











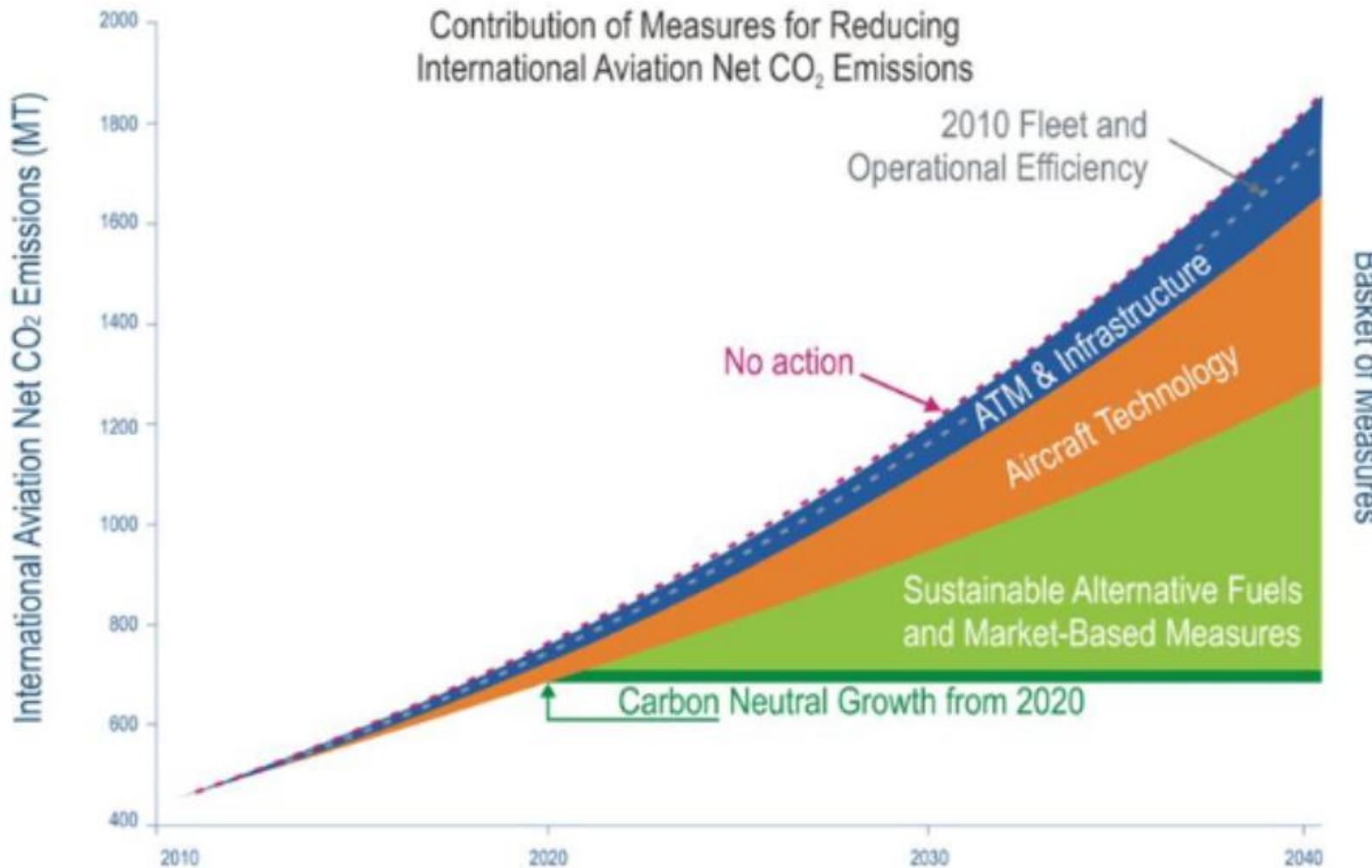




**500,000
in 1995**



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







Green Airports Conference

ASBU B0/1 environmental analysis



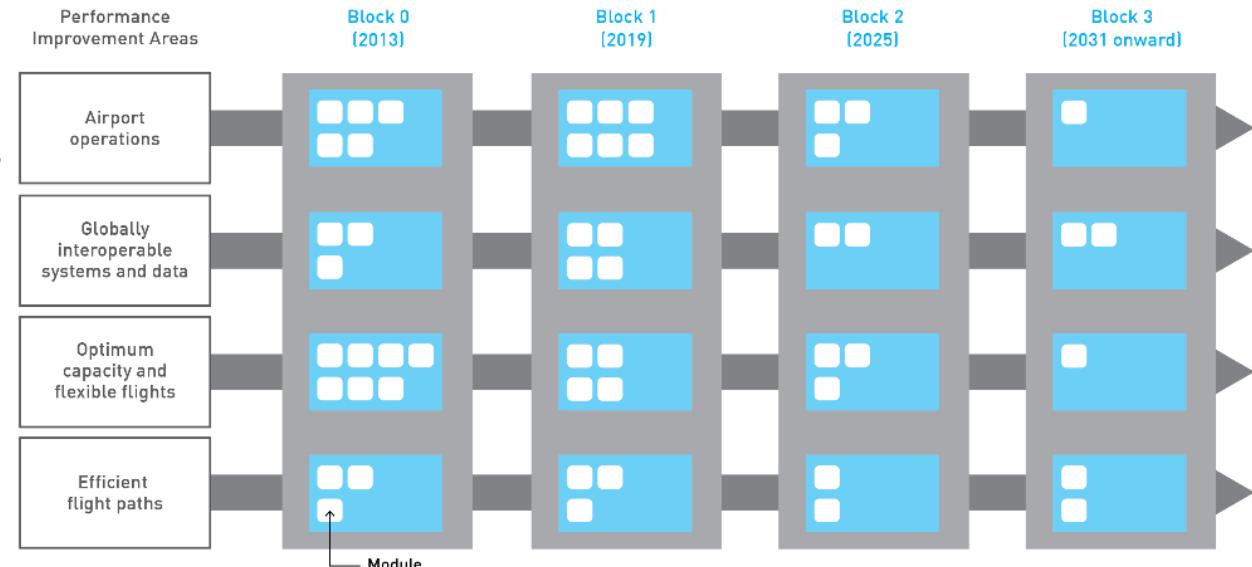
David Brain

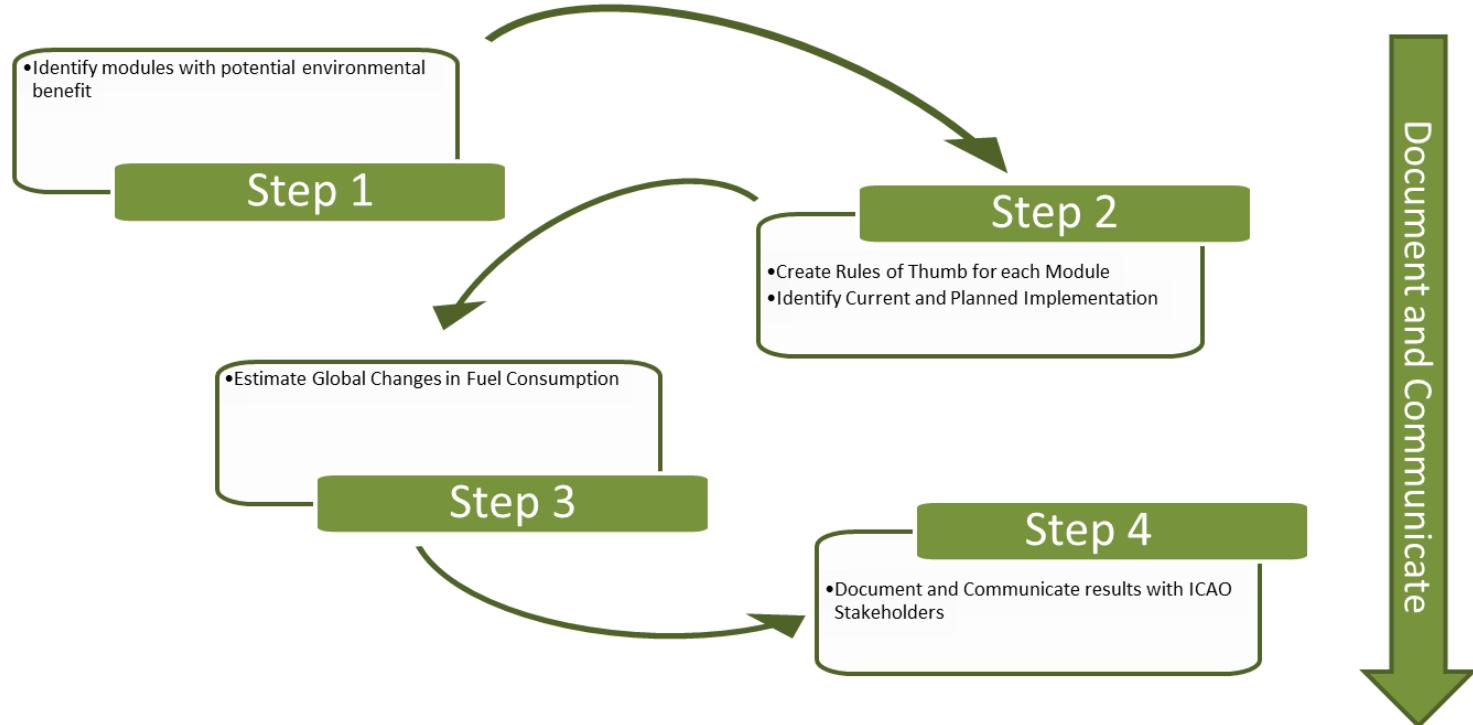
Lima, Peru 8-9 May, 2019

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 |
| Composite | 17,2 | 12,0 | |
| Americas India/Southwest Asia | 4 4.0% | | |
| North America | 110 1.2% | | |
| Europe India/Southwest Asia | 108 2.2% | | |
| Europe Other Asia/Pacific | 91 1.5% | 103 60% 82 50% 4,174 50% 2,387 288 2 1038 64,348 73,122 | |
| Europe Middle East | 143 1.4% | 142 60% 82 50% 4,060 50% 1,813 183 0 0 0 0 0 0 | |
| Europe Middle East | 275 1.8% | 317 60% 83 50% 2,599 50% 260 5 0 0 0 0 0 | |
| North America South America | 89 2.0% | 105 60% 83 50% 2,599 50% 260 5 0 0 0 0 0 | |
| North America Central America and Caribbean | 53 1.4% | 63 60% 80 50% 357 1,000 10% 1,876 193 2 696 12,990 14,307 | |
| Middle East Other Asia/Pacific | 53 2.6% | 63 60% 147 50% 1,396 20% 279 7 0 0 0 0 0 | |
| Middle East India/Southwest Asia | 204 2.2% | 245 60% 147 50% 38 3,716 70% 2,601 317 2 1140 43,251 49,149 | |
