

The Study of Guidelines for the Development of Energy Management and Efficiency of Air Transportation in Thailand



Executive Summary Report



**Energy Conservation
Promotion Fund**

BY



ISO 9001:2015 CERTIFICATE

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Acknowledgement

During the study project, Index International Group Company Limited, a consultanting company, would like to thank the Office of Transport and Traffic Policy and Planning for employing the consulting company to the Study of Guidelines for the Development of Energy Management and Efficiency of Air Transportation in Thailand including experts from related agencies, such as Department of Alternative Energy Development and Efficiency, Department of Airports, Airport of Thailand Public Company Limited, Bangkok Airways Public Company Limited, The Civil Aviation Authority of Thailand, Aeronautical Radio of Thailand Limited, Thai Airways Public Company Limited, Bureau of Climate Change Management and Coordination, Office of Natural Resources and Environmental Policy and Planning as well as the related other agencies that gladly provide in-depth interview, survey data, giving suggestions, comments and useful information for the study of the project until the study project is completely accomplished.

The consulting company also would like to thank the Office of Transport and Traffic Policy and Planning (OTP) for trusting the consulting company to conduct the Study of Guidelines for the Development of Energy Management and Efficiency of Air Transportation in Thailand.

The Consultant

January, 2019

Introduction

Currently, global energy consumption has been continuously increasing, resulting in global warming crisis, and awareness of the important of energy use. Thai government realizes the important of energy consumption reduction in transportation sectors, which is the greatest proportion of all sectors. The government has been trying to push forward a number of measures on roads, railways, waterway, and air transportation by utilizing modern effective technology in order to reduce transport cost, considering safety and the environment.

Due to the expansion of air transportation around the world, the growth of Thailand and regional economies, and the growth of tourism in Thailand cause the rapid increased the demand of air passenger travel and cargo transportation services. Moreover, it also resulted in energy consumption and greenhouse gas emission of airports in Thailand.

In the past, the amount of energy consumption from air transportation was calculated by the jet fuel consumption only. There had not been any studies regarding energy consumption analysis from airport activities. To determine the potential, the guidelines for energy conservation and management in the relevant section which from importance and necessity is supported by the Energy Conservation Promotion Fund Ministry of Energy and the Office of Transport and Traffic Policy and Planning (OTP). They conduct [The Study of Guidelines for the Development of Energy Management and Efficiency of Air Transportation in Thailand](#) to accomplish the goal of reducing energy consumption and greenhouse gas emissions.

Executive Summary Report is to present summary of the study results of the project for the relevant executives to utilize the information in The Study of Guidelines for the Development of Energy Management and Efficiency of Air Transportation in Thailand by summarizing the project operation.

The consultanting company really expects that the report is beneficial for the Ministry of Transport, Ministry of Energy including government and private agencies, especially for policy makers and executives in order to utilize as supporting information and guidelines for developing project measures and decision making for developing the project.

The Study of Guidelines for the Development of Energy Management and Efficiency of Air Transportation in Thailand

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The Study of Guidelines for the Development of Energy Management and Efficiency of Air Transportation in Thailand

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Conclusion

Objectives

The Study of Guidelines for the Development of Energy Management and Efficiency of Air Transportation in Thailand is aimed to analyze the potential and set targets for reducing energy consumption and greenhouse gas emissions causing from the aircraft activities and cargo transportation services and to conduct the action plan to enhance energy management and efficiency of air transportation in Thailand.

Project Plan Process

The study is a brief process plan of operation starting by collecting and reviewing various information, plans, policies and development strategies, research documents and statistical data on air transportation and energy consumption of various agencies at the moment. After those process, the pilot project area selected to survey, collect detailed data on operational activities in the airport area, evaluate and analyze energy use and greenhouse gas emissions. It is the prototype structure to collect and analyze the remaining airports data in Thailand to set as baseline. Moreover, the process is to analyze the problems and causes of loss of energy use as a guideline for determining appropriate measures for improving and managing energy efficiency. Then, the potential to reduce energy consumption is conducted by reviewing successful international best practices which used to consider successful aboard energy conservation measures which are suitable for Thailand and led to the draft action plan to enhance energy management and efficiency in air transportation in Thailand by brainstorming workshop meeting from various agencies associated to find conclusions in the action plan and in the project has developed a database. This database is to analyze energy consumption across all airports and implemented as a tool for the action plan.

The Selection of 3 Pilot Airports

The following criteria for selecting the 3 pilot airports are:

- Airports that are operated by government, state enterprise, and private sector agencies.
- The highest number of flights and passengers and good tendency of the expansion at large, medium and small airports with a variety of activities selected as a case study.
- Potential airport with opportunity to expand services in a long term.
- Serving both domestic and international passenger and flights.
- Being a connection to various of transportation networks.

According to following conditions, Krabi Airport (DOT), Phuket Airport (AOT) and Samui Airport (BA) are selected for this study project.

The results of this study project is the development of a draft action plan to enhance the energy management and efficiency of air transportation in Thailand. The action plan is divided into 3 phases: short term -3 years (2019-2021), medium term -5 years (2022-2027) and long term -10 years (2028-2037). These projects can be concluded as follow:

Short Term and Continuous Projects / Measures

- Turning off light at the apron area when no operation.
- Promoting travelling to and departing from airport via public transport.
- Capacity building for working in airport: Skill development of the airport personnel.
- Raising awareness in the organization about environment and energy saving.
- Replacement of the airport lighting.
- Tracking system installation on vehicles and GSE equipment.
- Provision of sufficient car parking space and parking management system.
- Roof construction for shuttle bus parking in the airside area.
- Improvement of the wall and building glass, such as attaching the thermal film.
- Airport facility management for energy saving, such as automatic power-off control use / motion sensor.
- The study on renewable energy at the airport.
- The study the concept of green building design in the airport for energy saving.
- The study on determination of proper service life and vehicle use on GSE equipment in the airside area.

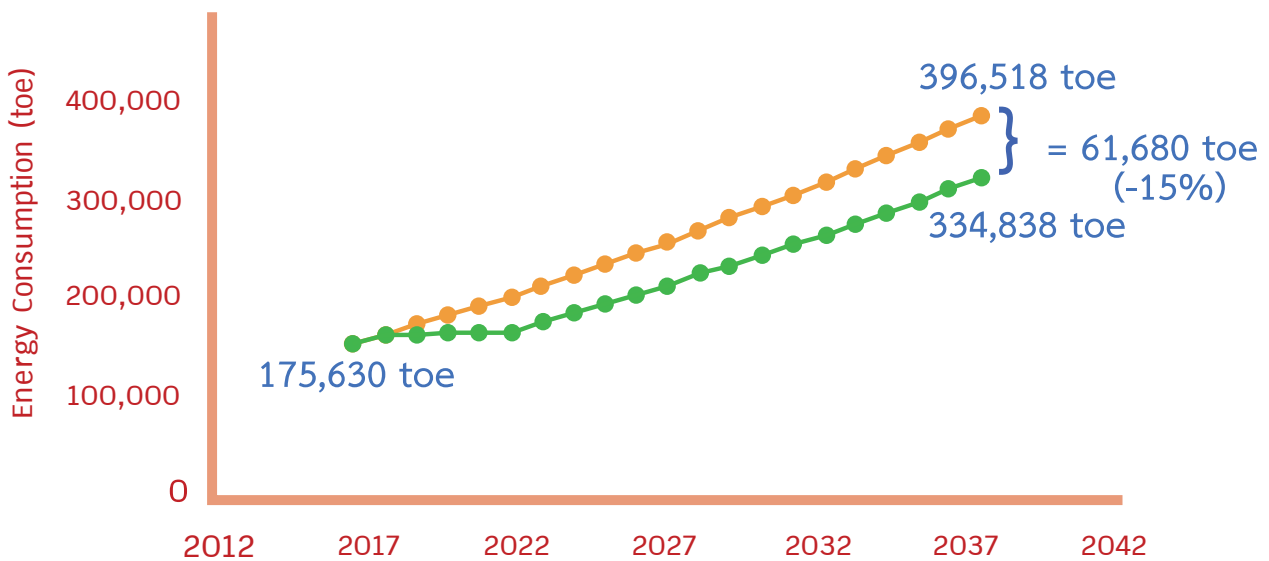
Medium and Long Term Projects/Measures

- Use of EV public bus for arrival and departure at the airport.
- Promotion of Electric Vehicle (EV) for arrival and departure at the airport.
- Improvement of high efficiency enhancement of air conditioning system.
- Construction of fuel stations and EV charging stations in the airside area.
- Promotion of using the EV shuttle bus in the airside area.

