Indonesia's Action Plan to Reduce Greenhouse Gas Emissions from Aviation Sector

This document provides a summary of Indonesia's action plan in order to support the global policy proposed by the ICAO in reducing the greenhouse gas emissions from the aviation sector.

The action plan is dedicated for reducing the impact of aviation activities upon climate change while taking into account the current capacity as well as the increase demand of aviation services, enabling this sector to develop in a sustainable manner.

This is the updated document after its second submission in 2015.

Directorate General of Civil Aviation of Indonesia

Ministry of Transportation

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Table Of Contents

List of Figures

List of Tables

1. INTRODUCTION AND BACKGROUND

Since 2015, Indonesia has submitted Intended Nationally Determined Contribution (INDC) to UNFCCC Secretariat prior to COP-21 in Paris. Such commitment to reduce emissions from 2020-2030 by 29% (unconditional) up to 41% (conditional) compared to business as usual in 2030. Indonesia decided to strengthen its INDC by enhancing clarity, transparency, and understanding both for national and international interests, and submitted to the UNFCCC Secretariat the NDC document prior to COP-22 in Marrakech.

In order to achieve the 2030 NDC target and expedite the transformational changes towards low carbon and climate resilience development, Indonesia has developed a strategy for NDC implementation. In terms of emission reduction targets, nothing has changed, but the most noticeable difference is that various adjustments have been made to the 2020-2024 RPJMN and Indonesia's Vision 2045. The updated NDC reflects the progression beyond the existing NDC particularly in the enhanced ambition on adaptation, enhanced clarity on mitigation by adopting the Paris Agreement rule book (Katowice Package) and national context that relates the existing condition and indicative pathways towards long-term vision.

In addition, Indonesia has also issued a Long-Term Strategy on Low Carbon and Climate Resilience 2050 (LTS-LCCR 2050) document to complement this latest NDC. Through LTS-LCCR 2050, Indonesia will increase ambition on GHG reduction by achieving the peaking of national GHG emissions in 2030 with forestry and other land uses as a leading sector as well as net-sink towards net-zero emission by taking into account the economy growth, climate resilience and impartiality. The LTS-LCCR 2050 document reflects increased ambition of our NDC in 2030, and with further exploring opportunity to rapidly progress towards net-zero emission in 2060 or sooner.

Indonesia is recognized its role to play in combatting global climate change in view of its extensive tropical rainforests with high biodiversity, high carbon stock values, as well as energy and mineral resources. As a form of commitment, the President of the Republic of Indonesia had issued Presidential Decree No. 98 of 2021 about Implementation of Carbon Economic Value for Achieving Nationally Determined Contribution Targets and Control of Greenhouse Gas Emissions in National Development which is a working document containing four mechanisms in implementing carbon economic value or carbon pricing. That regulation was issued along with the revocation of Presidential Decree No. 61 of 2011 about National Action Plan on Reduction of Greenhouse Gas Emissions and Presidential Decree No. 71 of 2011 about Conducting an Inventory of National Greenhouse Gases.

The Ministry of Transportation has issued Decree No. 201 of 2013 as well establishing the objectives of action plan on reduction of greenhouse gases for transportation sector. In accordance with the current circumstances, the revision of Decree No. 201 of 2013 has been considered to update and integrate development among sub-sector, including the sub-sector of aviation.

Framed on the implementation of the National Action Plan for Greenhouse Gases, the aviation national stakeholders and the Government of Indonesia are currently working together to reduce domestic and international GHG emissions from the aviation sector.

This document, finalized in December 2021, is an update of the 2015 Indonesia State Action Plan as a response to Assembly Resolution A40-18.

A. Indonesia Profile and Future Transportations Development Focus

Indonesia is the largest archipelago state in the world lies between latitudes 11° S and 6° N, and longitudes 95° E and 141° E. It consists of 17,508 islands, about 6.000 of which are inhabited. Referring to the 2020 national census, the population of Indonesia is 270,2 million.

Indonesian economy is the world's sixteenth largest by nominal GDP which in 2019 was US$ 1119.19 billion with a nominal per capita GDP of US$ 4.136. Using the estimation scenario (before the COVID-19 pandemic) of 5 % - 7 % GDP per year up to 2030, the Indonesia economy is potentially to become among the largest in the world with an estimated GDP between US$ 6.7 – 9.9 trillion. While so, in 2020-2021 Indonesia encounters a great challenge due to the global health crisis.

Considering as an archipelagic country, aviation sector has a very essential role in connecting the islands and vast areas of Indonesia and sector development is very important to strengthen inter and intra connectivity national and international economic corridors. There are three focuses on improving connectivity to support the acceleration and expansion of Indonesia's economic development: 1) Intra – Connectivity Economic Corridor, 2) Connectivity between economic corridor and 3) International Connectivity.

As air transport provides the national and remote regional connectivity and connected Indonesia to International destinations. It enables community travelling for business, leisure and family and provides rapid transport either for national logistic needs, government mission or on disaster relief.

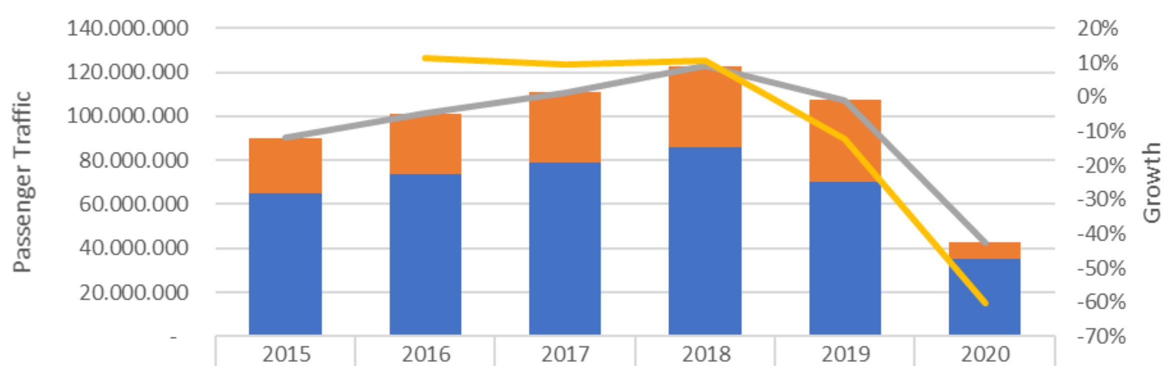
However, to be sustainable, the air transport shall always keep a balance between its economic, social and environmental costs and benefits.

B. Statistic and Growth Trends of Aviation Sector in Indonesia

Indonesia is an important market in terms of air transport since airlines business is experiencing tremendous growth, especially before the pandemic. Increasing demand on airlines services have spurred the growth of airlines, aircraft and routes, and the aviation industry.

Air transport connectivity has grown rapidly in recent year. Data in 2020 DGCA Indonesia has issued flight permits for 410 domestic routes connecting 138 cities in Indonesia, which were served by 14 airlines. For international routes, DGCA Indonesia has issued flight permits for 154 routes which connecting 26 cities in Indonesia with 66 cities abroad. These international routes were served by 8 national airlines and 48 foreign airlines only for passengers.

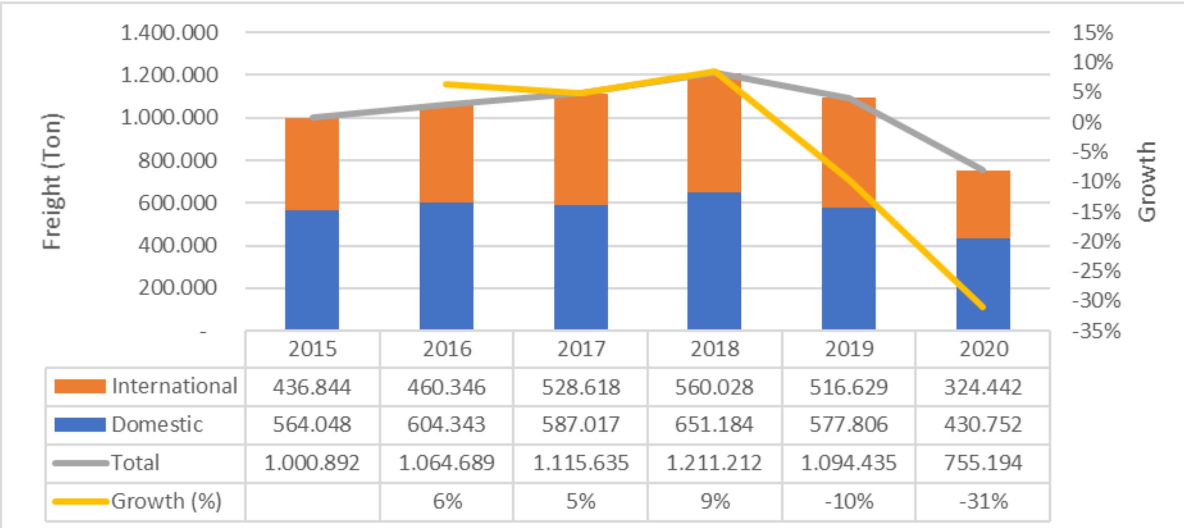
Passenger traffic in Indonesia since 2016-2018 has increased by 11% per annum, unfortunately, it is decreased 12% in 2019 and fell 60% in 2020 due to COVID-19 Pandemic. The passenger growth was promising before the pandemic. In the end of 2018, total passengers who travel within Indonesia and abroad reached over 122 million, which is increase 11% from 2017. In 2019 the total passenger decreases to 107 million, and even lower in 2020 to become only 42 million. Based on the data composition on 2015-2020, passenger traffic is typically dominated by domestic market, averaging 70% per annum. While the international market is averaging 30% per annum and it has been growing rapidly before the pandemic. Unfortunately, in 2020 the international flight ratio was getting lower to 20%.



	2015	2016	2017	2018	2019	2020
International	24.897.085	27.460.950	31.953.301	36.606.485	37.291.525	7.189.587
Domestic	65.171.698	73.913.803	78.998.407	86.200.160	70.233.668	35.393.966
Total	90.068.783	101.374.75	110.951.70	122.806.64	107.525.19	42.583.553
Growth (%)		11%	9%	11%	-12%	-60%

Figure 1 Graphic of Passenger Traffic

Data production of freight carried by air transport shows steadily increase in the past few years. During period of 2015-2018 air freight has been increased in average around 7% per annum. In 2019 and 2020 the freight traffic decrease by 10% and 31% compared to previous year.



	2015	2016	2017	2018	2019	2020
International	436.844	460.346	528.618	560.028	516.629	324.442
Domestic	564.048	604.343	587.017	651.184	577.806	430.752
Total	1.000.892	1.064.689	1.115.635	1.211.212	1.094.435	755.194
Growth (%)		6%	5%	9%	-10%	-31%

Figure 2 Graphic of Air Freight Traffic

The growth of air traffic poses challenges in providing air navigation services. Based on the requirements of Government Regulation 77/2012, the Indonesian DGCA has anticipated the increase of traffic without compromising the acceptable level of safety by creating a Single Air Navigation Services (Single ANSP) which is separated from the DGCA. The Single ANSP is established to increase the safety, efficiency, and capacity of air traffic in Indonesia. As a result, the DGCA would be more focus on its role as the regulator and the implementation of air navigation services is expected to be more efficient and effective. Parallel with the creation of a Single ANSP, Indonesia is committed to implement PBN (performance – based navigation) through the PBN implementation roadmap.

C. National and Air Transport Sector Action Plans on Mitigation of GHG

Assuming the growth until 2018 will be carried out after the pandemic, With GDP growth of around 5.17 % per year and an air transportation growth by approximately 10 % per year for domestic flights and up to 14 % for international flights, the fleets will also grow. The direct consequence is increment in energy consumption of aircraft fuel / jet fuel. The need of energy for flight activity since 2015-2020 can be represented by the aviation fuel sold by the national energy company (PERTAMINA) showed in the graphic below.

