ENVIRONMENTAL BENEFITS ASSESSMENT OF AVIATION SYSTEM BLOCK UPGRADES

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Forecasted air traffic growth, if not properly supported by the necessary Air Traffic Management (ATM) infrastructure, can lead to significant capacity challenges, increased safety risk, and adverse environmental impacts. In order to address these challenges, ICAO collaborated with States, industry, and international organizations to develop the Aviation System Block Upgrades (ASBU) strategy, which was adopted at the Twelfth Air Navigation Conference in 2012. The ASBU framework was developed to reflect and build consensus around the series of technologies, procedures, and operational concepts needed to meet future capacity and ATM challenges. This strategy, as laid out in the GANP (Global Air Navigation Plan), aims to harmonize regional air traffic management improvement programs by laying out a roadmap for the implementation of a series of essential ATM operational concepts which ensure that safety is maintained while future capacity, efficiency and environmental benefits are maximized.

During the Committee on Aviation Environmental Protection's 9th Meeting (CAEP/9) in February 2013, CAEP agreed to undertake an environmental benefits assessment of the ASBU Block 0 modules. Block 0 is the first of four blocks scheduled to be implemented between 2013 and 2031 (see **figure 1**). Many of the ASBU modules have potential to reduce the adverse environmental impacts of aviation, and quantifying these benefits can further support the facilitation and adoption of ASBU globally.

CAEP developed an approach to conduct the ASBU analysis that was in line with the environmental assessment approach outlined in the recently published ICAO Doc 10031, *Guidance on Environmental Assessment of Proposed Air Traffic Management Operational Changes*. Doc 10031 was developed by CAEP to provide "States, airport operators, Air Navigation Service Providers (ANSPs) and other stakeholders with environmental assessment guidance to support sound and informed decision making when analysing proposed ATM operational changes". **Figure 2** presents the ASBU analysis approach.

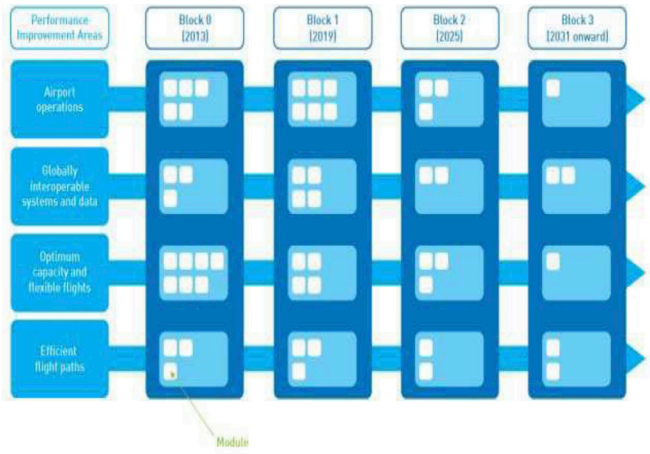

Figure 1. ASBU Timescale

The first step involved the screening of each ASBU module within Block 0 for potential environmental benefits. For Block 0, CAEP identified that the operational improvements in 15 of the 18 Block 0 modules had the potential to provide quantifiable environmental benefits. For the Block 0 analysis, CAEP created 23 Rules of Thumb for 13 of the Block 0 modules (see **table 1**).

To create a Rule of Thumb, the operational improvements identified in the Block 0 modules were analysed to identify how the associated data and information from pre- and post- implementation analyses would best capture the