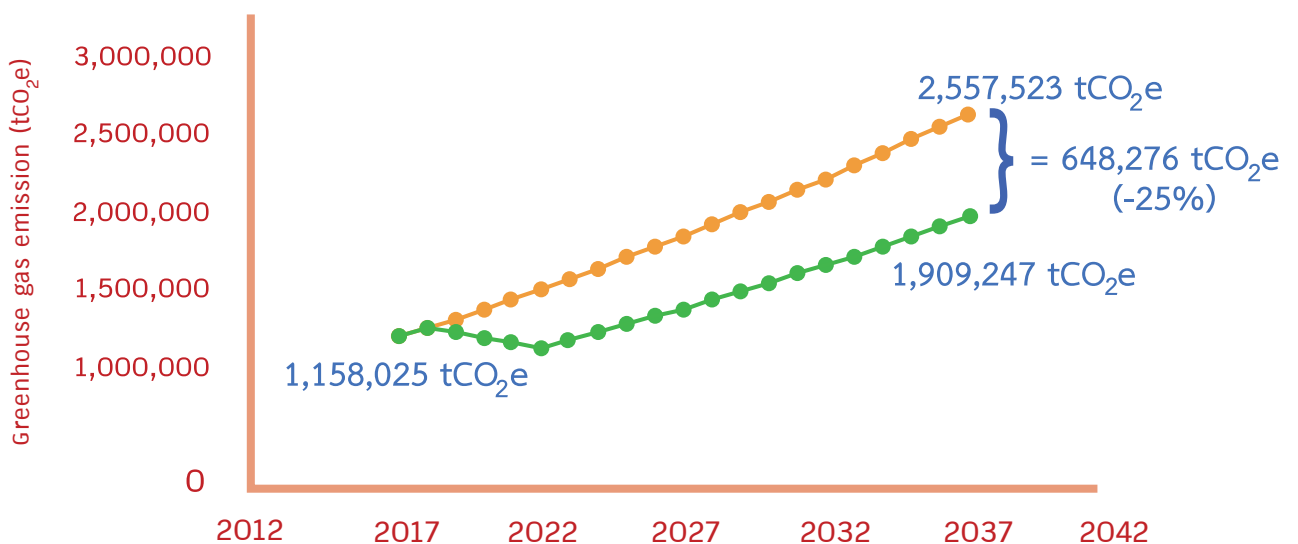
Year	Total Energy Consumption (toe)			Total Greenhouse Gas Emission (tCO ₂ e)		
	BAU	With Action Plan	Saving	BAU	With Action Plan	Reducing
2017	175,630.19	175,630.19	0	1,158,024.65	1,158,024.65	0
2022	220,699.13	187,466.77	33,232.36	1,449,036.89	1,085,668.83	363,368.06
2027	274,078.55	232,261.68	41,816.86	1,788,730.97	1,336,472.66	452,258.31
2032	331,628.26	280,270.94	51,357.33	2,151,501.74	1,604,171.16	547,330.57
2037	396,517.61	334,837.03	61,680.57	2,557,523.09	1,909,246.75	648,276.34

The implementation of the action plan is expected that in the 20 years or 2037 the energy consumption of airports in Thailand will be reduced from 396,518 toe to 334,838 toe (reduced 61,680 toe) resulting in greenhouse gas emissions from 2,557,523 tCO₂e to 1,909,247 tCO₂e (reduced 648,276 tCO₂e). It is accounted for 15-25 percent respectively, compared to the baseline (BAU).

Airport energy consumption in Thailand



Airport greenhouse gas emissions in Thailand



Principle and Reason

Project Background

According to the 20-years Energy Efficiency Plan : EEP2015 (2015-2036), It is aimed to reduce energy intensity by 30 percent in 2036, compared to 2010 with using 10 main measures. One of measures is the energy conservation measures for the transport sector, which is the highest energy consumption. However, the measure mentioned in the energy efficiency plan cover only land transportation sector which still have not been implemented for water and air transportation. Even there have been a studies about energy use in air transport sector, but only jet fuel consumption in the aircraft. There is no studies and analysis of energy consumption at the airport.



State of Problem

With the air transportation expansion increasingly and continuously around the world, the Thai and region expansion economy, along with tourism growth in Thailand, cause a number of the passenger and cargo transportation increased consistently. This also affects on other energy use at the airport and green house gas emissions in Thailand.

The Office of Transport and Traffic Policy and Planning (OTP) recognizes the importance of energy consumption in these dimension. To encourage and develop the effective energy use for transportation, OTP was purposed to be supported by the Energy Conservation Promotion Fund, Ministry of Energy for conducting *Study of Guidelines for the Development of Energy Management and Efficiency of Air Transportation in Thailand.*

Objectives

1

To study and analyze the potential of the effective aircraft and energy efficiency in Thailand.

2

To reduce energy consumption and greenhouse gas emission of the aircraft in Thailand.

3

To develop an energy conservation action plan for the domestic air transport.

Project Goals

Outputs

Expected outputs from this project study:

- (1) Baseline data of energy consumption and greenhouse gas emissions of all the airports in Thailand.
- (2) The targeted value of energy reduction and greenhouse gas emissions of aircrafts in Thailand.
- (3) Potential data and measures management and of methods of aircrafts efficiency in Thailand.
- (4) Database of energy consumption and greenhouse gas emissions of all of the aircrafts in Thailand.
- (5) An action plan to develop energy management and efficiency of aircraft transportation in Thailand.

