















500,000
in 1995



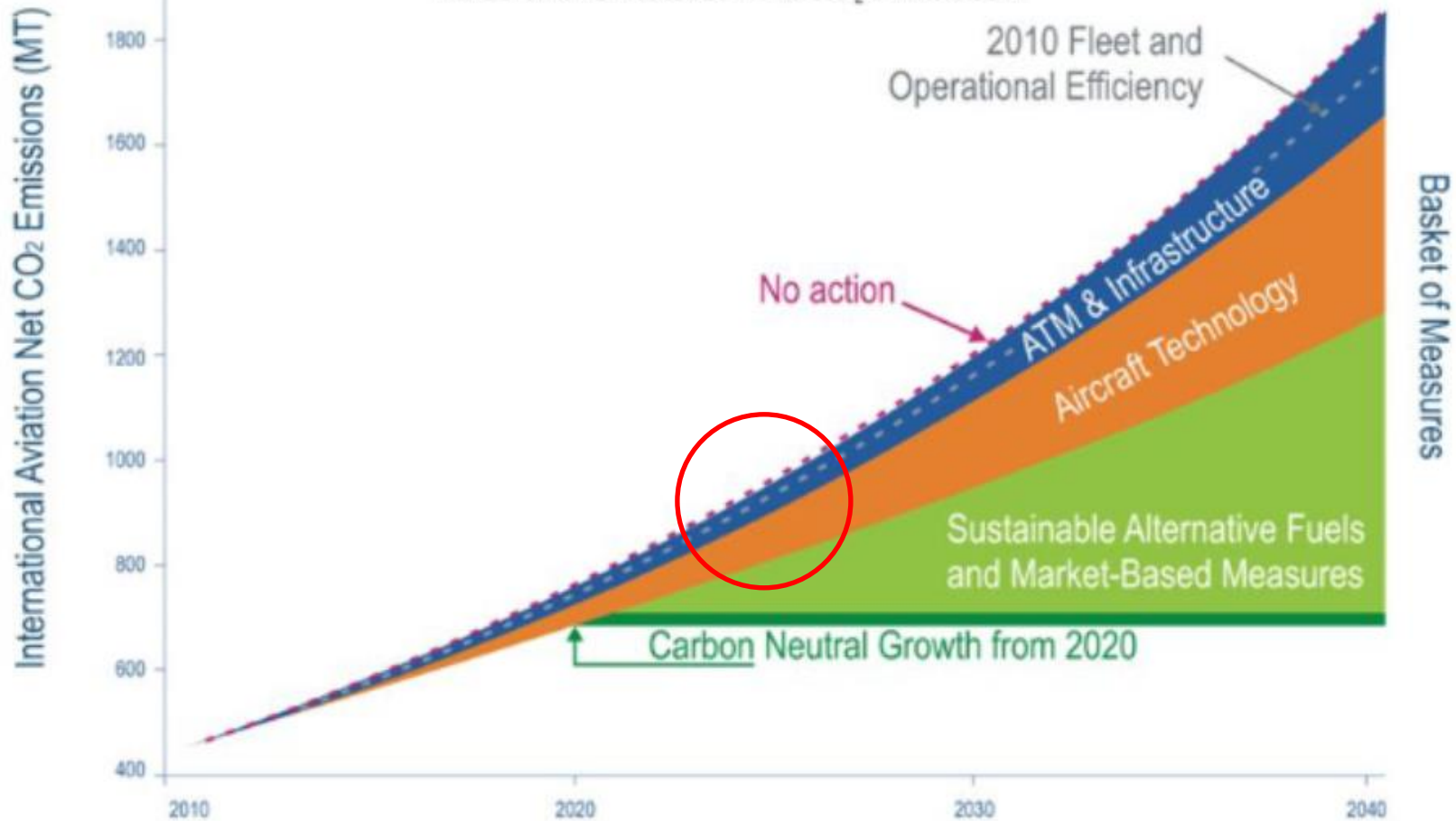
500,000 **2,600,000**
in 1995 **in 2018**

Contribution of Measures for Reducing International Aviation Net CO₂ Emissions

International Aviation Net CO₂ Emissions (MT)