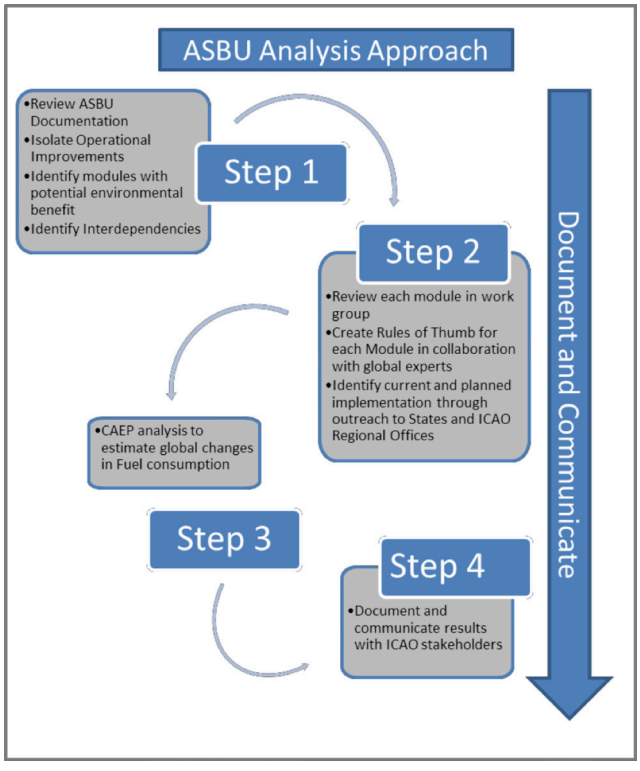

Figure 2. ASBU Analysis Approach

B0 Module	Environmental benefits in OI (Y/N)	RoT defined
APTA	Y	■ ■
ACDM	Y	■ ■
AMET	Y	■
ASUR	Y	■
CCO	Y	■ ■
CDO	Y	■ ■
FRTO	Y	■ ■
NOPS	Y	■ ■ ■
OPFL	Y	■
RSEQ	Y	■
SURF	Y	■ ■ ■
TBO	Y	■
WAKE	Y	■ ■
DATM	Y	-
FICE	Y	-
ACAS	N	-
ASEP	N	-
SNET	N	-
Total rules of thumb:		23

Table 1. Block 0 modules, potential environmental benefits and rules of thumb

potential environmental benefits, taking into account any interdependencies between the different modules with the objective to follow a conservative approach to avoid any double counting of benefits. Information was received from many States, regional implementation projects, e.g. SESAR, and a host of stakeholder groups and organisations in order to develop as realistic a rule of thumb as possible. Each rule of thumb consisted of a high-level formula or procedure for calculating a range of the fuel savings for a particular operational improvement, along with assumptions and applicability. Some Block 0 modules had more than one Rule of Thumb in order to capture multiple operational improvements brought about by the module and/or impacts to different phases of flight. One example is detailed below:

APTA-Approach procedures including vertical guidance; WAKE-Wake vortex; RSEQ-AMAN / DMAN; SURF-A-SMGCS, ASDE-X; ACDM-Airport CDM; FICE-Increased efficiency through ground - ground integration; DAIM-Digital AIM; AMET- Meteorological information supporting enhanced operational efficiency; FRTO-En route Flexible Use of Airspace and Flexible routes; NOPS-Air Traffic Flow Management; ASUR-ADS-B satellite based and ground based surveillance; ASEP-Air Traffic Situational awareness; OPFL-In-Trail procedures (ADS-B); ACAS-ACAS improvements; SNET-Ground based safety nets; CDO-Continuous Descent Operations, PBN STARs; TBO-Data link en-route; CCO-Continuous Climb Operations

Current and planned Block 0 implementation levels were identified through responses from States to ICAO State Letter 56 distributed on 10 September 2014. Responses were received from more than 60 States in addition to aggregated regional implementation data from EUROCONTROL and ICAO regional offices. In total, responses covered States representing more than 92% of global traffic (see **figure 3**). To identify the total fuel and CO_2 savings following the implementation of Block 0, the rule of thumb fuel savings (based upon current (2013) and future planned (2018) implementation levels), were applied to 2013 and 2018 traffic levels[2]. This allowed an estimation of the potential environmental benefits that would be achieved from B0 module implementation during the Block 0 timeframe and of the total Block 0 concept.