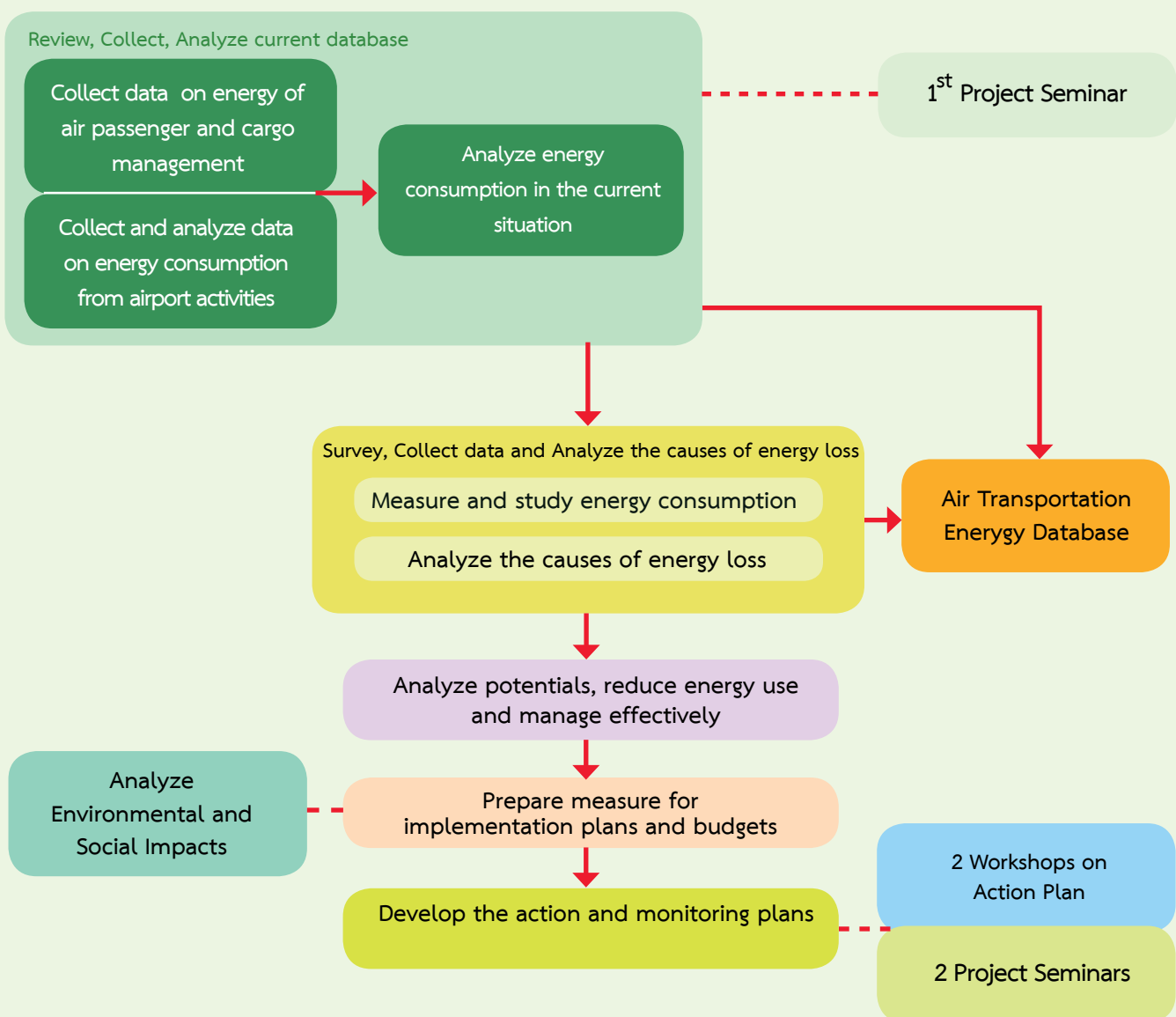
Outcomes

Expected outcomes from the implementation of this project as follow :

- (1) Operation of the action plan project helps to encourage energy conservation in the transportation sector due to lack of the current action plans of aircrafts from air transport energy efficiency.
- (2) The results of action plan helps save energy consumption and reduce greenhouse gas emissions of all the airports roughly 15-25 percent.
- (3) The results of the study are compiled as a part of the 20-year Energy Efficiency Plan (2015-2036).

Operational Guidelines

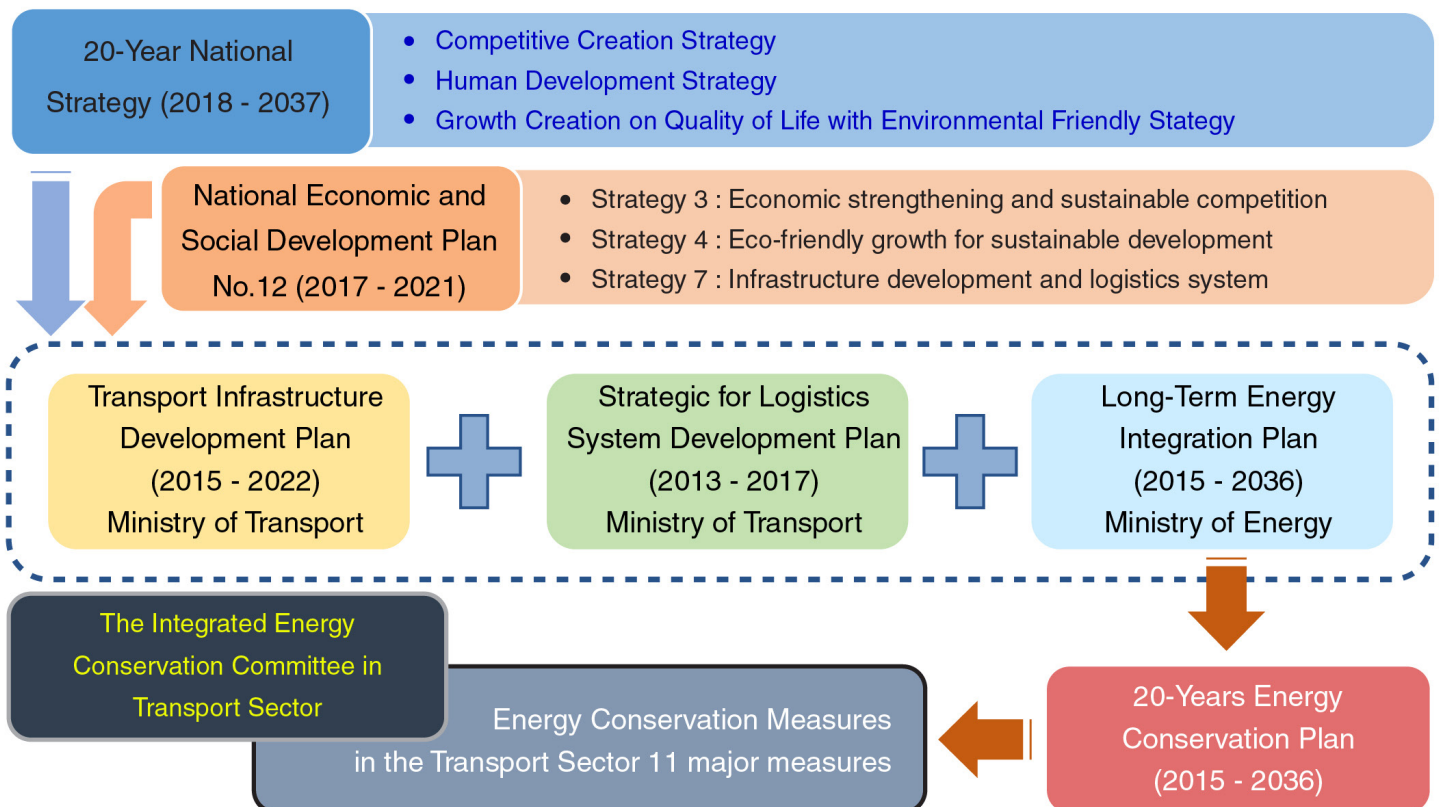
Here is the steps of an overall process for the study project.



- Methods of collecting and checking data, collecting and reviewing data, plans, policies and various development strategies, research report and statistical data on transportation and current energy consumption from various agencies. In order to acknowledge the direction of development and the linkage of each work plan in relation to the energy collection of the statistic data on air transportation energy consumption data from operational activities in the airport area will acknowledge the current energy consumption situation.
- Procedures of survey data in 3 selected pilot airports are to collect the data of airport activities, then evaluate, analyze energy consumption and greenhouse gas emissions used as the prototype structure for collecting and analyzing the remaining airports data in Thailand to be set as baseline. Also, Analyzing the problems and causes of energy loss is a guideline for determining appropriate measures. In order to improve and manage energy efficiency, The basic data of current energy consumption will be recorded in the database system.
- Energy consumption saving is considered as a successful international best practice. However, The anticipation of the number of energy consumption and greenhouse gas emissions in 20 years is considered as Business as Usual (BAU). The results of potential energy development will then be analyzed.
- Consideration of the measures of the best practice will be implemented appropriately to all the airport in Thailand setting the target of energy efficiency determining the details of activities to the process of the action plan are required The measures will be considered as the initial environmental and social impact assessment. If the measures focus on energy conservation and eco-friendly, the impact will be positive.
- The process of developing an action plan to enhance the energy management and efficiency from air transportation will be implemented various measures into draft action plan during into 3 phases short-term, medium-term and long-term composed of budget, target, expected result, and responsible agencies. By these processes, there were brainstorming workshop meetings to share opinions from the related various agencies to find the same conclusion.
- After developing an action plan, There is a plan conduction in order to be meet the target.
- The process of developing a database system for analysis energy consumption and greenhouse gas emissions is fully implemented and can be used as a tool to monitor the action plan.
- During the study project, there will be seminars, workshops meetings and survey throughout the project period in order to participate, share ideas and suggestions.