Contribution of Measures for Reducing International Aviation Net CO₂ Emissions





| ICAO

ENVIRONMENT

Green Airports Conference

ASBU B0/1 environmental analysis



David Brain

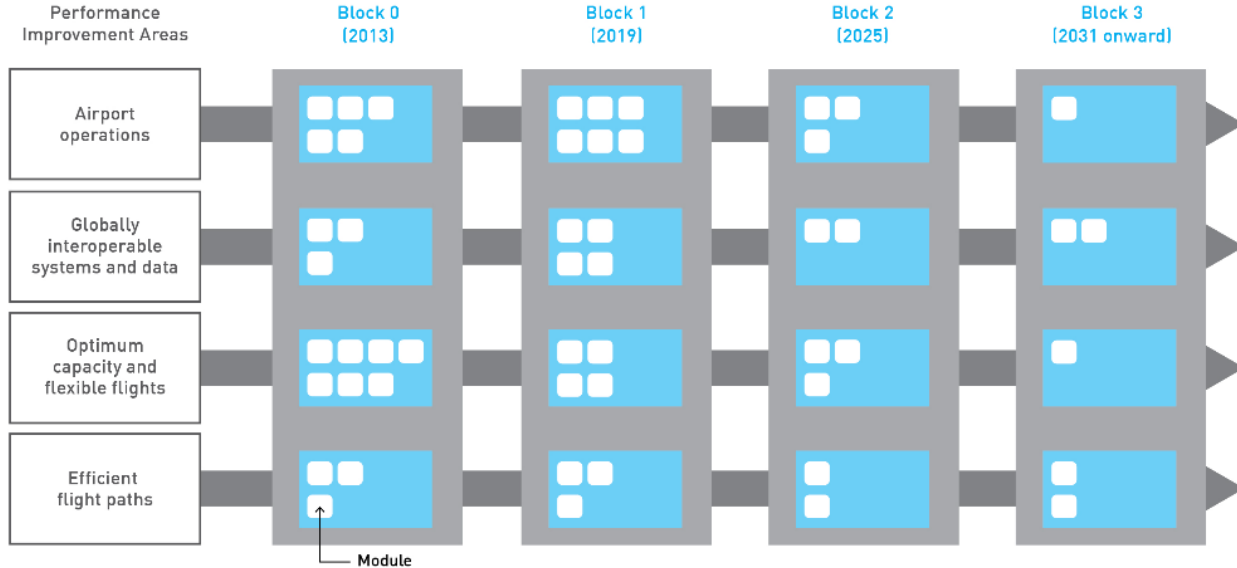
Lima, Peru 8-9 May, 2019

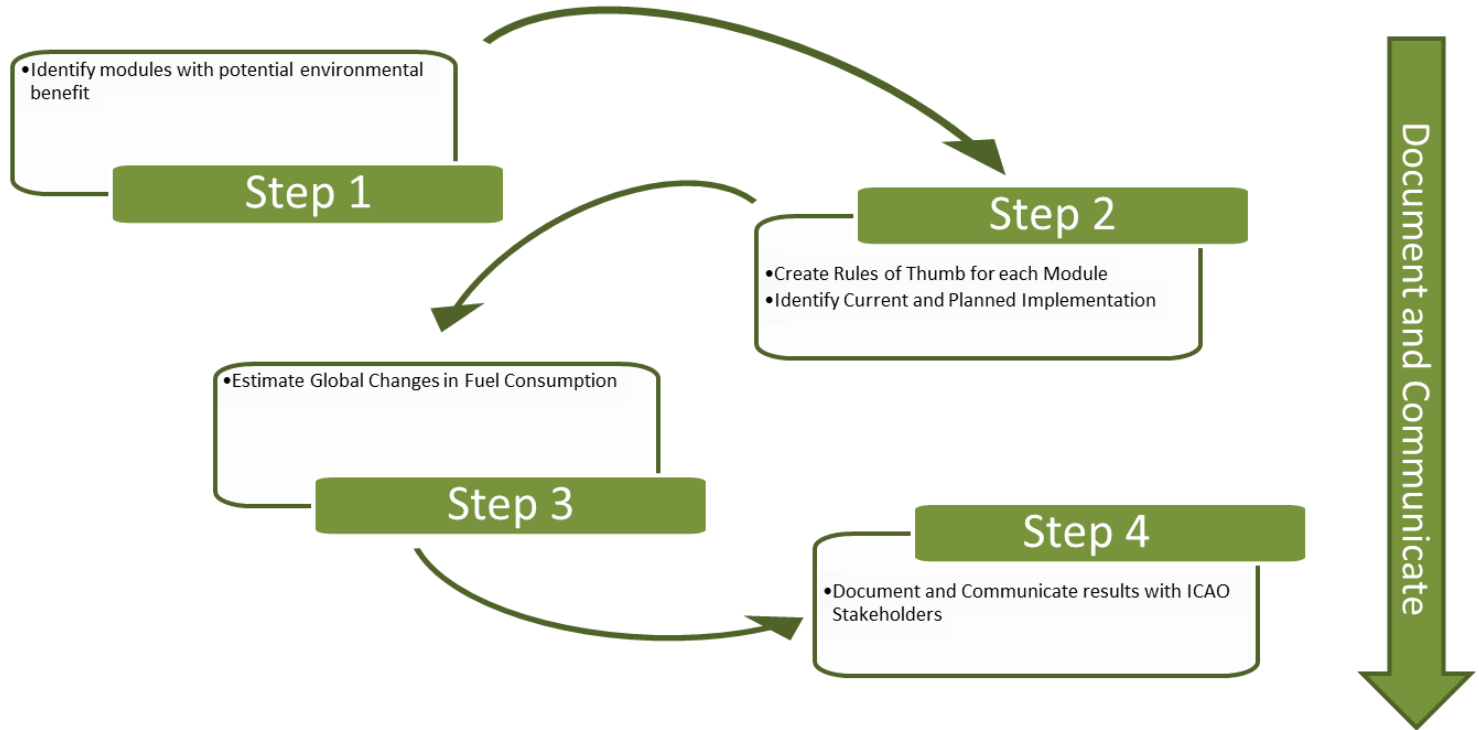


ICAO initiated the Aviation System Block Upgrade (ASBU) initiative as a programmatic framework that:

- **Develops a set of Air Traffic Management (ATM) solutions or upgrades**
- **Takes advantage of current equipage**
- **Establishes a transition plan, and**
- **Enables global interoperability**

Outlined in *ICAO Global Air Navigation Plan (Doc. 9750)*





Aligns with approach outline in ICAO Doc 10031, *Guidance on Environmental Assessment of Proposed Air Traffic Management Operational Changes*



- 53 rules of thumb (RoT) for ASBU B0 / B1 generic implementations

AC Class	High Ave Kg Saved per taxi min Taxi-out	Low Ave Kg Saved per taxi min Taxi-in**	Fleet %
RJ	7	4.9	6,0
SA	14,4	10.1	71,0
Small TA	20,5	14,4	12,9
Med TA	34	23,8	8,8
Large TA	70	49	1,3

AC Class	High Ave Kg Saved per taxi min Taxi-out	Low Ave Kg Saved per taxi min Taxi-in**	Fleet %
Composite	17,2	12,0	6,68

Region	High Ave Kg Saved per taxi min Taxi-out	Low Ave Kg Saved per taxi min Taxi-in**	Fleet %
American India/Southeast Asia	1192	1026	1,2%
Europe	75	2,2%	2,2%
Europe Other Asia/Pacific	91	1,5%	103
Europe Africa	418	1,5%	472
Europe Middle East	275	1,1%	317
North America South America	89	2,0%	195
North America Central America and Caribbean	234	1,4%	595
Middle East Oceania/Mongolia	25	2,3%	30
Middle East India/Southeast Asia	208	2,2%	245
Middle East Other Asia/Pacific	182	2,2%	181
Intra Africa	270	1,9%	313
Intra Asia/Pacific	1132	2,1%	1338
Intra Europe	4370	1,4%	4878
Intra Latin America	407	1,9%	475
Intra Middle East	284	1,7%	326
Intra North America	403	0,7%	428
Other International Routes	379	2,2%	456
TOTAL INTERNATIONAL	9743	1,6%	11954
Dom Africa	490	1,6%	555
Oceania/Mongolia	2095	2,8%	2795
Europe / Russia	3022	0,9%	3255
Latin America	3481	1,7%	3922
Middle East	263	1,3%	293
North America / Polar	9125	0,6%	9908
High	655	0,5%	683
Other Asia/Pacific	2056	1,6%	2343
India/Southeast Asia	659	1,2%	850
Total Domestic	26482	1,2%	29478
Global (International + Domestic)	36145	1,3%	33532

Now from the AIAA and Mitre papers and more realism

Fig 3 Baseline arrivals/hr 24 Single Runway

Assume 80% ADS-B OUT and 20% ADS-B in FIM-5 25 So given realistic example of on 20% FIM-5 capable in Block 1 you only gain 1 arrival/hr