| Middle East Other Asia/Pacific | 370 2.0% | 370 31% 20% 63 1,731 50% 558 0 0 0 0 0 0 | |
| Intra Asia/Pacific | 1132 2.1% | 1338 0 0 1,120 0 0 0 0 0 0 0 0 0 | |
| Extra Europe | 4370 1.4% | 4876 0 0 631 0 0 0 0 0 0 0 0 | |
| Latin America | 687 0.7% | 687 0 0 625 0 0 0 0 0 0 0 0 | |
| Intra Middle East | 284 1.7% | 328 0 0 500 0 0 0 0 0 0 0 0 | |
| Intra North America | 403 0.7% | 426 0 0 673 0 0 0 0 0 0 0 0 | |
| Other Americas Routes | 371 0.7% | 400 0 0 1,275 0 0 0 0 0 0 0 0 | |
| Total INTERNATIONAL | 9743 1.6% 11954 | 1068 | 819,332 920,846 |
| Dom Africa | 496 1.6% | 555 0 0 300 0 0 0 0 0 0 0 0 | |
| Europe Mongolia | 2269 0.9% | 2779 0 0 946 0 0 0 0 0 0 0 0 | |
| Europe Russia | 3022 0.9% | 3255 60% 1,953 31% 5 16 2 1 4 7,470 8,498 | |
| Latin America | 1861 1.7% | 2122 0 0 385 0 0 0 0 0 0 0 0 | |
| Middle East | 263 1.3% | 293 0 0 254 0 0 0 0 0 0 0 0 | |
| North America Polar | 5135 0.7% | 5793 96% 9,225 0.25% 1 0 2 1 6,694 7,288 | |
| Japan | 655 0.5% | 683 0 0 372 0 0 0 0 0 0 0 0 | |
| Other Asia/Pacific | 206 1.6% | 2343 0 0 364 0 0 0 0 0 0 0 0 | |
| Intra Southwest Asia | 659 0.5% | 800 0 0 374 0 0 0 0 0 0 0 0 | |
| Total Domestic | 20402 1.2% 22478 | 11178 | 13,876 15,768 |