Summary of Policy Review

The study of the project complies various relevant information and reviewed plans, policies and development projects related to transportation and energy. The study also provided the acknowledgement of the direction of development and strategic plan to achieve the same results and decrease the redundancy.



“ According to the review of various policies and relevant development strategies from the Ministry of Transport and the Ministry of Energy, there are connected and supporting sectors to achieve the same goal e.g. Reducing an energy use and greenhouse gas emissions in transportation sector. However, if considering in detail, there are no related measures to air transportation. The measures are mainly focused on land transport. Thus, the study of this project is a good opportunity to increase the measure of energy management and efficiency in air transportation sector. ”



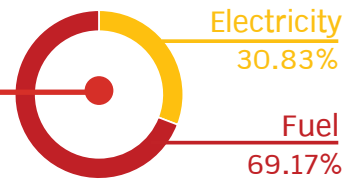
The Current Situation

There are 3 departments operating airports in Thailand i.e. Department of Airports (DOA) belonging to the government operates 28 regional airports, Airports of Thailand Public Company Limited (AOT) belonging to the state enterprise operates 6 airports and Bangkok Airways Public Company Limited (BA) operates the private 3 airports.

The results of the data analysis found that In 2017, roughly 70% of the current baseline was from fuel consumption and the rest 30% was from electricity. The current baseline of energy consumption and greengouse gas emission were 175,630 toe and 1,158,025 tCO₂e.

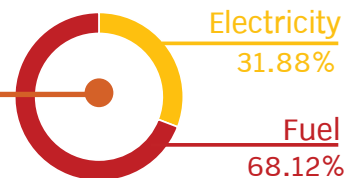
- Energy consumption of airports in 2017 (175,630 toe)

E_{Energy}

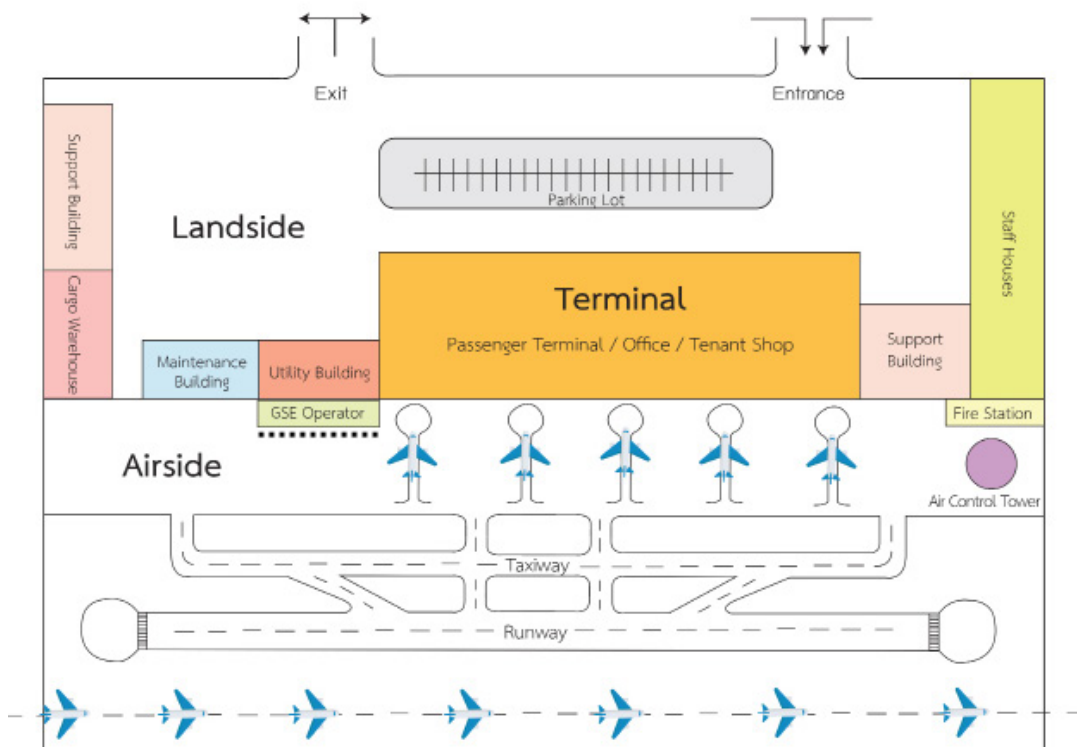


- Greenhouse gas emissions of airports in 2017 (1,158,025 tCO₂e)

GHG

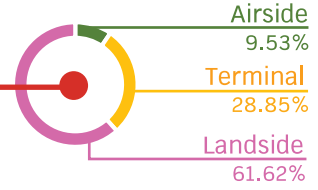


The energy consumption can be categorized into these activity areas i.e. Landside, Terminal areas and Airside area.

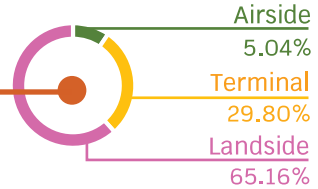


A Landside area is the highest amount of energy consumption and greenhouse emission by 62% followed by terminal area 29% and Airside area 9%.

-Energy-



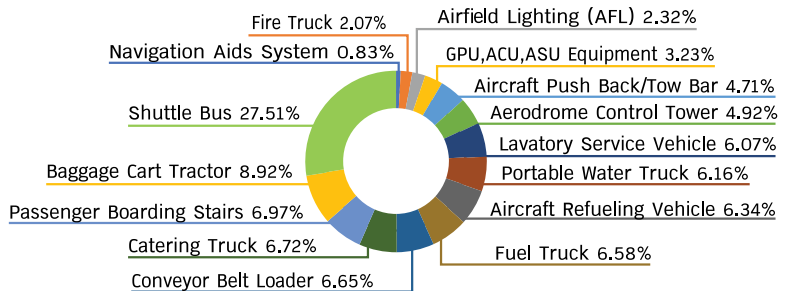
-GHG-



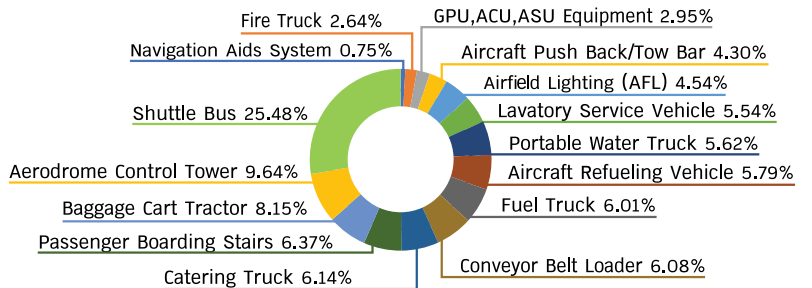
Airside Area

The energy consumption and greenhouse gas emission from passenger, baggage carts tractor, and passenger boarding stairs in Airside area are mostly from shuttle busses, baggage carts tractor and passenger boarding respectively.