Rule of Thumb Likely requires more equipage

FIM-5 Runway Arrival Rate 22 24 26 28 30 32

Assume 90/20 Equipage 23 25 28 31 34 37

Additional arrivals 1 1 2 3 4 5

Time saving - min/airplane seconds saved per A/C 0.12 0.10 0.16 0.21 0.24 0.25

Low Fuel benefit B737/A320 6.1 5.1 8.4 10.6 12.0 13.0

High Fuel benefit B737/A321 7.6 6.4 10.5 13.3 15.0 16.2

Low Fuel benefit B777/A350 26.2 22.1 36.4 45.8 52.0 56.0

High Fuel benefit B777/A351 28.6 24.1 39.8 50.1 56.8 61.2

Low Fuel benefit B747/A380 31.3 26.4 43.6 54.8 62.2 67.0

High Fuel benefit B747/A381 35.4 29.9 49.3 62.0 70.3 75.7

kg saved per arrival For 2020s and not much equipage

Low Fuel benefit B737/A320 2.8 2.3 3.8 4.8 5.5 5.9

High Fuel benefit B737/A321 3.4 2.9 4.8 6.0 6.8 7.4

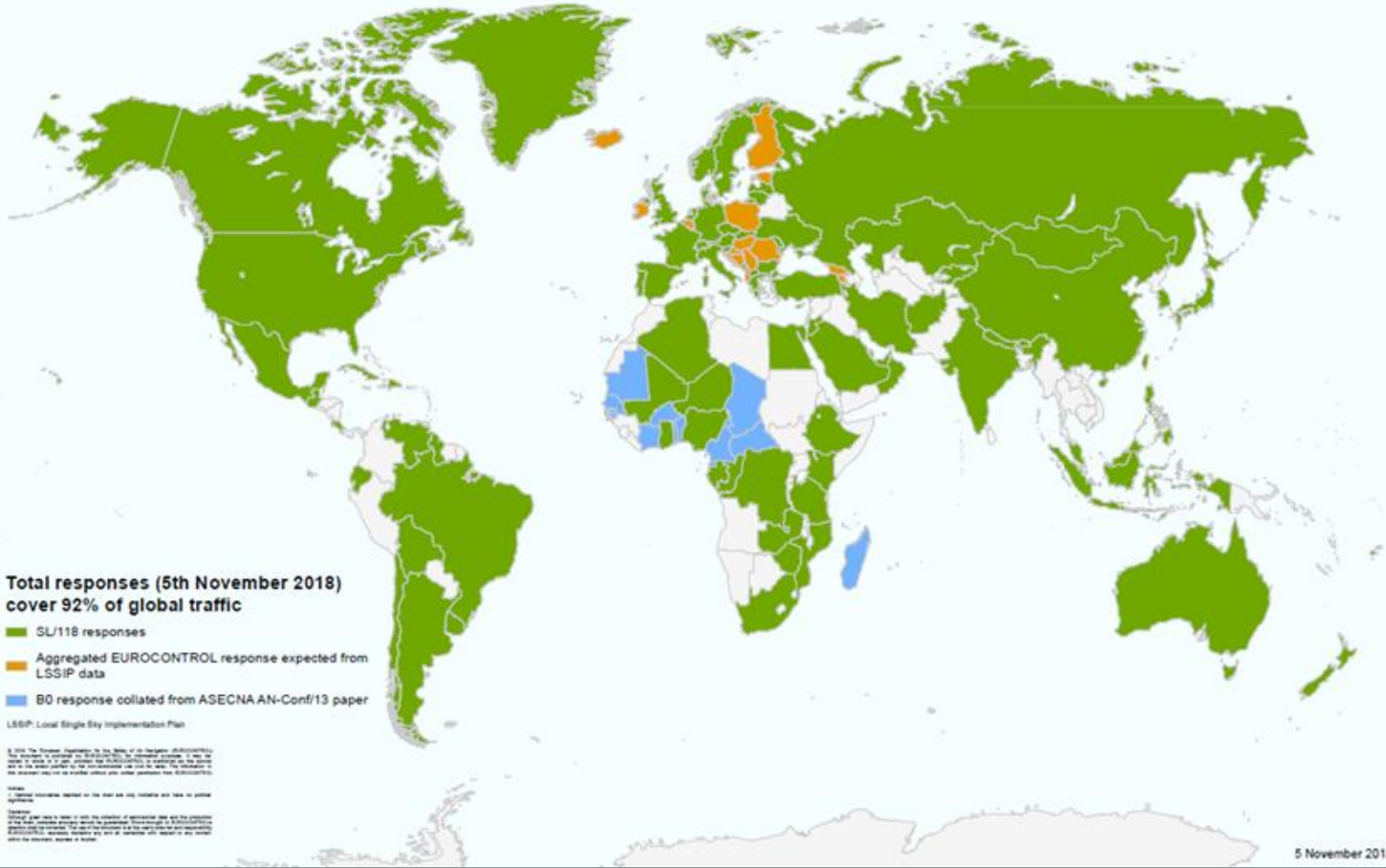
AC Class	Low kg/arr	High kg/arr	Low kg/dep	High kg/dep
RJ	2,2	4,8	7,1	16,4
SA	2,9	6,4	9,4	21,9
Small TA	4,8	10,5	15,4	35,7
Med TA	6,8	14,9	21,7	50,5
Large TA	10,7	23,4	34,2	79,4
Composite	6,829	3,6	7,8	11,5

Fuel Savings (kgs) per Flight from R Setting Enabled by Performance

Aircraft Class >>>	Savings (kgs)	Distance Savings (NM)
Range:		
RoT low	11-95	1-5
RoT high	40-187	17-27

AC Class	Ave Kg Saved per flight	Modified Fleet %
SA	21,0	74,0
Small TA	89,3	13,4

AC Class	Low Fuel	High Fuel	Low Fuel	High Fuel	Low Fuel	High Fuel	Low Fuel	High Fuel
RJ	900-1220	4030	1832	30,53	0,509	1832	31	0,51
SA	900-1220	5815	2643	44,05	0,734	2640	41,0	0,68
SA	1900	5357	2435	40,58	0,676	2460	41,0	0,68
SA	4000-5500	5060	2300	38,33	0,639	2460	41,0	0,68
Small WB-1 B57/67-A33/34	900-1220	8580	3900	65,00	1,083	4009	66,8	1,11
Small WB-1 B57/67-A33/34	1900	7883	3583	59,72	0,995	4009	66,8	1,11
Small WB-2 B57/67/87-A33/34	4000-5500	9995	4543	75,72	1,262	5642	94,0	1,57
Medium WB B777-A340/350	4000-5500	11865	5393	89,88	1,498	5642	94,0	1,57
Medium WB B777-A340/350	9000-14000	12960	5891	98,18	1,636	8887	148,1	2,47
Large WB 747/A380	4000-5500	17279	7854	130,90	2,182	8887	148,1	2,47
Large WB 747/A380	9000-14000	21824	9920	165,33	2,756	2986	49,8	0,829
Composite						2986	49,8	0,829