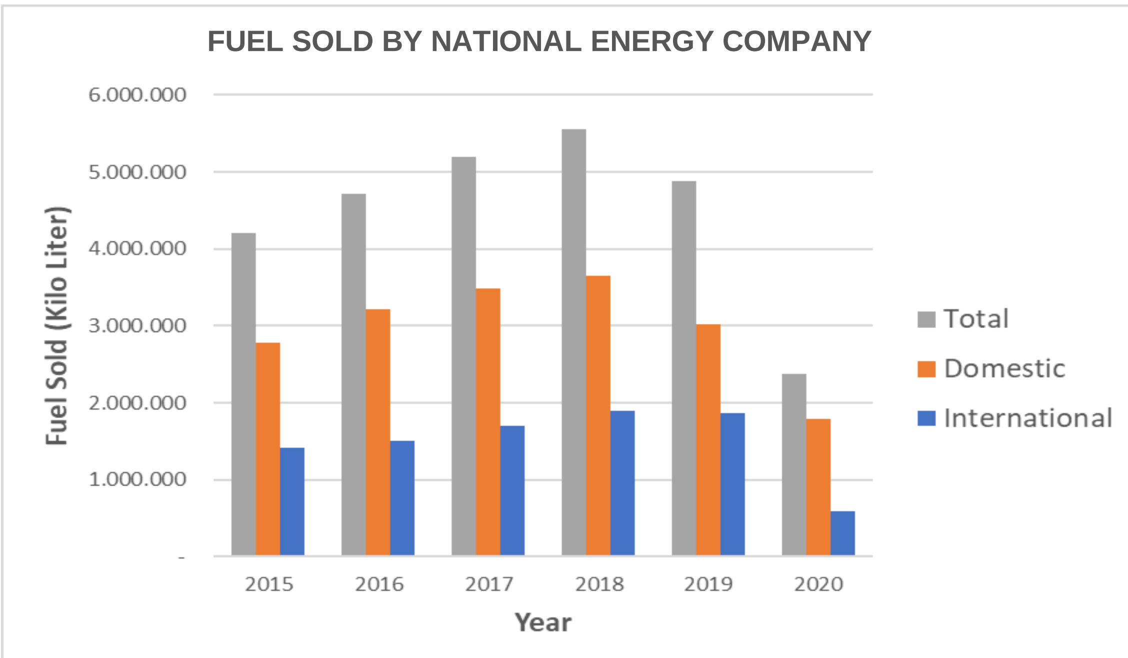


Figure 3 Graphic of Fuel Sold by National Energy Company

As mentioned in the introduction, the goal is to reduce GHG emissions 29% (equivalent to 834 million tones CO2) or 41% (equivalent to 1,185 million tones CO_2) with contribution of the international support up to 2030. With the baseline and assumption used for projection and policy scenario 2020-2030, the projected BAU and emission reduction for both unconditional (CM1) and conditional (CM2) reduction, as mentioned earlier, are as in the Table below.

Table 1 National GHG Reduction Measures and Target from Each Sector Category

Sector	GHG Emission Level 2010* (MTon CO_2e)	GHG Emission Level 2030 MTon CO_2e			GHG Emission Reduction MTon CO_2e		GHG Emission Reduction % of Total BaU		Annual Average Growth BAU (2010-2030)	Average Growth 2000-2012
		BaU	CM1	CM2	CM1	CM2	CM1	CM2		
1. Energy*	453.2	1,669	1,355	1,223	314	446	11%	15.5%	6.7%	4.50%
2. Waste	88	296	285	256	11	40	0.38%	1.4%	6.3%	4.00%
3. IPPU	36	70	67	66	3	3.25	0.10%	0.11%	3.4%	0.10%
4. Agriculture**	111	120	110	116	9	4	0.32%	0.13%	0.4%	1.30%
5. Forestry and Other Land Uses (FOLU)***	647	714	217	22	497	692	17.2%	24.1%	0.5%	2.70%
TOTAL	**1,334**	**2,869**	**2,034**	**1,683**	**834**	**1,185**	**29%**	**41%**	**3.9%**	**3.20%**

Notes: **CM1**= Counter Measure 1 (*unconditional mitigation scenario*)
CM2= Counter Measure 2 (*conditional mitigation scenario*)

*) Including fugitive.
**) Only include rice cultivation and livestock.
***) Including emission from estate crops plantation.

(Sources : *Updated Nationally Determined Contribution Republic of Indonesia*, 2021)

The national measures will be implemented gradually making them compatible with the level of air transport growth and employment absorption and thus can create dynamic air transport activities and have a positive contribution to the national economy, social development and in an environmentally friendly manner.

The success of the programs depends on the commitment of all stakeholders in facilitating and contributing their support either in management side or human resources, technology, and knowhow.

Framed on that policy framework, the Directorate General of Civil aviation (DGCA) has expressed the commitment for the reduction of GHG emissions in accordance with ICAO and IATA global policy by developing “The Indonesia Action Plan on Mitigation of Climate Change and Reduction of Green House Gas Emissions for Aviation” (RAN-GRK sub-sector Aviation) which have three focuses: Green Flight, Green Corridors and Green/Eco Airports, through six (6) pillars of national basket of measures as follows:

1. Update the policy and regulations in order to support the aviation industry sustainable growth and in line with the environmental climate change program (Regulatory Framework).

2. Renew the national fleets by the next generation aircraft and engine technology that better fuels efficiency, low carbon emissions and lower noise impact. (Technology Improvement)
3. Develop and improve the aviation infrastructure and facilities that comply with the environmental requirement and eco-airport.
4. Improve the airspace system management and develop more efficient air traffic navigation services by installing the navigation facilities seamless with PBN program. (Effectiveness and seamless infrastructure)
5. Establish renewable energy supply (solar energy) for airport facilities and bio fuels for aircraft and ground service equipment in order to reduce fossil-based energy used.
6. Develop the system to support the ICAO policy on the Market-based Measures (MBMs) known as Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA).

2. BASELINE SCENARIO

A. Methodology and Data

The calculation method used to determine the baseline scenario is in accordance with the ICAO Doc 9988 “Guidance on the Development of States’ Action Plans on CO_2 Emissions Reduction Activities” Third Edition, Chapter 3. Based on the available data, the method B (fleet size of more than ten aircraft and data available for at least two years) was chosen by following the steps.

1. Collect historical annual data from 2015-2020 for RTK and flight information consisting of: airport pair or flight distance, number of flights, and type of aircraft of transport category.
2. Generate calculation of the annual CO_2 emission for each past year by using the ICAO Carbon Emission Calculator Version 2.7.
3. Calculate the annual fuel consumption (in volume liter) for each past year by converting the CO_2 emission using data of:
    - Emission factor of jet fuel: 3.157 kg CO_2/kg.
    - Fuel specific gravity: 0.75 kg/l.
4. Calculate the fuel efficiency for each past year by dividing the fuel consumption by the RTK.
5. Calculate the average fuel efficiency for year 2015-2018 (before the covid-19 pandemic) to determine the future fuel efficiency.
6. Use the past trend of RTK for year 2015-2018 (before the covid-19 pandemic) to determine the future trend of RTK.
7. Calculate the future fuel consumption and CO_2 emission.

B. Baseline Scenario

Estimated baseline of fuel consumption and CO_2 emissions for international, domestic, and total flight within Indonesia from 2015-2030 are given in the following tables and graphs.

For the definition of international flight used in this document is refer to the ICAO methodology (all international flights operated by all air carriers registered in Indonesia).

Table 2 Baseline Scenario for International Flight

INTERNATIONAL FLIGHT			
Year	**RTK (Ton kilometers)**	**Fuel (Litres)**	**CO_2 emissions (Metric tonnes)**
2015	2.568.591.000	1.247.826.712	2.954.542
2016	3.124.132.000	1.377.794.360	3.262.273
2017	3.723.871.000	1.583.244.524	3.748.727
2018	4.176.193.290	1.748.451.472	4.139.896
2019	3.553.734.406	1.505.477.130	3.564.593
2020	856.771.133	431.267.422	1.021.133
2021	1.060.683.256	469.524.907	1.111.718
2022	1.560.683.256	690.856.254	1.635.775
2023	2.060.683.256	912.187.601	2.159.832
2024	2.560.683.256	1.133.518.947	2.683.889
2025	3.060.683.256	1.354.850.294	3.207.947
2026	3.560.683.256	1.576.181.641	3.732.004
2027	4.060.683.256	1.797.512.988	4.256.061
2028	4.560.683.256	2.018.844.334	4.780.119
2029	5.060.683.256	2.240.175.681	5.304.176
2030	5.560.683.256	2.461.507.028	5.828.233

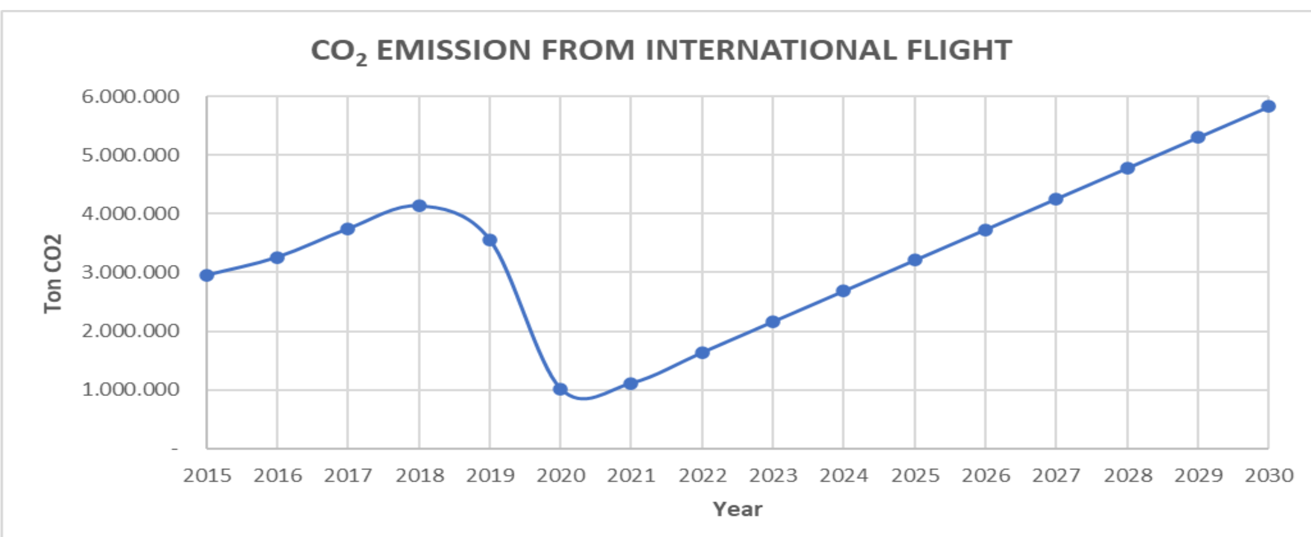


Figure 4 Graph of Baseline Scenario for International Flight

Table 3 Baseline Scenario for Domestic Flight

DOMESTIC FLIGHT			
Year	**RTK (Ton kilometers)**	**Fuel (Litres)**	**CO_2 emissions (Metric tonnes)**
2015	5.936.263.000	3.459.940.683	8.192.275
2016	6.497.360.000	3.966.679.433	9.392.105
2017	6.931.705.000	4.005.474.928	9.483.963
2018	7.791.888.000	4.487.951.207	10.626.346
2019	6.340.008.810	3.670.193.467	8.690.101
2020	2.946.331.096	2.140.392.044	5.067.913
2021	3.256.600.096	1.910.957.005	4.524.668
2022	3.856.600.096	2.263.034.070	5.358.299
2023	4.456.600.096	2.615.111.135	6.191.929
2024	5.056.600.096	2.967.188.199	7.025.560
2025	5.656.600.096	3.319.265.264	7.859.190
2026	6.256.600.096	3.671.342.329	8.692.821
2027	6.856.600.096	4.023.419.394	9.526.451
2028	7.456.600.096	4.375.496.458	10.360.082
2029	8.056.600.096	4.727.573.523	11.193.712
2030	8.656.600.096	5.079.650.588	12.027.343

