DIRECTORATE GENERAL OF
CIVIL AVIATON
TURKEY

ICAO State Action Plan
for
Emission Reduction
TURKEY

June 2018

ICAO Action Plan on CO_2 Emission Reduction of Turkey.

Directorte General of Civil Aviation TURKEY

Gazi Mustafa Kemal Bulvarı No:128/A
06570 Maltepe / ANKARA

Principal Contacts	Deniz KAYMAK Asst. Aviation Expert T +90 312 203 61 02 deniz.kaymak@shgm.gov.tr	Ahmet Berkan KORKMAZ Asst. Aviation Expert T +90 312 203 60 87 ahmet.korkmaz@shgm.gov.tr

DGCA 2018

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1.Intrduction

a) Turkey, is a member of the European Civil Aviation Conference (ECAC). ECAC is an intergovernmental organisation covering the widest grouping of Member States1 of any European organisation dealing with civil aviation. It is currently composed of 44 Member States, and was created in 1955.

b) ECAC States share the view that environmental concerns represent a potential constraint on the future development of the international aviation sector. Together they fully support ICAO's on-going efforts to address the full range of these concerns, including the key strategic challenge posed by climate change, for the sustainable development of international air transport.

c) Turkey, like all of ECAC's forty-four States, is fully committed to and involved in the fight against climate change and works towards a resource-efficient, competitive and sustainable multimodal transport system.

d) Turkey recognizes the value of each State preparing and submitting to ICAO an updated State action plan for CO2 emissions reductions as an important step towards the achievement of the global collective goals agreed since the 38th Session of the ICAO Assembly in 2013.

e) In that context, it is the intention that all ECAC States submit to ICAO an action plan . This is the action plan of Turkey.

f) Turkey shares the view of all ECAC States that a comprehensive approach to reducing aviation CO_2 emissions is necessary, and that this should include:

i. emission reductions at source, including European support to CAEP work in this matter (standard setting process),

ii. research and development on emission reductions technologies, including public-private partnerships,

1 Albania, Armenia, Austria, Azerbaijan, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Georgia, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Moldova, Monaco, Montenegro, Netherlands, Norway, Poland, Portugal, Romania, San Marino, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, The former Yugoslav Republic of Macedonia, Turkey, Ukraine, and the United Kingdom

iii. development and deployment of low-carbon, sustainable alternative fuels, including research and operational initiatives undertaken jointly with stakeholders,

iv. improvement and optimisation of Air Traffic Management and infrastructure use within Europe, in particular through the Single European Sky ATM Research (SESAR), and also beyond European borders, through the Atlantic Initiative for the Reduction of Emissions (AIRE) in cooperation with the US FAA, and

v. Market Based Measures, which allow the sector to continue to grow in a sustainable and efficient manner, recognizing that the measures at (i) to (iv) above cannot, even in aggregate, deliver in time the emissions reductions necessary to meet the global goals. This sustainable growth becomes possible through the purchase of carbon units that foster emission reductions in other sectors of the economy, where abatement costs are lower than within the aviation sector.

g) In Europe, many of the actions which are undertaken within the framework of this comprehensive approach are in practice taken collectively, throughout Europe, most of them led by the European Union. They are reported in Section 1 of this Action Plan, where the involvement of Turkey is described, as well as that of other stakeholders.

h) In Turkey a number of actions are undertaken at the national level, including those by stakeholders. These national actions are reported in Section 2 of this Plan.

i) In relation to European actions, it is important to note that:

i. The extent of participation will vary from one State to another, reflecting the priorities and circumstances of each State (economic situation, size of its aviation market, historical and institutional context, such as EU/ non EU). The ECAC States are thus involved to different degrees and on different timelines in the delivery of these common actions. When an additional State joins a collective action, including at a later stage, this broadens the effect of the measure, thus increasing the European contribution to meeting the global goals.

ii. Acting together, the ECAC States have undertaken to reduce the region's emissions through a comprehensive approach. Some of the measures, although implemented by some, but not all of ECAC's 44 States, nonetheless yield emission reduction benefits across the whole of the region (for example research, ETS).

2. General Information about Turkey

Turkey is a country located at a point where the 3 continents of the world (Asia, Africa and Europe) are closest to each other and where Asia and Europe meets. **Figure 1** shows the location of Turkey on the map, as can be seen from the figure the country lies like a natural bridge between Asia and Europe.

Figure 1. Location of Turkey

Turkey has been experiencing an economic growth in unprecedented rates since the beginning of the last decade. Such macro-economic success had inevitably spilled over to several different business sectors and aviation is one of the leading among them. As a result of remarkable economic growth, aviation sector in Turkey has experienced significant progress in public air transport and the country has become one of the leading countries in airway passenger transportation as well as airport construction and management both in Europe and in the world.

It is important to mention that Turkey's geographical position which sets the country in between Asia and Europe contributes to the development of the aviation

sector in Turkey. Thanks to its geographical position Turkey has managed to transform itself in to a transit hub especially for the transatlantic flights departing from North America and flying to the Middle East.

As in many developing countries the civil aviation sector is crucial supporter of trade activities of the country and a foremost promoter of the tourism sector. However, dependency of the sector on such variables creates a delicate situation for the country. Fluctuations in the world economy and within the country, seasonal changes and some other factors bring about consequences that can immediately affect the sector. As a result, in general terms the dynamism of the aviation sector is actually one of the most important determiners for the potential of the country.

2.1. Structure of the Civil Aviation Sector

Directorate General of Civil Aviation (DGCA) is the main body regulating the civil aviation sector in Turkey. Turkish DGCA established under the auspices of the Ministry of Transportation, Maritime Affairs and Communications (MoTMC) as a public legal entity with private budget status.

Mission of the Turkish DGCA is to ensure reliability and sustainable development of Turkish Civil Aviation.

Vision of the Turkish DGCA is to establish a strong, independent and participatory corporate structure and to achieve a globally efficient and reputable position in the field of civil aviation.

The quality policy is to provide efficient and reputable civil aviation management services, which are open to all stakeholders, which are participatory and committed to ethical principles, and which are geared towards further enhancing the system on a continuous basis; through our commitment to the principle of ensuring flight safety and security and sustainable development in civil aviation, and an excellence-oriented approach.

The organizational chart shown in Figure 2 and the main duties and responsibilities of the Turkish DGCA are outlined below:

- To determine the principles that would ensure the establishment and further development of civil aviation activities and the related technical, economic, and social developments, in line with public interest and national security purposes; to follow up implementation of these principles; and to audit the same,

- To designate airworthiness terms of commercial aircrafts that operate in the airspace of Turkey; to issue relevant documentation and to register aircraft; to audit licenses of flight crew in accordance with the legislation,

- To determine the licensing terms of personnel, who work in Turkish civil aviation industry, as required by their specialization; to issue such licenses and to register such personnel,

- To regulate the terms and conditions for the permissions to be granted for Turkish real or legal persons, who seek to perform air transportation activities in or out of the country, and for foreign real or legal persons, who seek to perform transportation activities in the country; and to audit their activities,

- To regulate and audit air navigation of commercial aircraft, as well as traffic communication services in Turkey's airspace in line with public safety, by consulting with related institutions and to take the required precautions in this regard,

- To set the technical qualities and operating conditions of the airports in terms of air navigation safety, and to inspect the implementations in this regard,

- To follow up the developments in the field of international civil aviation, to take measures in order to incorporate these developments to the civil

aviation activities carried out in Turkey; to ensure that civil aviation plans are prepared; and to collaborate with other international organizations for the implementation of these plans,

- To collaborate with relevant organizations in air search and rescue operations carried out in Turkish airspace; to investigate civil aviation accidents and to take the required measures as per the results of such investigations,
- To lay down and regulate the establishment and working principles of civil aviation training organizations,
- To take legal action against real and legal persons acting in violation of the legislations and rules, under which the civil aviation activities are regulated and
- To follow the implementation of international bilateral and multilateral agreements regarding air transportation, to participate in the works carried out in this regard.

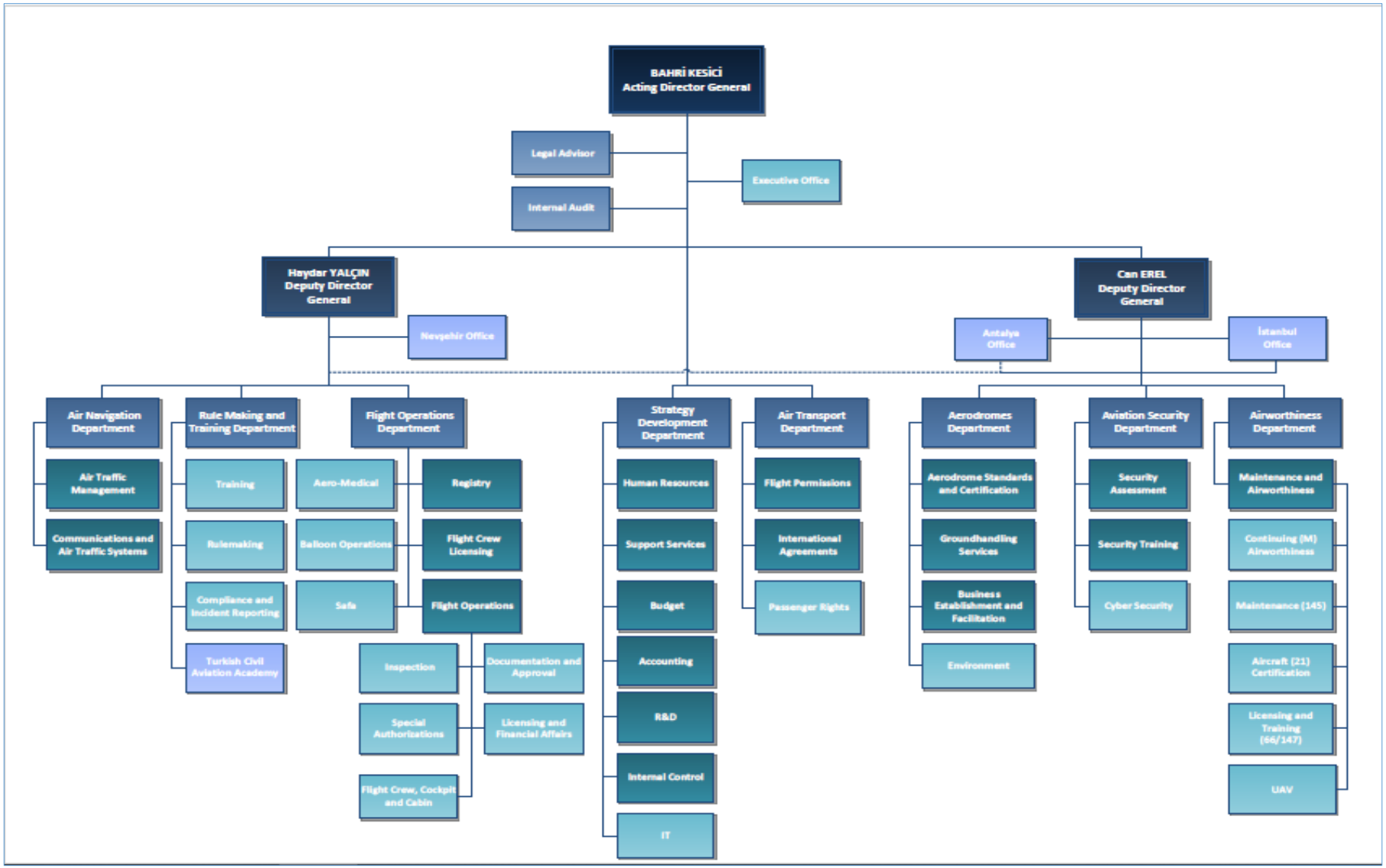


Figure 2. Organizational Chart of Civil Aviation Authority

2.2. Current Status of Aviation

Turkey's airline industry has been developing significantly due to its position and connections with other countries, which is foreseen to progress in the coming years in terms of passenger and flight traffic.

The stability gained, the measures taken, and the liberalization policies applied in the aviation industry as of 2003 have led to the industry's further growth, which in turn, made the industry an important actor for our country's economic development and wealth.

Development of air transportation expands international trade, enables easier and faster travelling, and boosts tourism. Moreover, a modern and strong aviation system also supports realization of Turkey's goals within the scope of the EU harmonization process.

The growth performance of Turkey's aviation industry is three times that of the world average. While the global industry has seen an average growth rate of 5% in the last two years, Turkey's rate of growth over the same period was 15%. The number of people employed by Turkey's aviation industry increased from its level of approximately 65 thousand people in 2003, to over 196 thousand as of the end of 2017.

As of 2017, Turkey has 55 airports open to civil commercial air traffic, where 50 of these are international airports. The major airports can be listed as İstanbul Atatürk Airport, İstanbul Sabiha Gökçen Airport, Ankara Esenboğa Airport, İzmir Adnan Menderes, Antalya Airport, Trabzon Airport and Adana Airport. Locations of the airports are provided in the Figure 3 below and the number of international and domestic airports at years 2014 and 2017 are shown in the **Table 1** respectively.

Figure 3. Location of Airports

Table 1. Number of Airports in Turkey

Aerodromes	2014	2017
Domestic-International Lines	25	50
Domestic Lines	28	5
Total	53	55

On the other hand, investments to the aviation sector still continues and the biggest project of Turkish Republic, "İstanbul New Airport" is being constructed. Once completed and fully operated, it will be the world's largest airport with three terminals, six runways, and annual capacity of up to 200 million passengers. The construction is divided into four phases, the completion of the first phase and the opening of Istanbul New Airport is planned for 29 October 2018, Republic Day in Turkey. In Figure 4 Overview of the İstanbul New Airport is shown. The capacity-related problems encountered at Atatürk and Sabiha Gökçen Airports are targeted to be overcome with the third airport, in support of the increasing number of international passengers.

Figure 4. Overview of the İstanbul New Airport

Due to the special geographical position and rapid expansion in the economic growth, air transportation in Turkey is developing much faster than other European countries. The annual growth rate of the flight traffic had slightly exceeded 10% and the passenger traffic had reached 12% of annual growth rate for the last seven years. Aircraft movements and total passengers are given in the **Table 2** and **Table 3** respectively.