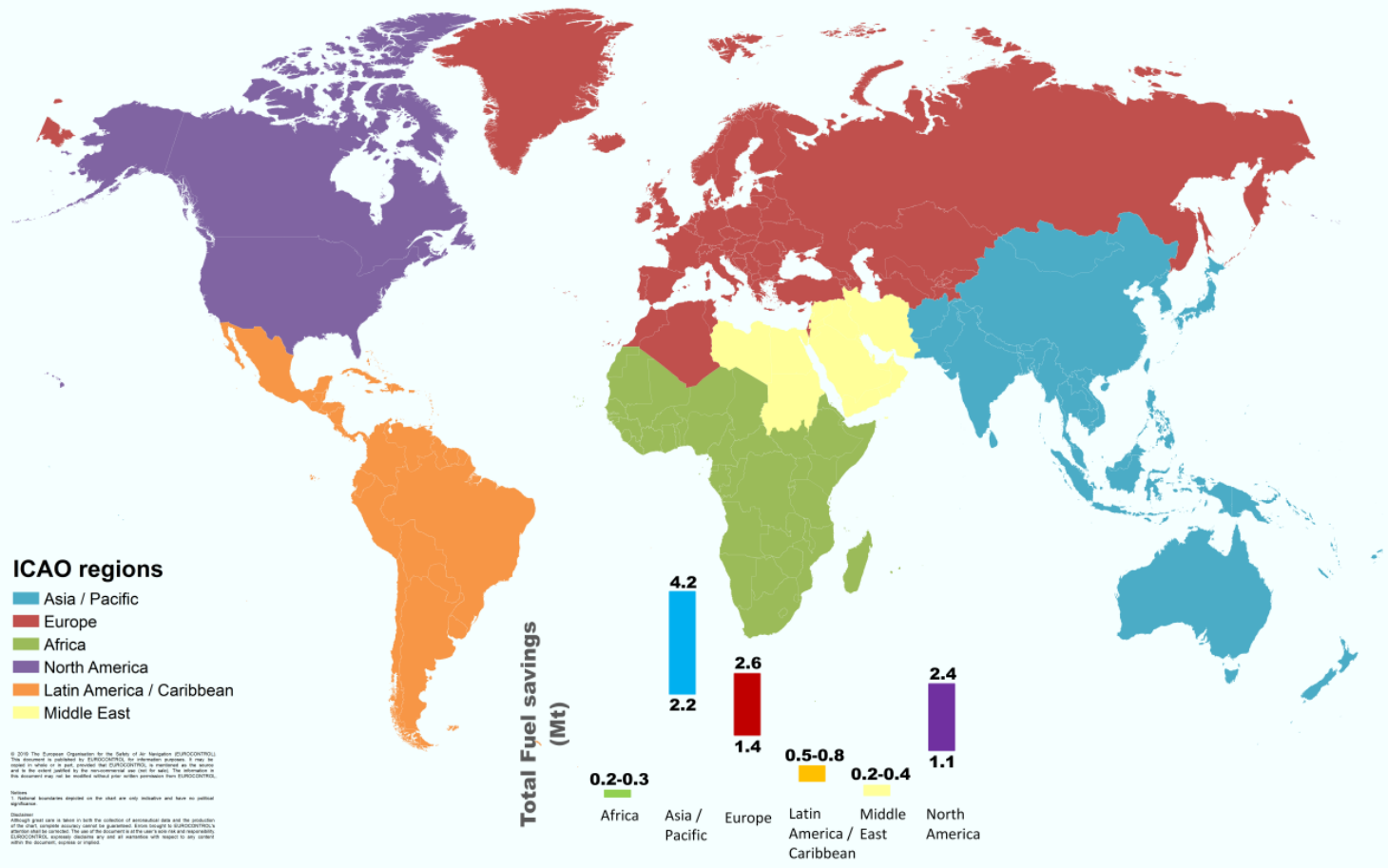


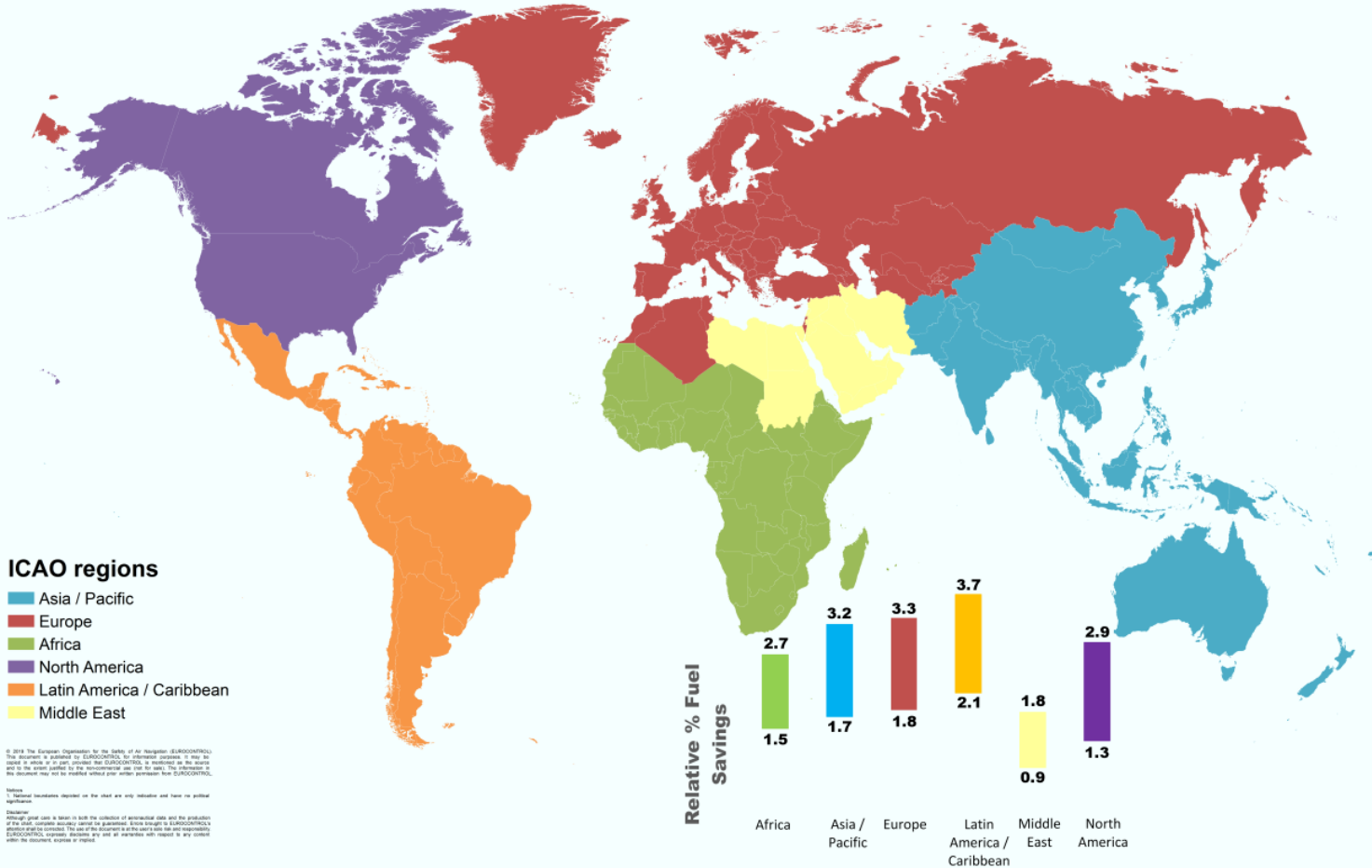


- Global annual fuel burn savings from ASBU Block 0/1 elements
- 5.4-10.7Mt fuel burn or 17.2-33.7Mt CO₂

ICAO Region	Fuel savings (Mt)	Fuel / CO ₂ savings (%)	CO ₂ savings (Mt)	Cost savings (\$billion)*	Cost savings (€billion)
Africa	0.2-0.3	1.5-2.7	0.5-1.0	0.1 – 0.2	0.1 – 0.2
Asia/Pacific	2.2-4.2	1.7-3.2	6.9-13.3	1.3 – 2.5	1.2 – 2.2