| Global International & Domestic | 30145 1.7% 33322 | 17166 704 | 824,306 836,714 |

| Now from the AIAA and Mitre papers and more realism | |
|---|-------------------------------|
| Baseline arrivals/hr | 24 |
| Fig 3 Assume 80% ADS-B OUT and 20% ADS-B in FIM-5 | |
| Runway Arrival Rate | 22 24 26 28 30 32 |
| Assume 80/20 Equipage | 23 25 28 31 34 37 |
| Additional arrivals | 1 2 3 4 5 |
| Time saving - min/airplane | 0.12 0.10 0.16 0.21 0.24 0.25 |
| seconds saved per A/C | 7.1 6.0 9.9 12.4 14.1 15.2 |
| Pounds saved per arrival | |
| 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 | |
| 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 |
| Low Fuel kg/arr | |
| Low Fuel | 2,2 4,8 7,1 16,4 |
| High Fuel | 2,9 6,4 9,4 21,9 |
| Low kg/arr | |
| Small TA | 1,11 |
| Med TA | 1,57 |
| Large TA | 2,47 |
| Composite | 0.829 |
| Kg saved per flight | |
| For 2020s and not much equipage | |
| Low Fuel | 2,2 4,8 7,1 16,4 |
| High Fuel | 2,9 6,4 9,4 21,9 |
| Low kg/arr | |
| RJ | 0.51 |
| SA | 0.68 |
| Small TA | 1,11 |
| Med TA | 1,57 |
| Large TA | 2,47 |
| Composite | 0.829 |
| Low 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 |
| High kg/dep | |
| Composite | 3,6 7,8 11,5 26,7 |