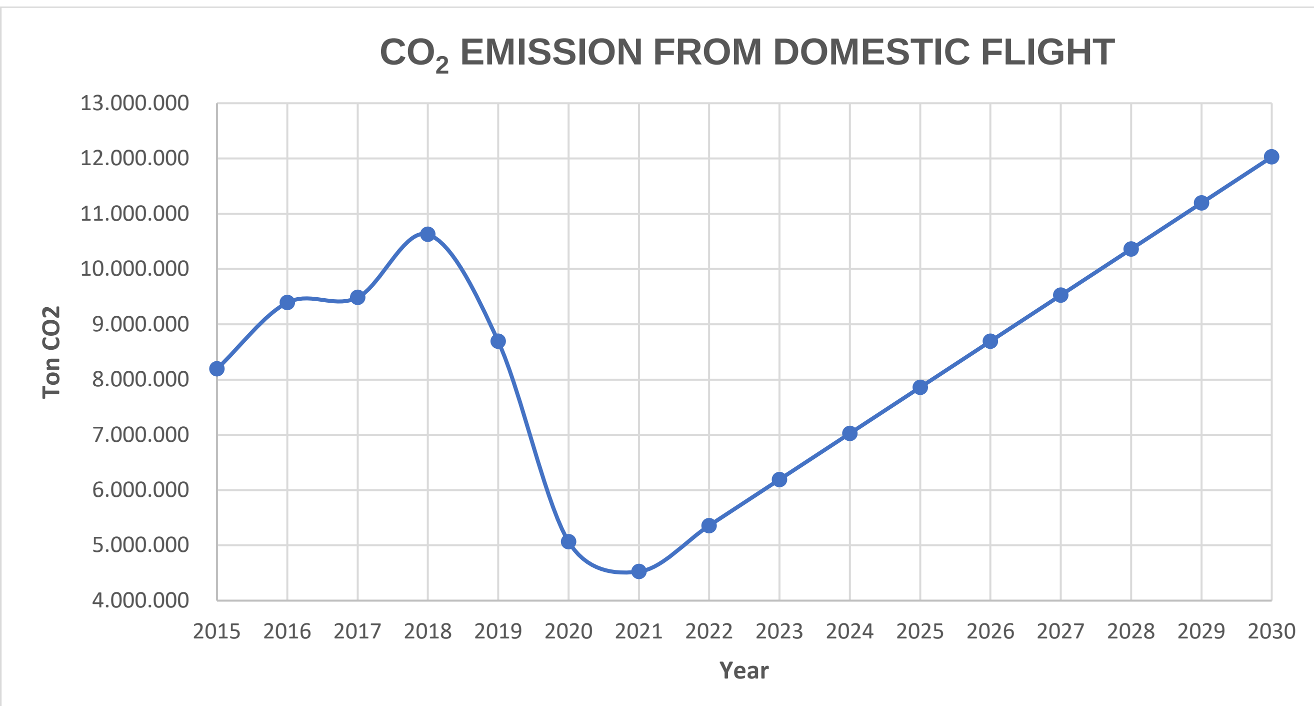


Figure 5 Graph of Baseline Scenario for Domestic Flight

Table 4 Baseline Scenario for International and Domestic Flight

TOTAL (INTL+ DOM FLIGHT)			
Year	**RTK (Ton kilometers)**	**Fuel (Litres)**	**CO_2 emissions (Metric tonnes)**
2015	8.504.854.000	4.707.767.395	11.146.816
2016	9.621.492.000	5.344.473.793	12.654.378
2017	10.655.576.000	5.588.719.452	13.232.690
2018	11.968.081.290	6.236.402.679	14.766.242
2019	9.893.743.216	5.175.670.597	12.254.694
2020	3.803.102.229	2.571.659.466	6.089.047
2021	4.317.283.352	2.380.481.912	5.636.386
2022	5.417.283.352	2.953.890.324	6.994.074
2023	6.517.283.352	3.527.298.735	8.351.762
2024	7.617.283.352	4.100.707.147	9.709.449
2025	8.717.283.352	4.674.115.558	11.067.137
2026	9.817.283.352	5.247.523.970	12.424.825
2027	10.917.283.352	5.820.932.381	13.782.513
2028	12.017.283.352	6.394.340.793	15.140.200
2029	13.117.283.352	6.967.749.204	16.497.888
2030	14.217.283.352	7.541.157.616	17.855.576

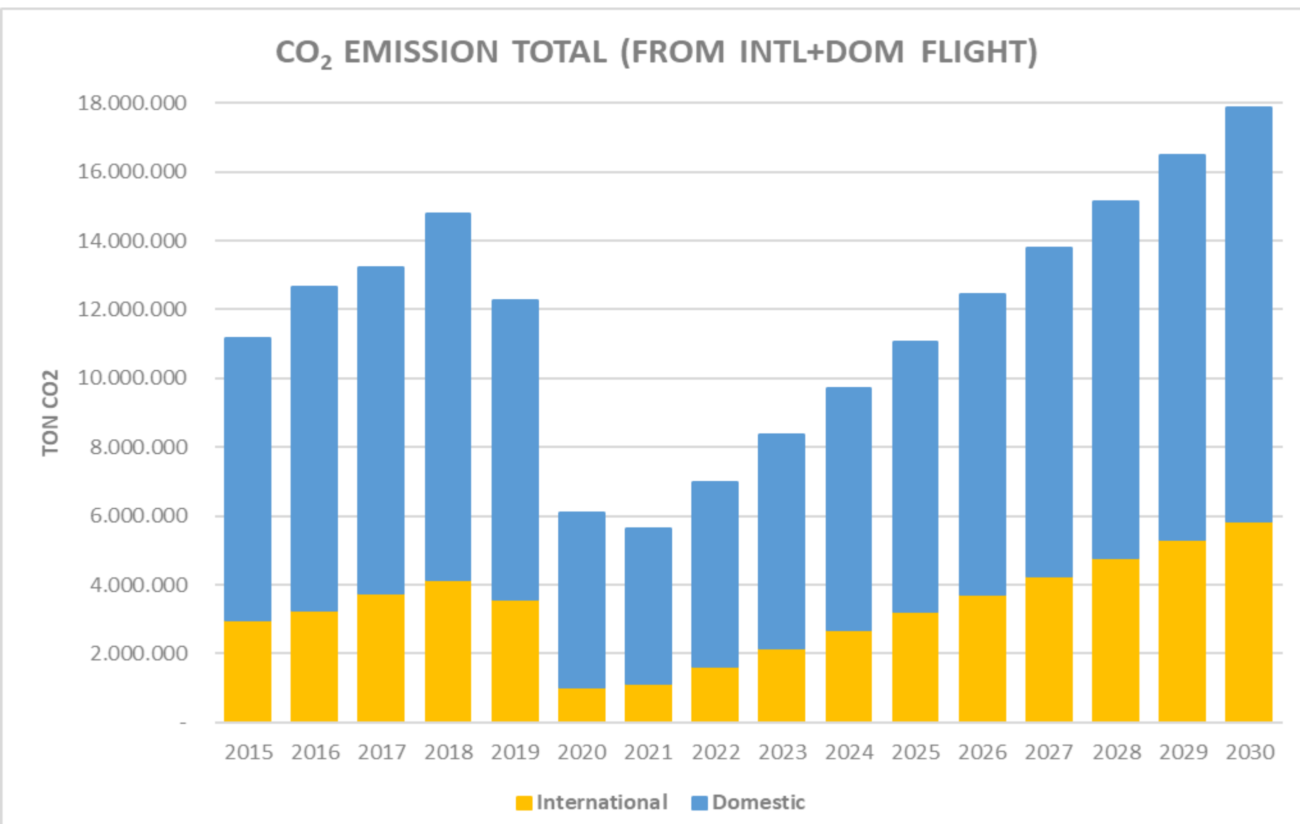


Figure 6 Graph of Baseline Scenario for International and Domestic Flight

3. MEASURES TO MITIGATE CO_2 EMISSIONS

The measure to mitigate CO2 emission for aviation sector in Indonesia is divided into main Program and Support Program. The main Program is referring to the ICAO "basket of Measures" classification such as:

a) Technology and Standards
    1. Aircraft Fleet Renewal
b) Operational Improvements:
    1. Aircraft Operational and Maintenance Improvement
    2. Airspace System Management Improvement
c) Sustainable Aviation Fuels
d) Market-Based Measures By CORSIA
e) Additional Measure:
    1. Renewable Energy for Airport
    2. Eco-Airport

While the Support Program are:

1. Rule making
2. Development of the system database/inventory
3. International cooperation
4. Development of environmental unit within the DGCA Indonesia organization
5. Cost benefits analysis for the emission reduction measures

A. Actions (Main Program)

a) Technology and Standards

1) Aircraft Fleet Renewal

Aircraft fleets in Indonesia increased in the average of 3% each year from 2012 up to 2020, being all of them new technology aircraft. The implementation of fleet renewal has started simultaneously since 2012 until 2020, with assumptions that the decrease of old technology fleet is 10% during 2012-2013, and 15% during the period of 2014-2019, so finally by 2020 it can be considered that the total serviceable fleet for transport category aircraft which has been replaced, incorporating the latest technology, and burning less fuel, has reach 95%.

As one of the efforts to reduce the carbon emission and maintenance costs, some national carriers have renewed their fleet to the latest type of aircrafts. By now, the aviation authority has registered the average of 110 aircrafts per year (2015-2020) where 40-50% is brand new aircrafts. In year 2020, the average fleet age of Indonesia flag carrier is around 9 years old.

Based on the decree No. 201 Year 2013 regarding the national action plans for reducing the Gas House Emission from transportation sector and the decree KP.13 Year 2021 regarding the strategic plan 2020-2024 of Civil Aviation, Indonesia targeted to renew the transport category fleet minimal 5% per year.

To implement this program, this is important to learn the newest technology of aircraft, engine, and propeller available in the market that increase the fuel efficiency and reduce the emission. The technical knowledge, training, and capacity building in order to operate and maintain the performance of those technology are also needed by the airline operator and aircraft MRO personnel, as well as the authorities (DGCA) especially from the Directorate of Aircraft Airworthiness and Operation (DAAO).

b) Operational Improvements

1) Aircraft Operational and Maintenance Improvement

This action focuses on the implementation of the best practices in operations to enhance the operational procedures and aircraft maintenance for transport category airplane. The main purpose is to save the fuel burned and spare parts. Regarding the implementation of this action, the initiatives are normally proposed by the air operators that already familiar with their own operational procedures. The air operators (Garuda Indonesia, Lion air, Batik Air and Indonesia Air Asia) are actively involved to enhance their operational procedures since 2016 until now.

Some examples of the enhanced procedures to be implemented are as follows:

- Single engine taxi;
- Utilizing closest alternate airports;
- Optimum center of gravity
- Optimization of GPU usage
- Fuel Tankering
- Reduced Landing Flaps
- Reduce Unnecessary Extra
- Idle Reverse Thrust on Landing
- Cost index;
- Potable water management;
- Direct routes and optimum flight level;
- Continuous Descent Arrival (Idle reserve on landing);
- Contingency fuel reduction 10% to 6% for international sector;

In order to keep improving the operational aspect, the stake holders such as airline operator personnel, MRO personnel and authority (DGCA) especially from the Directorate of Aircraft Airworthiness and Operation (DAAO) need to learn about the aircraft technology and capability that support the operation improvement and also need the capacity building to do the operation.

2) Airspace System Management Improvement

2.1 Indonesia PBN Implementation Progress

Indonesia has improved the airspace system management through the implementation of PBN including SID/STAR (RNAV 1 SID/STAR, RNP 1 SID/STAR), Approach (RNP APCH, RNP AR APCH), and Enroute. Performance-Based Navigation (PBN) provides the means for flexible routes and terminal procedures, which results in congestion reduction, energy and fuel conservation, environment protection, aircraft noise reduction, safety improvement and accessibility to challenging airports, and increase in airspace capacity.

For continuation of PBN implementation in the future, Indonesia has made the new PBN Implementation Plan until 2024. This plan accommodates the ICAO mandate to prioritize the international airports, international routes for flight connection between the states, and also accommodate the President of Indonesia program of boosting in tourism sector.