Europe	1.4-2.6	1.8-3.3	4.4-8.2	0.8 – 1.5	0.7 – 1.4
Latin America/Caribbean	0.5-0.8	2.1-3.7	1.5-2.6	0.3 – 0.5	0.2 – 0.4
Middle East	0.2-0.4	0.9-1.8	0.7-1.4	0.1 – 0.3	0.1 – 0.2
North America	1.1-2.4	1.3-2.9	3.5-7.6	0.7 – 1.5	0.6 – 1.3
Global	5.4-10.7	1.6-3.0	17.2-33.7	3.3 – 6.4	2.9 – 5.6

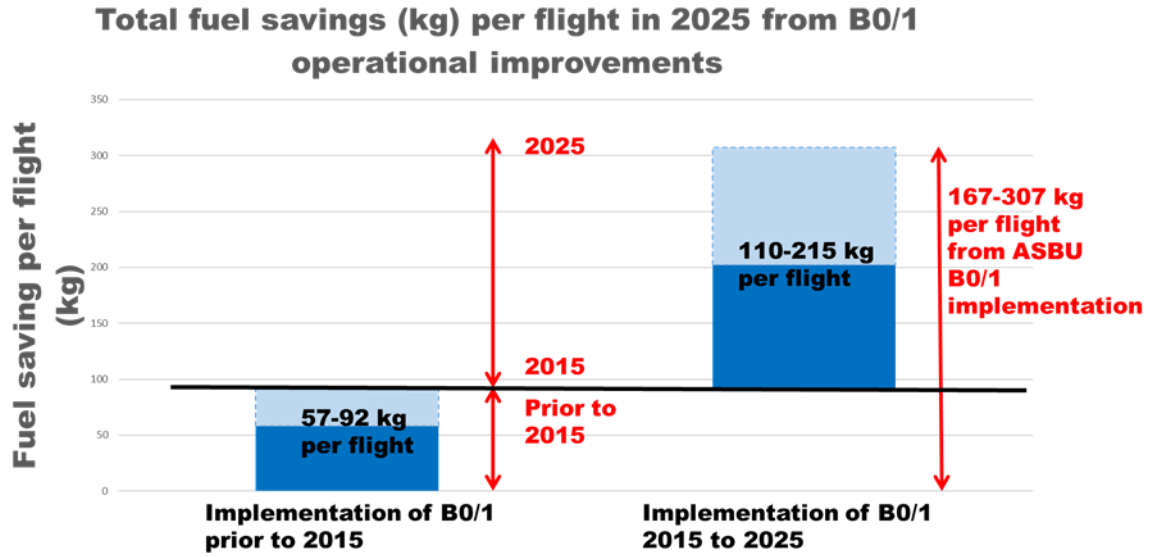
*IATA fuel price and exchange rate 24/01/19