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

| Range: | Aircraft Class >> | Savings (kgs) | Distance Savings (NM) |
|----------|-------------------|-----------------|-----------------------|
| | RoT low | 11-95 | 1-5 |
| RoT high | | 40-187 | 17-27 |
| | | 2986 49,8 0,829 | 100% |

| Base | Low | High |
|------|-----|------|
| 150 | 120 | 210 |
| 120 | 90 | 150 |
| 150 | 120 | 210 |
| 375 | 3 | |

Assumption
Fuel efficiency gain
Base Fuel burn kg/min



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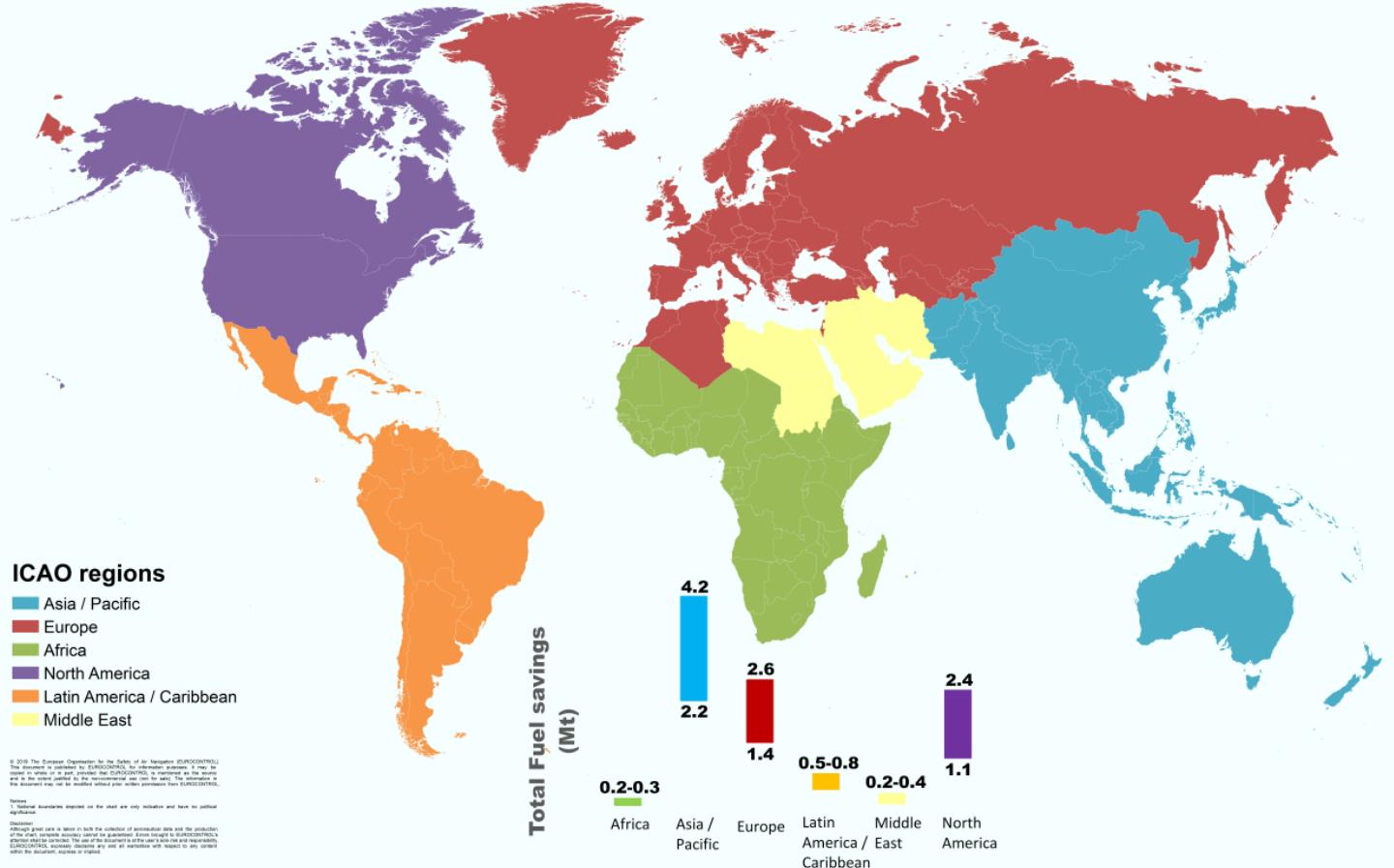
NOTES:
• Aggregated responses reported on the chart are only indicative and have no precise significance.
• Countries with no shaded area in this chart do not have an implementation plan in place. In general, the EUROCONTROL is awaiting the finalization of the LS6IP for these countries. The implementation of the LS6IP will be reflected in the next version of the chart.
• The chart does not include the responses of countries which have not yet submitted their LS6IPs to the ICAO. These countries are also not included in the 92% coverage figure.