PBN Implementation status

By 21 August 2021, the number of Indonesia's airports that already implement fully/partly PBN flight procedures are as follows:

Table 5 Implementation of PBN Procedure in Indonesia

<table>
<tr><th>Airports</th><th>PBN</th><th>Qty</th></tr>
<tr><td rowspan="2">International Airport (with instrument runway)</td><td>PBN IAP</td><td>30 of 32 airports
(3 airports with RNP AR)</td></tr>
<tr><td>PBN SID/STAR</td><td>14 of 32 airports</td></tr>
<tr><td rowspan="2">Domestic Airport (with instrument runway)</td><td>PBN IAP</td><td>28 of 29 airports</td></tr>
<tr><td>PBN SID/STAR</td><td>6 of 29 airports</td></tr>
</table>

As addition with data above, there are domestic and remote airports in Indonesia with PBN procedures as follows:

Table 6 Domestic and Remote Airports In Indonesia wiith PBN Procedures

Airports	PBN	Qty
Domestic airports (non-instrument runway)	PBN IAP	12 airports
	PBN SID/STAR	2 airports
Remote airports (non-instrument runway)	PBN IAP	21 airports

Indonesia has implemented PBN domestic enroute, as follows:

Table 7 PBN Implementation in Domestic enroute

ATS Route	Routes	Publication	Navspec
T1	Jakarta - Bali	17 Aug 2017	RNAV 10
T2	Surabaya - Jakarta	27 Aug 2020	RNAV 2
T3	Jakarta - Surabaya - Bali	27 Aug 2020	RNAV 2
T4	Bali - Jakarta	27 Aug 2020	RNAV 2
T5	Jakarta - Makassar	27 Aug 2020	RNAV 2
T6	Makassar - Jakarta	27 Aug 2020	RNAV 2
T10	Jakarta – Banda Aceh	12 Aug 2021	RNAV 2
Z21	Medan – Aek Godang	2 Mar 2017	RNP 2
Z22	Medan - Sibolga	2 Mar 2017	RNP 2
Z23	Medan - Binaka	2 Mar 2017	RNP 2
Z24	Medan - Lasikin	2 Mar 2017	RNP 2
Z25	Medan - Rembele	2 Mar 2017	RNP 2
Z26	Medan – Lhok Sukon	2 Mar 2017	RNP 2

To support the PBN implementation, Indonesia has some PBN cooperation projects as follows:

1. Cooperation with NAVBLUE to develop PBN procedures on airports not equipped with Instrument Flight Procedure and operated by ATR aircraft as follows:
    - In 2019: 2 airports (Haji Hasan Aroeboesman Airport - Ende and Torea Airport – Fakfak) published at 10 Sep 2020 and
    - In 2020: 2 airports (Gewayantana Airport - Larantuka and Soa Airport – Bajawa) still in publication process.
2. EU South-East Asia Aviation Partnership Project – Design of RNP APCH Procedures for airports in Atambua, Bajawa, and Larantuka (kick off meeting in February 2020);

3. Cooperation with EASA for PBN implementation including assistance in New Staff Instruction on PBN and inspector training for RNP AR Approval (training held in April 2021).

Indonesia has been conducting socialization and training of PBN implementation for ATS personnel. In the first semester of 2021, there are PBN training at 9 airports.

It is reported that the implementation PBN Enroute RNAV2 between Jakarta – Surabaya – Bali – Makassar has shortened the distance by 10 NM and reduce the fuel consumption by 160 kg/flight thus can give emission reduction by 2023 ton/year (with emission assumption of 3.15 gram per fuel).

New PBN Implementation plan until 2024

The Indonesia PBN implementation plan until 2024 are as follows:

Table 8 PBN Implementation Plan

Airport / Route		Status	Target Year
International Airport IAP	Raja Haji Fisabilillah, Tanjung Pinang	Coordination with adjacent ATS authority	2021
	Hang Nadim, Batam	Coordination with adjacent ATS authority	2021
	Supadio, Pontianak (Rwy 33)	Design process	2022
International Airport SID/STAR	Raja Haji Fisabilillah, Tanjung Pinang	Coordination with adjacent ATS authority	2021
	Hang Nadim, Batam	Coordination with adjacent ATS authority	2021
	Halim Perdanakusuma,	Design process	2021
	H As Hanandjoeddin,	Design process	2021
	Sam Ratulangi, Manado	Plan	2022
	Supadio, Pontianak	Plan	2022
	Minangkabau, Padang	Plan	2023
	Zainuddin Abdul Madjid, Lombok	Plan	2023
	El Tari, Kupang	Plan	2023
	Juwata, Tarakan	Plan	2024
	Sentani, Jayapura	Plan	2024
	Frans Kaisiepo, Biak	Plan	2024
	Adi Sumarmo, Solo	Plan	2024
	Sultan Syarif Kasim II, Pekanbaru	Plan	2024

Domestic Airport RNP AR	Sultan Babullah, Ternate	Design process	2022
Domestic Enroute RNAV 2	Cluster 2: Semarang - Surabaya - Kupang	Design process	2021
	Cluster 3: Surabaya - Papua	Plan	2022
	Cluster 3: Jakarta – Manado & Semarang – Surabaya – Balikpapan	Plan	2023
Lower ATS Domestic Enroute RNP2	Balikpapan - Tarakan	Plan	2022
	Kupang - Bali	Plan	2023
	Luwuk – Gorontalo - Palu	Plan	2024

*The plan may still be changed according to the needs or technical considerations of flight operations

For International ATS route, Indonesia currently is in process of coordination with related countries.

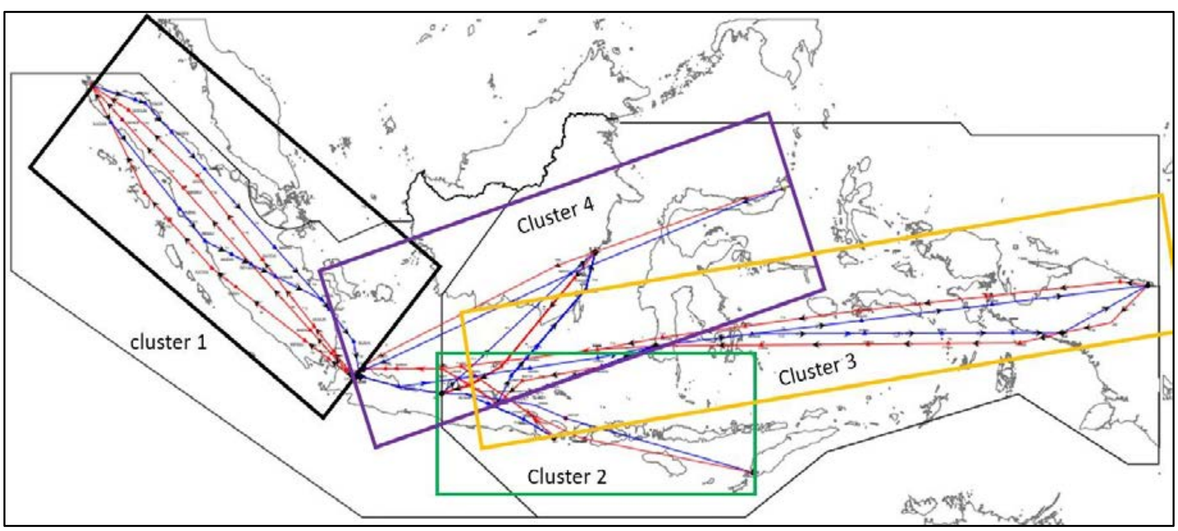


Figure 7 Design of PBN Domestic Enroute RNAV 2

2.2 Indonesia Air Traffic Flow Management (ATFM) Implementation Progress

Air Traffic Flow Management (ATFM) increases air traffic management efficiency and effectiveness, and contributes to aviation safety, efficiency, cost-effectiveness, and environmental sustainability of an ATM system.

In the implementation of ATFM Concepts, Indonesia has conducted as follows:

- **At the regional level**, Indonesia has participated in the Distributed Multi-Nodal ATFM Network Project as Node Level 2 in August 2015 by involving 3 (three) airports (Soekarno-Hatta Airport of Jakarta, Juanda Airport of Surabaya, and I Gusti Ngurah Rai Airport of Denpasar) by ensuring the compliance of tactical ATFM measures disseminate by Node Level 3 during periods of constraints.
- **At the National level**, Indonesia has implementing partial ATFM since Q4 2015, in which ATM planning phase conducted by AirNav Indonesia periodically, the strategic phase conducted by Indonesia Airport Slot Management (IASM), pre-tactical conducted by AirNav by using Chronos system. The Chronos system is also able to facilitate tactical slot issuance for delay, postpone, and non-regular flight.
- From Q2 year 2020 Indonesia is working on integration and data sharing between AirNav Indonesia and Angkasa Pura II in order to enable the ATFM and A-CDM operation in Soekarno-Hatta International Airport of Jakarta and working together to determine variable taxi time (VTT). The next stage of the program is upgrading the Airport Operation Control System in I Gusti Ngurah Rai International Airport of Denpasar, Bali to enable integration and data sharing with relevant ATFM & A-CDM stakeholders as well as generated operational milestones. The final achievement of the program is to conduct ATFM & A-CDM operational city pair between Soekarno-Hatta International Airport of Jakarta and I Gusti Ngurah Rai International Airport of Denpasar, Bali. The success of this program will be continued by expanding the city pairs network to Juanda International Airport of Surabaya.

2.3 Development of Indonesia Air Navigation Carbon Emission Calculator (INAVCEC)

Directorate of Air Navigation (DAN) Indonesia which involve in the DCGA Environmental Team realized that Indonesia has not yet had a tool to calculate emission solely from air navigation aspect, therefore DAN developed Indonesia Air Navigation Carbon Emission Calculator (INAVCEC) to calculate emission carbon used by aircraft from air navigation aspect.

Background Process

Every year DAN has to provide data for Environment Team and made target emission reduction from air navigation aspect. However, the data provided was calculated generally and less accurate. The identification of this problem led to the following findings in the national context:

i. No mechanism to calculate emission carbon produced in air navigation aspect;
ii. No quantitative data for emission carbon produced as an impact of air traffic services;
iii. No tools to facilitate the calculation of emission carbon produced in air navigation aspect; and
iv. No measurable strategic plan which targeting environmental protection in the air navigation aspect.

Furthermore, DAN formulated a calculation mechanism into the national regulation with the ICAO guidance in Doc. 9988 Guidance on the Development of States' Action Plans on CO2 Emissions Reduction Activities. Then DAN in collaboration with Airnav Indonesia constructed an application to facilitate the calculation of emission carbon produced in air navigation aspect.

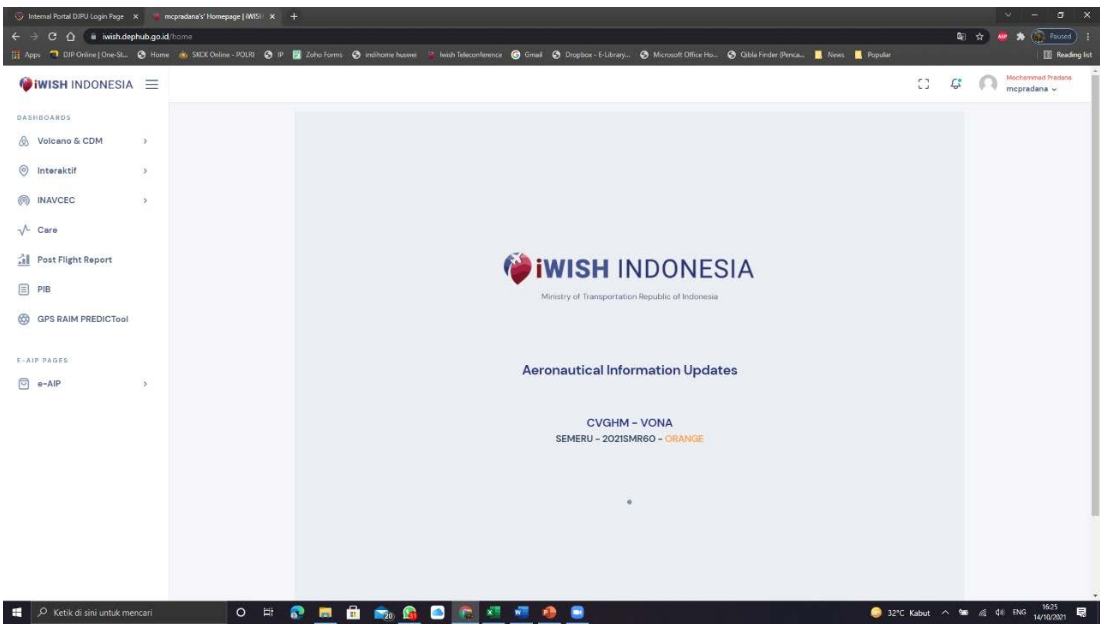
Development Process of Indonesia Air Navigation Carbon Emission Calculator (INAVCEC)

Implementation of the application to calculate emission carbon gas produced in the air navigation aspect was merely accessed by Airnav Indonesia and DAN, which this condition means this application could not be utilized by aviation communities in Indonesia nor internationally.