Based upon States' planned implementation of the ASBU Block 0 modules between 2013 and 2018, fuel burn savings are estimated to range between 49-102kg per flight globally. This corresponds to 2.2-4.6Mt in global annual fuel savings in 2018 resulting from planned ASBU Block 0 implementations since 2013. In addition, traffic growth will also contribute by increasing the pool of potential recipients of the environmental benefits from modules implemented before the end of 2013. Overall, an increase in total fuel savings of 0.62-1.31% in 2018 relative to the 2013 fuel savings is estimated to be attributed to Block 0 implementation.

Module	Operational improvement	Phase of flight	Rule of thumb	Notes	Implementation 2013	Implementation 2018
B0-WAKE	Optimised Wake Turbulence-RECAT	Ground	21-32 seconds reduced taxi time (range)	Benefit to be available during Peak hours Peak hours concern 17% departure movements (based upon SESAR / NextGen assumptions)	See response to ICAO SL/56	See response to ICAO SL/56

Table 2. Rule of thumb example

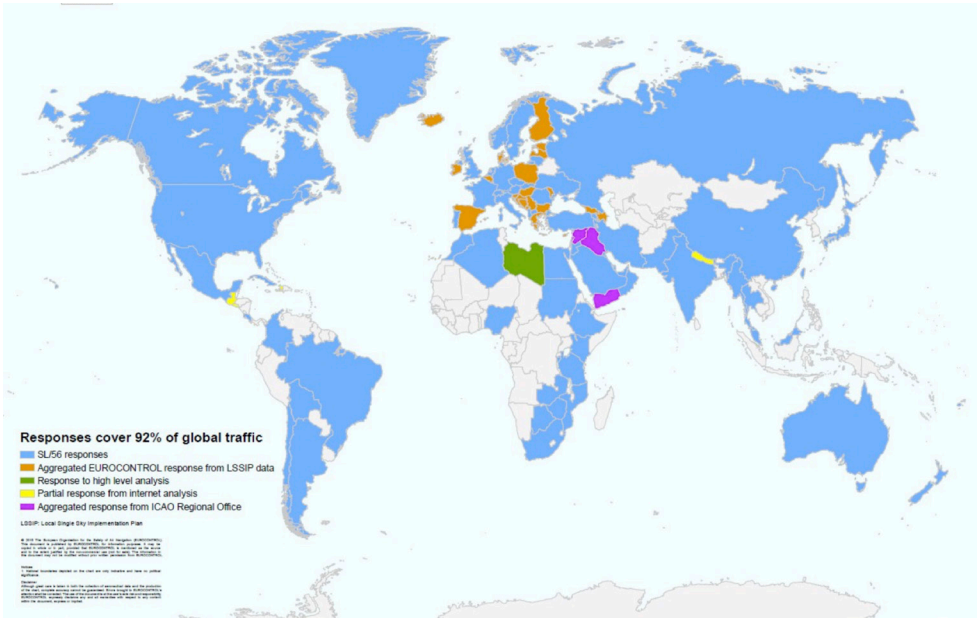

Figure 3. Coverage of responses to ICAO SL/56

The implementation of some of the ASBU Block 0 modules will lead to better predictability within the global air traffic system as well as overall efficiency improvements. Therefore, the amount of fuel loaded onto aircraft can be reduced by the amount of the estimated benefit, which, as explained in ICAO Doc 10013 - *Operational Opportunities to Minimize Fuel Use and Reduce Emissions*, can result in an additional 2.5-4.5% savings relative to the reduction described above due to the reduced weight of the aircraft. In this analysis, the reduction in fuel load was estimated to provide up to an additional 5.4kg of fuel burn savings per flight, resulting in a total average fuel savings of 55-107kg per flight globally. Overall, therefore, a total annual fuel saving of 2.5-4.9Mt in 2018 can be attributed to ASBU Block 0 implementation since 2013, with a corresponding increase in total fuel savings of 0.69-1.38% in 2018 relative to the 2013 fuel savings. This corresponds to a global CO_2 saving of between 7.8-15.4Mt. In fuel costs, these figures correspond to yearly fuel savings of up to €2.1 billion or $2.3 billion. **Figure 4** places these results in the context of the annual CO_2 emissions of several States.