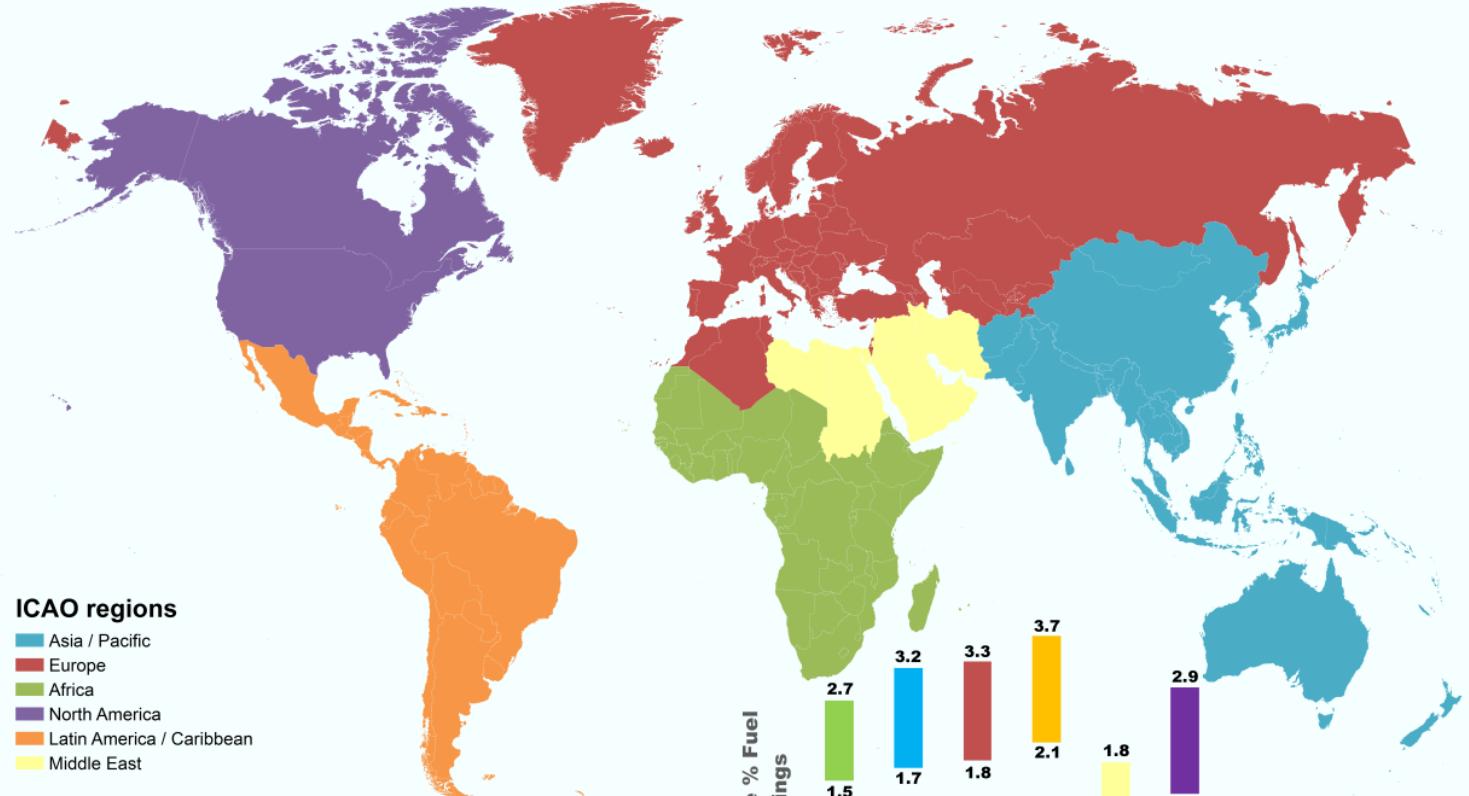
- Global annual fuel burn savings from ASBU Block 0/1 elements
- 5.4-10.7Mt fuel burn or 17.2-33.7Mt CO₂

| 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



Results



ICAO regions

- Asia / Pacific
- Europe
- Africa
- North America
- Latin America / Caribbean
- Middle East