- ASBU B0 / B1 modules implemented prior to 2015: 57-92kg fuel per flight (180-289 kg CO₂)
- ASBU fuel savings are estimated to provide a total annual global fuel savings in 2025 of between 167-307kg per flight (528-970kg CO₂)





- The total global annual savings by 2025, from the current and planned implementation of B0 / B1 operational improvements:

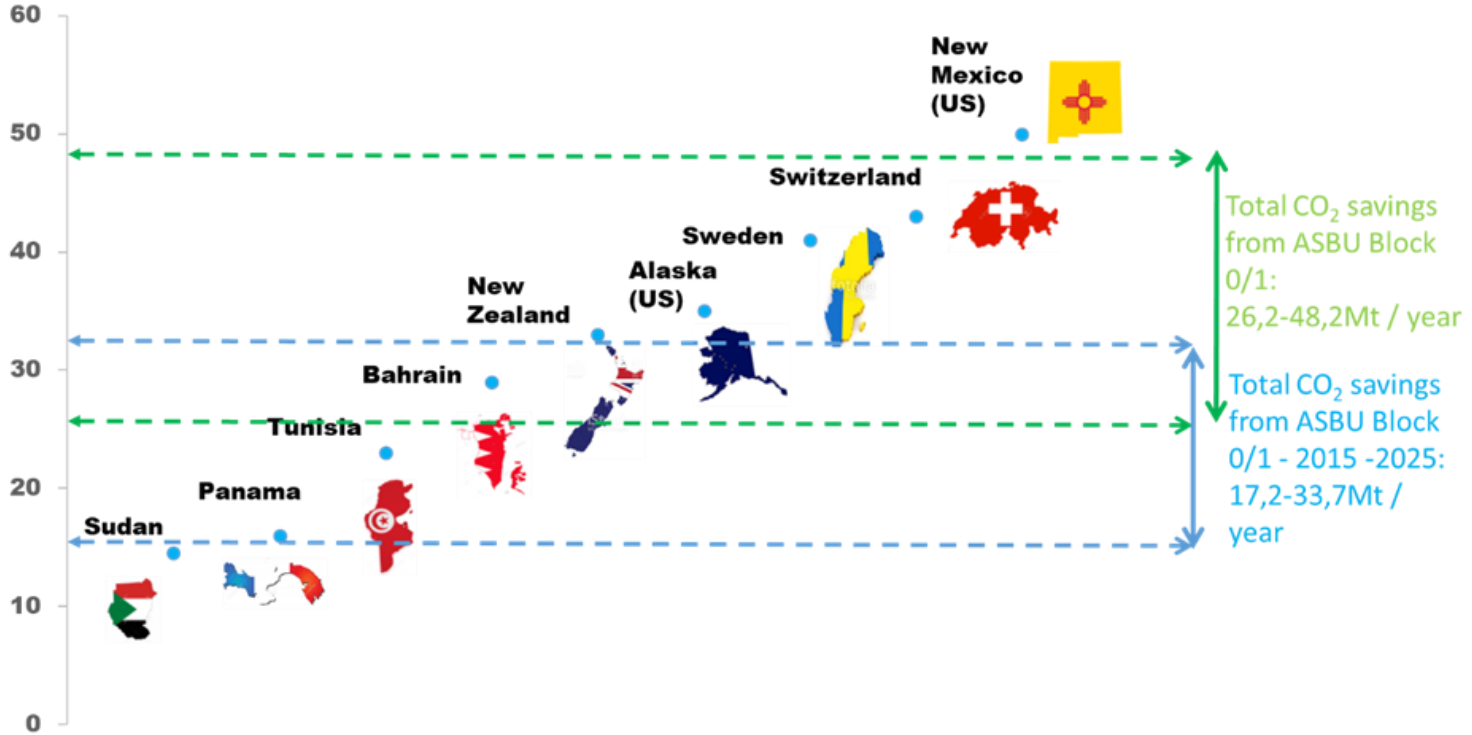
ICAO Region	Fuel savings (Mt)	Fuel / CO ₂ savings (%)	CO ₂ savings (Mt)	Cost savings (\$billion)*	Cost savings (€billion)*
Africa	0.2-0.4	2.1-3.5	0.8-1.2	0.1 – 0.2	0.1 – 0.2
Asia/Pacific	3.0-5.9	2.3-4.5	9.5-18.5	1.8 – 3.5	1.6 – 3.1
Europe	1.9-3.4	2.5-4.2	6.2-10.6	1.2 – 2.0	1.0 – 1.8
Latin America/Caribbean	0.6-1.1	2.9-4.9	2.0-3.4	0.4 – 0.7	0.3 – 0.6
Middle East	0.3-0.5	1.1-2.2	0.8-1.7	0.2 – 0.3	0.1 – 0.3
North America	2.2-4.1	2.6-4.9	7.0-13.1	1.3 – 2.5	1.2 – 2.2
Global	8.3-15.2	2.4-4.3	26.2-48.2	5.0 – 9.2	4.4 – 8.1