Table 2. Aircraft Movements at Major Airports

Movements	Airports					
	İstanbul Atatürk	Sabiha Gökçen	Ankara Esenboğa	İzmir Adnan Menderes	Antalya	Turkey Total
2010	288,246	105,962	73,929	63,178	148,821	919,411
2011	325,209	121,407	82,965	70,327	164,732	1,042,369
2012	364,322	126,043	85,883	73,152	160,984	1,093,047
2013	406,317	150,575	96,818	76,865	171,543	1,223,795
2014	439,532	186,152	94,418	81,756	177,884	1,345,954
2015	464,774	219,158	98,61	86,994	174,715	1,456,673

Movements	Airports					
	İstanbul Atatürk	Sabiha Gökçen	Ankara Esenboğa	İzmir Adnan Menderes	Antalya	Turkey Total
2016	466,396	231,927	105,61	86248	127,358	1,452,995
2017	460,785	220,171	117,837	89,907	159,335	1,500,457

Table 3. Total Passengers at Major Airports

Total Passengers	Airports					
	İstanbul Atatürk	Sabiha Gökçen	Ankara Esenboğa	İzmir Adnan Menderes	Antalya	Turkey Total
2010	32,143,819	11,189,678	7,763,914	7,485,098	22,013,027	102,800,392
2011	37,394,694	13,124,670	8,485,467	8,523,533	25,027,657	117,620,469
2012	32,143,819	14,686,052	9,273,108	9,355,902	25,096,144	130,351,620
2013	51,297,790	18,521,762	10,942,060	10,233,140	27,018,623	149,430,421
2014	56,695,166	23,494,646	11,035,606	10,970,663	28,303,192	165,720,234
2015	61,332,124	28,108,738	12,113,439	12,178,100	27,769,404	181,074,531
2016	60,415,470	29,667,853	13,044,116	12,051,243	18,768,535	173,738,174
2017	64,106,104	31,386,038	15,817,158	12,824,310	25,872,451	193,045,343

Progressive increase of aircraft movements at the major airports and associated heightening of the number of passenger can be realized more accurately in the Figure 5 and Figure 6 provided below.

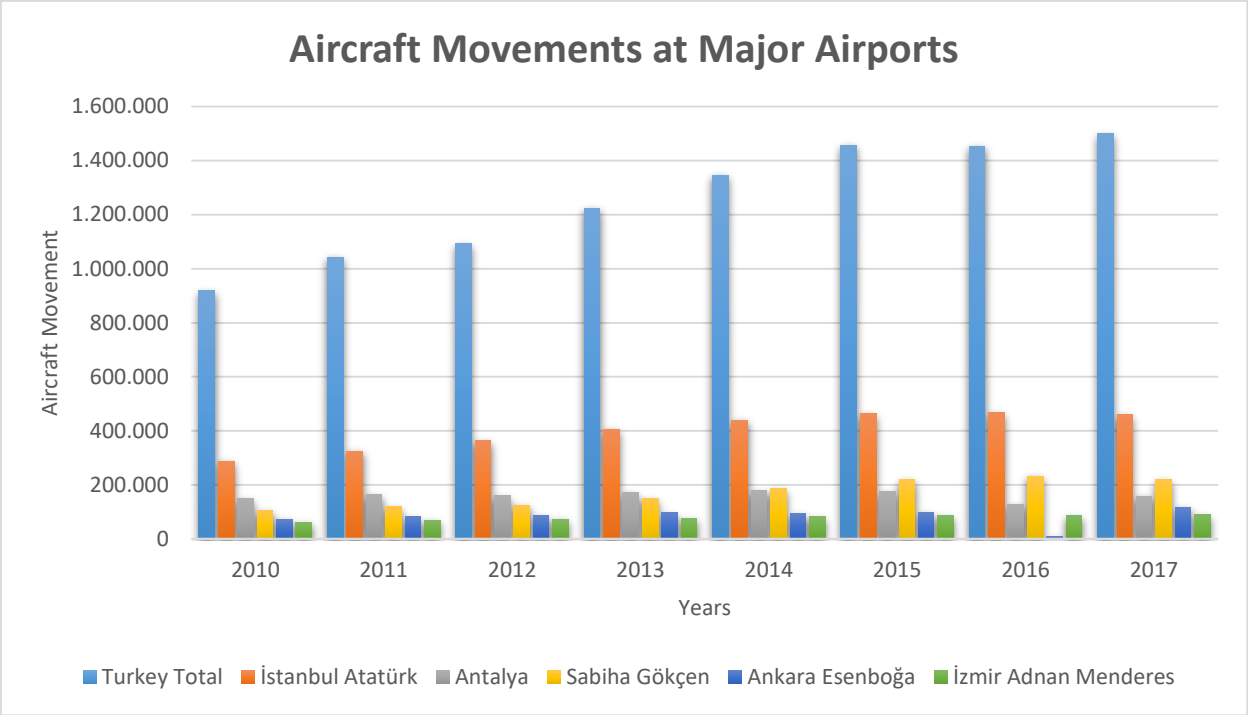


Figure 5. Aircraft Movements at Major Airports

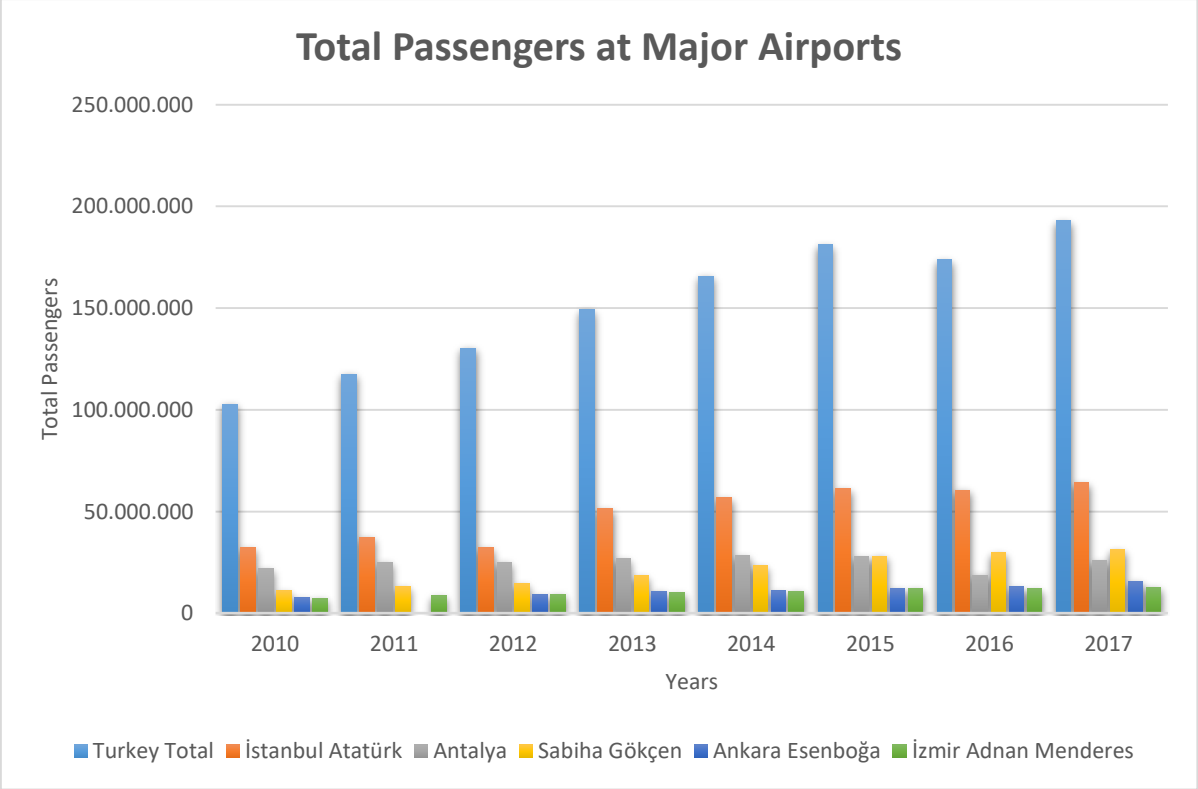


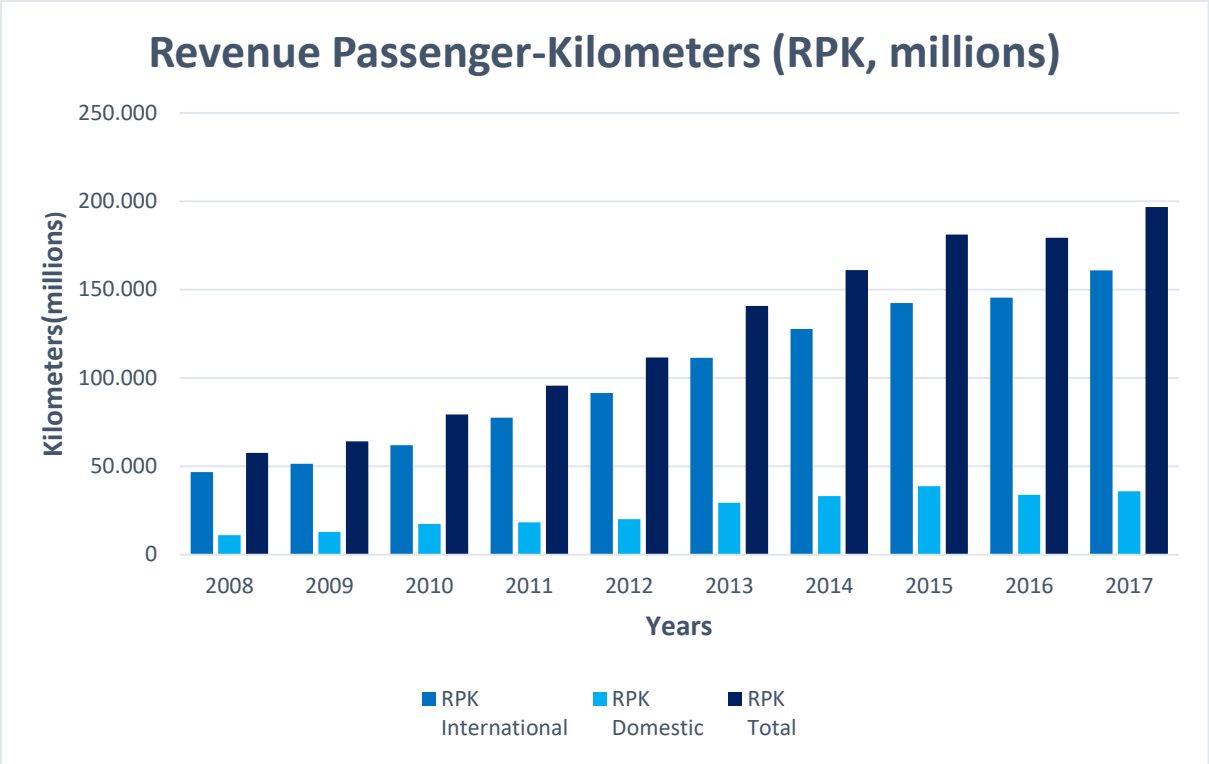
Figure 6.Total Passengers at Major Airports

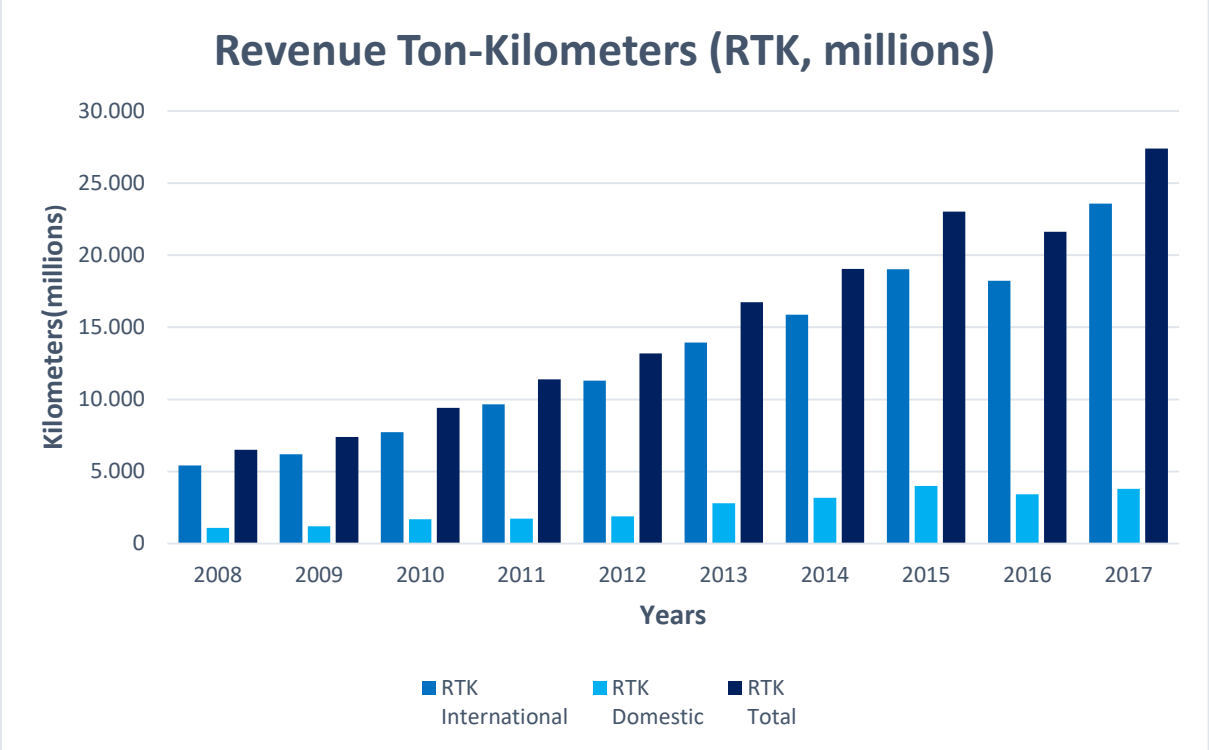
2.3. Air Traffic Data

Table 4 below shows the scheduled and non-scheduled transport performance of commercial air traffic of Turkey in the past ten years, measured in revenue passenger-kilometers (RPK) and freight/mail tonne-kilometres (FTK) respectively. Also the passenger and cargo transport capacities in terms of revenue tonne-kilometres (RTK) is shown.