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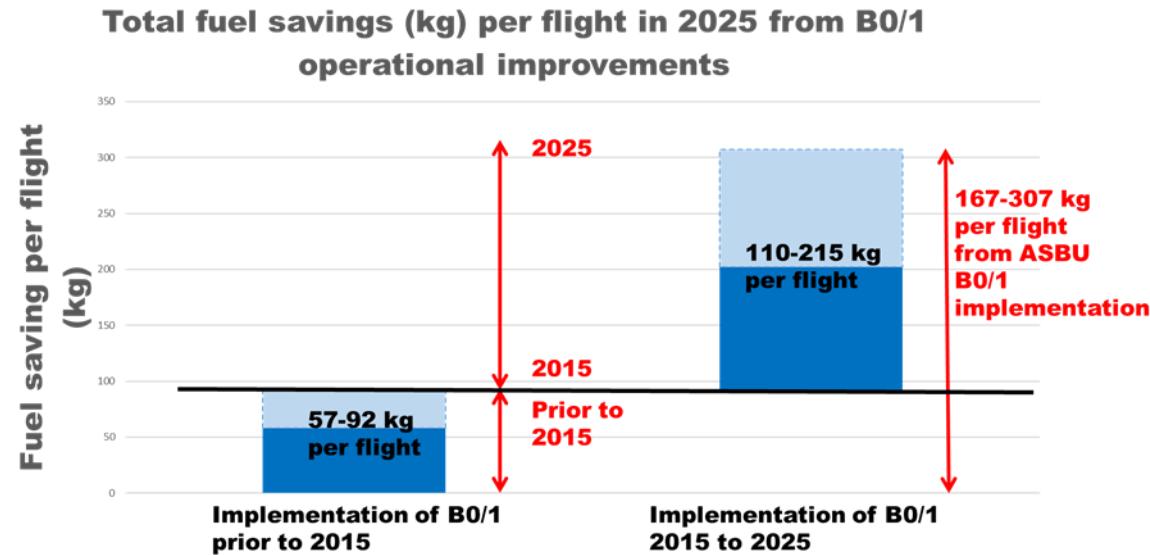
Notes:
1. Regional boundaries depicted on the chart are only indicative and have no political significance.

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Relative % Fuel Savings

| Region | Relative % Fuel Savings |
|---------------------------|-------------------------|
| Africa | 2.7 |
| Asia / Pacific | 3.2 |
| Europe | 3.3 |
| Latin America / Caribbean | 3.7 |
| Middle East | 1.8 |
| North America | 2.9 |

- 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)