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It should also be noted that although the ASBU framework was first developed in 2012, many of the operational improvements contained within the ASBU Block 0 modules are existing concepts that already have provided substantial environmental benefits prior to 2013. The fuel saving benefits from Block 0 operational improvement implementations prior to 2013 are estimated to range between 95-152kg per flight. This is equivalent to between 3.6-5.7Mt fuel savings (11-18Mt CO_2) in 2013.

Therefore, in total, the fuel saving benefits that could be attributed to the operational improvements defined in the Block 0 modules that will be implemented by the end of 2018 are equivalent to between 150-259kg of fuel per global aircraft movement in 2018. Additional savings can also be obtained from traffic growth between 2013 and 2018, which increased the pool of potential recipients of the environmental benefits from modules implemented before the end of 2013. The total savings are therefore equivalent to 6.8-11.8Mt fuel savings (21-37Mt CO_2 savings) or 2.1-3.6% of total global fuel burn in 2018, taking into account the benefits from both module implementation and the increased traffic between 2013 and 2018. These results are summarised in **Figure 5**.

ICAO Region	Total estimated fuel burn savings (Mt)	Total estimated fuel burn savings (% of total fuel burn 2018)
Asia / Pacific	0.46 to 1.10	0.36 to 0.93
North America	**0.71 to 1.32**	0.80 to 1.56
Europe	0.61 to 1.23	0.68 to 1.45
Africa	0.15 to 0.24	0.95 to 1.60
Middle East	0.26 to 0.44	1.15 to 2.04
Latin America/ Caribbean	0.37 to 0.61	**1.45 to 2.47**

Table 3. Total fuel savings per ICAO region and relative % fuel savings compared to 2018 fuel burn per ICAO region

Table 3 displays the range of estimated Block 0 fuel savings (from 2013-2018 implementation) per ICAO region, and the percentage estimated fuel savings per ICAO region relative to 2018 regional fuel burn (also detailed in **Figure 6**).

In conclusion, it can be seen that the estimated total fuel savings are higher in those regions with higher traffic movements as

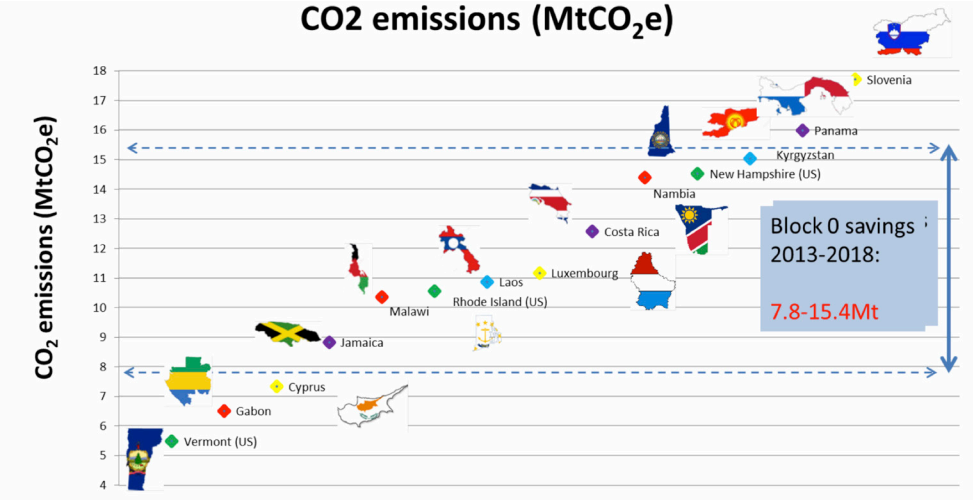

Figure 4. CO_2 savings from B0 implementation compared to Country and US State emissions[3]