As Indonesia has already developed Indonesia Web-Based Aeronautical Information System Handling (IWISH) and the system already supports the implementation of collaborative decision-making (CDM) by involving the regulator, air navigation services provider, airport operator, airline operator, and other stakeholders, Indonesia tried to integrate the application of emission calculator for air navigation into the IWISH system and created INAVCEC.

INAVCEC calculate emission carbon gas produced by aircraft since the aircraft block-off until block-on and calculate all air navigation configuration such as when the aircraft start engine, taxi-out, ground holding, take-off, climbing, enroute, descending, approach, holding, landing, taxi in, and cut engine. INAVCEC also can calculate emission carbon gas produced base on flight plan routes which can be customized by users. Users can use prediction tools in INAVCEC to find out the best route suggested by INAVCEC to produce less emission carbon gas and the system also can provide an annual report for users so they will get the total amount of emission carbon gas per year to make a better plan for next year.

INAVCEC can be accessed as one of the IWISH features on: https://iwish.dephub.go.id/inavcec/dashboard. The appearance of INAVCEC on the IWISH web will look as follows:



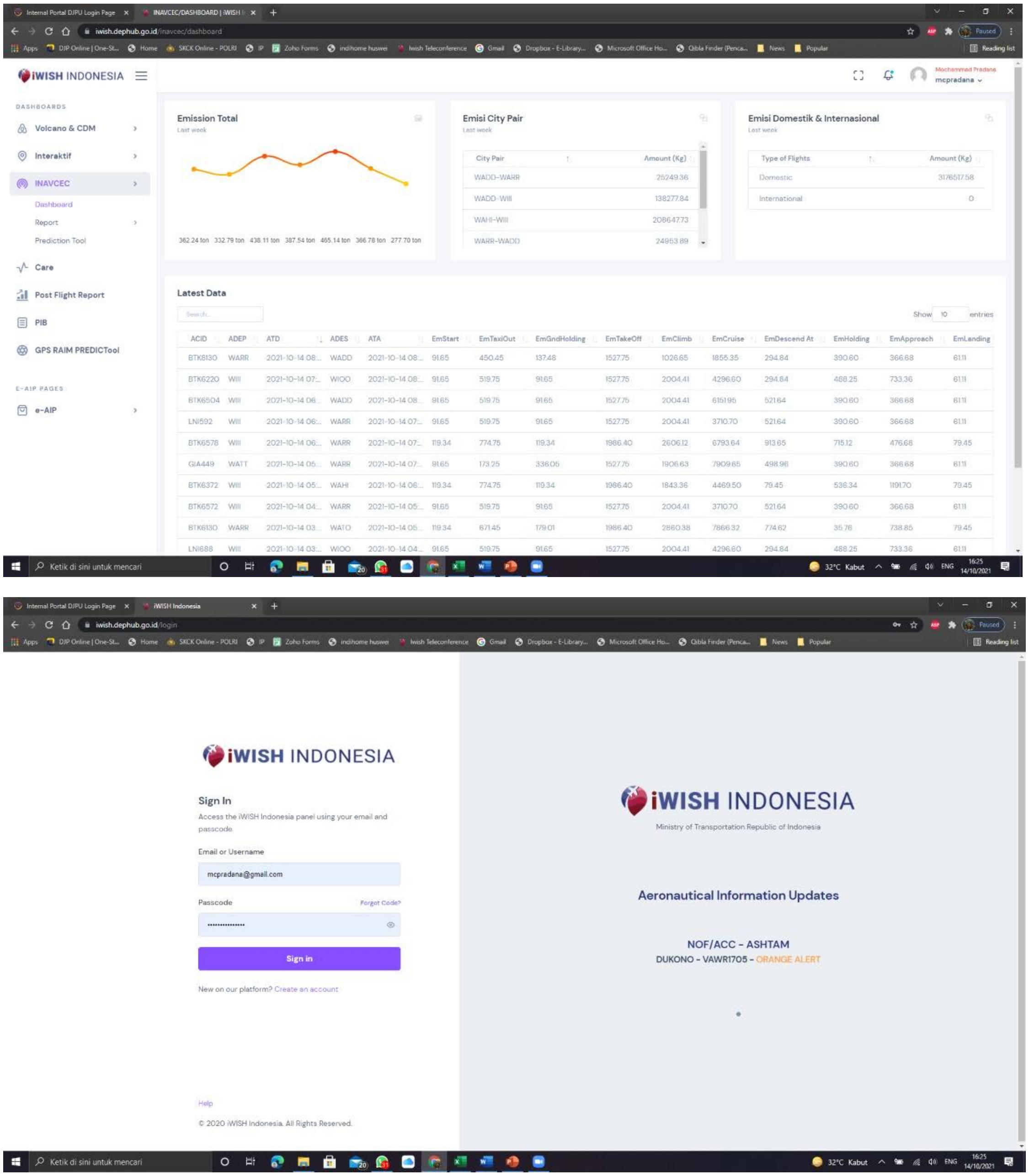


Figure 8 INAVCEC Apps Preview

Indonesia expects that INAVCEC will be used internationally and still processing to develop the system for international user.

To implement these programs, this is important to learn the newest technology of ATM and PBN. The technical knowledge, training, and capacity building in order to operate the technology calculate the emission reduction are also needed by the navigation provider, airline, aircraft crew, as well as the authorities (DGCA) especially from the Directorate of Air Navigation.

c) Sustainable Aviation Fuels

1. Alternative fuel / Bioavtur

The utilization of bio-jet fuel has been regulated through the Ministry of Energy and Mineral Resources Decree No. 12 Year 2015 with a target 5% blending on 2025. By the end of 2013, some actions have been performed to support the implementation of bio-jet fuels. Started with the establishment of the memorandum of understanding between the Ministry of Transportation and the Ministry of Energy and Mineral Resources at the end of 2013 and continued with the establishment of the Aviation Biofuels and Renewable Energy Task Force by mid-2014 which expected can reinforce the implementation processes.

In December 2020, Indonesia National Energy Company (PERTAMINA) started to conduct several test productions of bio-jet fuel using the “Co-Processing” method. Palm Kernel Oil (PKO) was used for the bio- feedstock, with blending up to 2,4%. A new “Catalyst” developed by the Bandung Institute of Technology (ITB) and PERTAMINA was used in the process. The production tests are considered successful. However, further studies are needed for using Palm Oil as the bio-feedstock. PERTAMINA has successfully converted one refinery unit in December 2021, as green-fuel unit production, with flexibility to produce fossil fuel, co-processing bio jet fuel, and full green diesel (HVO). Further supports are required to conduct test on the bio-jet fuel for commercial flight.

In 2021, the Garuda Maintenance Facility/GMF (a Subsidiary Company of the Garuda Indonesia airline) in cooperation with the Bandung Institute of Technology, ran an engine test using bio-jet fuel J2,4 (blending of 2,4% bio-jet fuel) developed by PERTAMINA. The result shows that the performance of the engine using bio-jet fuel mixed is as good as using conventional avtur. The study was continued with ground run test and flight test by using the CN-235 military aircraft manufactured by PTDI for the bio-jet fuel J2,4. Based on the pilot experience and the engine variables, the result showed no significant different in aircraft performance when using the bio-jet fuel compared to the conventional avtur. For the next development test, the test on the civil aviation is planned to be conducted.

To implement this program, this is important to learn the development updates of bio-jet fuel or Sustainable Aviation Fuel (SAF), in the terms of its technology, processing and handling methodology, Life Cycle calculation, sustainability criteria compliance, pricing, feedstock supply security, and procedure to claim the emission reduction toward CORSIA offsetting requirements. The technical knowledge, training, and capacity building regarding the implementation of biofuel is essential for by the oil producer, catalyst producer, airline, as well as the authorities such as ministry of Energy and Mineral Resource (DG EBTKE) and ministry of Transportation (DGCA).

d) Market-Based Measures By CORSIA

Indonesia DGCA has officially submitted its position to voluntarily join the implementation of CORSIA on the pilot phase in 2021.

Up until now, DGCA Indonesia has actively followed the discussion of CORSIA conducted within ICAO Committee on Aviation Environmental Protection (CAEP) as well as capacity building programs performed by ICAO in various regions.

The MRV activity has been started during 2019 and 2020. For the report year 2019, Eight Airline Operators had participated in CORSIA scheme. The Emission Monitoring Plan (EMP) has been submitted by those Airline Operators and approved by DGCA Indonesia. The reported emission for year 2019 is around 3-million-ton CO_2. In 2020, COVID-19 pandemic has become a great challenge in aviation industry. The reported emission for year 2020 is around 1-million-ton CO_2, decreased due to the significant drop of flight activity. Until mind 2021, National Accreditation Body (BKN KAN), with coordination with DGCA, has accredited three Local Verification Bodies (VB) for CORSIA scheme.

To implement this program, this is important to follow the updates from ICAO, since it is a new scheme. The technical knowledge, training, and capacity building about the process of MRV (monitoring-Report-Verification), Verification Body Accreditation, Sustainable Aviation claim and also Emission Unit cancellation are needed by airline, Verification Body, as well as the authorities such as National Accreditation Body and DGCA (Directorate of Airworthiness and Aircraft Operation).

e) Additional Measure

1) Renewable energy using solar-cell for airport facilities

The implementation of renewable energy program at the airport has increased significantly since 2011. Currently the renewable energy program at the airport has only been implemented through the installation of solar-cell system and the utilisation of solar-powered lighting system, see Table below.

Table 9 Renewable Energy Implementation in Indonesia's Airports

Description	Solar-cell system	Solar-Powered lighting
Number of airports installed	47 Airports	106 Airports + 3 DGCA regional office
Total CO_2e saving	14.813 ton CO2e	1.046,5 ton CO2e

*Note: Cumulative data until 2020

Until 2020, the solar-cell system has been installed at 47 airports. In addition, total 106 Airports and 3 DGCA regional office have installed solar-powered lighting for access road and car park which produced power.

In addition to this measure, in October 2020 it was signed a MOU between DGCA Indonesia (Ministry of Transportation) and the Directorate General of Renewable Energy and Energy Conservation – EBTKE (Ministry of Energy and Mineral Resources) regarding the implementation of energy conservation and renewable energy in airport.

2) Eco-airport continuous implementation.

Eco-airport program is covering three main programs such as: (1) utilization of renewable energy; (2) usage of light emitting diode (LED); and (3) implementation of greening program. Until 2020, the utilization of renewable energy at the airport has been implemented in 126 airports and 3 DGCA regional offices out of 251 existing airports in Indonesia. The policy to utilise renewable energy at airports has generated approximately 52.8 million KWh electricity power. As mentioned previously, currently the renewable energy program is achieved through the installation of solar-cell system and solar powered lighting for access road and car park.

Table 10 Eco-Airport Implementation in Indonesia

Utilization of renewable energy	
Number of Airports	126 Airports + 3 DGCA regional office
Total capacity installed	6.0 MW
Total KWh produced	52.866.410 KWh
Total CO_2e saving	15.859,5 ton CO_2e
Usage of LED	
Number of Airports	18 Airports
Total LED installed	18.602 Units
Total KWh reduced	5.209.769 KWh
Total CO_2e saving	14.275 ton CO_2e
Implementation of greening program	
Number of Airports	12 Airports
Total trees planted	14.436 trees
Total CO_2e saving	977.009 ton CO_2e
Grand Total CO_2e saving	**1.007.143,5 ton CO_2e**

*Note: Cumulative data as 2020

As shown in Table 3, the installation of LED has been implemented in total 18 airports until 2020. Moreover, as many as 14,436 trees has been planted in 12 airports to support greening airport program, saved approximately 977,009 ton CO2e. Greening airport program was planning to be implemented in 55 airports with 300 trees planted for each airport. Finally, until 2020 the eco-airport program in Indonesia has successfully reduced emissions up to 1.007.143,5 ton CO2e.

To enhance the eco-airport program, DGCA has stipulated two regulations in 2017 which cover airport waste management and airport emission reduction namely Ministry of Transport Decree number 54 year 2017 regarding Waste Management from Airport and Aircraft Operations and DGCA Decree number INST 011 year 2017 regarding Actions to Reduce Airport's Green House Gases Emissions. Through these regulations, airport operators shall conduct necessary actions to calculate airport emissions, manage airport waste, reduce airport emissions and report those actions to the Minister of Transport through Director General of Civil Aviation.