Table 4. Scheduled and Non-Scheduled Air Transport Data of Turkey

	Revenue Passenger-Kilometers (RPK, millions)			Freight/Mail Tonne-Kilometres (FTK, millions)			Revenue Tonne-Kilometres (RTK, millions)		
Year	International	Domestic	Total	International	Domestic	Total	International	Domestic	Total
2017	160,918	35,926	196,844	4,906	64	4,970	23,592	3,805	27,397
2016	145,435	33,886	179,321	3,558	26	3,584	18,227	3,407	21,634
2015	142,315	38,779	181,094	3,024	26	3,050	19,041	3,987	23,028
2014	127,805	33,170	160,975	2,999	30	3,029	15,882	3,163	19,045
2013	111,450	29,311	140,761	2,671	24	2,695	13,951	2,802	16,753
2012	91,520	20,057	111,577	2,273	21	2,294	11,306	1,882	13,188
2011	77,495	18,197	95,692	1,860	19	1,879	9,648	1,735	11,383
2010	61,931	17,442	79,373	1,442	19	1,461	7,722	1,687	9,409
2009	51,357	12,837	64,194	1091	17	1,108	6,196	1,206	7,402
2008	46,643	11,029	57,672	749	33	782	5,408	1,087	6,495


Revenue Passenger-Kilometers (RPK, millions)
250.000
200.000
150.000
100.000
50.000
0
Kilometers(millions)
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
Years
RPK International
RPK Domestic
RPK Total


Revenue Ton-Kilometers (RTK, millions)
30.000
25.000
20.000
15.000
10.000
5.000
0
Kilometers(millions)
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
Years
RTK International
RTK Domestic
RTK Total

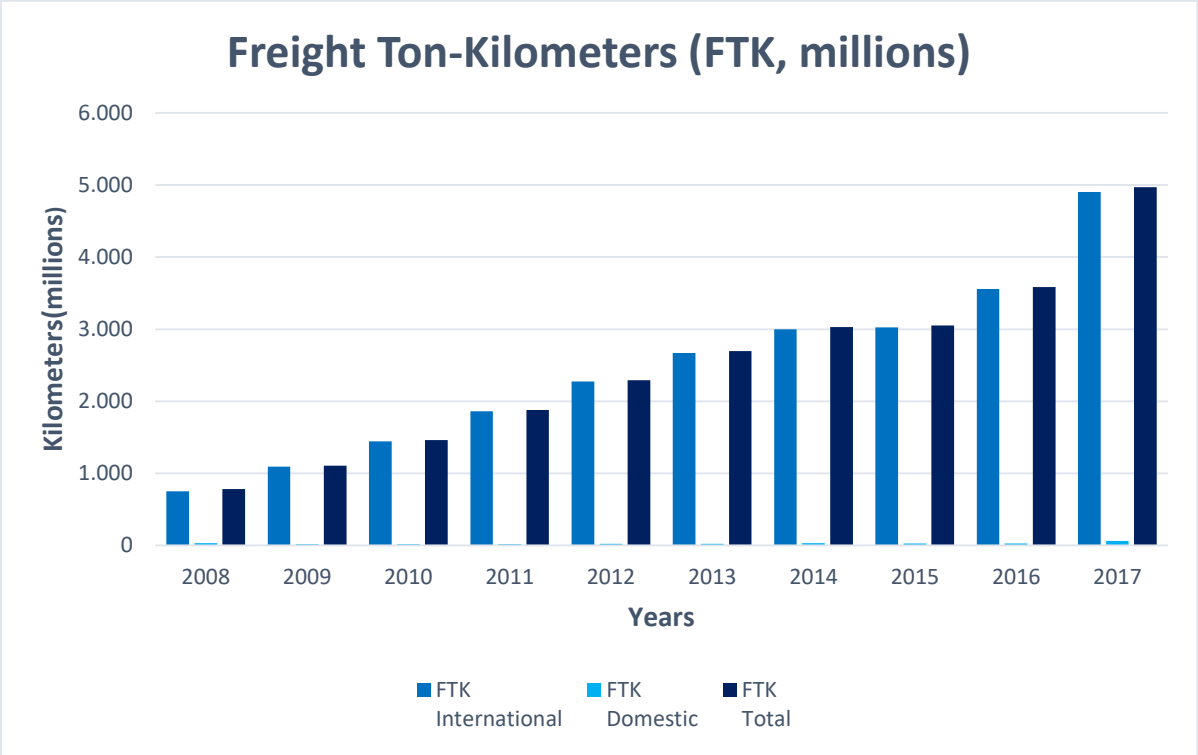
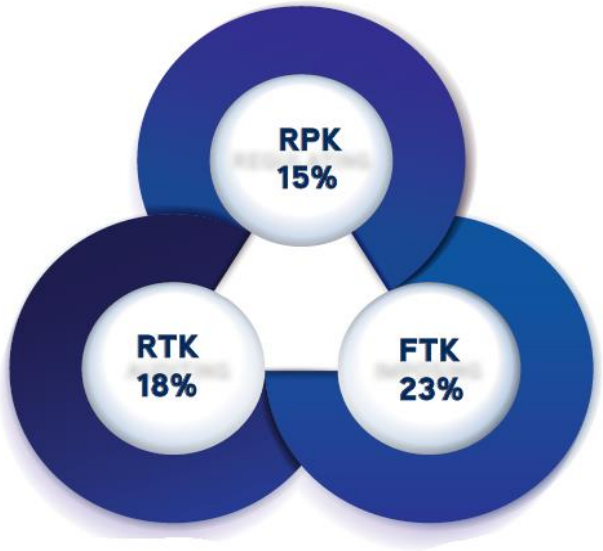


Figure 7. Development of RPK, RTK and FTK in Turkey



To visualize the development of air traffic in Turkey, Figure 7 above is provided in terms of RPK, RTK and RFTK by separating international and domestic flights. A remarkable increase have performed in air transport of Turkey between years 2008-2017. Revenue Passenger-Kilometers is tripled in last seven-eight years with an average 15% increase annually and reached to 196,844 million in 2017. Similarly Revenue Tonne-Kilometer is nearly quadrupled between years 2008-2015, with an annual average 18% increase reached up to 27,397 million. On the other hand, Freight Tonne-Kilometer was recorded as 782 million in 2008 and with an average 25% increase annually reached 4,970 million in 2017.

According to Annual Reports of the ICAO Council published in 2017 Turkey ranks;

- 12th worldwide by RPK,
- 11th worldwide by RTK,
- 13th worldwide by FTK.

Figure 8 below shows the Turkey's place in global air transportation industry for the year 2017.

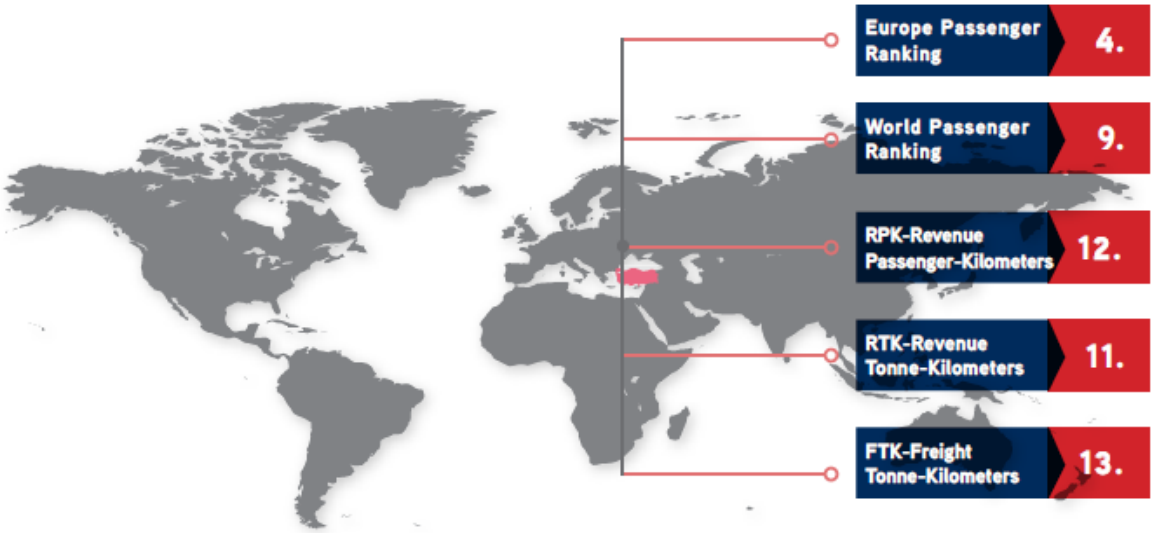


Figure 8. Turkey's Place in Global Air Transportation Industry in 2017

In addition to extensive growth of air transport in Turkey, the fleet age is significantly young this situation contributes to the fuel efficiency. The average fleet age of the passenger aircrafts in Turkey is around 7-9.

3.ECAC Baseline Scenario

The baseline scenario is intended to serve as a reference scenario for CO_2 emissions of European aviation in the absence of any of the mitigation actions described later in this document. The following sets of data (2010, 2016) and forecasts (for 2020, 2030 and 2040) were provided by EUROCONTROL for this purpose:

European air traffic (includes all commercial and international flights departing from ECAC airports, in number of flights, revenue passenger kilometres (RPK) and revenue tonne-kilometres (RTK)), its associated aggregated fuel consumption, its associated CO_2 emissions.

The sets of forecasts correspond to projected traffic volumes in a scenario of "Regulation and Growth", while corresponding fuel consumption and CO_2 emissions assume the technology level of the year 2010 (i.e. without considering reductions of emissions by further aircraft related technology improvements, improved ATM and operations, alternative fuels or market based measures).

Traffic Scenario "Regulation and Growth"

As in all forecasts produced by EUROCONTROL, various scenarios are built with a specific storyline and a mix of characteristics. The aim is to improve the understanding of factors that will influence future traffic growth and the risks that lie ahead. In the 20 year forecasts published by EUROCONTROL the scenario called 'Regulation and Growth' is constructed as the 'most likely' or 'baseline' scenario for traffic, most closely following the current trends. It considers a moderate economic growth, with some regulation particularly regarding the social and economic demands.

Amongst the models applied by EUROCONTROL for the forecast the passenger traffic sub-model is the most developed and is structured around five main group of factors that are taken into account:

Global economy factors represent the key economic developments driving the demand for air transport.

Factors characterizing the **passengers** and their travel preferences change patterns in travel demand and travel destinations.

Price of tickets set by the airlines to cover their operating costs influences passengers' travel decisions and their choice of transport.

More hub-and-spoke or point-to-point **networks** may alter the number of connections and flights needed to travel from origin to destination.

Market structure describes size of aircraft used to satisfy the passenger demand (modelled via the Aircraft Assignment Tool).

Table 5. Summary characteristics of EUROCONTROL scenarios presents a summary of the social, economic and air traffic related characteristics of three different scenarios developed by EUROCONTROL. The year 2016 serves as the baseline year of the 20-year forecast results[2] updated in 2018 by EUROCONTROL and presented here. Historical data for the year 2010 are also shown later for reference.

[2] Challenges of Growth 2018: Flight forecast, EUROCONTROL September 2018 (to be published)

Table 5. Summary characteristics of EUROCONTROL scenarios

	Global Growth	*Regulation and Growth*	*Fragmenting World*
2023 traffic growth	High ↗	**Base →**	Low ↘
Passenger Demographics (Population)	Aging UN Medium-fertility variant	**Aging** **UN Medium-fertility variant**	Aging UN Zero-migration variant
Routes and Destinations	Long-haul ↗	**No Change →**	Long-haul ↘
Open Skies	EU enlargement later +Far & Middle-East	**EU enlargement** **Earliest**	EU enlargement Latest
High-speed rail (new & improved connections)	20 city-pairs faster implementation	**20 city-pairs**	20 city-pairs later implementation.
Economic conditions **GDP growth**	Stronger ↗	**Moderate →**	Weaker ↘↘
EU Enlargement	+5 States, Later	**+5 States, Earliest**	+5 States, Latest
Free Trade **Price of travel**	Global, faster	**Limited, later**	None
Operating cost	Decreasing ↘↘	**Decreasing ↘**	No change →
Price of CO_2 in Emission Trading Scheme	Moderate	**Lowest**	Highest
Price of oil/barrel	Low	**Lowest**	High
Change in other charges	Noise: ↗ Security: ↘	**Noise: ↗** **Security: →**	Noise: → Security: ↗
Structure **Network**	Hubs: Mid-East ↗↗ Europe ↘ Turkey↗ Pt-to-pt: N-Atlant.↗↗	**Hubs: Mid-East ↗↗** **Europe&Turkey ↗** **Pt-to-pt: N-Atlant.↗**	No change →
Market Structure	Industry fleet forecast + STATFOR assumptions	**Industry fleet forecast + STATFOR assumptions**	Industry fleet forecast + STATFOR assumptions

Further assumptions and results for the baseline scenario

The ECAC baseline scenario was generated by EUROCONTROL for all ECAC States. It covers all commercial international passenger flights departing from ECAC airports, as forecasted in the aforementioned traffic scenario. The number of passengers per flight is derived from Eurostat data.

EUROCONTROL also generates a number of all-cargo flights in its baseline scenario. However, no information about the freight tonnes carried is available. Hence, historical and forecasted cargo traffic have been extracted from another source (ICAO[3]). This data, which is presented below, includes both belly cargo transported on passenger flights and freight transported on dedicated all-cargo flights.

Historical fuel burn and emission calculations are based on the actual flight plans from the PRISME data warehouse used by EUROCONTROL, including the actual flight distance and the cruise altitude by airport pair. These calculations were made for 98% of the passenger flights; the remaining flights in the flight plans had information missing. Determination of the fuel burn and CO_2 emissions for historical years is built up as the aggregation of fuel burn and emissions for each aircraft of the associated traffic sample. Fuel burn and CO_2 emission results consider each aircraft's fuel burn in its ground and airborne phases of flight and are obtained by use of the EUROCONTROL IMPACT environmental model. While historical traffic data is used for the year 2016, the baseline fuel burn and emissions in 2016 and the forecast years (until 2040) are modelled in a simplified approach on the basis of the historical/forecasted traffic and assume the technology level of the year 2010.

The following tables and figures show the results for this baseline scenario, which is intended to serve as a reference case by approximating fuel consumption and CO_2 emissions of European aviation in the absence of mitigation actions.

[3] ICAO Long-Term Traffic Forecasts, Passenger and Cargo, July 2016.

Table 6. Baseline forecast for international traffic departing from ECAC airports

Year	Passenger Traffic (IFR movements) (million)	Revenue Passenger Kilometres[4] RPK (billion)	All-Cargo Traffic (IFR movements) (million)	Freight Tonne Kilometres transported[5] FTKT (billion)	Total Revenue Tonne Kilometres[14,6] RTK (billion)
2010	4.6	1,218	0.20	45.4	167.2
2016	5.2	1,601	0.21	45.3	205.4
2020	5.6	1,825	0.25	49.4	231.9
2030	7.0	2,406	0.35	63.8	304.4
2040	8.4	2,919	0.45	79.4	371.2

Table 7. Fuel burn and CO2 emissions forecast for the baseline scenario

Year	Fuel Consumption (109 kg)	CO2 emissions (109 kg)	Fuel efficiency (kg/RPK)	Fuel efficiency (kg/RTK)
2010	37.98	120.00	0.0310	0.310
2016	46.28	146.26	0.0287	0.287
2020	49.95	157.85	0.0274	0.274
2030	61.75	195.13	0.0256	0.256
2040	75.44	238.38	0.0259	0.259
For reasons of data availability, results shown in this table do not include cargo/freight traffic.				

[4] Calculated based on 98% of the passenger traffic.

[5] Includes passenger and freight transport (on all-cargo and passenger flights).

[6] A value of 100 kg has been used as the average mass of a passenger incl. baggage (ref: ICAO).