such regions usually have an enhanced need to mitigate ATM inefficiencies and, due to the higher traffic levels, have more potential to benefit from such efficiency enhancing measures, e.g. Europe and North America. However when comparing the regional percentage fuel burn savings relative to 2018 regional fuel burn, it can be seen that the relative savings are much similar between regions, in fact, it appears that regions with lower total fuel burn may be reaping the benefits of the operational improvements detailed in the ASBU framework, e.g. Latin America, Middle East and Africa. This may be a clear demonstration of how the ASBU framework is supporting the ICAO 'No Country Left Behind' initiative, where the main goal is to ensure globally harmonized implementation so that all States have access to the significant socio-economic benefits of safe and reliable air transport.

In addition to the overall assessment, CAEP analyzed the module-level benefits across all ICAO regions. Of the studied Block 0 modules, four modules (six operational improvements) are estimated to provide up to 85% of the expected fuel savings due to planned worldwide implementation between 2013 and 2018. These modules are: B0-ASUR B0-CCO B0-CDO and B0-ACDM. The operational improvements within modules B0-APTA, B0-AMET, B0-RSEQ, B0-TBO and B0-SURF are estimated to provide the next 13% of the total fuel saving benefits.

Due to the usefulness of the results of this analysis, it is expected that a similar analysis of ASBU Block 1 modules will be completed during the CAEP/11 cycle.