*IATA fuel price and exchange rate 24/01/19



CO₂ emissions MtCO₂e

CO₂ emissions MtCO₂e

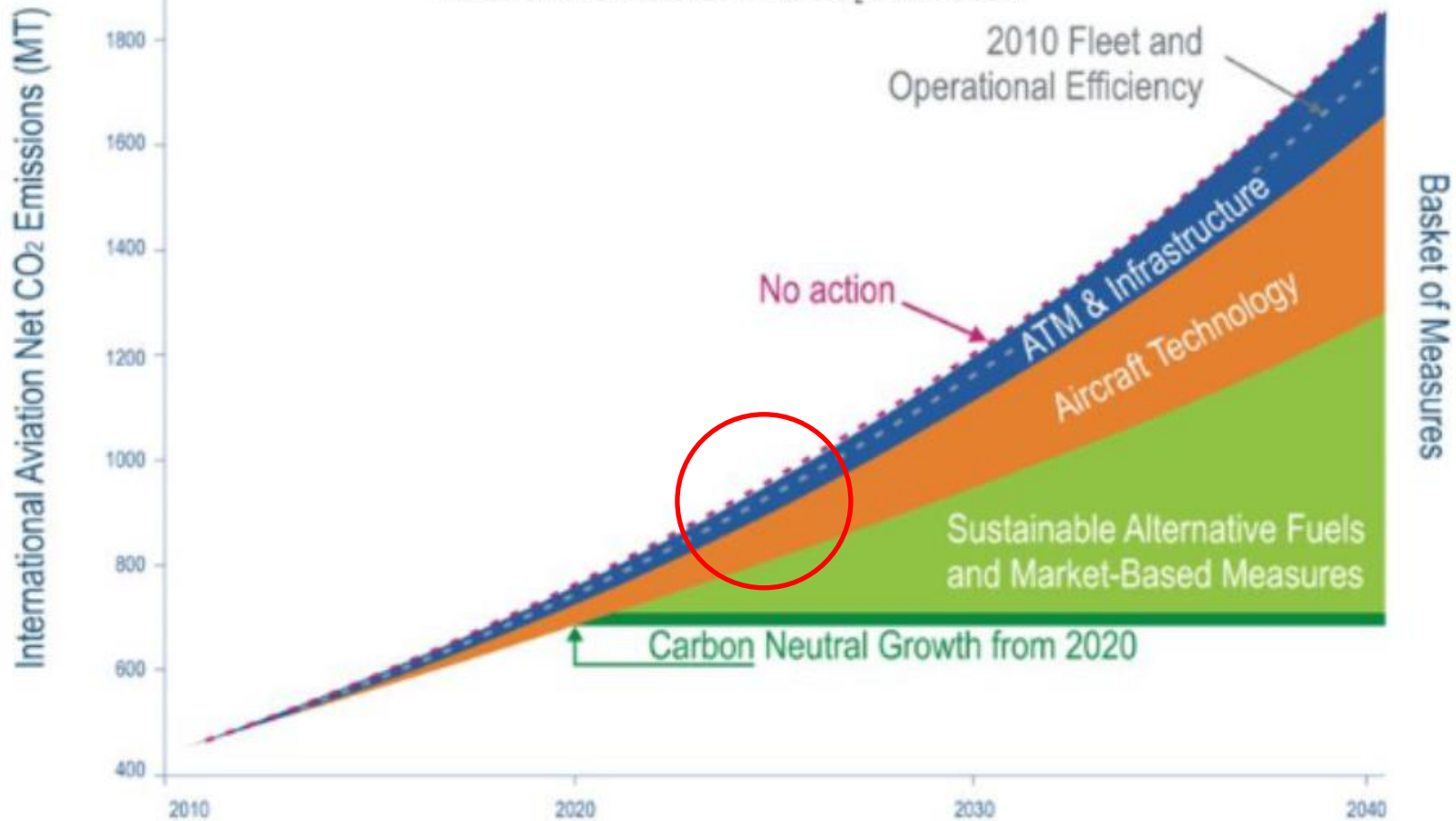


Contribution of Measures for Reducing International Aviation Net CO₂ Emissions

International Aviation Net CO₂ Emissions (MT)



Contribution of Measures for Reducing International Aviation Net CO₂ Emissions





**Operations can provide
26.2 – 48.2mT CO₂ savings
per year in 2025.....**

Is this enough?





ICAO

ENVIRONMENT



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