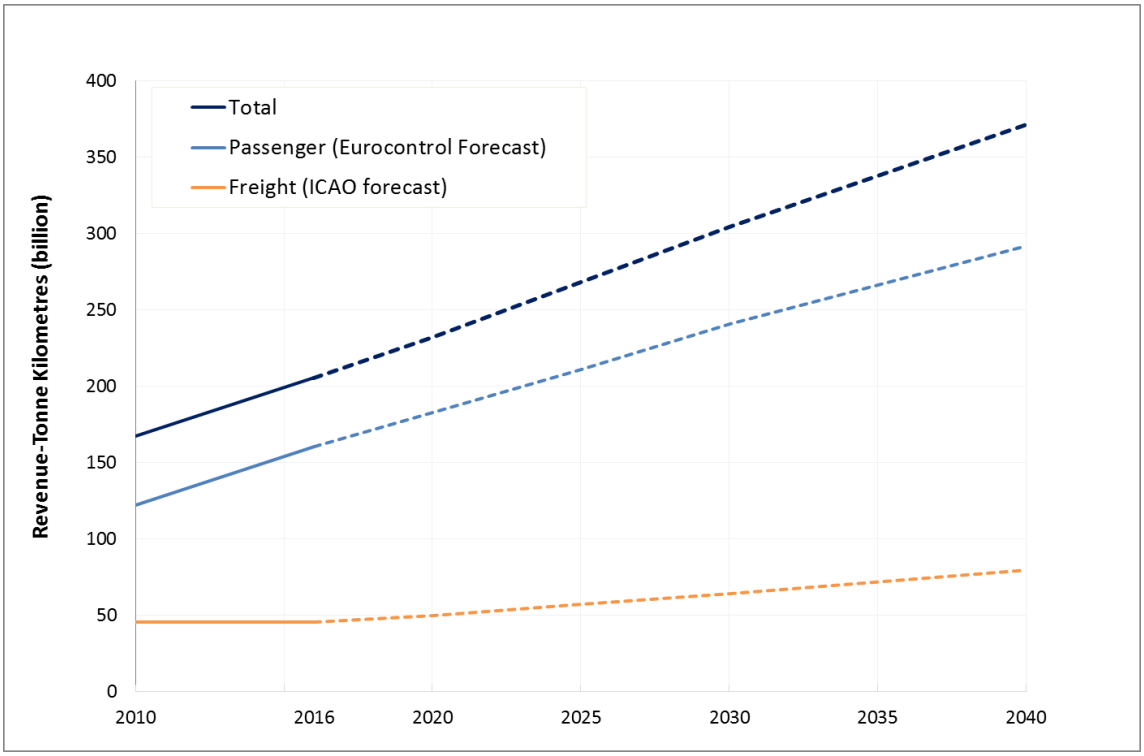


Figure 9. Forecasted traffic until 2040 (assumed both for the baseline and implemented measures scenarios)

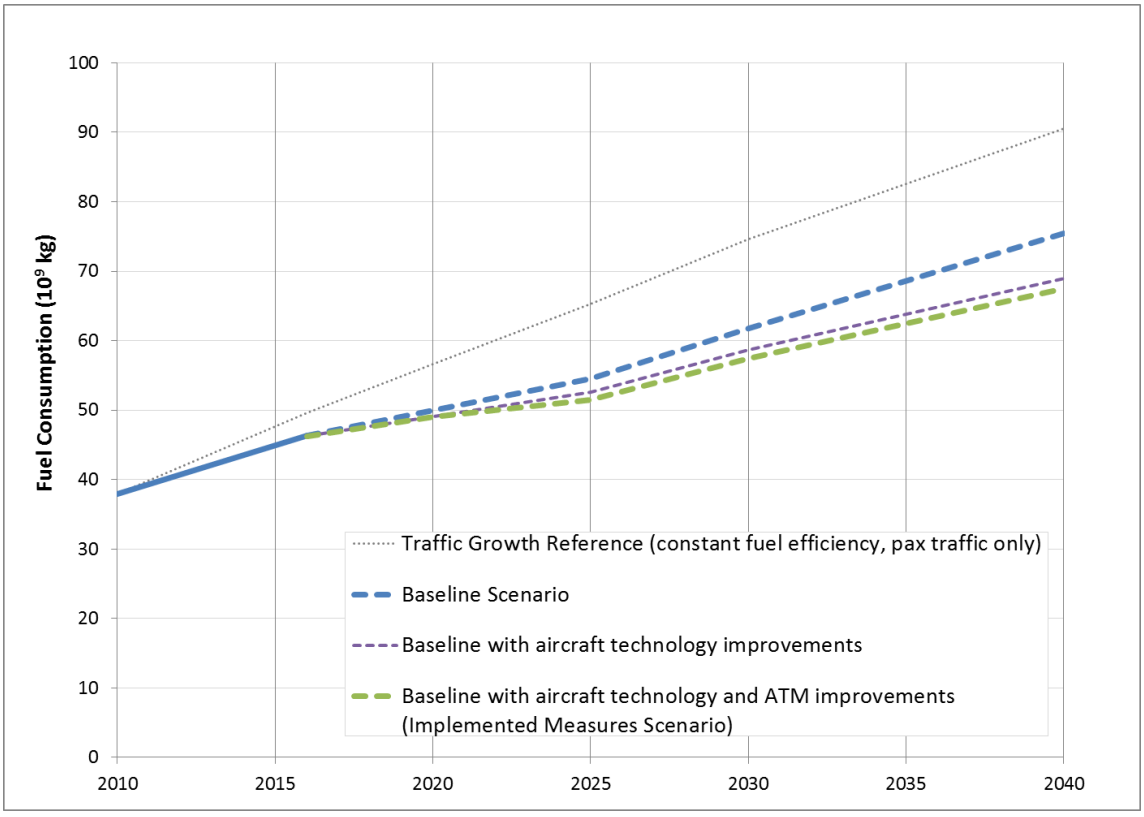


Figure 10. Fuel consumption forecast for the baseline and implemented measures scenarios (international passenger flights departing from ECAC airports)

2. ECAC Scenario with Implemented Measures, Estimated Benefits of Measures

In order to improve fuel efficiency and to reduce future air traffic emissions beyond the projections in the baseline scenario, ECAC States have taken further action. Assumptions for a top-down assessment of effects of mitigation actions are presented here, based on modelling results by EUROCONTROL and EASA. Measures to reduce aviation's fuel consumption and emissions will be described in the following chapters.

For reasons of simplicity, the scenario with implemented measures is based on the same traffic volumes as the baseline case, i.e. EUROCONTROL's 'Regulation and Growth' scenario described earlier. Unlike in the baseline scenario, the effects of aircraft related technology development, improvements in ATM/operations and alternative fuels are considered here for a projection of fuel consumption and CO_2 emissions up to the year 2040.

Effects of improved aircraft technology are captured by simulating fleet roll-over and considering the fuel efficiency improvements of new aircraft types of the latest generation (e.g. Airbus A320NEO, Boeing 737MAX, Airbus A350XWB etc.). The simulated future fleet of aircraft has been generated using the Aircraft Assignment Tool (AAT) developed collaboratively by EUROCONTROL, EASA and the European Commission. The retirement process of the Aircraft Assignment Tool is performed year by year, allowing the determination of the amount of new aircraft required each year. In addition to the fleet rollover, a constant annual improvement of fuel efficiency of 0.96% per annum is assumed to aircraft deliveries during the last 10 years of the forecast (2030-2040). This rate of improvement corresponds to the 'medium' fuel technology scenario used by CAEP to generate the fuel trends for the Assembly.

The effects of improved ATM efficiency are captured in the Implemented Measures Scenario on the basis of efficiency analyses from the SESAR project. Regarding SESAR effects, baseline deployment improvements of 0.2% in terms of fuel efficiency are assumed to be included in the base year fuel consumption for 2010. This improvement is assumed to rise to 0.3% in 2016 while additional

improvements of 2.06% are targeted for the time period from 2025 onwards[7]. Further non-SESAR related fuel savings have been estimated to amount to 1.2% until the year 2010, and are already included in the baseline calculations[8].

Regarding the introduction of sustainable alternative fuels, the European ACARE roadmap targets described in section B chapter 2.1 of this document are assumed for the implemented measures case. These targets include an increase of alternative fuel quantities to 2% of aviation's total fuel consumption in the year 2020, rising linearly to 25% in 2035 and 40% in 2050. An average 60% reduction of lifecycle CO_2 emissions compared to crude-oil based JET fuel was assumed for sustainable aviation fuels, which is in line with requirements from Article 17 of the EU's Renewable Energy Directive (Directive 2009/28/EC)[9]. The resulting emission savings are shown in Table 6 and Figure 4 in units of equivalent CO_2 emissions on a well-to-wake basis. Well-to-wake emissions include all GHG emissions throughout the fuel lifecycle, including emissions from feedstock extraction or cultivation (including land-use change), feedstock processing and transportation, fuel production at conversion facilities as well as distribution and combustion[10].

For simplicity, effects of market-based measures including the EU Emissions Trading Scheme (ETS) and ICAO's Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) on aviation's CO_2 emissions have not been modelled explicitly in the top-down assessment of the implemented measures scenario presented here. CORSIA aims for carbon-neutral growth (CNG) of aviation, and this target is therefore shown in Figure 4[11].

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[7] See SESAR1 D72 "Updated Performance Assessment in 2016" document, November 2016, project B05, project manager: ENAIRE.

[8] See SESAR1 D107 "Updated Step 1 validation targets – aligned with dataset 13", project B.04.01, December 2014, project manager: NATS.

[9] According to article 17 of the EU RED (Directive 2009/28/EC), GHG emission savings of at least 60% are required for biofuels produced in new installations in which production started on or after 1 January 2017.

[10] Well-to-wake CO_2e emissions of fossil-based JET fuel are calculated by assuming an emission index of 3.88 kg CO_2e per kg fuel (see DIN e.V., "Methodology for calculation and declaration of energy consumption and GHG emissions of transport services (freight and passengers)", German version EN 16258:2012), which is in accordance with 89 g CO_2e per MJ suggested by ICAO CAEP AFTF.

[11] Note that in a strict sense the CORSIA target of CNG is aimed to be achieved globally (and hence not necessarily in each world region).

Tables 4-6 and Figures 3-4 summarize the results for the scenario with implemented measures. It should be noted that Table 4 shows direct combustion emissions of CO_2 (assuming 3.16 kg CO_2 per kg fuel), whereas Table 6 and Figure 4 present equivalent CO_2 emissions on a well-to-wake basis. More detailed tabulated results are found in Appendix A.

Table 8. Fuel burn and CO_2 emissions forecast for the Implemented Measures Scenario (new aircraft technology and ATM improvements only)

Year	Fuel Consumption (10^9 kg)	CO_2 emissions (10^9 kg)	Fuel efficiency (kg/RPK)	Fuel efficiency (kg/RTK)
2010	37.98	120.00	0.0310	0.310
2016	46.24	146.11	0.0286	0.286
2020	49.03	154.93	0.0245	0.245
2030	57.38	181.33	0.0242	0.242
2040	67.50	213.30	0.0237	0.237
For reasons of data availability, results shown in this table do not include cargo/freight traffic.				

Table 9. Average annual fuel efficiency improvement for the Implemented Measures Scenario (new aircraft technology and ATM improvements only)

Period	Average annual fuel efficiency improvement (%)
2010-2016	-1.36%
2016-2020	-1.40%
2020-2030	-1.11%
2030-2040	-0.21%

Table 10. Equivalent (well-to-wake) CO_2e emissions forecasts for the scenarios described in this chapter

Year	Well-to-wake CO_2e emissions (10^9 kg)				% improvement by Implemented Measures (full scope)
	Baseline Scenario	Implemented Measures Scenario			
		Aircraft techn. improvements only	Aircraft techn. and ATM improvements	Acft. techn. and ATM improvements + alternative fuels	
2010	147.3				NA
2016	179.6	*179.6*	*179.4*	179.4	-0.1%
2020	193.8	*190.4*	*190.2*	187.9	-3.0%
2030	239.6	*227.6*	*222.6*	199.5	-16.7%
2040	292.7	*267.7*	*261.9*	214.8	-26.6%

For reasons of data availability, results shown in this table do not include cargo/freight traffic.

Note that fuel consumption is assumed to be unaffected by the use of alternative fuels.

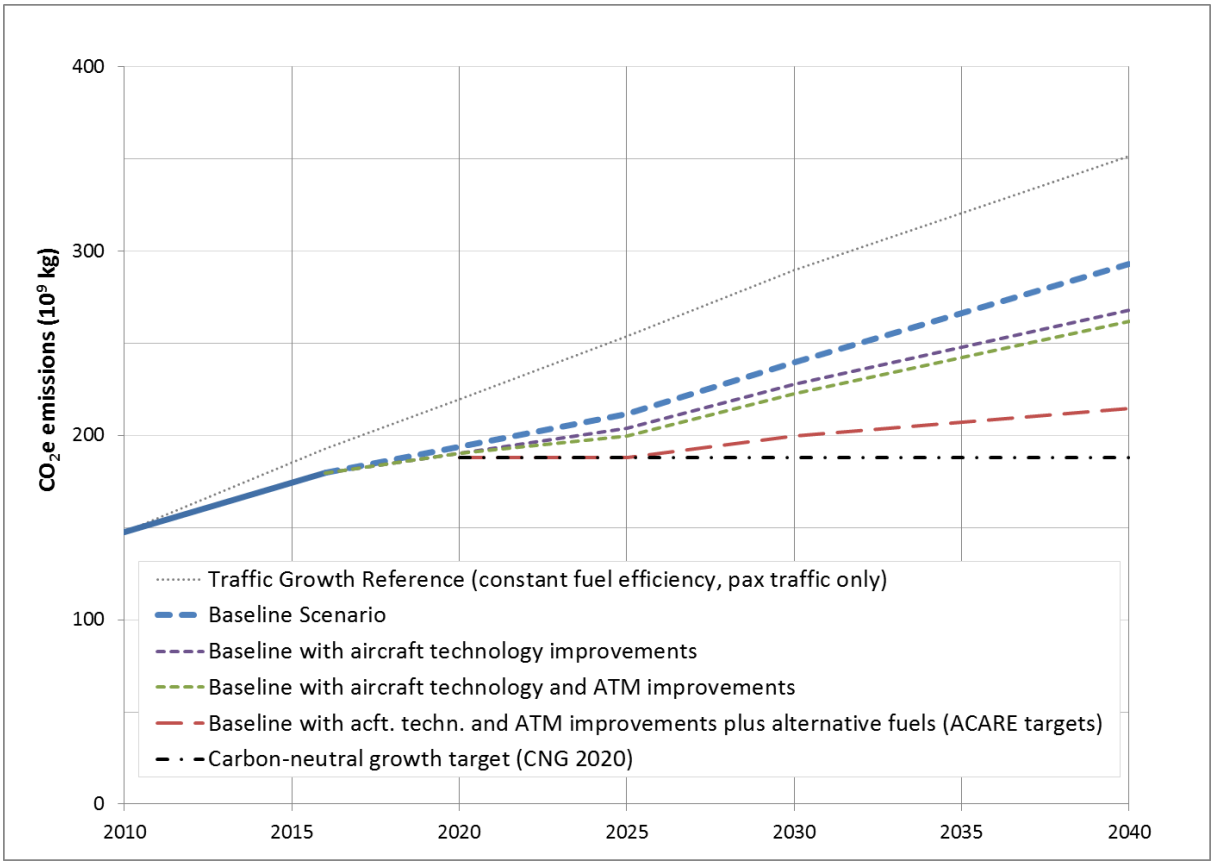


Figure 11. Equivalent (well-to-wake) CO2 emissions forecast for the baseline and implemented measures scenarios

As shown in Figures, the impact of improved aircraft technology indicates an overall 8.5% reduction of fuel consumption and CO_2 emissions in 2040 compared to the baseline scenario. Whilst the data to model the benefits of ATM improvements and sustainable alternative fuels shown in Figure may be less robust, they are nevertheless valuable contributions to reduce emissions further. Overall fuel efficiency, including the effects of new aircraft types and ATM-related measures, is projected to improve by 24% between 2010 and 2040.