Energy



GHG



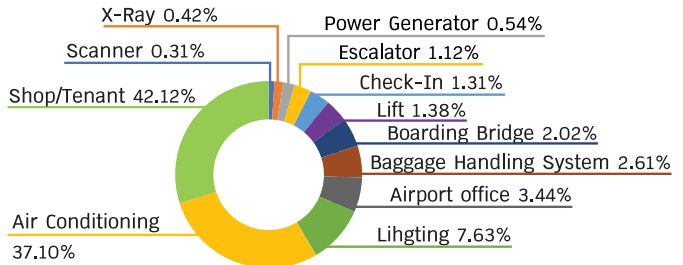


Terminal Area

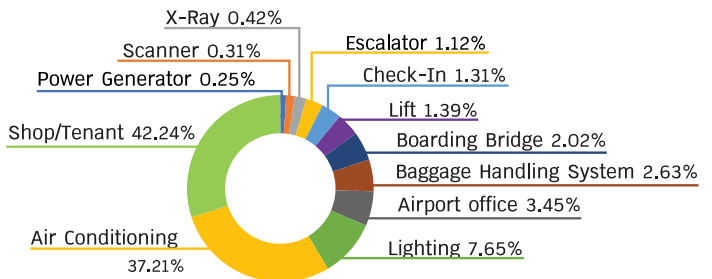
The energy consumption and greenhouse gas emission in terminal area are mostly from air-conditioning consumption, commercial stores and lightings.



Energy



GHG

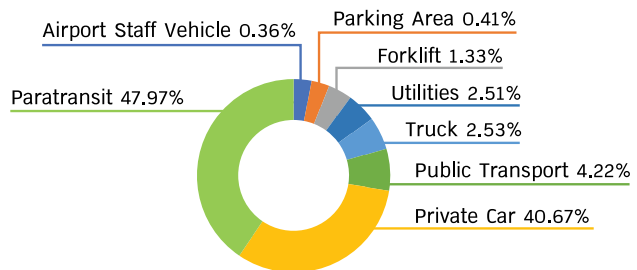


Landside Area

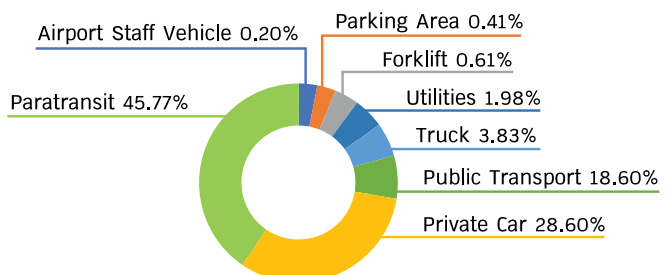
The energy consumption and greenhouse gas emission in landside area come from private cars, in-and-out commuting to the airport by para-transit transportation such as taxis, vans and rental cars.



Energy

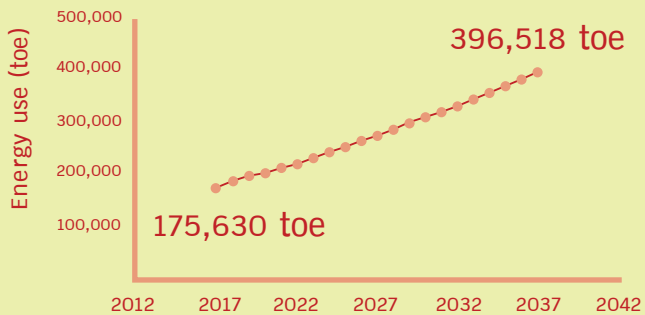


GHG





Airport energy usage in Thailand.



If there is no action is taken, it is expected that all airports in Thailand will have consumed the energy by 396,518 toe and emitted a greenhouse gas roughly 2,557,523 tco₂e.

Greenhouse gas emissions in Thailand.



Problems and Causes of Energy Loss

- Airside Area -

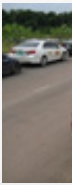
Having a small number of boarding bridges requires the use of a large amount of Ground Service Equipment (GSE). If the boarding bridges is installed more encourages to reduce the number of carts equipment and the shuttle buses because they are vehicles consuming a lot of fuel. In addition, the shuttle busses are required to start engine 10-15 minutes in advanced to make hydraulic system ready to use and cooling inside for passengers. Sometimes if the weather is hot, the driver starts the bus while no flight are landed and it causes to fuel loss.

There are always several damaged Ground Service Equipments that need to be repaired as well as some types of vehicles with long service life causing poor performance and energy loss.

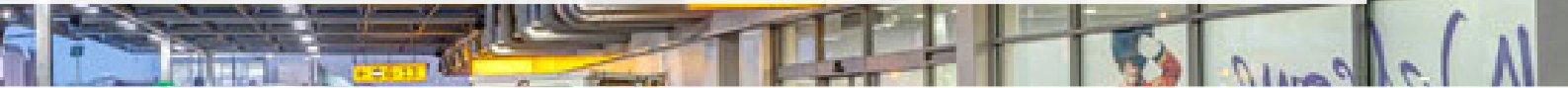


- Terminal Area -

Air conditioning having service life, insufficient cooling capacity to the passengers along with glass building design without thermal film affect to improper operation of air-conditioners.



This project have studied, surveyed, collected energy consumption data from pilot airport representatives of 3 different operators such as Krabi Airport (DOA) belonging to the government, Phuket Airport (AOT) belonging to the state enterprise and Samui Airport (BA) belonging to the private agency. Then, analyze problems and causes of energy loss will be analyzed.



- Landside Area-

Case study of a warehouse at Phuket Airport, there are several cargo trucks in and out. Most cargoes are frozen seafood products. The loading and unloading of products need many labors and took long time that other cargo trucks were not be able to transmit their products. Some truck had not shut the engine down while conveying the products. These causes are considered as a fuel lost.

The airport parking lot cannot accommodate enough cars. Finding an vacant space around parking lot causes of fuel loss.

The last factor causing of fuel loss is having a checking points at the entrance and exit close to the main highway. Also, it affects to the traffic congestion in rush hour.



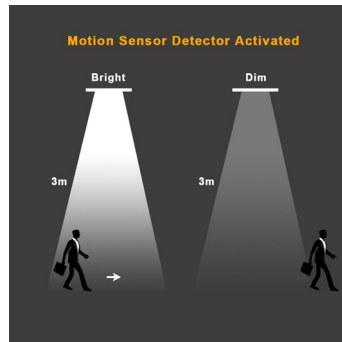
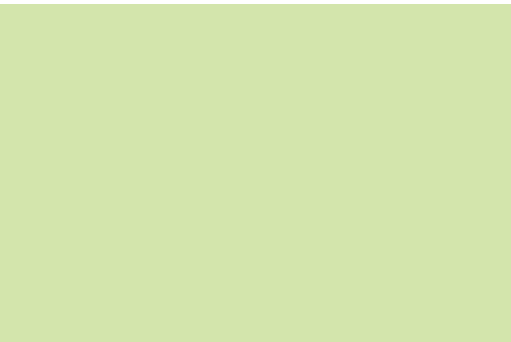
Best Practice in Foreign Countries



The LED lighting installation in various areas of the airport, such as the landside area, the passenger terminal area, and the airside area.



An electricity consumption from solar energy in airports by installing solar panels on the roof of the Airports and parking lot.



Installation of Motion Sensor to control automatic electricity consumption as the actual consumption.



Check-In System.

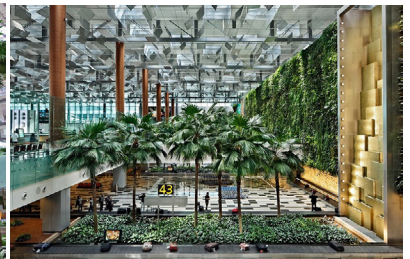
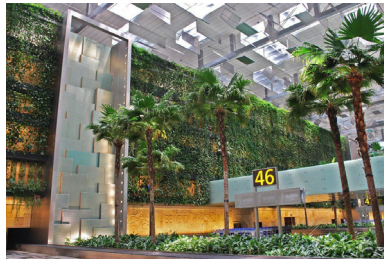


Thermal insulation installation.

Strengthening the transportation connectivity to conveniently access to the airports and reduce private car use.



Using natural light and designing shading building to decrease energy use in the day time and heat from outside into the building.



Using the electric vehicles instead of fuel vehicles.



Turning off some electrical appliances when outside of office hours.