Furthermore, DGCA recommends airport operators to use ACI's Airport Carbon and Emissions Reporting Tool (ACERT) in order to calculate emissions produced by airport. A technical workshop has been held by ACI and Angkasa Pura early this year to learn how to manage airport in environmentally basis and how to use ACI's ACERT. In addition, Soekarno-Hatta Airport received ACI's Airport Carbon Accreditation (ACA) for Mapping level in 2014. Last year ACI is invited to do ACA certification for I Gusti Ngurah Rai Airport in Bali and Ahmad Yani Airport in Semarang. This process is still on-going. Those actions mentioned above have shown strong commitment from airport operators and DGCA Indonesia to implement eco-airport concept.

To implement this program, this is important to learn the newest technology of Eco-airport technology and methods. The technical knowledge, training, and capacity building in order to build, operate and maintain the eco-airport are also needed by the airport provider, as well as the authorities (DGCA) especially from the Directorate of Airport.

B. Action Support

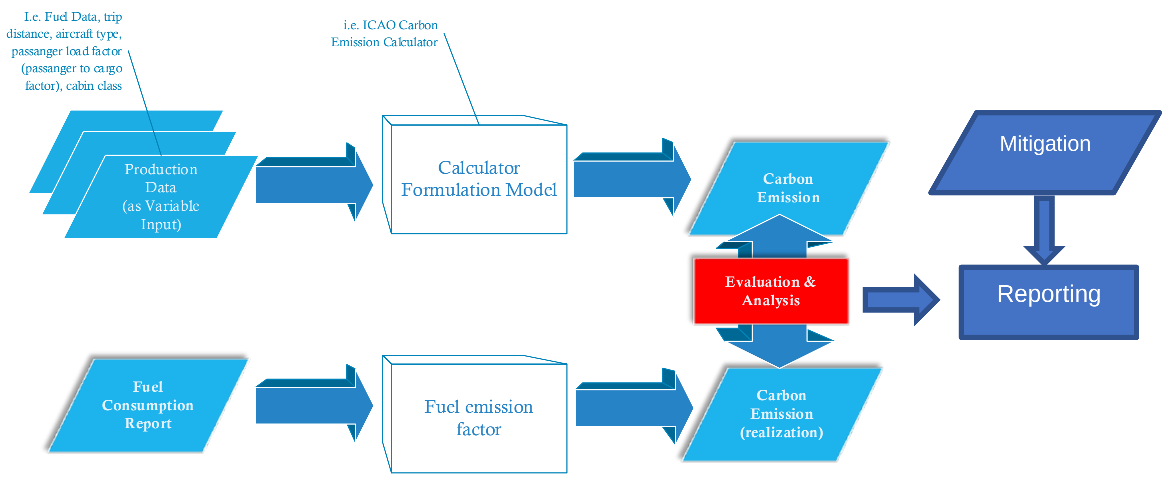
1) Rule making

Rule making process in conjunction with the implementation of the aviation bio-jet fuel, GSE bio-diesel, renewable energy, PBN, eco-airport and national roadmap on Carbon Emissions Reductions Program (2021-2024).

As the efforts to inventories and familiarize air operators in collecting fuel use data, Director General has issued a DG Instruction No. 2 Year 2016 to submit fuel use information through ICAO Form-M.

2) Development of the system database/inventory

Since 2017, DGCA Indonesia has started to develop an IT Environmental Management System (EMS) tool to process a monitoring-reporting-verification (MRV) in a form of data inventory, calculation and reporting through graphics presentation. IT-EMS-Tool was developed by integrating air transport report from air operator (Modified Form C and Form M). This tool is also developed as a mitigation effort to decrease the CO_2 gas emission in line with ICAO Rule of Thumb Doc. 9988 which includes aircraft-related technology development, alternative fuel, improved air traffic management and infrastructure use, efficient operations, economic/market-based measures, airport improvements and regulatory measures. Figure below shows the MRV process in IT-EMS.



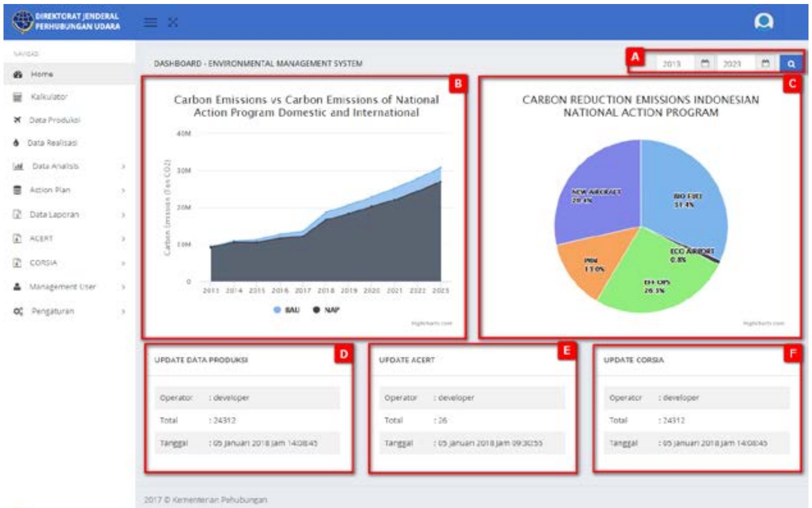


Figure 9 Environmental Management System (EMS) Apps Preview

3) International Cooperation

As a member of ICAO, Indonesia is committed to give the best effort to follow and comply with the regulation and policy made by ICAO, including regarding the environment protection. Indonesia is aware to build international cooperation to maximize the contribution, together with other countries and aviation organizations globally.

Since the aviation environmental protection issue is considered as a new issue within the DGCA Indonesia, the capacity building program has been formulated to advance the skill and knowledge of the DGCA staffs. Supported by the ICAO Global Aviation Training through cooperation with Indonesia Civil Aviation Human Resources Development Center, several trainings have been conducted to accommodate the needs of the staffs. International cooperation with several international aviation organizations have been performed to seek for a possibility to cooperate in advancing the DGCA staff’s capability. DGCA signed MOU with FAA on the Promotion of Sustainable Aviation Alternative Fuels and Renewable Energy (2015), and with EASA concerning cooperation in the Field of Civil Aviation (2019).

In 2018 DGCA Indonesia run a capacity building project with ICAO through the program INS 13801 Management Service Agreement (MSA) annex 5 to send two members of DGCA Indonesia environment protection team to join fellowship technical visitor program at FAA-Office of Environmental and Energy (AEE). The program run for six months from 29 January to 20 July 2018 to work in the analysis of the impact of noise and emission in the airport to the surrounding environment. By using modelling tool AEDT, the participants simulate noise and emission dispersion model caused by the flight activity in the Juanda Airport in Indonesia and predict the impact to the environmental.

DGCA Indonesia joins the ICAO CAEP (Committee on Aviation Environmental Protection) as member and delegates the experts to CAEP Working Group. DGCA Indonesia also actively join in various capacity building such as training, workshop and group discussion held by ICAO, EASA and FAA since 2018 - now, both in offline and online mode.

4) Development of environmental unit within the DGCA Indonesia organization

Due to the growing of workload and to accommodate as well as to optimize the implementation of the national action plans concerning aviation environmental protection, it is necessary to establish a dedicated unit within the DGCA organization. The creation of new Unit requires coordination internally and externally between Ministry of Transportation with other relevant Ministries. Meanwhile, DGCA Indonesia has established environmental protection taskforce as per DG Decree 303 of 2019 and 304 of 2019.

5) Cost benefits analysis for the emission reduction measures

In implementing the National Action Plan for reducing greenhouse gas emissions in the civil aviation sector in Indonesia, it can be seen that from several mitigation activities the most contributing to emission reduction are fleet renewal, aircraft operational efficiency and PBN implementation. As an indicator of the benefits, the fuel consumption of the aircraft becomes more efficient than BAU. As expected by 2024, it can save about 175 Kilo Liters, equivalent to $ 123 Million, by reducing emissions of 415 million tons CO_2.

These assessments have examined costs and contribution to CO_2 reduction for a number of technology and fuel‐based measures based on a range of assumptions relevant with energy prices and baseline conditions. Despite these differences, a consistent finding of these assessments is that many technology and fuel‐related GHG reduction measures in the air transportation sector are relatively low cost or may even save money over time. It can be happened because many measures have the potential to reduce fuel consumption. These savings increase as fuel prices increase. However, it was generally found that the absolute contribution of low‐cost CO_2 abatement from air transport will (in general) be less than that of other sectors ‐ although this varies by region and country.

The imbalance between low net abatement costs and high capital investment costs provides a potential rationale for government intervention. Some countries had been able to stabilize or even reduce their transport‐related CO_2 emissions against a down slop of the economic growth.

The potential for irreversible outcomes and uncertainty of the impacts of GHG reduction implies that standard cost‐benefit assessment may not be suitable to evaluate GHG reduction policies. Assessing measures according to their cost effectiveness in contributing to GHG mitigation objectives cost calculation has the benefit of being able to help governments equalize costs across sectors, or within sectors, although it may be difficult to compare technical and non‐technical measures under this framework. Policy‐makers and manufacturers have to deal with a need to balance current low‐cost GHG‐reducing technology with higher‐cost investments.

4. EXPECTED RESULTS

By Implementing the measures to mitigate CO2 emissions mentioned in the Chapter 3 such as aircraft fleet renewal, aircraft operational improvement, airspace system management improvement, alternative fuel / bioavtur development and implementation for international flight and with the addition of the Eco-Airport program for the program in the domestic flight, it is estimated that the emission caused by flight activity will be as follows:

Table 11 Emission Expected Result for International Flight

	INTERNATIONAL			
Year	**RTK (Ton kilometers)**	**Fuel (Litres)**	**CO_2 emissions (Metric tonnes)**	**Fuel Efficiency**
2021	1.060.683.256	439.010.163	1.039.466	0,41
2022	1.560.683.256	634.301.760	1.501.868	0,41
2023	2.060.683.256	849.152.901	2.010.582	0,41
2024	2.560.683.256	1.063.768.400	2.518.738	0,42
2025	3.060.683.256	1.275.627.389	3.020.367	0,42
2026	3.560.683.256	1.490.066.839	3.528.106	0,42
2027	4.060.683.256	1.704.670.550	4.036.234	0,42
2028	4.560.683.256	1.859.688.212	4.403.277	0,41
2029	5.060.683.256	2.067.136.091	4.894.461	0,41
2030	5.560.683.256	2.274.609.210	5.385.706	0,41

Table 12 Emission Expected Result for Domestic Flight

	DOMESTIC			
Year	**RTK (Ton kilometers)**	**Fuel (Litres)**	**CO_2 emissions (Metric tonnes)**	**Fuel Efficiency**
2021	3.256.600.096	1.544.711.052	3.657.490	0,47
2022	3.856.600.096	1.847.332.663	4.374.022	0,48
2023	4.456.600.096	2.129.003.228	5.040.947	0,48
2024	5.056.600.096	2.409.425.584	5.704.917	0,48
2025	5.656.600.096	2.594.595.742	6.143.354	0,46
2026	6.256.600.096	2.865.618.136	6.785.067	0,46
2027	6.856.600.096	3.137.584.667	7.429.016	0,46
2028	7.456.600.096	3.388.945.157	8.024.175	0,45
2029	8.056.600.096	3.656.037.630	8.656.583	0,45
2030	8.656.600.096	3.923.343.555	9.289.497	0,45

Table 13 Emission Expected Result for Total Flight

	TOTAL INTERNATIONAL + DOMESTIC			
Year	**RTK (Ton kilometers)**	**Fuel (Litres)**	**CO_2 emissions (Metric tonnes)**	**Fuel Efficiency**
2021	4.317.283.352	1.983.721.215	4.696.956	0,46
2022	5.417.283.352	2.481.634.423	5.875.890	0,46
2023	6.517.283.352	2.978.156.129	7.051.529	0,46
2024	7.617.283.352	3.473.193.984	8.223.655	0,46
2025	8.717.283.352	3.870.223.131	9.163.721	0,44
2026	9.817.283.352	4.355.684.975	10.313.173	0,44
2027	10.917.283.352	4.842.255.218	11.465.250	0,44
2028	12.017.283.352	5.248.633.369	12.427.452	0,44
2029	13.117.283.352	5.723.173.721	13.551.045	0,44
2030	14.217.283.352	6.197.952.765	14.675.203	0,44

For the international flight, in 2030 it is predicted to generate a cumulative emission 53,4 mega ton CO_2. However, by implementing the measures planned on the national action for mitigating the CO_2 emission, the emission will be reduced by 3 mega ton or 5,67% compares to the BAU emission to become only 50,4 mega ton cumulatively.