Under the currently assumed aircraft and ATM improvement scenarios, the rate of fuel efficiency improvement is expected to slow down progressively until 2040. Aircraft technology and ATM improvements alone will not be sufficient to meet the post-2020 carbon neutral growth objective of aviation, nor will the use of alternative fuels even if Europe's ambitious targets for alternative fuels are met. This confirms that additional action, particularly market-based measures, are required to fill the gap.

4. Actions Taken at Supranational Level

4.1. Aircraft Related Technology Development

4.1.1. Aircraft emissions standards (Europe's contribution to the development of the aeroplane CO2 standard in CAEP)

European Member States fully supported the work achieved in ICAO's Committee on Aviation Environmental Protection (CAEP), which resulted in an agreement on the new aeroplane CO_2 Standard at CAEP/10 meeting in February 2016, applicable to new aeroplane type designs from 2020 and to aeroplane type designs that are already in-production in 2023. Europe significantly contributed to this task, notably through the European Aviation Safety Agency (EASA) which co-led the CO_2 Task Group within CAEP's Working Group 3, and which provided extensive technical and analytical support.

The assessment of the benefits provided by this measure in terms of reduction in European emissions is not provided in this action plan. Nonetheless, elements of

assessment of the overall contribution of the CO_2 standard towards the global aspirational goals are available in CAEP.

4.2. Improved Air Traffic

The EU's Single European Sky Initiative and SESAR

4.2.1. SESAR Project

The European Union's Single European Sky (SES) policy aims to reform Air Traffic Management (ATM) in Europe in order to enhance its performance in terms of its capacity to manage larger volumes of flights in a safer, more cost-efficient and environmental friendly manner.

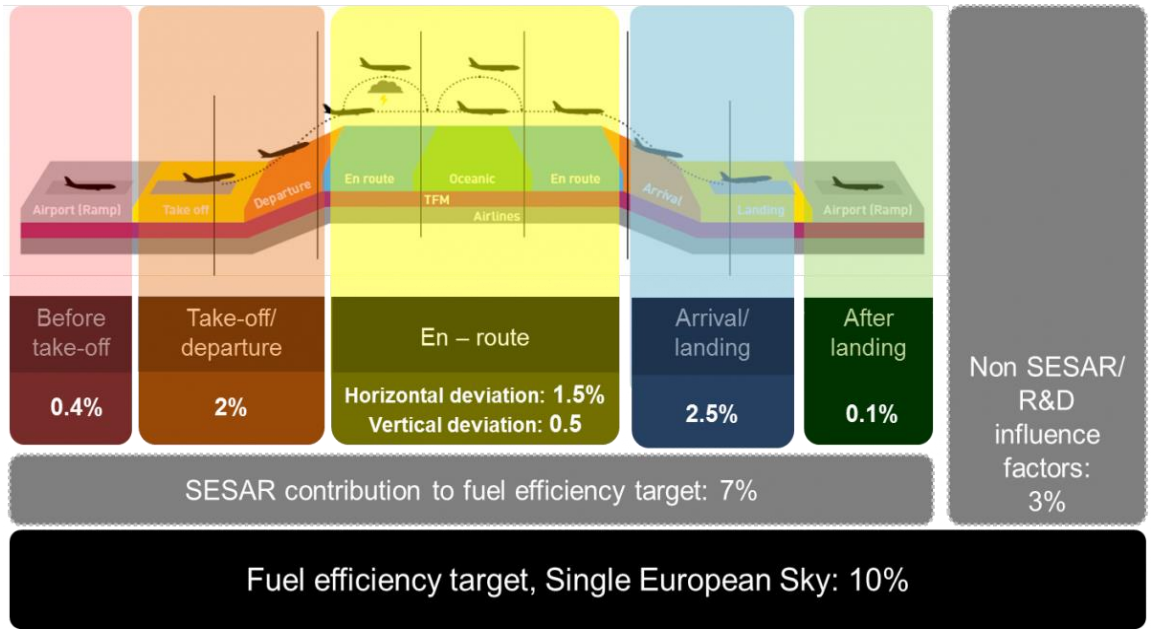
- The initial SES aims with respect to the 2005 performance were to:
- Triple capacity of ATM systems,
- Reduce ATM costs by 50%,
- Increase safety by a factor of 10, and
- Reduce the environmental impact by 10% per flight.

SESAR, the technology pillar of the Single European Sky, contributes to the Single Sky's performance targets by defining, developing, validating and deploying innovative technological and operational solutions for managing air traffic in a more efficient manner.

Guided by the European ATM Master Plan, the SESAR Joint Undertaking (JU) is responsible for defining, developing, validating and delivering technical and operation solutions to modernise Europe's air traffic management system and deliver benefits to Europe and its citizens. The SESAR JU research programme has been split into 2 phases, SESAR 1 (from 2008 to 2016) and SESAR 2020 (starting in 2016). It is delivering solutions in four key areas, namely airport operations, network operations, air traffic services and technology enablers.

The SESAR contribution to the SES high-level goals set by the Commission are continuously reviewed by the SESAR JU and are kept up to date in the ATM Master Plan.

Concerning the environmental impact, the estimated potential total fuel and CO_2 emission savings per flight are depicted below by flight segment:



By the end of SESAR 1, the validation exercises conducted showed that the solutions identified could provide by 2024 (as compared to the 2005 baseline) 2.36% reduction per flight in gate-to-gate greenhouse gas emissions.

4.3. Economic/Market Based Measures

ECAC members have always been strong supporters of a market-based measure scheme for international aviation to incentivise and reward good investment and operational choices, and so welcomed the agreement on the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA). The 31 EEA states in Europe have already implemented the EU Emissions Trading System (ETS), including the aviation sector with around 500 aircraft operators participating in the cap and trade approach to limit CO_2 emissions. It was the first and is the biggest international system capping greenhouse gas emissions. In the period 2012

to 2018 EU ETS has saved an estimated 100 million tonnes of intra-European aviation CO_2 emissions.

4.3.1. The EU Emissions Trading System

The EU Emissions Trading System (EU ETS) is the cornerstone of the European Union's policy to tackle climate change, and a key tool for reducing greenhouse gas emissions cost-effectively, including from the aviation sector. It operates in 31 countries: the 28 EU Member States, Iceland, Liechtenstein and Norway. The EU ETS is the first and so far the biggest international system capping greenhouse gas emissions; it currently covers half of the EU's CO_2 emissions, encompassing those from around 12 000 power stations and industrial plants in 31 countries, and, under its current scope, around 500 commercial and non-commercial aircraft operators that fly between airports in the European Economic Area (EEA). The EU ETS Directive has recently been revised in line with the European Council Conclusions of October 2014[12] that confirmed that the EU ETS will be the main European instrument to achieve the EU's binding 2030 target of an at least 40% domestic reduction of greenhouse gases compared to 1990[13] .

The EU ETS began operation in 2005; a series of important changes to the way it works took effect in 2013, strengthening the system. The EU ETS works on the "cap and trade" principle. This means there is a "cap", or limit, on the total amount of certain greenhouse gases that can be emitted by the factories, power plants, other installations and aircraft operators in the system. Within this cap, companies can sell to or buy emission allowances from one another. The limit on allowances available provides certainty that the environmental objective is achieved and gives allowances a market value. For aviation, the cap is calculated based on the average emissions from the years 2004-2006. Aircraft Operators are entitled to free allocation based on an efficiency benchmark, but this might not cover the totality of emissions. The remaining allowances need to be purchased from auctions or from

[12] http://www.consilium.europa.eu/en/meetings/european-council/2014/10/23-24/

[13] Directive (EU) 2018/410 of the European Parliament and of the Council of 14 March 2018 amending Directive 2003/87/EC to enhance cost-effective emission reductions and low-carbon investments, and Decision (EU) 2015/1814, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32018L0410

the secondary market. The system allows aircraft operators to use aviation allowances or general (stationary installations) allowances to cover their emissions.

By 30th April each year, companies, including aircraft operators, have to surrender allowances to cover their emissions from the previous calendar year. If a company reduces its emissions, it can keep the spare allowances to cover its future needs or sell them to another company that is short of allowances. The flexibility that trading brings ensures that emissions are cut where it costs least to do so. The number of allowances reduces over time so that total emissions fall.

As regards aviation, legislation to include aviation in the EU ETS was adopted in 2008 by the European Parliament and the Council[14]. The 2006 proposal to include aviation in the EU ETS, in line with the resolution of the 2004 ICAO Assembly deciding not to develop a global measure but to favour the inclusion of aviation in open regional systems, was accompanied by a detailed impact assessment[15]. After careful analysis of the different options, it was concluded that this was the most cost-efficient and environmentally effective option for addressing aviation emissions.

In October 2013, the Assembly of the International Civil Aviation Organisation (ICAO) decided to develop a global market-based mechanism (MBM) for international aviation emissions. Following this agreement the EU decided to limit the scope of the EU ETS to flights between airports located in the European Economic Area (EEA) for the period 2013-2016 (Regulation 421/2014), and to carry out a new revision in the light of the outcome of the 2016 ICAO Assembly. The temporary limitation follows on from the April 2013 'stop the clock' decision[16] adopted to promote progress on global action at the 2013 ICAO Assembly.

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[14] Directive 2008/101/EC of the European Parliament and of the Council of 19 November 2008 amending Directive 2003/87/EC so as to include aviation activities in the scheme for greenhouse gas emission allowance trading within the Community, http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32008L0101

[15] http://ec.europa.eu/clima/policies/transport/aviation/documentation_en.htm

[16] Decision No. 377/2013/EU derogating temporarily from Directive 2003/87/EC establishing a scheme for greenhouse gas emission allowance trading within the Community, http://eur-lex.europa.eu/LexUriServ.LexUriServ.do?uri=CELEX:32013D0377:EN:NOT

The European Commission assessed the outcome of the 39th ICAO Assembly and, in that light, made a new legislative proposal on the scope of the EU ETS. Following the EU legislative process, this Regulation was adopted in December 2017[17].

The legislation maintains the scope of the EU ETS for aviation limited to intra-EEA flights. It foresees that once there is clarity on the nature and content of the legal instruments adopted by ICAO for the implementation of CORSIA, as well as about the intentions of other states regarding its implementation, a further assessment should take place and a report be presented to the European Parliament and to the Council considering how to implement CORSIA in Union law through a revision of the EU ETS Directive. This should be accompanied, where appropriate, by a proposal to the European Parliament and to the Council to revise the EU ETS Directive that is consistent with the Union economy-wide greenhouse gas emission reduction commitment for 2030 with the aim of preserving the environmental integrity and effectiveness of Union climate action.

The Regulation also sets out the basis for the implementation of CORSIA. It provides for European legislation on the monitoring, reporting and verification rules that avoid any distortion of competition for the purpose of implementing CORSIA in European Union law. This will be undertaken through a delegated act under the EU ETS Directive.

The EU ETS has been effectively implemented over recent years on intra-EEA flights, and has ensured a level playing field with a very high level of compliance[18]. It will continue to be a central element of the EU policy to address aviation CO_2 emissions in the coming years.

The complete, consistent, transparent and accurate monitoring, reporting and verification of greenhouse gas emissions remains fundamental for the effective

[17] Regulation (EU) 2017/2392 of the European Parliament and of the Council of 13 December 2017 amending Directive 2003/87/EC to continue current limitations of scope for aviation activities and to prepare to implement a global market-based measure from 2021, http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2017.350.01.0007.01.ENG&toc=OJ:L:2017:350:TOC

[18] Report on the functioning of the European carbon market, COM(2017) 693 final, https://ec.europa.eu/commission/sites/beta.../report-functioning-carbon-market_en.pdf

operation of the EU ETS. Aviation operators, verifiers and competent authorities have already gained wide experience with monitoring and reporting; detailed rules are prescribed by Regulations (EU) N°600/2012[19] and 601/2012.[20]

The EU legislation establishes exemptions and simplifications to avoid excessive administrative burden for the smallest operators of aircraft. Since the EU ETS for aviation took effect in 2012 a *de minimis* exemption for commercial operators – with either fewer than 243 flights per period for three consecutive four-month periods or flights with total annual emissions lower than 10 000 tonnes CO_2 per year applies. This means that many aircraft operators from developing countries are exempted from the EU ETS. Indeed, over 90 States have no commercial aircraft operators included in the scope of the EU ETS. In addition, from 2013 flights by non-commercial aircraft operators with total annual emissions lower than 1 000 tonnes CO_2 per year are excluded from the EU ETS. A further administrative simplification applies to small aircraft operators emitting less than 25 000 tonnes of CO_2 per year, who can choose to use the small emitters' tool rather than independent verification of their emissions. In addition, small emitter aircraft operators can use the simplified reporting procedures under the existing legislation. The recent amendment to extend the intra-EEA scope after 2016 includes a new simplification, allowing aircraft operators emitting less than 3 000 tCO_2 per year on intra-EEA flights to use the small emitters' tool.

The EU legislation foresees that, where a third country takes measures to reduce the climate change impact of flights departing from its airports, the EU will consider options available in order to provide for optimal interaction between the EU scheme and that country's measures. In such a case, flights arriving from the third country could be excluded from the scope of the EU ETS. This will be the case between the EU and Switzerland following the agreement to link their respective emissions trading systems, which was signed on 23rd November 2017. The EU

[19] Commission Regulation (EU) No 600/2012 of 21 June 2012 on the verification of greenhouse gas emission reports and tonne-kilometre reports and the accreditation of verifiers pursuant to Directive 2003/87/EC of the European Parliament and of the Council, http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32012R0600&from=EN

[20] Regulation (EU) No 601/2012 of the European Parliament and of the Council of 21 June 2012 on the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC of the European Parliament and of the Council, http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32012R0601

therefore encourages other countries to adopt measures of their own and is ready to engage in bilateral discussions with any country that has done so. The legislation also makes it clear that if there is agreement on global measures, the EU shall consider whether amendments to the EU legislation regarding aviation under the EU ETS are necessary.