Potential Development and Measures in Reducing Energy Consumption



During the study, these were 2 brainstorming sessions on the guideline of action plans to reduce energy consumption from air transportation with the cooperators. The first session was held on December 3, 2018 with cooperations at Raja Room 1, Prince Palace Hotel, Mahanak, Bangkok and the second session was held on December 20, 2018 at Sapphire Suite, Novotel Platinum Pratunam Hotel, Bangkok.



The purpose of session are to distribute knowledge and discuss about the potential development of reducing energy consumption, effective energy management at the airport.



There are also 2 project seminars in Bangkok. The purposes of the seminars are to present the conclusion of the study project, exchange the opinions and suggestions from any cooperative sectors in order to develop the project in the future.

The conclusion of potential and measure of energy consumption that are practically possible and suitable for perspective at the airports in Thailand.

Replacing the old lights with LED lights in the airport. Save up at least 50% of energy consumption.



LED replacement

50%

High efficiency of air conditioning system in both passenger terminal buildings and the airport office save energy consumption by 20-40 percent.



Change air conditioning

20%-40%

Renovating the heat-blocking and renovating glass reduce heat from the outside and therefore, save roughly 5 percent of energy use.



Improve wall and glass building

5%

Using public transportation for the arrival and departure at the airport instead of private vehicles surges up 5 to 15 percent of energy consumption.



Promote public transportation

5%-15%

The implementation of electric shuttle buses in the Airside area to save up energy by 40%.



Use EV shuttle bus in Airside

40%

The airport facility management for energy saving such as using automatic power-off control/Motion sensor reduces energy consumption by 5%.



Airport facility management

5%

Conduction of gas stations and EV charging stations can save up energy consumption by 10%.



10%

Build fuel stations and electric charging in Airside

Capacity building to the airport officers and rise awareness of energy consumption could decrease the energy use by 5 percent.



Capacity building

5%

Maintenance of GSE equipment
2%-9%



Regular maintenance of Ground Service Equipment saves fuel consumption by 2%-9% and also tire-pressure monitoring can reduce up to 2 percent of energy consumption.

Use the EV bus travelling to the airport
30%



EV buses can reduce energy consumption by 30 percent.

Prepare the roof for shuttle bus in Airside
5%



Roof construction for transferring the passenger in the airside area saves energy consumption by 5 percent.

Install tracking system on GSE
5%



Tracking systems installation on vehicles and GSE devices saves energy consumption by 5 percent.

Turn off the lights in apron if no operation
5%



Switching off the lights in apron area when no operation saves energy consumption by 5 percent.

Promote airport users to use EV cars
10%



Encouragement of electric vehicle use (EV) saves 10 percent of energy consumption.

Parking management
5%



Providing sufficient parking space as well as parking management technology saves energy consumption by 5 percent.

The study on determining proper service life, vehicle use and GSE equipment in Airside.

The study on alternative energy in the airport.

The study on concept of green building.

The Action Plan to Enhance Energy Management and Energy Conservation of Air Transportation in Thailand

The action plan is divided into 3 phases: short-term 3 years (2019-2021), medium-term 5 years (2022-2027) and long-term 10 years (2028-2037) consisting of the project name / measures, target values, duration, budget, energy saving result and cooperative sectors. This action plan is also conducted by integrating the process of brainstorming session and conclusions from related department from 2 workshop meetings in Krabi and Phuket and 2 seminars in Bangkok.



Draft Action Plan

Plan / Project	Energy saving target (percent)	Duration for operating the action plan Short Term (2019-2021) Medium Term (2022-2027) Long Term (2028-2037)	Budget (million Baht)	Energy saving (toe)	Department
6. Airport facility management for energy saving, such as automatic power-off control use / Motion Sensor	5	● ● ●	0.365	6.18	DOA/AOT/BA/DEDE
7. Construction of fuel stations and EV charging stations in Airside area	10	●	80.00	2,788.76	DOA/AOT
8. Capacity building to the airport personnels • Save energy driving • Repairing, maintenance of equipment, machinery, vehicles, and other equipment	5	● ● ●	17.10	1,383.47	DOA/AOT/BA
9. EV buses for the arrival and departure at the airport.	30	●	18.00	3,149.66	MOT (DOA/AOT) /BA /DEDE
10. Roof construction for transferring passenger in Airside area	5	●	15.00	442.51	DOA/AOT
11. Tracking system installation on vehicles and GSE equipment	5	● ●	4.00	1,383.47	Entrepreneur/ Airlines
12. Switching the lights off in apron area when no operation	5	● ●	-	52.55	DOA/AOT/BA
13. Promotion of using Electric Vehicle (EV) for the arrival and departure at the airport.	10	●	36.00	11,445.10	DOA/AOT/BA

Draft Action Plan

Plan / Project	Energy saving target (percent)	Duration for operating the action plan			Budget (million Baht)	Energy saving (toe)	Department
		Short Term (2019-2021)	Medium Term (2022-2027)	Long Term (2028-2037)			
14. Provision of sufficient car parking space and parking management system	5	●	●	●	16.00	n/a	DOA/AOT
15. Raising awareness in the organization about environment and energy saving	10	●	●	●	57.00	n/a	MOT (DOA/AOT)/ BA/DEDE
16. The study on determination of proper service life, vehicle use and GSE equipment in Airside area	5	●	●		10.00	n/a	MOT (DOA/AOT)
17. The study on alternative energy to replace the fuel in the airport area	20	●	●		10.00	n/a	DEDE
18. The study on concept of green building design at the airport for energy efficiency	20	●	●		10.00	n/a	DEDE

Note : MOT is Ministry of Transport
 DOA is Department of Airports
 AOT is Airports of Thailand Public Company Limited
 BA is Bangkok Airways Public Company Limited
 DEDE is Department of Alternative Energy Development and Efficiency

The action plan has been prioritized by considering various factors such as from the problems of operation, measures without investment can be implemented. Practically acceptable measures in the airport, the anticipation of investment budget comparing to the benefits. However, conclusion of measure operation plans are as follow :

Short Term and Continuous Projects/Measures

- Turning off the lights in the apron area when no operation.
- Encouragement of inbound and outbound trip in the airport by public transportation.
- Capacity building for the officer at the airport.
- Raising awareness in the organization about environment and energy efficiency.
- Replacement of LED light bulbs in the airport.
- Tracking system installation on vehicles and GSE equipment.
- Provision of sufficient car parking space and parking management system.
- Roof construction for parking shuttle buses in the Airside area.
- Improvement of the wall and glasses of the building adhered thermal film.
- Airport facility management for energy saving, such as automatic power-off control / Motion Sensor
- The study on alternative renewal energy in the airport.
- The study on the concept of green building design at the airport for energy saving
- The study on determining proper service life of vehicle use and GSE equipment in Airside.

Medium and Long Term Projects/Measures

- Use of EV public bus travel to and from airport.
- Promoting use of Electric Vehicle (EV) for the arrival and departure at the airport.
- Improvement of high efficiency air conditioning system.
- Construction of fuel stations and EV charging stations in Airside area.
- Using EV shuttle bus for passenger in the Airside area.



3 Pilot Projects **Krabi / Phuket / Samui**



Krabi Airport

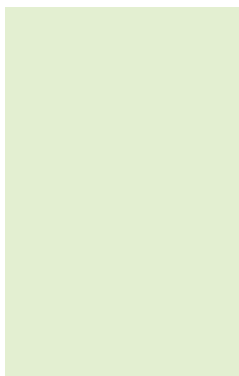
The appropriate project/measures plans for Krabi Airport are as follow :

Short Term and Continuous Projects/Measures

- Turning off the lights in the apron area when no operation.
- Promoting the arrival and departure at the airport by public transport.
- Capacity building for airport officers.
- Raising awareness in the organization about environment efficiency and saving.
- LED light replacement in the airport.
- Tracking system installation on vehicles and GSE equipment.
- Provision of sufficient car parking space and parking management system.
- Roof construction for shuttle bus in the Airside area.
- Improvement of the wall and glass of building, such as adhered the thermal film.
- Airport facility management for energy saving, such as automatic power-off control use/ motion sensor.
- The study on renewable energy at the airport.
- The study on the concept of green building design at the airport for energy saving.
- The study on determination of proper service life, vehicle use and GSE equipment in Airside area.