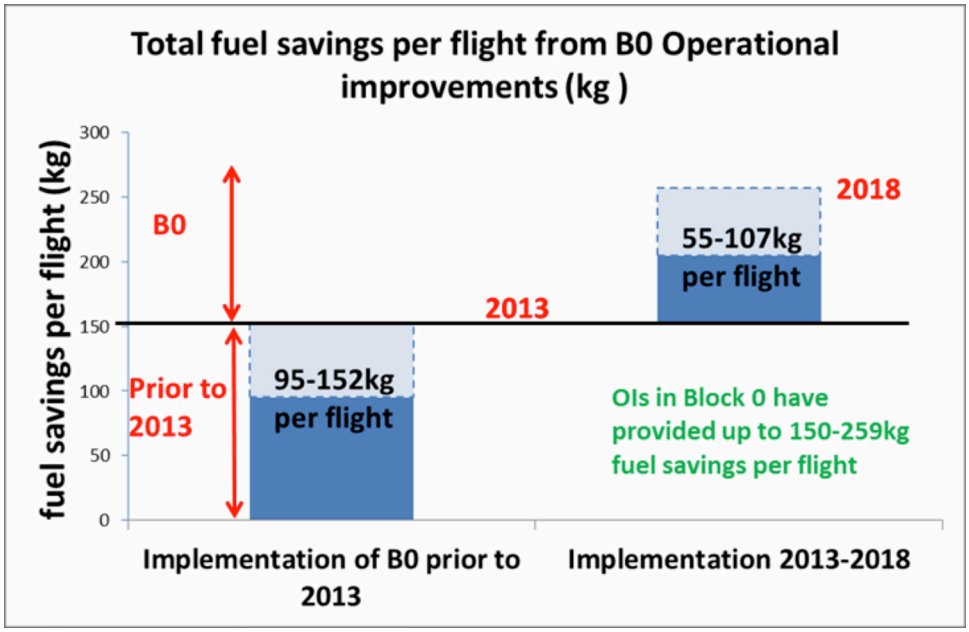

Figure 5. Range of ASBU Block 0 per-flight Fuel Savings

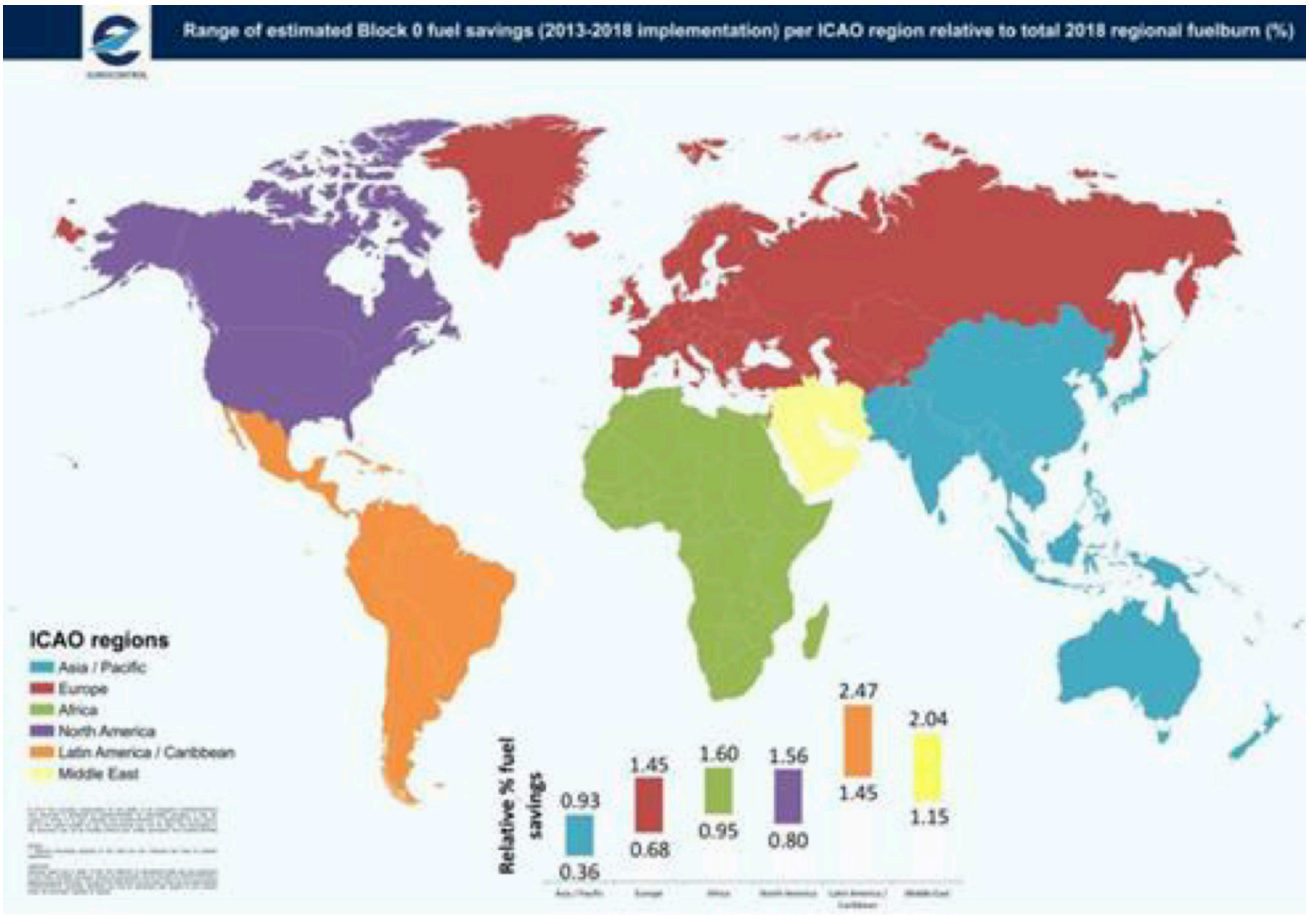

Figure 6. Block 0 fuel savings (Mt) per ICAO region relative to 2018 regional fuel burn

References

1. The ASBU environmental analysis estimated benefits to be attributed to implementations between the B0 timeframe (2013 and 2018) as detailed in the GANP 2013. It is expected that the GANP 2016 will propose an extended definition of B0 to 2019.
2. World Resources Institute (2014) for countries (Total Country GHG emissions excluding emissions from land-use change and forestry 2012 (MtCO2e)) and US Environmental Protection Agency (2013) for US States (CO2 Emissions from Fossil Fuel Combustion - Million Metric Tons CO2 (MMTCO2)).