Impact on fuel consumption and/or CO_2 emissions

The environmental outcome of an emissions trading system is determined by the emissions cap. Aircraft operators are able to use allowances from outside the aviation sector to cover their emissions. The absolute level of CO_2 emissions from the aviation sector itself can exceed the number of allowances allocated to it, as the increase is offset by CO_2 emissions reductions in other sectors of the economy covered by the EU ETS.

With the inclusion of intra-European flights in the EU ETS it has delivered around 100 MT of CO_2 reductions/offsets between 2012 and 2018. The total amount of annual allowances to be issued will be around 38 million, whilst verified CO_2 emissions from aviation activities carried out between aerodromes located in the EEA has fluctuated between 53.5 MT CO_2 in 2013 and 61MT in 2016. This means that the EU ETS is now contributing more than 23 MT CO_2 of emission reductions annually[21], or around 100 MT CO_2 over 2012-2018, partly within the sector (airlines reduce their emissions to avoid paying for additional units) or in other sectors (airlines purchase units from other ETS sectors, which would have to reduce their emissions consistently). While some reductions are likely to be within the aviation sector, encouraged by the EU ETS's economic incentive for limiting emissions or use of aviation biofuels, the majority of reductions are expected to occur in other sectors.

[21] Report on the functioning of the European carbon market, COM(2017) 693 final, https://ec.europa.eu/commission/sites/beta.../report-functioning-carbon-market_en.pdf

Putting a price on greenhouse gas emissions is important to harness market forces and achieve cost-effective emission reductions. In parallel to providing a carbon price which incentivises emission reductions, the EU ETS also supports the reduction of greenhouse gas emissions through €2.1bn fund for the deployment of innovative renewables and carbon capture and storage. This funding has been raised from the sale of 300 million emission allowances from the New Entrants' Reserve of the third phase of the EU ETS. This includes over €900m for supporting bioenergy projects, including advanced biofuels.

In addition, through Member States' use of EU ETS auction revenue in 2015, over €3.5bn has been reported by them as being used to address climate change. The purposes for which revenues from allowances should be used encompass mitigation of greenhouse gas emissions and adaptation to the inevitable impacts of climate change in the EU and third countries. These will reduce emissions through: low-emission transport; funding research and development, including in particular in the field of aeronautics and air transport; providing contributions to the Global Energy Efficiency and Renewable Energy Fund, and measures to avoid deforestation.

In terms of its contribution towards the ICAO global goals, the states implementing the EU ETS have delivered, in "net" terms, a reduction of around 100 MT of aviation CO_2 emissions over 2012-2018 for the scope that is covered, and this reduction will continue to increase in the future under the new legislation. Other emission reduction measures taken, either collectively throughout Europe or by any of the 31 individual states implementing the EU ETS, will also contribute towards the ICAO global goals. Such measures are likely to moderate the anticipated growth in aviation emissions.

Table 11. Summary of estimated EU-ETS emission reductions

Estimated emissions reductions resulting from the EU-ETS	
Year	Reduction in CO_2 emissions
2012-2018	100 MT

The table presents projected benefits of the EU-ETS based on the current scope (intra-European flights).

4.3.2. The Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)

In October 2016, the Assembly of ICAO confirmed the objective of targeting CO_2-neutral growth as of 2020, and for this purpose to introduce a global market-based measure for compensating CO_2 emissions above that level, namely Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA). The corresponding resolution is A39-3: Consolidated statement of continuing ICAO policies and practices related to environmental protection – Global Market-based Measure (MBM) scheme.

According to the Assembly Resolution, the average level of CO_2 emissions from international aviation covered by the scheme between 2019 and 2020 represents the basis for carbon neutral growth from 2020, against which emissions in future years are compared. In any year from 2021 when international aviation CO_2 emissions covered by the scheme exceed the average baseline emissions of 2019 and 2020, this difference represents the sector's offsetting requirements for that year.

CORSIA is divided into 3 phases[22]: There is a pilot phase (2021-2023), a first phase (2024-2026) and a second phase (2027-2035). During CORSIA's pilot phase and the first phase, participation from states is voluntary. The second phase applies to all ICAO Member States.

[22] Further information on https://www.icao.int/environmental-protection/Pages/market-based-measures.aspx

CORSIA Implementation Plan Brochure (© ICAO)

Exempted are States with individual share of international aviation activities in RTKs, in year 2018 below 0.5 per cent of total RTKs and States that are not part of the list of States that account for 90 per cent of total RTKs when sorted from the highest to the lowest amount of individual RTKs. Additionally Least Developed Countries (LDCs), Small Island Developing States (SIDS) and Landlocked Developing Countries are exempted as well.

CORSIA operates on a route-based approach. The offsetting obligations of CORSIA shall apply to all aircraft operators on the same route between States, both of which are included in the CORSA. Exempted are

a) emissions form aircraft operators emitting less than 10 000 tCO_2 emissions from international aviation per year,

b) emissions from aircraft whose Maximum Take Off Mass (MTOM) is less than 5 700 kg, and

c) emissions from humanitarian, medical and firefighting operations.

According to the "Bratislava Declaration" from September 3rd 2016 the Directors General of Civil Aviation Authorities of the 44 ECAC Member States declared their intention to implement CORSIA from the start of the pilot phase, provided certain conditions were met. This shows the full commitment of the EU, its Member States and the other Member States of ECAC to counter the expected in-sector growth of total CO_2 emissions from air transport and to achieving overall carbon neutral growth.

4.4. Support to Voluntary Actions

4.4.1. ACI Airport Carbon Accreditation

This is a certification programme for carbon management at airports, based on carbon mapping and management standards specifically designed for the airport industry. It was launched in 2009 by ACI EUROPE, the trade association for European airports.

The underlying aim of the programme is to encourage and enable airports to implement best practice carbon and energy management processes and to gain public recognition of their achievements. It requires airports to measure their CO_2 emissions in accordance with the World Resources Institute and World Business Council for Sustainable Development GHG Protocol and to get their emissions inventory assured by an independent third party.

This industry-driven initiative was officially endorsed by EUROCONTROL and the European Civil Aviation Conference (ECAC). It is also officially supported by the United Nations Environmental Programme (UNEP). The programme is overseen by an independent Advisory Board.

At the beginning of this reporting year (May 2016) there were 156 airports in the programme. Since then, a further 36 airports have joined and 3 have withdrawn, bringing the total number of airports at the end of this reporting year (May 2017) to 189 covering 38.1 % of global air passenger traffic.

In 2017, for the first time, airports outside Europe achieved the highest accreditation status: 1 airport in North America, 5 in Asia-Pacific and 1 in Africa have been recognised as carbon neutral. European airports doubled their pledge and set the bar at 100 European airports becoming carbon neutral by 2030 from the 34 currently assessed to be carbon neutral.

Airport Carbon Accreditation is a four-step programme, from carbon mapping to carbon neutrality. The four steps of certification are: Level 1 "Mapping", Level 2 "Reduction", Level 3 "Optimisation", and Level 3+ "Carbon Neutrality".

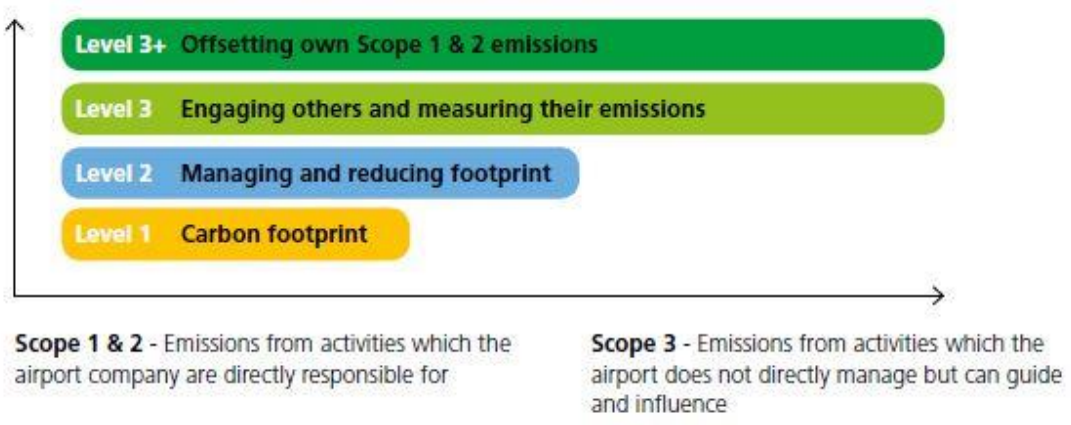

Figure 12. Four steps of Airport Carbon Accreditation

Levels of certification (ACA Annual Report 2016-2017)

One of its essential requirements is the verification by external and independent auditors of the data provided by airports. Aggregated data are included in the *Airport Carbon Accreditation* Annual Report thus ensuring transparent and accurate carbon reporting. At level 2 of the programme and above (Reduction, Optimisation and Carbon Neutrality), airport operators are required to demonstrate CO_2 reductions associated with the activities they control.

For historical reasons European airports remain at the forefront of airport actions to voluntarily mitigate and reduce their impact on climate change. The strong growth momentum was maintained for the reporting year which ended with 116 airports in the programme. These airports account for 64.8% of European passenger traffic and 61% of all accredited airports in the programme this year.

Anticipated benefits:

The Administrator of the programme has been collecting CO_2 data from participating airports over the past five years. This has allowed the absolute CO_2 reduction from the participation in the programme to be quantified.

Table 12: Emissions reduction highlights for the European region

	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017
Total aggregate scope 1 & 2 reduction ($ktCO_2$)	51.7	54.6	48.7	140	130	169	156	155
Total aggregate scope 3 reduction ($ktCO_2$)	360	675	366	30.2	224	551	142	899

Table 13: Emissions offset for the European region

	2015-2016	2016-2017
Aggregate emissions offset, Level 3+ (tCO_2)	222	252 218

The table above presents the aggregate emissions offset by airports accredited at Level 3+ of the programme. The programme requires airports at Level 3+ to offset their residual Scope 1 & 2 emissions as well as Scope 3 emissions from staff business travel.

Table 14: Summary of Emissions under airports direct control

Variable	2013 -2014		2014-2015	
	Emissions	Number of airports	Emissions	Number of airports
Aggregate carbon footprint for 'year 0'[23] for emissions under airports' direct control (all airports)	22.04 MT CO_2	85	2.09 MT CO_2	92
Carbon footprint per passenger	2.01 kg CO_2		1,89 kg CO_2	
Aggregate reduction in emissions from sources under airports' direct control (Level 2 and above)[24]	87.4 ktonnes CO_2	56	139 ktonnes CO_2	71
Carbon footprint reduction per passenger	0.11 kg CO_2		0.15 kg CO_2	
Total carbon footprint for 'year 0' for emissions sources which an airport may guide or influence (level 3 and above)[25]	12.8 MT CO_2	31	14.0 MT CO_2	36
Aggregate reductions from emissions sources which an airport may guide or influence	224 ktonnes CO_2		551 ktonnes CO_2	
Total emissions offset (Level 3+)	181 ktonnes CO_2	16	294 ktonnes CO_2	20

Its main immediate environmental co-benefit is the improvement of local air quality.

Costs for the design, development and implementation of *Airport Carbon Accreditation* have been borne by ACI EUROPE. *Airport Carbon Accreditation* is

[23] 'Year 0' refers to the 12 month period for which an individual airport's carbon footprint refers to, which according to the Airport Carbon Accreditation requirements must have been within 12 months of the application date.

[24] This figure includes increases in CO_2 emissions at airports that have used a relative emissions benchmark in order to demonstrate a reduction.

[25] These emissions sources are those detailed in the guidance document, plus any other sources that an airport may wish to include.

a non-for-profit initiative, with participation fees set at a level aimed at allowing for the recovery of the aforementioned costs.

The scope of *Airport Carbon Accreditation,* i.e. emissions that an airport operator can control, guide and influence, implies that aircraft emissions in the LTO cycle are also covered. Thus, airlines can benefit from the gains made by more efficient airport operations to see a decrease in their emissions during the LTO cycle. This is consistent with the objective of including aviation in the EU ETS as of 1 January 2012 (Directive 2008/101/EC) and can support the efforts of airlines to reduce these emissions.

5. Actions Taken at National Level and Co-benefits

In this chapter, actions taken in national level and co-benefits which are obtained from international civil aviation activities are referred. Even though Turkey is not a large country in terms of land area, there are several airports holding both domestic and international flights. For this reason, airports, airline operators, ground handling services and air navigation services are managed considering both operations.

5.1. Aircraft Related Technology Development

As it is well-known, aircraft efficiency increases day-by-day by manufacturers. This led to decrease in fuel consumption and GHG emission reduction significantly. In that context, airline operators having newest fleet gains an important advantage for saving fuel and emissions. Thanks to fast growing aviation sector in the country, fleet age of airline operators in Turkey are quite young with respect to other important operators in different countries and regions. Especially for the single-aisle body aircrafts like Boeing 737-800, 737-900 ER, Airbus A320-200 and A321-200 are used both in domestic and international flights.

5.1.1. Purchase of new aircraft

Turkish airlines, Turkey's biggest airline operator, is a fast growing leader company in which aircraft orders are held with serious searches. In order to have less emissions and high fuel efficiency Turkish Airlines has ordered new Airbus NEO and Boeing MAX models which are going to be delivered according to **Table 15**. Moreover, operator is going to buy wide body Airbus and Boeing models to support environmentally sustainable aviation.

Table 15: Aircraft orders of Turkish Airlines

Aircraft Model	2018	2019	2020	2021	2022
B737-9 MAX	-	5	5	-	-
B737-8 MAX	7	12	19	15	12
A321 NEO	3	18	18	20	18
TOTAL	10	35	42	35	30

Pegasus Airlines, which is the Turkey's biggest lowcost operator, works solely on reduction of fuel consumption and emission. Emission reductions from purchasing new aircraft depend on the aircraft industry. For that reason, Pegasus airlines changes its fleet with new Airbus NEO aircrafts, which are the most efficient ones in the market.