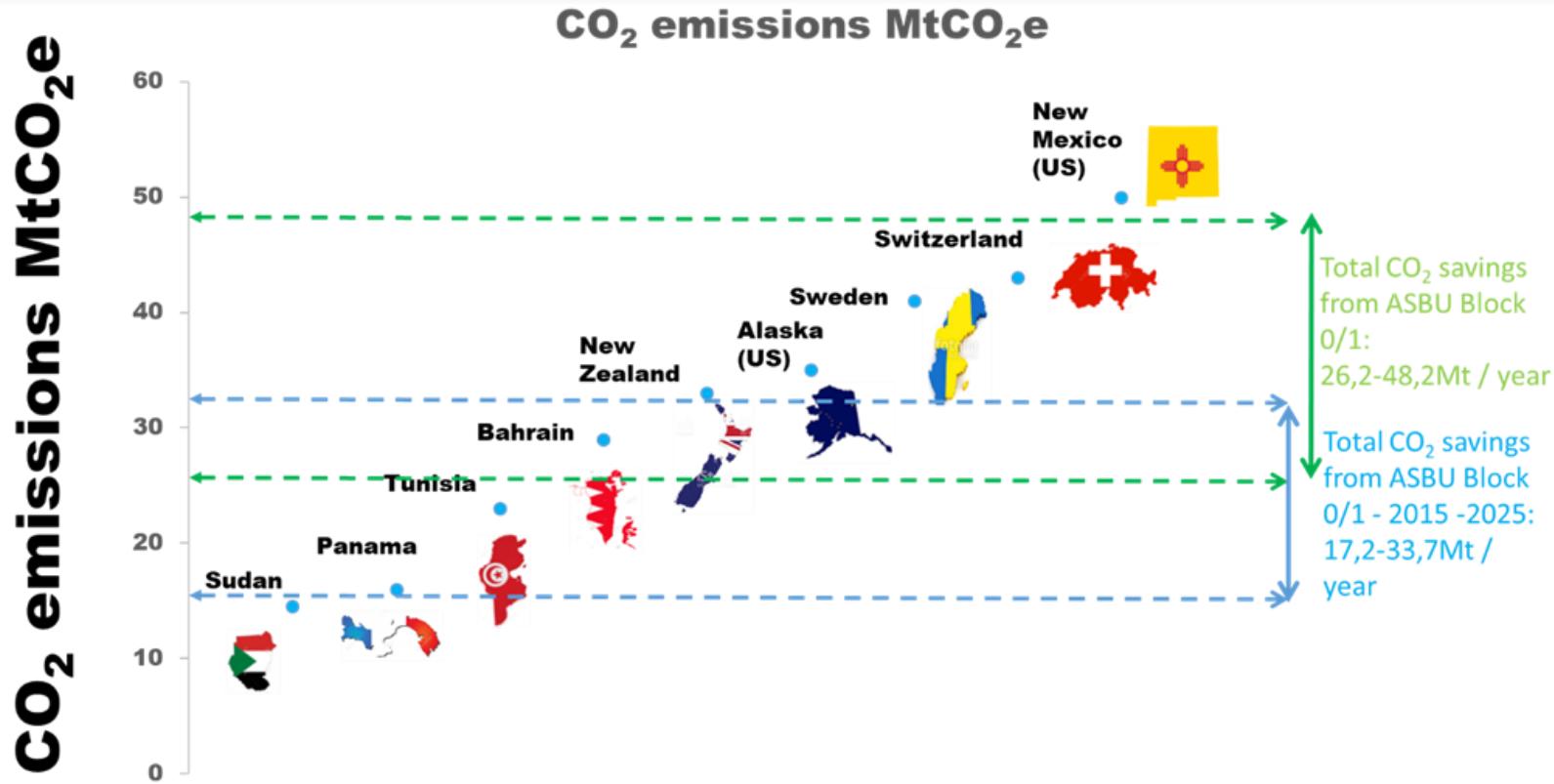


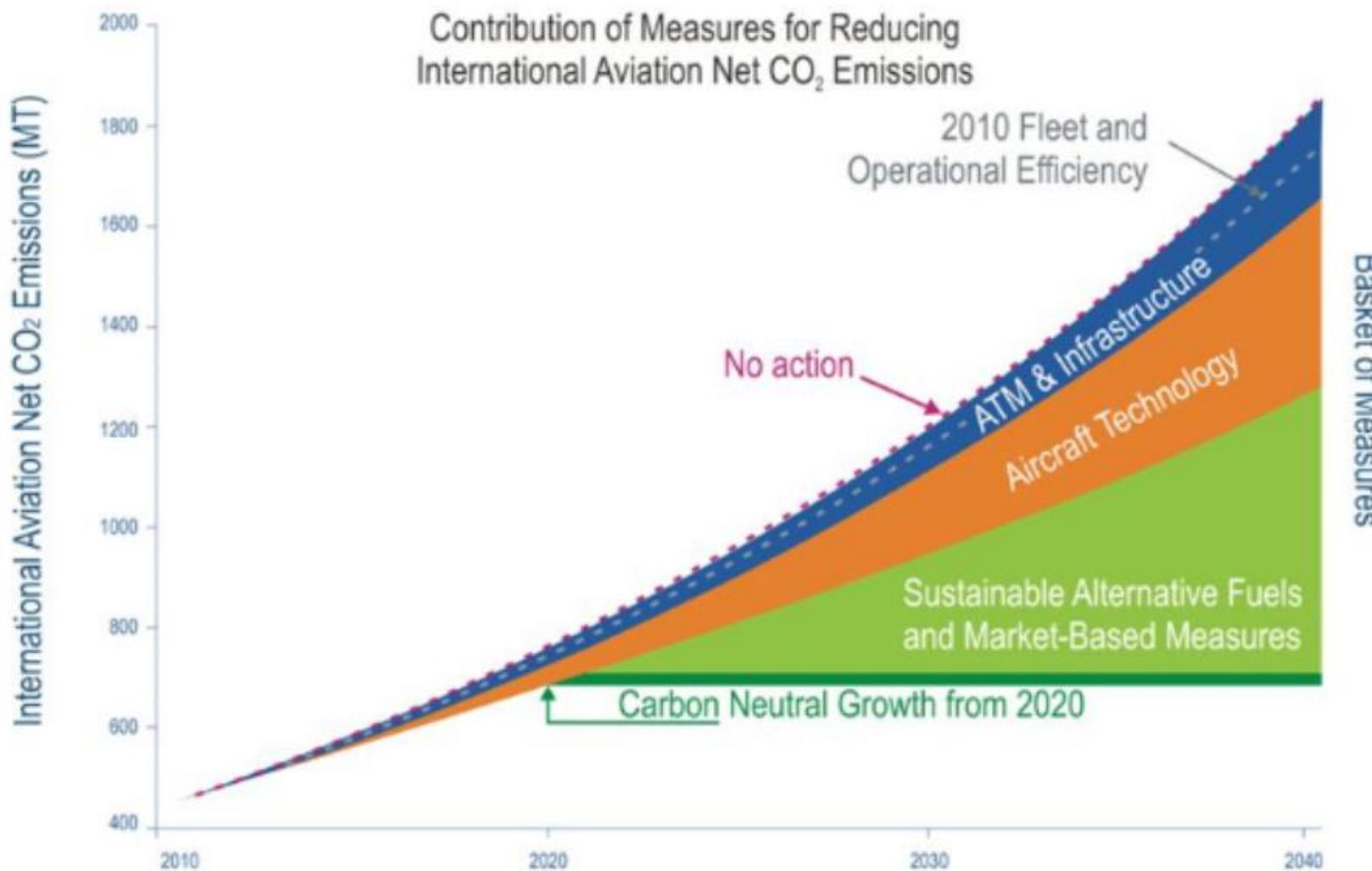
- The total global annual savings by 2025, from the current and planned implementation of B0 / B1 operational improvements:

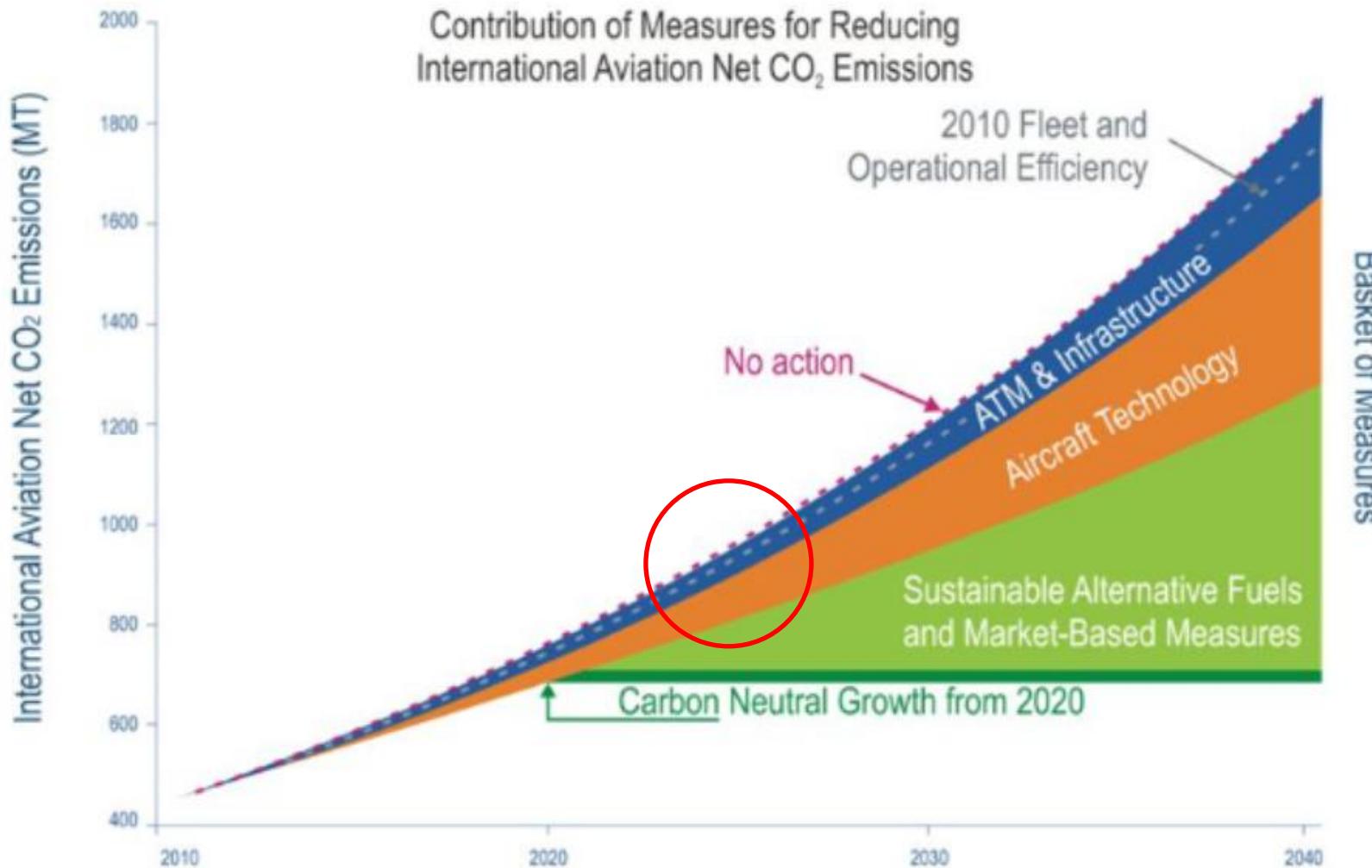
| ICAO Region | Fuel savings (Mt) | Fuel / CO ₂ savings (%) | CO ₂ savings (Mt) | Cost savings (\$billion)* | Cost savings (€billion)* |
|-------------------------|----------------------|---------------------------------------|------------------------------------|------------------------------|-----------------------------|
| 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

Results









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

Is this enough?



CONFEDERACION





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and Caribbean
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(SAM) Office
Lima

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Headquarters
Montréal

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Central African
(WACAF) Office
Dakar

European and
North Atlantic
(EUR/NAT) Office
Paris

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(ESAF) Office
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Asia and Pacific
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Bangkok



THANK YOU