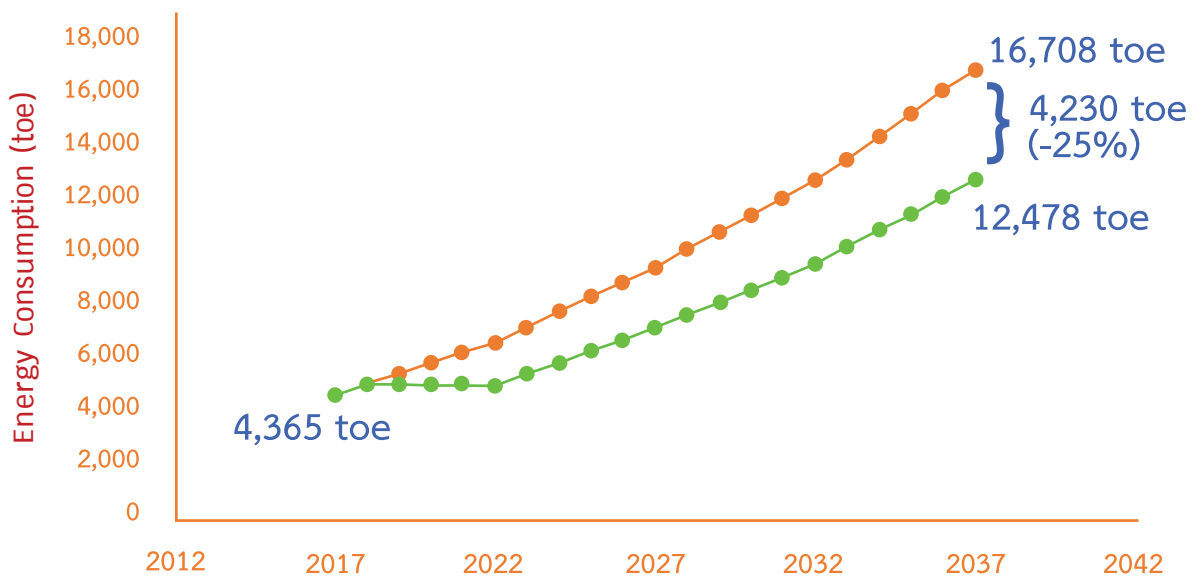
Medium and Long Term Projects/Measures

- Use of EV public bus for inbound and outbound trip in the airport.
- Encouragement of electric vehicle use for transferring the passenger through the airport.
- Improvement of high efficiency of air conditioning system.
- Construction of fuel stations and EV charging stations in Airside area.
- Using EV shuttle bus for passenger in the Airside area.

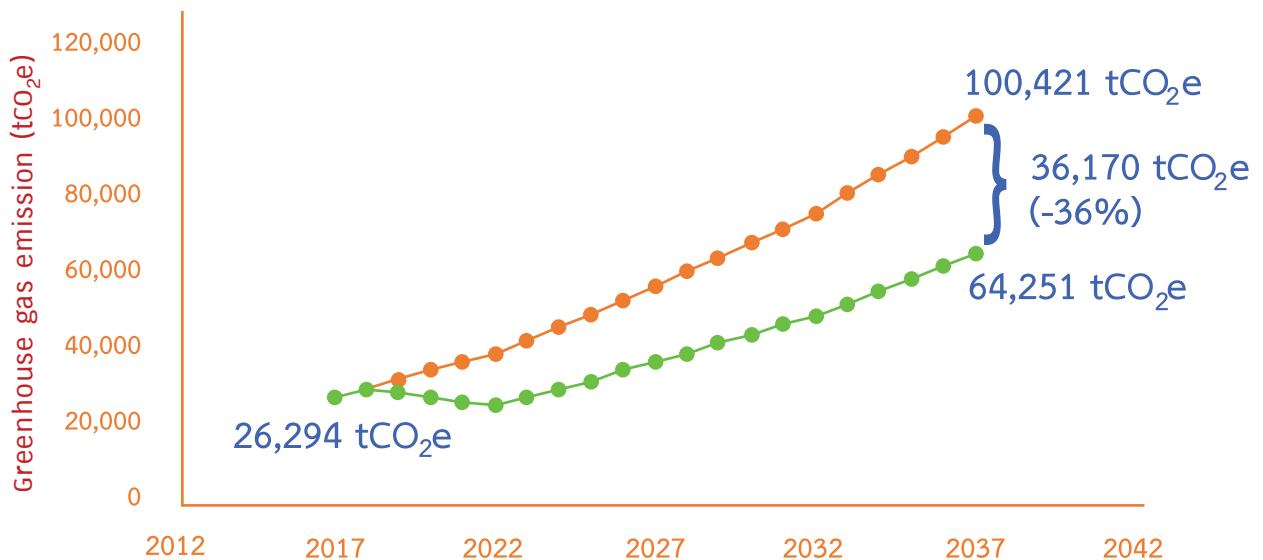


The appropriate implementation action plan is expected that in the 20 years (2037) the energy consumption of Krabi airports will be reducing from 16,708 toe, saving 4,230 toe to 12,478 toe and greenhouse gas emission from 100,421 tCO₂e to 64,251 tCO₂e (reduced by 36,170 tCO₂e). It is equivalent to 25 percent and 36 percent respectively, when compared to the baseline (BAU).

Energy consumption in Krabi Airport



Greenhouse gas emissions in Krabi Airport



Phuket Airport

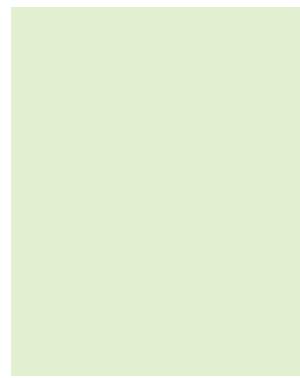
The appropriate project/measures plans for Phuket Airport are as follow :

Short Term and Continuous Projects/Measures

- Turning off the light in apron area when is no operation.
- Promoting travel to and from airport via public transport.
- Capacity building for the airport personnel.
- Raising awareness in the organization about environment and energy conservation.
- Replacement of LED light at the airport.
- Tracking system installation on vehicles and GSE equipment.
- Sufficient car parking space and parking management system.
- Roof construction for parking shuttle buses in the Airside area.
- Improvement of the wall and glasses of building such as adhered the thermal film.
- Airport facility management for energy saving, such as automatic power-off control use/ Motion Sensor.
- The study on the renewable energy in the airport.
- The study on the concept of green building design in the airport for energy saving.
- Determination of proper service life, vehicle use and GSE equipment in the Airside area.