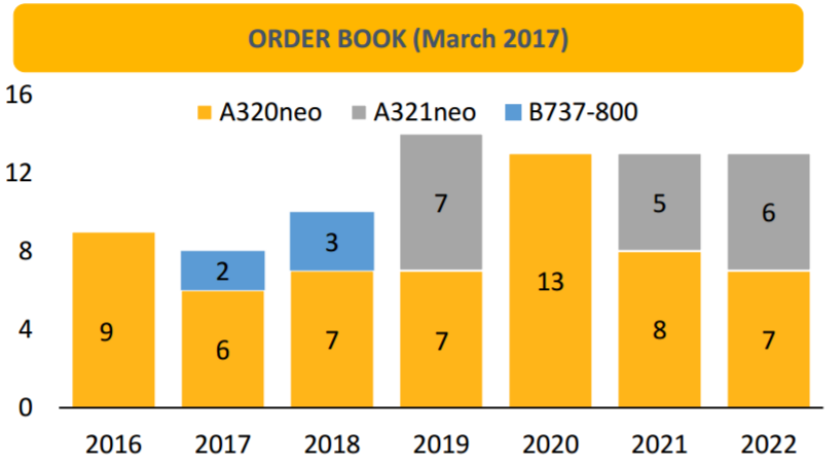

Figure 13: Aircraft purchase and expected date to be delivere for Pegasus Airlines

5.1.2. Retrofitting and Upgrade Improvements on Existing Aircraft

According to the Newton's law of motion, acceleration depends on mass and force. Greater the mass, smaller the acceleration or greater the force needed to accelerate. Therefore, every single weight in a plane is important. Aircraft operators in Turkey work hard to reduce their weight so that they produce less emission. Another factor affecting aircraft fuel consumption is air drag. Since aircrafts cruise at very high speeds, plane must be designed for sustaining air streamline pathways without separation at the edges which creates vortex. Therefore wings, winglets and sharklets are developed to reduce this turbulent flow around those points, so that, lessen the emission and fuel consumption.

Turkish airlines has established a fuel efficiency program in which several fuel consumption reduction practices are implemented. Several programs have been implemented for reducing the emissions within Turkish Airlines, which can be seen in **Figure 14**.

Figure 14: Turkish Airlines fuel efficiency program and consumption reduction prevention headings

In terms of retrofitting and upgrade improvements, there are many projects which has been ongoing for a long time. Some of these are:

- Aircraft weight reductions
- Engine core water wash
- Airframe/engine drag/aerodynamics/wash/paint

- Engine and APU build standard
- Maintenance saving
- Empty weight cabin equipment
- Empty weight magazines
- Empty weight catering services
- Duty free removal (Equipment + magazines)
- Empty weight potable water

Due to its low-cost carrier status, Pegasus airlines give significant attention on fuel efficiency and emission reduction. Their best practices are really benchmark for the industry and it shows how much it can be done. Starting with weight reduction practices:

1. **Ovens:** There were up to 8 ovens (having 19kg) in each aircraft had and it was too much. For that reason number of ovens have been reduced to 3 for each aircraft
2. **Coffee Maker & Water Boiler:** there were some unused coffee maker & water boilers in aircrafts. The number of items have been reduced and standardized for each aircraft.
3. **Emergency Exit Tray:** In the emergency exits, the trays on the sides of the seats have been used and the ones behind the seat in the front were removed. They both were closing the emergency exit and were making weight.
4. **Airstair:** Unused airstaires on airplanes (157 kg) have been dismantled and all future aircraft has been purchased without airstair.
5. **Light Weight Carpets:** In current planes the carpets have been replaced with Light Weight carpets and upcoming planes have been ordered with Light Weight carpet.

6. **Light Weight Seat Covers:** The seats on existing planes have been replaced by Light Weight leather and upcoming planes have been ordered with a Light Weight seat.

7. **Light Weight Trolley:** The trolleys on existing planes have been replaced by Light Weight trolleys and our future planes have been ordered with Light Weight trolley.

8. **Extra Fuel Uplift:** Weight saving by reducing the amount of Extra Fuel Uplift.

9. **Landing Fuel:** Weight saving by reducing the amount of Landing Fuel

10. **EFB Class-I:** Moving all documents in the cockpit to electronic center by passing Class-II instead of EFB Class-I used in airplanes

11. **Wireless Sistem QR:** Thanks to the Wireless System, flight data comes to Pegasus Headquarters after each landing and is analyzed.

12. **Paint Excesses:** Overlay paint has been removed due to wet-lease

13. **Potable Water:** The potable water reservoir is filled in 1/2 on the domestic route and 3/4 tank on the international routes.

14. **Team Luggage:** Pegasus team does not carry a luggage for 1 day.

15. **Carbon Brake:** Carbon Brake is 400 kg lighter than regular ones and at the same time the life of the brakes is prolonged.

16. **IFE Systems:** Unused IFE systems have been removed from aircrafts.

17. **Jump Seat**: The number of jump seats have been reduced from 4 to 2 in the Aft section of planes.

18. **Cleaning Materials:** Cleaning materials have been loaded onto the aircraft with a lighter standard unit instead of heavy trolley.

19. **Pegasus Magazine:** Monthly Pegasus magazines in airplanes have been made thinner by making page layouts thinner.

20. **Catering Loads:** In catering loads, the weight of the products is taken into account and the weight of the load is minimized.

5.2. Fuels

In terms of fuels, Turkey works to find alternative fuels and produces small portion of biofuel. Due to availability and cost of these fuels, they are not taken as priority for emission reduction. However in the future, biofuel producers can go into the aviation biofuel business because fuel consumption of aircraft operators are very high.

5.3. Improved Air Traffic and Infrastructure

Because of the geologic location of Turkey, management of air traffic is very important. Lots of international flights are performed on the air space of Turkey. In addition to this, military air corridors also plays an important role on air traffic management.

Turkish DGCA Air Navigation Department and State Airport Authority arrange meetings with Turkish Armed Forces to lessen distances between domestic routes and decrease the CO_2 emissions.

Standard Operations Procedures (Standard Operations Procedures) for pilotage in Flight Operations have been revised with the addition of fuel saving applications and statistical ratios have been increased or decreased the on the following technical issues through regular trainings and publications. Examples of best practices are:

- Single engine taxi procedures
- Observance of departure and departure times in Flight Plans
- Climb-cruise-descent-final approach procedures
- Controlled commander extra fuel requests
- Optimized new flight plan system
- Route OptimizationsPBN (Performance Based Navigation)

- The Closest Alternate airport selection

For instance, in order to reduce emissions in İstanbul Sabiha Gökçen International Airport, additional taxi way has been built as shown in the **Figure 15**. Pegasus, who are using the Sabiha Gökçen Aiport as base airport, also have implemented new practices such as aircraft flying in a fixed pattern waiting for permission to land, inefficient routings, and sub-optimal flight profiles.

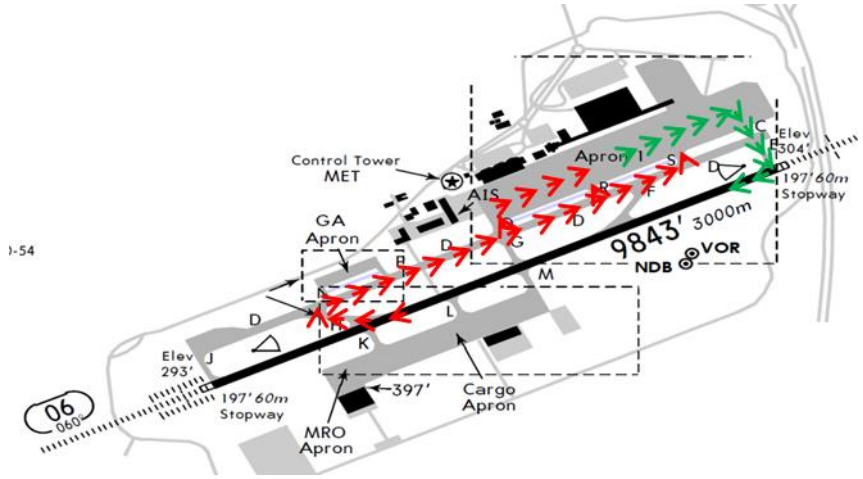

Figure 15: New taxi way built on Sabiha Gokçen Airport

5.4. Airport Improvements

Istanbul Grand Airport (IGA)

An action plan has been prepared in order to take the necessary actions by assessing the impacts of the potential climatic changes on İstanbul New Airport (INA) project. In consequence of the extreme climatic events happening in unexpected periods, a future-oriented action plan is being prepared on the airport's vulnerability as assets and operations to the climate change. All details of the assets and operational activities of the airport are examined by evaluating each one of the subjects such as the current designs, machinery, equipment, and geological location. In this way, it is aimed to minimize the impact of the extreme climatic events on İstanbul New Airport through its stronger and more rationalistic structure, even before formation of such events.

INA Climate Change Action Plan consists of two components. The first component is the strategies to adapt to and mitigate the Climate Change. The second one is preparation of the potential greenhouse gas emissions inventory for the airport. In this work, the greenhouse gas calculations made within the scope of the Environmental and Social Impact Assessment (ESIA) are detailed more according to the planning becoming clearer. In this way, the greenhouse gas inventory is being mapped. Accordingly, it is possible to monitor the emissions through the records and measurements to be acquired during the operation, and the greenhouse gases reduction methodologies are developed. Within the scope of the Green Airport Program, all these activities will be verified by independent accredited inspection bodies, and submitted to the Directorate General of Civil Aviation. The Climate Change Adaptation and Action Plan has been completed, INA is the first airport that has conducted this study[26]

General Directorate Of State Airports Authority (DHMI)

To begin with, management of most of Turkish civil airports (49 of 55) and mission of regulation and control of Turkish airspace are performed by DHMI (General Directorate of State Airports Authority). General Directorate of State Airports Authority (DHMI) is a state economic enterprise (SEE) operating, which has legal entity, autonomy over its activities, liability limited with its capital, is associated with Ministry of Transportation, and its services are accepted as privilege with latest legal regulation.

Vision of the DHMI is to provide an air navigation and airport operating services at international standards in the aviation sector, leaning on high quality, safe, human and environment sensitive high technology infrastructure and systems and qualified labor force. One of the most important principles for DHMI is Sensitivity to Environment and Human. In that respect, waste management (including wastewater, dangerous wastes, packaging wastes, etc.), greenhouse gas emission reductions projects and noise mapping projects have been implementing.

26 http://sustainability.igairport.com/en/units/operation-and-sustainability/works-performed-operation-and-sustainability/climate-change-action-plan

Especially for the GHGs reduction, DHMI plants tree, prevent heat loss at airports, switching LNG, uses LED lights and provides energy from solar power.

TAV

TAV Esenboga started to enter into ACI Airport Carbon Accreditation program in the year 2010. As a start-up, TAV Esenboga applied and certified within the Level-1 "Mapping" and continued at the same level of certification until the year 2013. In 2013, TAV Esenboga gave a decision to upgrade the application level up to the highest level which is defined as Level 3+ "Neutralization". For the last four applications, TAV Esenboga has been remaining at the same Level 3+ with showing how TAV is giving an importance to this subject in terms of environmental policies. The reductions are still in progress as being achieved each year while the annual passenger flows have been regularly increasing on the other side till up to date.

According to TAV Esenboga plans, as of for the time being, yearly application level is to be kept for the future coming years as well as per the approach of the company and its giving importance to the sustainability.

5.5. Economic/Market Based Measures

As decided within the ECAC, with Bratislava Declaration Turkey expressed her intention to implement the CORSIA scheme to compensate international aviation CO_2 emissions from the very beginning in 2021. In Turkey like any other member states of ICAO, transition of the SARPs into national legislation has initiated and planned to be finalized before the scheme starts.

5.6. Co-benefits support to Voluntary Actions

Sometimes international aviation and domestic aviation use common processes in which reduction of emission is achieved. For example, ground handling operations, air traffic management can be classified in that conjuncture. For the airport operations ACI Airport Carbon Accreditation Programme is well known voluntary action for reducing and neutralizing GHG emissions. There are several airports having ACI carbon accreditation certificate. Moreover, Turkish DGCA has been

implementing a Green Airport project in which airports trying to reduce their emissions voluntarily. Detailed information is given in the following subchapters.

ACI Airport Carbon Accreditation Programme

Some airports in Turkey also participated ACI Carbon Accreditation Programme to control their emissions. List of airports having this certificate can be seen in **Table 16**.

Table 16: List of airports particapating ACI Carbon Accreditation Programme

Company	Airport	Level
ICF Airports	Antalya Airport	3+
Tepe Akfen TAV Airports	İzmir Adnan Menderes Airport	
	Ankara Esenboğa Airport	
	İstanbul Atatürk Airport	3

Green airport project

In 2009, Directorate General of Civil Aviation launched a project that systematically decreases the existing or future damages of airport establishments on the environment and human health and to eliminate if possible. The attractive side of this project show itself by providing incentives up to 50% for service tariffs at the airports.

Under the guidance of Directorate General of Civil Aviation (DGCA), "Green Airport Project" provided that, the airline operators and service providers at the airports, which comply with the certain requirements, will be called "Green Airport". DGCA shall provide to the organisations and establishments 20% of reduction on service tariffs (permit, licence certificate costs) which comply with the relevant requirements for that airport. In addition to 20% reduction, in case of all organisations and establishments at the airport in question provide all necessary

conditions determined by DGCA, the reduction rate will be increased to 50%. However, the Green Airport Project is only applicable for airport organisations and establishments.

Requirements for Airport Operators

According to the general terms of the Green Airport Project, a "Noise Study Commission" should be established at the airport and under the control of airport operator. Within the scope of its authorisation, Noise Study Commission should make noise measurements, noise action plan and noise map preparations.

For the airports, whose departure and arrival capacity is more than 50.000 per year, noise measurement, control and monitoring systems should be installed to the surroundings of the airport in order to determine noise level.

With the purpose of reducing greenhouse gas emissions airport operators required to fulfil the conditions stated on below in order to gain the right of tariff reduction:

Determining particular areas that operators shall be severally responsible from and defining greenhouse gas emission roots on those areas. Later on, the data about emission roots should be collected and greenhouse gas emissions of the previous year should be calculated by using the data collected.

Preparing "Carbon Footprint Report" which should be confirmed by the Ministry of Environment and Urban Planning so as proves that the report is complied with the standards of ISO 14064.

Preparing "Greenhouse Gas Management Report" with the conditions listed on below and implementing those conditions in business activities:

- Supreme board should be established to be in charge regarding climate change, greenhouse gas and energy topics.
- A procedure should be adopted to control greenhouse gas emission.
- Monitoring fuel and energy consumption
- Developing goals to reduce greenhouse gas and energy

- Should adopt procedure and control mechanisms to minimise emissions during operations
- All personnel should be trained in order to create awareness of the importance of greenhouse gas emission.

Considering the 3 years average of greenhouse emissions and the reduction accordingly, a document should be prepared which shows that "greenhouse management plan" has been applied.

Following the "Greenhouse Management Plan" greenhouse emissions per person should decrease to at least 1% every year including passengers as well.

Probative documents which provides that all necessary studies has been made in order to reduce green house gas emissions should be sent to DGCA.

According to the provisions of Green Airport Project, companies that provide ground handling services are encouraged to use electrical power-operated vehicles instead of vehicles run with gasoline.

The project started firstly in terminal luggage separation area of Atatürk, Adana, Adnan Menderes, Antalya, Dalaman, Esenboğa, Milas Bodrum and Trabzon Airports, where the traffic is intense; with the relevant instructions were given to ground handling services to switch electric power-operated vehicles for moving the luggage instead of those operating on gasoline.