For the domestic flight, in 2030 it is predicted to generate a cumulative emission 134,2 mega ton CO_2. However, by implementing the measures planned on the national action for mitigating the CO_2 emission, the emission will be reduced by 21,85 mega ton or 16,28% compares to the the BAU emission to become only 112,4 mega ton cumulatively.

And for the total of international dan domestic flight, in 2030 it is predicted to generate a cumulative emission 287,6 mega ton CO_2. However, by implementing the measures planned on the national action for mitigating the CO_2 emission, the emission will be reduced by 24,88 mega ton or 13,26% compares to the the BAU emission to become only 162,7 mega ton cumulatively.

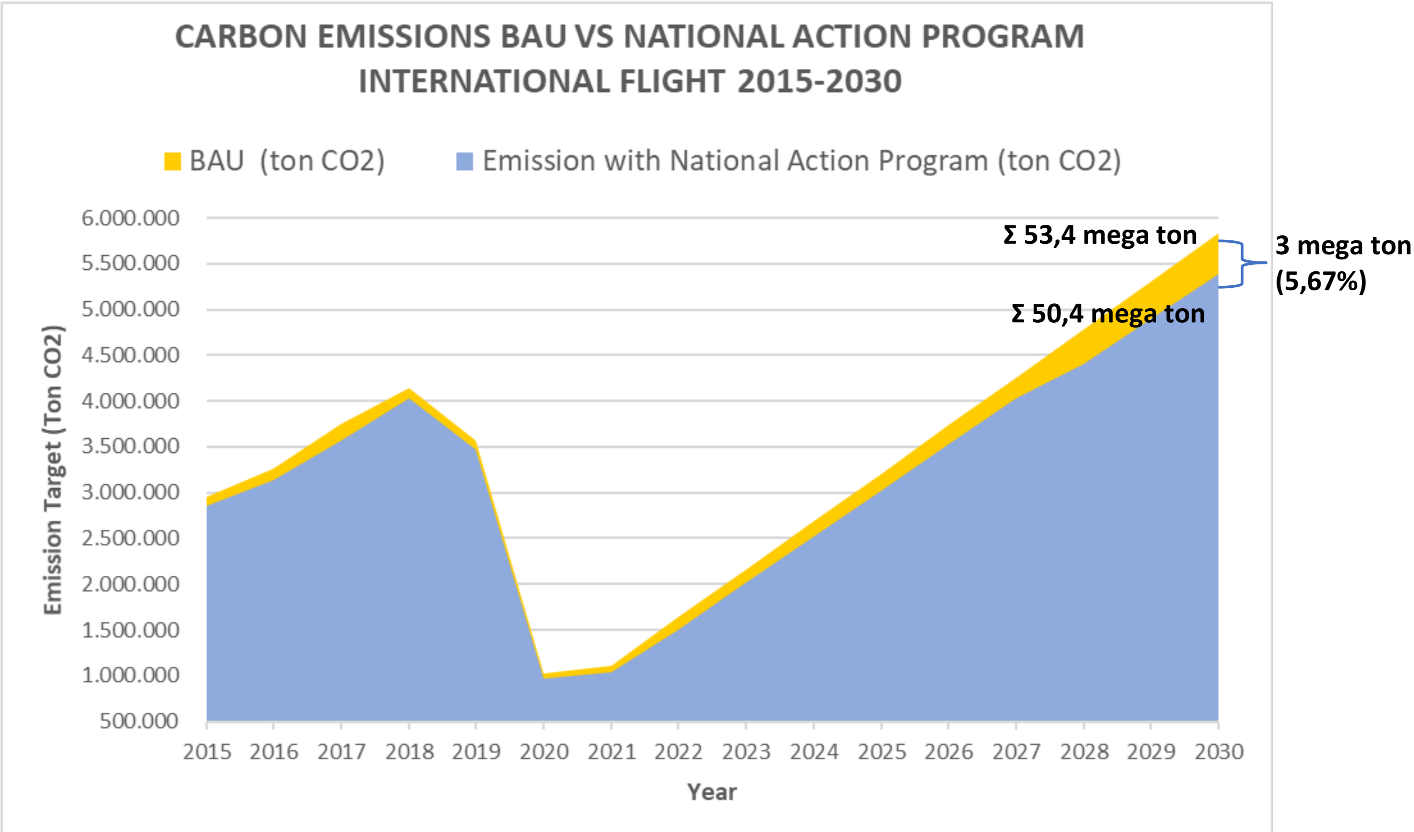


Figure 10 Carbon Emissions BAU VS National Action Program for International Flight

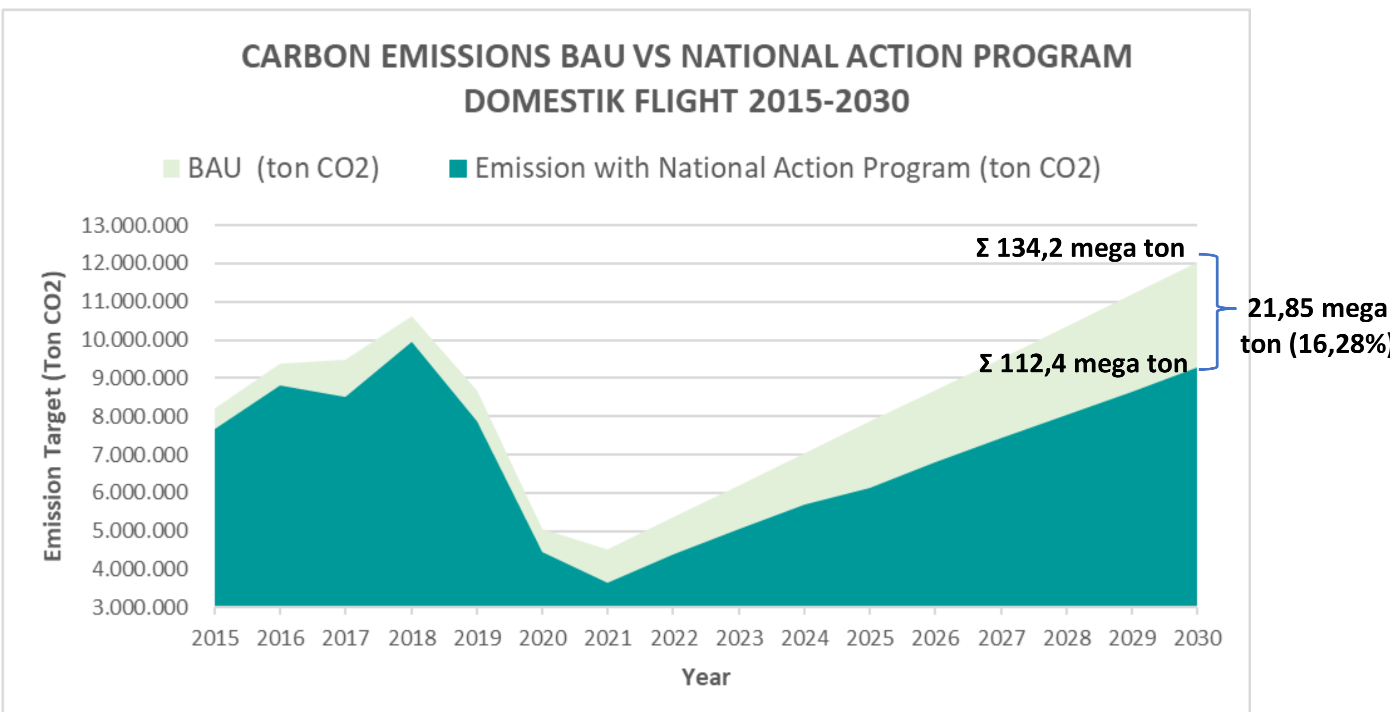


Figure 11 Carbon Emissions BAU VS National Action Program for Domestic Flight

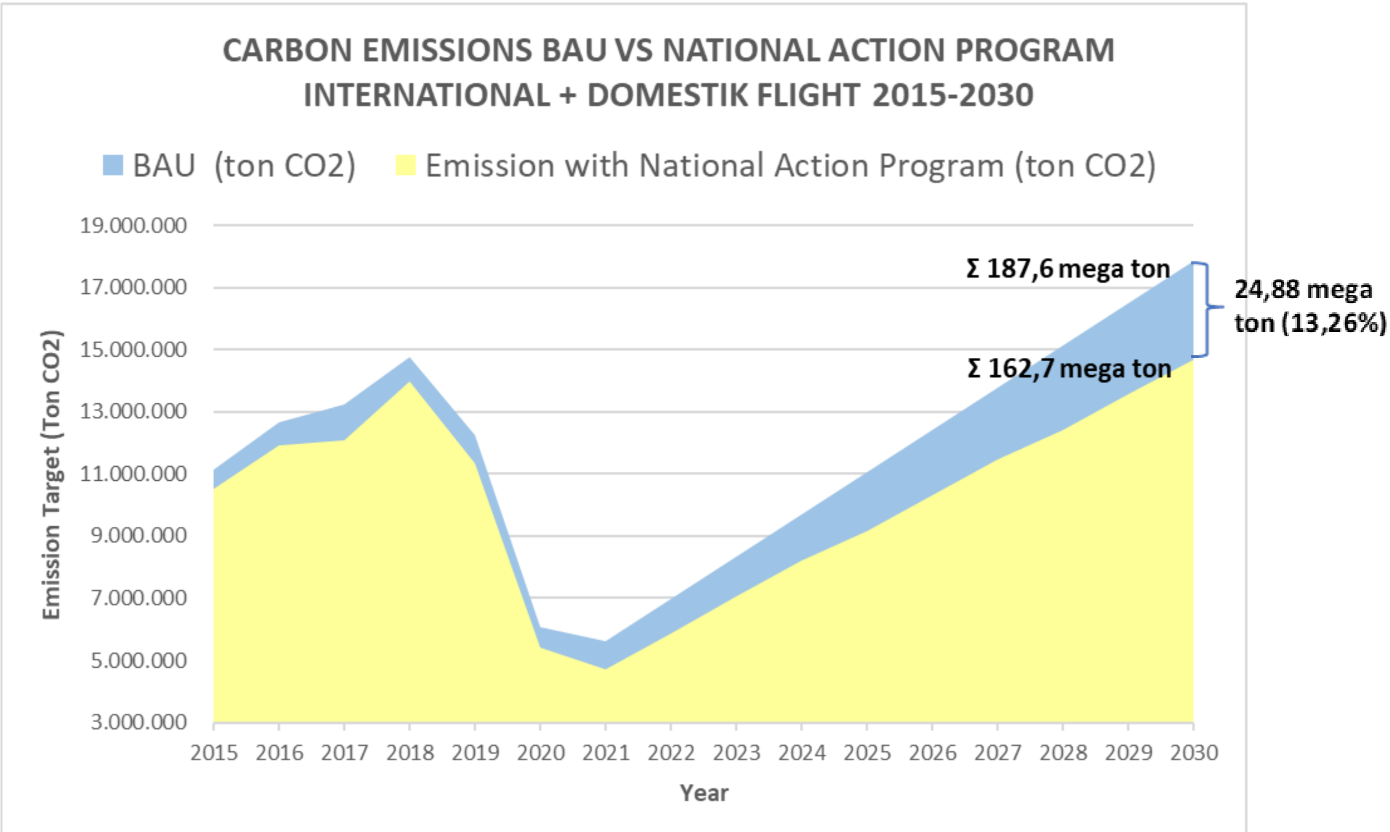


Figure 12 Carbon Emissions BAU VS National Action Program for All Flight

5. ASSISTANCE NEEDS

Indonesia still has many to improve to maximize the effort in mitigation the CO_2 Emission from the aviation sector. There for, assistance is needed in terms of capacity building, sharing knowledge and joint project, both in policy and implementation side. Some topics that are relevant for Indonesia's action plan are such as:

- Development of green technology for aviation around the world
- Capacity building about the development of sustainable aviation fuel from the authority role and sharing experience in its implementation
- Topic of Navigation and airport system management

