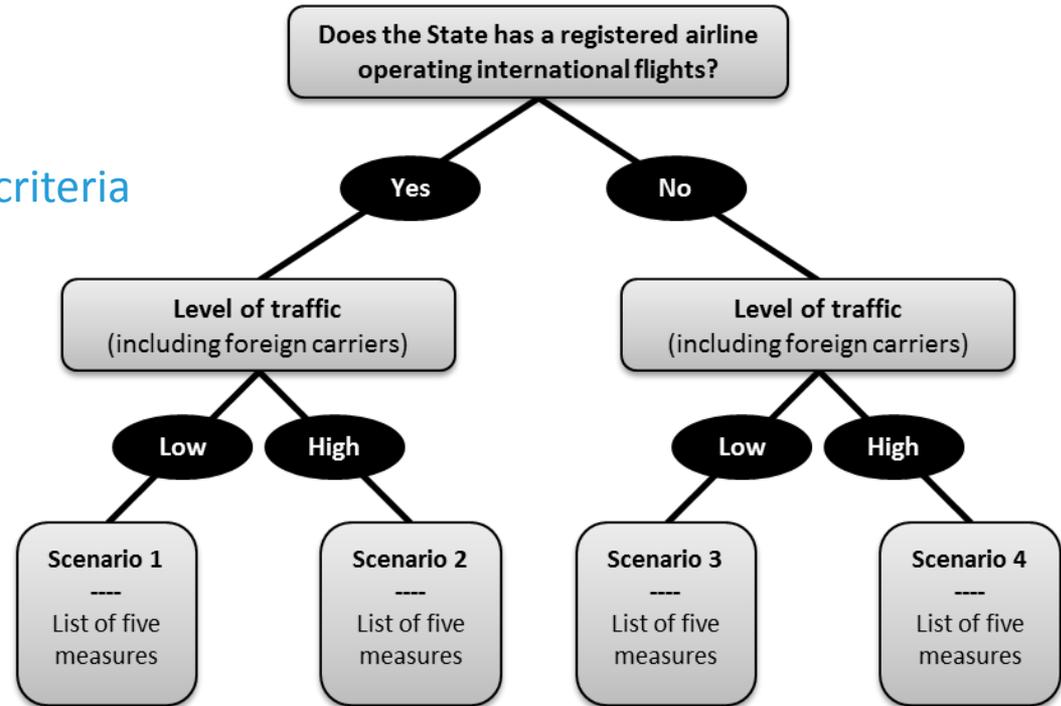
“Get the maximum of CO₂ abated with a maximum cost of 0\$ and with a maximum of 5 mitigation measures”



Case Study: Approach used

- Step 2:**

Elaborate 4 scenarios based on 2 criteria





Case Study: Approach used

- Step 3:

Select 5 mitigation measures by taking into consideration the 2 criteria for each scenario

Process:

- Sort the 20 mitigation measures from the highest to the lowest potential CO₂ abated
- Select the top 5 mitigation measures respecting both criteria
- Sum the cost for the 5 mitigation measures with a limit of 0\$



Illustrative example:

Measure	CO ₂ Reduction (t)	Cost (\$/t of CO ₂)	Total Cost (\$)	Respect criteria?
A	10,000	-100	-1,000,000	Yes
B	8,000	-200	-1,600,000	Yes
C	7,000	-500	-3,500,000	No
D	6,000	10,000	60,000,000	Yes
E	5,000	-500	-2,500,000	Yes
F	4,000	-500	-2,000,000	Yes
G	1,000	1000	1,000,000	Yes
TOTAL			52,900,000	



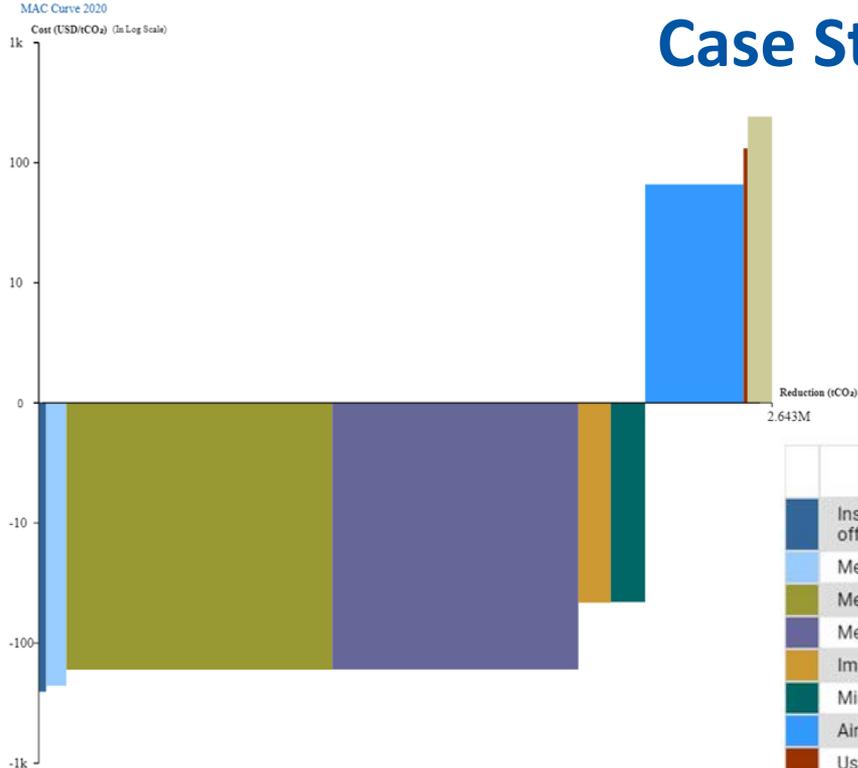
Illustrative example:

Measure	CO ₂ Reduction (t)	Cost (\$/t of CO ₂)	Total Cost (\$)	Respect criteria?
A	10,000	-100	-1,000,000	Yes
B	8,000	-200	-1,600,000	Yes
C	7,000	-500	-3,500,000	No
D	6,000	10,000	60,000,000	Yes
E	5,000	-500	-2,500,000	Yes
F	4,000	-500	-2,000,000	Yes
G	1,000	1000	1,000,000	Yes
TOTAL			-6,100,000	



Case Study: Results

For the 4 scenario created, a total of 9 different mitigation measures have been highlighted



Measure	Cost (USD/tCO ₂)	Reduction (tCO ₂)
Installation of fixed electrical ground power and pre-conditioned air to allow APU switch-off	-254	26,082.11
Measures to improve collaborative decision making (A-CDM)	-226	73,208.66
Measures to increase fuel efficiency of departure and approach procedures	-166	964,285.04
Measures to introduce CCO and CDO	-165	892,351.94
Improve fuel efficiency through modifications	-46	117,192.07
Minimizing weight	-45	124,516.26
Airport infrastructure (runways, taxiways, highspeed turnoffs)	65	356,258.60
Use cleaner alternative sources of power generation	131	1,133.23
Development of biofuels	241	87,716.49



Case Study: Results

S1	Does States have a national airlines? Level of traffic	Yes Low
1.	Measures to increase fuel efficiency of departure and approach procedures	
2.	Measures to introduce CCO and CDO	
3.	Minimizing weight	
4.	Improve fuel efficiency through modifications	
5.	Development of sustainable aviation fuels	

S2	Does States have a national airlines? Level of traffic	Yes High
1.	Measures to increase fuel efficiency of departure and approach procedures	
2.	Measures to introduce CCO and CDO	
3.	Airport infrastructure (runways, taxiways, highspeed turnoffs)	
4.	Minimizing weight	
5.	Improve fuel efficiency through modifications	



Case Study: Results

S3	Does States have a national airlines? Level of traffic	No Low
1.	Measures to increase fuel efficiency of departure and approach procedures	
2.	Measures to introduce CCO and CDO	
3.	Development of sustainable aviation fuels	
4.	Installation of fixed electrical ground power and pre-conditioned air to allow APU switch-off	
5.	Use cleaner alternative sources of power generation	

S4	Does States have a national airlines? Level of traffic	No High
1.	Measures to increase fuel efficiency of departure and approach procedures	
2.	Measures to introduce CCO and CDO	
3.	Airport infrastructure (runways, taxiways, highspeed turnoffs)	
4.	Development of sustainable aviation fuels	
5.	Measures to improve collaborative decision making (A-CDM)	



Case Study: Conclusion

- The two mitigation measures with the highest potential in term of CO₂ abated are present in the four scenario.

S1	Does States have a national airlines? Level of traffic	Yes Low
1.	Measures to increase fuel efficiency of departure and approach procedures	
2.	Measures to introduce CCO and CDO	

S3	Does States have a national airlines? Level of traffic	No Low
1.	Measures to increase fuel efficiency of departure and approach procedures	
2.	Measures to introduce CCO and CDO	

S2	Does States have a national airlines? Level of traffic	Yes High
1.	Measures to increase fuel efficiency of departure and approach procedures	
2.	Measures to introduce CCO and CDO	

S4	Does States have a national airlines? Level of traffic	No High
1.	Measures to increase fuel efficiency of departure and approach procedures	
2.	Measures to introduce CCO and CDO	



Case Study: Conclusion

- In the case where the State has no national airlines and with a low level of traffic (scenario 3), the **installation of fixed electrical ground power and pre-conditioned air units** augmented by **photovoltaic panels** represents an excellent opportunity to consider in the case of developing States and SIDS

S3	Does States have a national airlines? Level of traffic	No Low
1.	Measures to increase fuel efficiency of departure and approach procedures	
2.	Measures to introduce CCO and CDO	
3.	Development of biofuels	
4.	Installation of fixed electrical ground power and pre-conditioned air to allow APU switch-off	
5.	Use cleaner alternative sources of power generation	



ICAO

ENVIRONMENT

NO COUNTRY LEFT BEHIND



For more information on this project, please visit ICAO's website:

https://www.icao.int/environmental-protection/Pages/ICAO_UNDP.aspx



ICAO

ENVIRONMENT

NO COUNTRY LEFT BEHIND



ICAO

North American
Central American
and Caribbean
[NACC] Office
Mexico City

South American
[SAM] Office
Lima

ICAO
Headquarters
Montréal

Western and
Central African
[WACAF] Office
Dakar

European and
North Atlantic
[EUR/NAT] Office
Paris

Middle East
[MID] Office
Cairo

Eastern and
Southern African
[ESAF] Office
Nairobi

Asia and Pacific
[APAC] Sub-office
Beijing

Asia and Pacific
[APAC] Office
Bangkok



THANK YOU