The same provision about electrical power-operated vehicle is also applicable for companies provide maintenance operations. According to the provisions of Green Airport Project, companies that provide ground handling services are encouraged to use electrical power-operated vehicles instead of vehicles run with gasoline.

In addition to vehicle alteration, maintenance organizations are also required to gain an "Acoustic Report" which illustrates whether the environmental noise levels are exceeded or not. In case of a violation of the top limit, all necessary precautions should be taken by the operator according to Regulation on Ambient Noise Control and Management

All air transportation operators either registered in Turkey or abroad, required to hold Noise Certificate to manage take-off or landing activities to the airports open to domestic and international air traffic. Local or foreign air operators not holding that certificate will have to pay noise compensation for take-off and landing and the amount of compensation shall be determined by the Ministry of Transport.

Medical wastes producing by Polyclinic, medical rooms or any other health facilities at the airports shall be subject to the provisions of Regulation on Medical Waste Control.

Green Airport Project is clearly raising the bar in terms of quality at the airports in Turkey and enhancing environmental awareness across the airline and airport industry. With the incentives provided by Green Airport Project, establishments gained Green Company Certificate are rise to 160 companies so far including airport operators, ground handling service providers and airlines. TAV Istanbul Ataturk Airport Operation, Istanbul Sabiha Gökçen International Airport Investment Development and Operation Inc. (ISG), TGS, HAVAS and CELEBI ground handling service companies, Pegasus Airlines can be counted as an example.

6. Conclusion

In this action plan comprehensive statistical data regarding to aviation sector is demonstrated in order to reflect the extensive growth of the sector in Turkey. Furthermore an overview of the measures taken for environmental protection both international and national level are provided. As briefly explained in the report the measures includes aircraft technology development, investments on new aircraft technology, retrofitting and upgrade improvements, route optimization by improving the air traffic management, airport improvements and economic measures. Besides, a voluntary project, to reduce the impacts of the airports on human health and environment, called the Green Airport project initiated by Turkish DGCA is included in this plan to demonstrate the co-benefits.

Finally it is clear that the Turkish aviation sector has been undergoing a comprehensive transformation. Its recent success not only reflects the

geographical location of the country which leaves it as a natural hub for air transportation but also a well-planned and coordinated policy that ranges from regulatory efforts to environmentally conscious designs and from better quality services to intensive transparency policies. It is by no means a coincidence that the industry has already taken off to position itself as one of the leading in Europe.

APPENDIX-I

EMISSION REDUCTION

Results Derived From EBT Tool

Three scenarios have been evaluated for Turkey's expected RTK growth and efficiency. By the help of the EBT tool, upcoming emission reduction practices have been seleceted and fuel efficiency change in fuel efficiencies have been found calculated. which are located at the tables below.

BASELINE (12% GROWTH RATE)				
Year	International RTK ('000)	International Fuel burn (Tonnes)	International CO_2 Emissions (tonnes)	Efficiency (Fuel burn / RTK)
2016	18,227,000.00	5,139,890.00	16,242,052.40	0.282
2017	20,414,240.00	5,468,812.50	17,281,447.50	0.268
2018	22,863,948.80	6,116,779.19	19,329,022.24	0.268
2019	25,607,622.66	6,842,486.34	21,622,256.83	0.267
2020	28,680,537.37	7,655,169.01	24,190,334.07	0.267
2021	32,122,201.86	8,565,184.42	27,065,982.77	0.267
2022	35,976,866.08	9,584,140.94	30,285,885.37	0.266
2023	40,294,090.01	10,725,044.60	33,891,140.94	0.266
2024	45,129,380.81	12,002,464.18	37,927,786.81	0.266
2025	50,544,906.51	13,432,716.97	42,447,385.63	0.266
2026	56,610,295.29	15,034,077.08	47,507,683.57	0.266
2027	63,403,530.73	16,827,009.09	53,173,348.72	0.265
2028	71,011,954.42	18,834,429.87	59,516,798.39	0.265
2029	79,533,388.95	21,082,001.93	66,619,126.10	0.265
2030	89,077,395.62	23,598,461.95	74,571,139.76	0.265

BASELINE (15% GROWTH RATE)				
Year	International RTK ('000)	International Fuel burn (Tonnes)	International CO_2 Emissions (tonnes)	Efficiency (Fuel burn / RTK)
2016	18,227,000.00	5,139,890.00	16,242,052.40	0.282
2017	20,961,050.00	5,615,298.55	17,744,343.42	0.268
2018	24,105,207.50	6,448,852.42	20,378,373.65	0.268
2019	27,720,988.63	7,407,188.42	23,406,715.41	0.267
2020	31,879,136.92	8,508,912.43	26,888,163.28	0.267
2021	36,661,007.46	9,775,428.57	30,890,354.28	0.267
2022	42,160,158.58	11,231,353.53	35,491,077.15	0.266
2023	48,484,182.36	12,904,994.70	40,779,783.25	0.266
2024	55,756,809.72	14,828,900.81	46,859,326.56	0.266
2025	64,120,331.17	17,040,495.68	53,847,966.35	0.266
2026	73,738,380.85	19,582,807.26	61,881,670.94	0.266
2027	84,799,137.98	22,505,306.08	71,116,767.21	0.265
2028	97,519,008.67	25,864,869.45	81,732,987.46	0.265
2029	112,146,859.97	29,726,890.17	93,936,972.94	0.265
2030	128,968,888.97	34,166,551.43	107,966,302.52	0.265

BASELINE (18% GROWTH RATE)				
Year	International RTK ('000)	International Fuel burn (Tonnes)	International CO_2 Emissions (tonnes)	Efficiency (Fuel burn / RTK)
2016	18,227,000.00	5,139,890.00	16,242,052.40	0.282
2017	21,507,860.00	5,761,784.60	18,207,239.34	0.268
2018	25,379,274.80	6,789,702.92	21,455,461.23	0.268
2019	29,947,544.26	8,002,135.35	25,286,747.71	0.267
2020	35,338,102.23	9,432,150.51	29,805,595.61	0.267
2021	41,698,960.63	11,118,767.31	35,135,304.70	0.267
2022	49,204,773.55	13,108,020.13	41,421,343.61	0.266
2023	58,061,632.79	15,454,216.75	48,835,324.93	0.266
2024	68,512,726.69	18,221,423.23	57,579,697.41	0.266
2025	80,845,017.49	21,485,216.09	67,893,282.84	0.266
2026	95,397,120.64	25,334,749.76	80,057,809.24	0.266
2027	112,568,602.35	29,875,195.80	94,405,618.73	0.265
2028	132,830,950.78	35,230,620.65	111,328,761.25	0.265
2029	156,740,521.92	41,547,380.66	131,289,722.89	0.265
2030	184,953,815.86	48,998,127.48	154,834,082.84	0.265

EXPECTED RESULTS : FUEL SAVINGS					
Year	Annual Fuel burn before implementation of mitigation actions (Tonnes)	Annual Fuel burn after implementation of mitigation actions (Tonnes)	Annual Fuel savings (Tonnes)	Annual CO_2 savings (Tonnes)	Change Fuel savings (%)
2016	5,139,890.00	5,139,890.00	0.00	0	0.00
2017	9,765,736.62	9,765,736.62	0.00	0	0.00
2018	19,505,035.69	19,059,494.69	445,541.00	1,407,909.56	-2.28
2019	38,962,772.99	38,514,621.89	448,151.10	1,416,157.48	-1.15
2020	77,839,972.79	77,388,576.49	451,396.31	1,426,412.34	-0.58
2021	155,523,701.19	155,073,923.98	449,777.22	1,421,296.02	-0.29
2022	310,759,940.57	310,305,137.00	454,803.56	1,437,179.25	-0.15
2023	620,987,584.99	620,526,520.95	461,064.04	1,456,962.37	-0.07
2024	1,240,984,058.28	1,240,515,193.13	468,865.16	1,481,613.91	-0.04
2025	2,480,113,870.40	2,479,635,280.55	478,589.85	1,512,343.93	-0.02
2026	4,956,744,147.74	4,956,253,431.17	490,716.57	1,550,664.36	-0.01
2027	9,906,919,457.67	9,906,413,614.54	505,843.13	1,598,464.29	-0.01
2028	19,801,411,740.26	19,800,887,023.71	524,716.55	1,658,104.30	0.00
2029	39,579,244,286.54	39,578,696,016.25	548,270.29	1,732,534.12	0.00
2030	79,113,631,530.49	79,113,053,859.62	577,670.88	1,825,439.98	0.00

Company Name	Activity	Description of Activity	Estimated annual CO_2e (ton) savings			Total Company Emission Saving (annual avg)
			2011	2012	2013	
PEGASUS AIRLINES	Weight Reduction	Extra Fuel Uplift		87	5	134,315
		Landing Fuel	2616	2084	2374	
		EFB Class-I	339	434	582	
		Ovens	772	990	1326	
		Coffee Maker Water Boiler	276	354	475	
		Airstair	2128	2727	3653	
		Emergency Exit Tray Tables	16	200	268	
		Light Weight Carpet	542	69	931	
		IFE/SEB System	0	1164	1559	
		Second Observer Seat	54	69	93	
		Carbon Brake	121	4487	6709	
		Layover Bags	81	104	199	
		Trolley	134	17	171	
		Hygien materials	407	521	698	
		Magazine Weight	598	391	523	
		Potable Water Dış Hat	453	0	0	
		Extra Fuel Uplift	47138	68136	87054	
	Improvement on Flight Procedures	One Engine Taxi-in	699	624	1245	
		Reverse Thrust Idle	488	1328	1601	
		Flight Level	13940	20744	23395	
		Flaps 1 in lieu of 5	1101	1784	2093	
		APU usage	9127	13583	16124	
	Operational Improvements	%MAC	2541			
		Flap Retraction Altitude (FRA)	8	2253	2026	
		Retractable Landing Light	1394	2074	2561	
		Engine Washing	3388	5428	7272	
		Alternate Airport	4990	5837	11170	

Company Name	Activity	Description of Activity	Total Company Emission Saving (avg)
TURKISH AIRLINES	Decreasing Paper Use (DCMS Project)	Accessing Line Information Forms via Tablet	158,530[27]
		Filling the Cabin Maintenance Log over Tablet	
		Filling Aircraft Water Follow-Up Forms and Cleaning Feedback Forms over tablet	
	Maintenance & Engineering	APU Maintenance Savings	
		Engine core water wash	
		Airframe/engine drag/aerodynamics/wash/paint	
		Aircraft weight reductions	
		Engine and APU build standard	
	Martketing & Sales	Empty weight cabin equipment	
		Empty weight magazines	
		Empty weight catering services	
		Duty free removal (Equipment + magazines)	
		Empty weight potable water	
	Flight Planning and Dispatch	Optimised Flight Planning System	
		Alternate Seleciton	
		Hold Fuel Optimization	
		Pilot & Dispatcher Additional Fuel	
	Flight Ops	APU Fuel Savings	
		APU Single Pack after Opt Time	
		APU No Pack after Opt Time	
		Engine out Taxi out	
		Reduced flap take off	
		Pilot Technique & Flight Management	
		Low Noise Low Drag Approaches	
		Reduced Flap Landings	
		Idle Reverse on Landing	
		Engine out Taxi in	

DHMI

[27] Average of 8 years, annual saving including both international and domestic

According to all actions taken by the DHMI, following values have been calculated as the annual ton CO2e reduction from international flights.

Company Name	Estimated annual CO_2e (ton) savings		Total Company Emission Saving (annual/avg)
GENERAL DIRECTORATE OF STATE AIRPORTS AUTHORITY	Fuel-Oil to LNG conversion	7843	8632
	LED Light Change	119	
	Solar Power production	670	

Company Name	Activity	Description of Activity	Estimated annual CO_2e savings	Total Company Emission Saving
ÇELEBİ GROUND HANDLING	Transportation: fleet	In 2011, we have continued our efforts to switch out our fleet of airport service tractors from diesel to electric (where possible). While the aviation authority will soon be requiring transition to electric tractors operating in covered spaces, we began this transition prior to announcement of this regulation. Therefore, we consider this a voluntary reduction of scope 1 emissions.	245	708
	Transportation: fleet	In 2012, we have continued our efforts to switch out our fleet of airport service tractors from diesel to electric (where possible). While the aviation authority will soon be requiring transition to electric tractors operating in covered spaces, we began this transition prior to announcement of this regulation. Therefore, we consider this a voluntary reduction of scope 1 emissions.	245	
	Energy efficiency: Building services	Switching 48 of floodlights to LED type.	17.01	
	Energy efficiency: Building services	Switching 98 of T8 type lighting fixtures to LED type.	7.62	
	Low carbon energy installation	We have operated a solar panel as a pilot facilty with capacity of 2794,4 kWh/year in Antalya Station at Antalya Airport.	1.48	
	Energy efficiency: Building services	Switched 48 of floodlights to LED type.	17.01	
	Energy efficiency: Building services	Switched 98 of T8 type lighting fixtures to LED type.	7.62	
	Transportation: fleet	In 2014, we operated ground support equipment (GSE) tracking and control system which covers 140 GSE in Istanbul Atatürk Airport station. So that, we are expecting %5 fuel consumption reduction for both in idle run and operational movement in a year.	92.03	
	Fugitive emissions reductions	We have started to switch our HFC-236fa halocarbon type of fire fighting extinguishers to CO2 type in our five stations.	96.52	
	Other	We have switched our 6 of diesel-fueled equipment (3 stacker lift unit, 1 forklift and 2 belt-conveyor) into electrical equipment in 2016.	3.38	

Company Name	Activity	Description of Activity	Estimated annual CO_2e (ton) savings	Total Company Emission Saving
TAV AIRPORTS	Energy Efficiency-Emission Reductions	LED replacement of 150W projectors underneath the viaduct	76.16	1260
		LED replacement of 1000W projectors located at departure level	108.96	
		LED replacement of 400W projectors located at departure level	209.07	
		LED replacement of 150W projectors located at departure level	15.23	
		LED replacement of 400W projectors located at rotunda of PBB's	26.88	
		LED replacement of 1x70W spot fixtures located at departure level	46.59	
		LED replacement of 1000W projectors located at apron	197.70	
		LED replacement of 13W spot fixtures located at WC's	59.91	
		LED replacement of 58W fluorescents located at arrival level	71.82	
		LED replacement of 150W projectors located at street lighting poles	69.55	
		LED replacement of 18W bolards located at street lighitng	5.61	
		LED replacement of 58W lightings located at Carpark	175.71	
		LED replacement of 150W projectors located at street carpark terrace level	36.77	
		LED replacement of 150W projectors located on the viaduct	15.05	
		LED replacement of 2x26W spot fixtures located at arrival level	50.77	
		LED replacement of 2x32W spot fixtures located at arrival level	91.04	
		LED replacement of 18W bolards located at terminal building	3.57	