6. CONTACT INFORMATION

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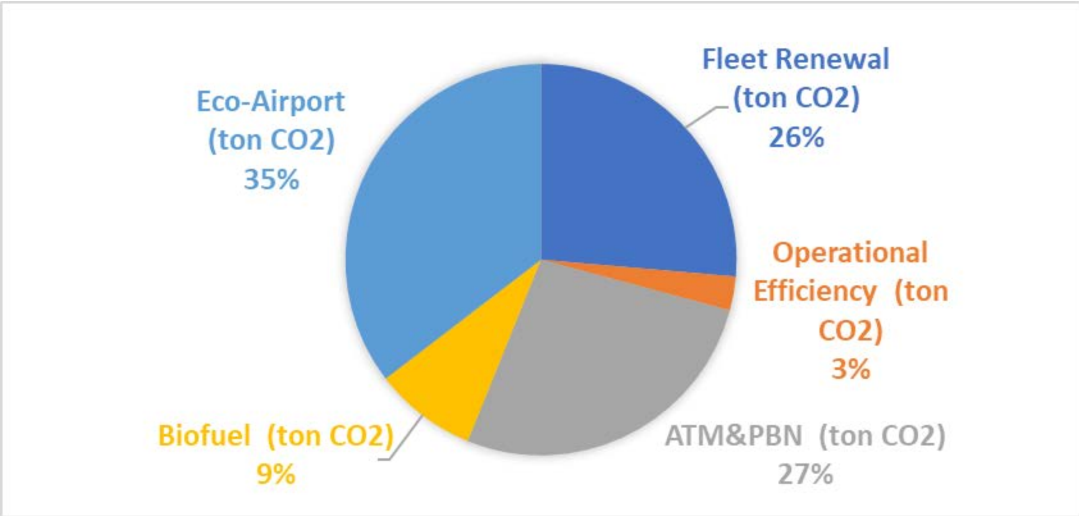
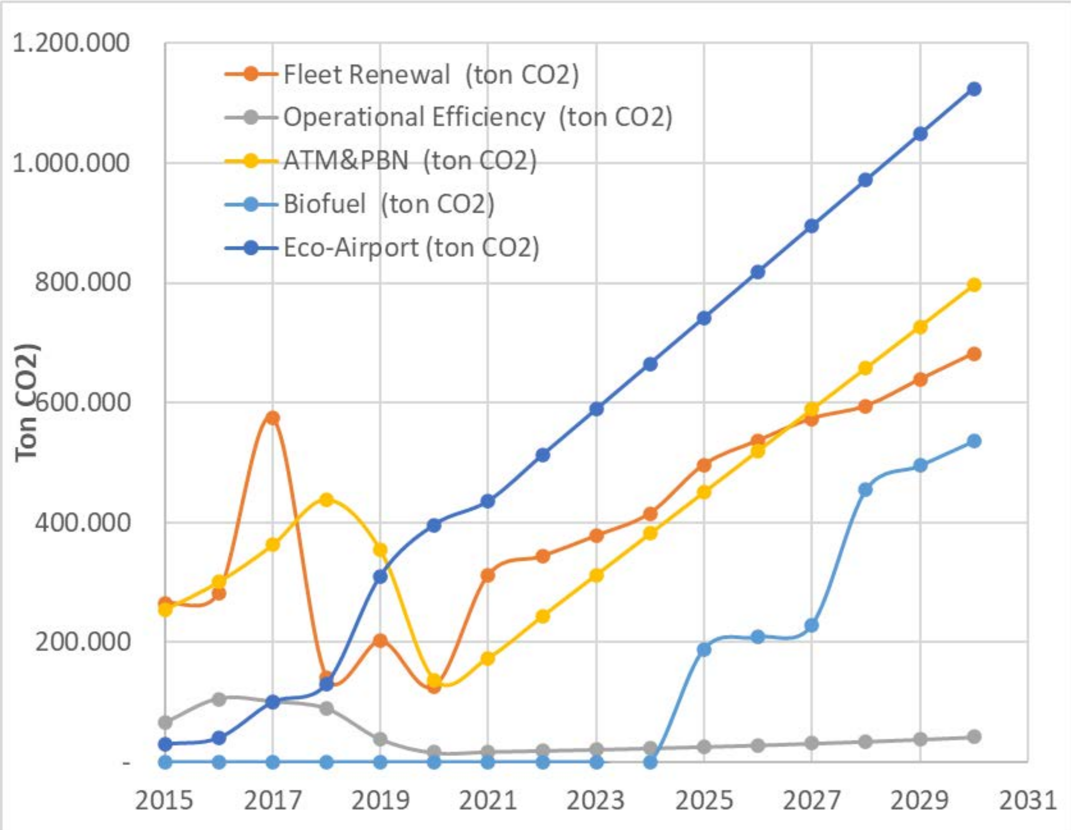
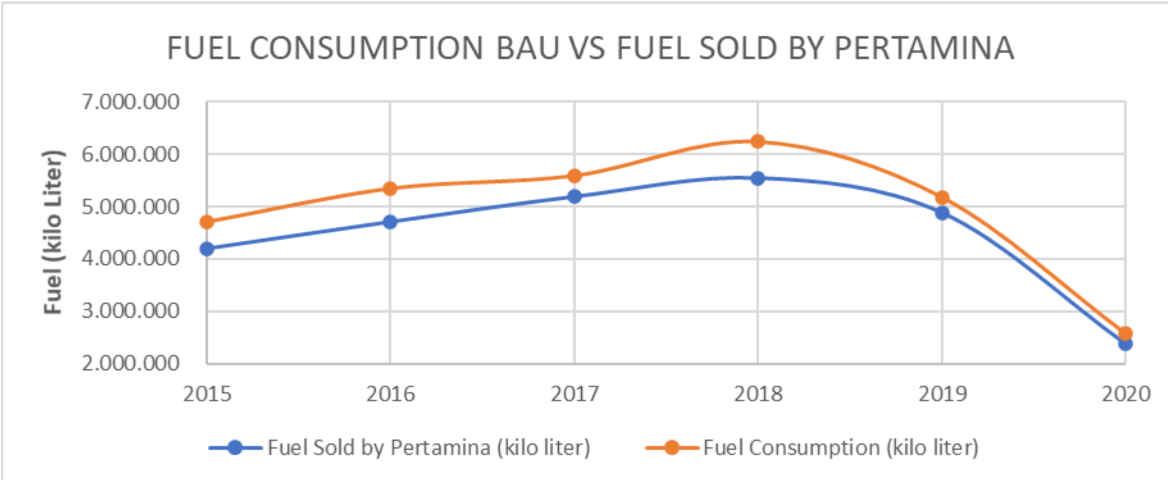
— END OF ACTION PLAN —

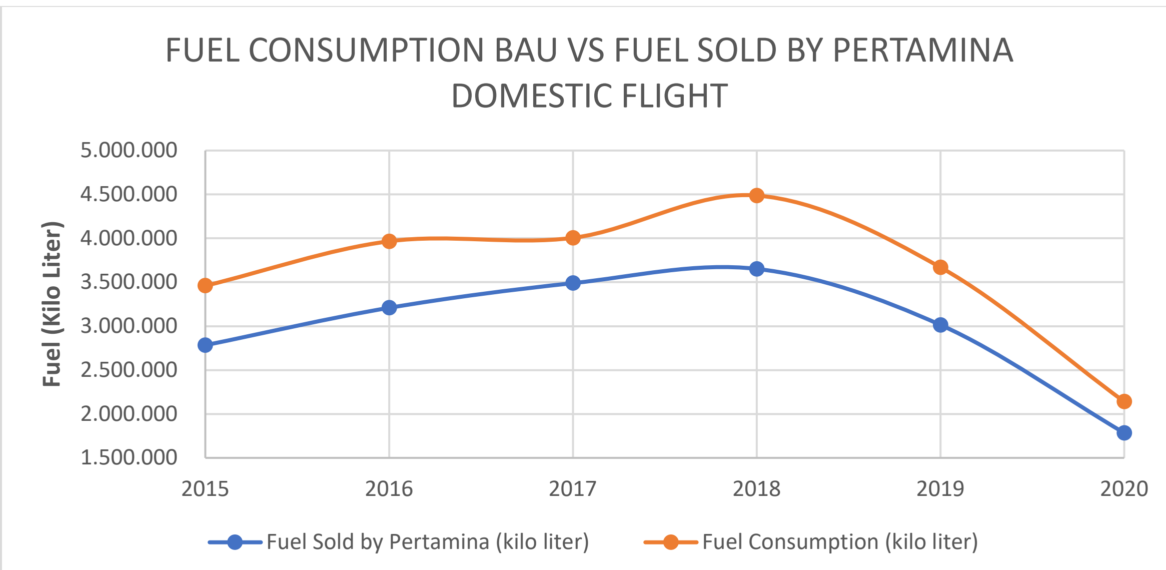
APPENDIX

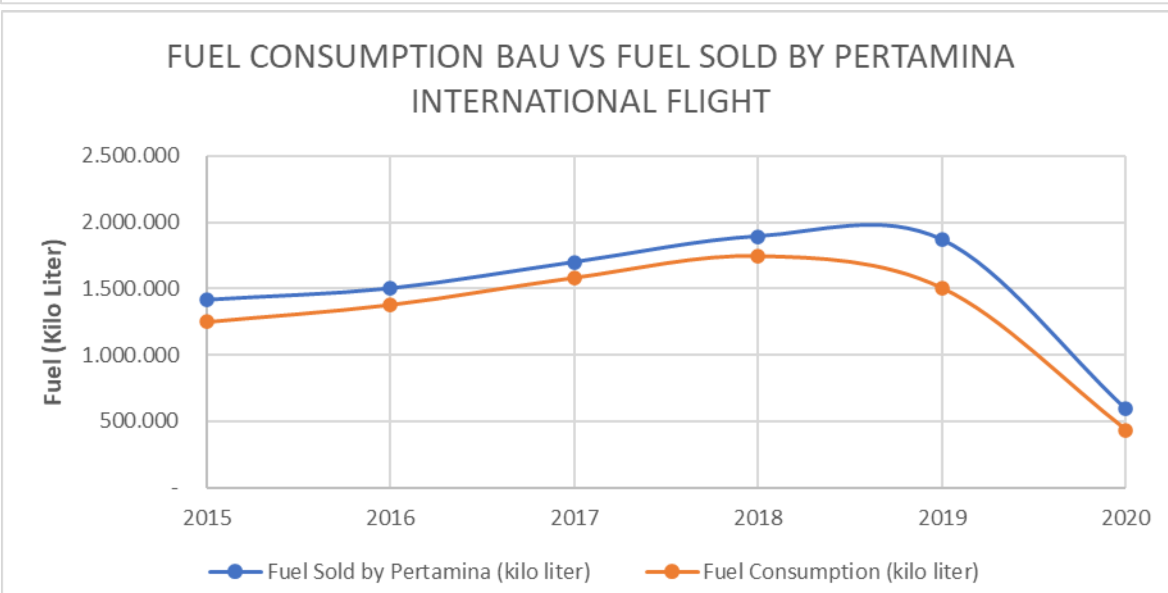
EMISSION REDUCTION PROGRAM
INDONESIA NATIONAL PLAN ACTION
CUMULATIVE 2030






FUEL CONSUMPTION BAU VS FUEL SOLD BY PERTAMINA
Fuel (kilo Liter)
7.000.000
6.000.000
5.000.000
4.000.000
3.000.000
2.000.000
2015
2016
2017
2018
2019
2020
Fuel Sold by Pertamina (kilo liter)
Fuel Consumption (kilo liter)


FUEL CONSUMPTION BAU VS FUEL SOLD BY PERTAMINA
DOMESTIC FLIGHT
Fuel (Kilo Liter)
5.000.000
4.500.000
4.000.000
3.500.000
3.000.000
2.500.000
2.000.000
1.500.000
2015
2016
2017
2018
2019
2020
Fuel Sold by Pertamina (kilo liter)
Fuel Consumption (kilo liter)


FUEL CONSUMPTION BAU VS FUEL SOLD BY PERTAMINA
INTERNATIONAL FLIGHT
Fuel (Kilo Liter)
2.500.000
2.000.000
1.500.000
1.000.000
500.000
-
2015
2016
2017
2018
2019
2020
Fuel Sold by Pertamina (kilo liter)
Fuel Consumption (kilo liter)