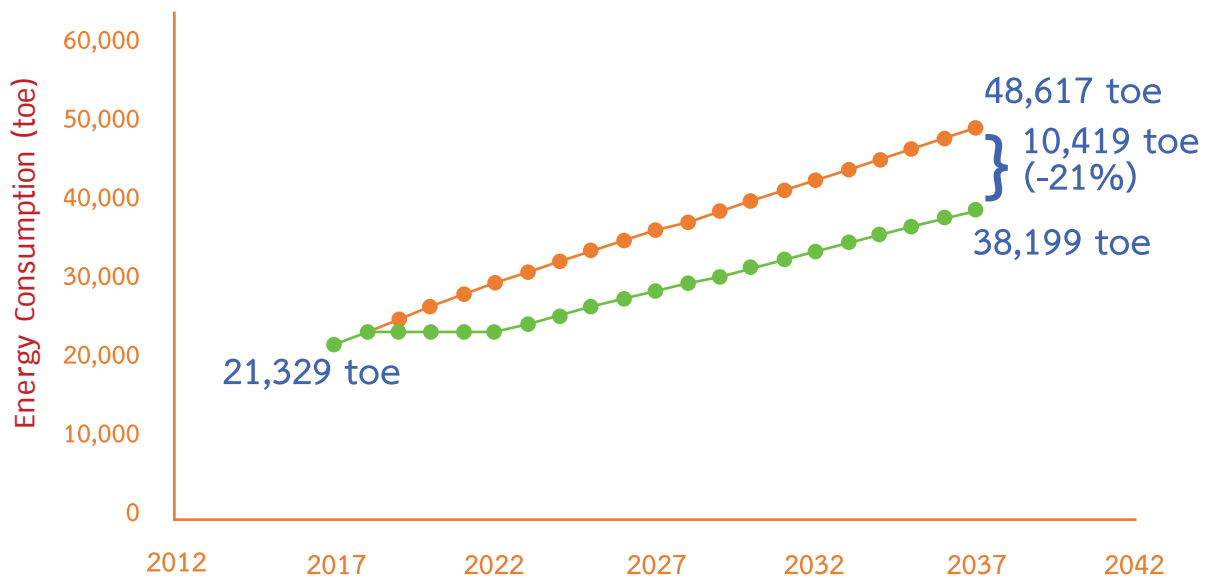
Medium and Long Term Projects/Measures

- Use EV public bus travel to come to the airport.
- Promoting use of Electric Vehicle (EV) for the arrival and departure at the airport.
- High efficiency improvement of air conditioning system.
- Using EV shuttle bus for transferring passengers at the airport.

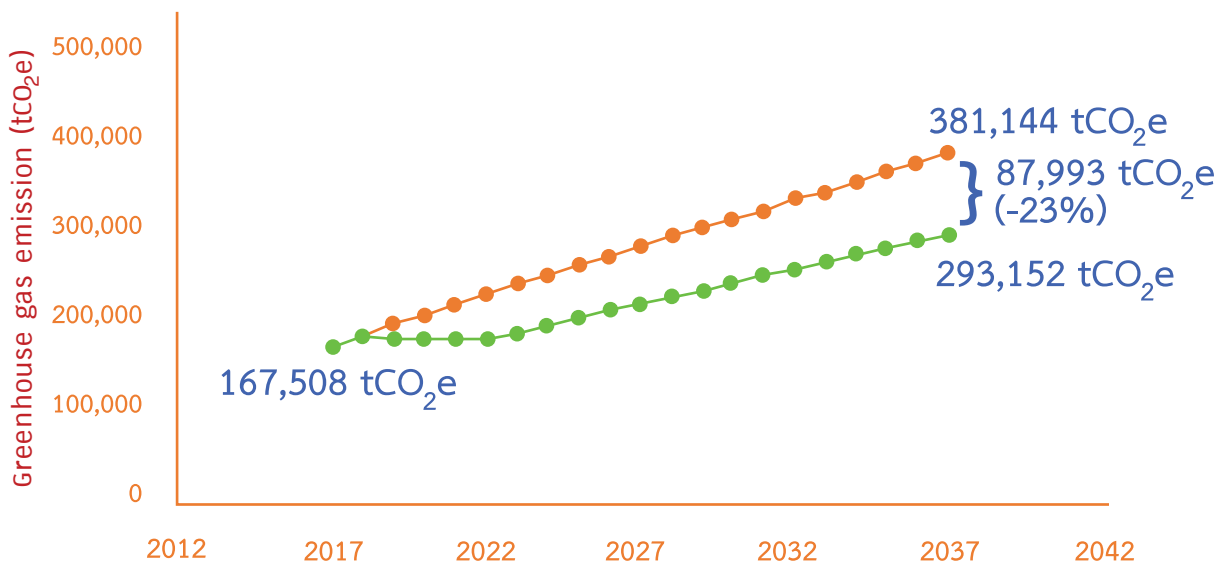


The appropriate implementation of the action plan is expected that in the 20 years (2037) energy consumption of the Phuket airport will be reduced from 48,617 toe to 38,199 toe (reduced by 10,419 toe) and greenhouse gas emission from 381,144 tCO₂e to 293,152 tCO₂e (reduced 87,993 tCO₂e) or equivalent to 21 percent and 23 percent respectively when compared to the baseline (BAU).

Energy consumption in Phuket Airport



Greenhouse gas emissions in Phuket Airport



Samui Airport

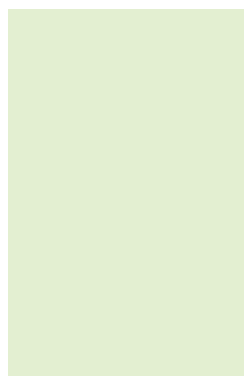
The appropriate project/measures plans for Samui Airport are as follow :

Short Term and Continuous Projects/Measures

- Switching off the lights in apron area when is no operation.
- Encouragement of inbound and outbound trip at the airport by using public transport.
- Skill development for airport personnel.
- Raising awareness in the organization regarding environment efficiency and energy saving.
- Replacement of LED lights in the airport.
- Tracking system installation on vehicles and GSE equipment.
- Airport facility management for energy saving, such as using automatic power-off control use / Motion Sensor.
- The study on alternative energy in the airport.
- The study on the concept of green building design.
- Determination of proper service life, vehicle use and GSE equipment in the Airside area.

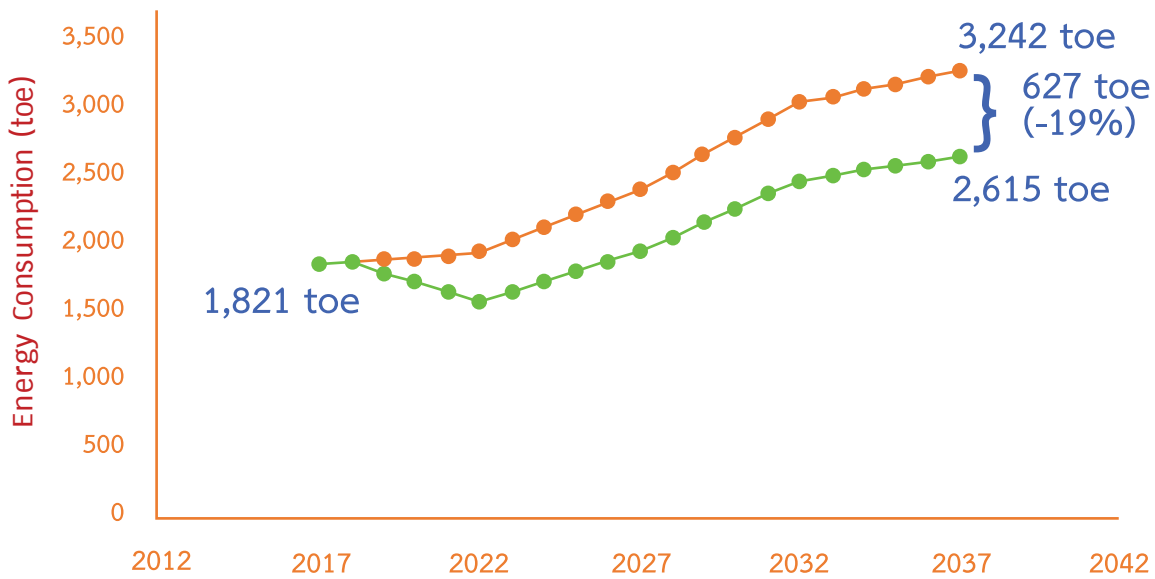
Medium and Long Term Projects/Measures

- Use EV public bus for incoming and going out of the airport.
- Enhancing the use of electric vehicle (EV) for arrival and departure passengers at the airport.
- High efficiency improvement of air conditioning system.

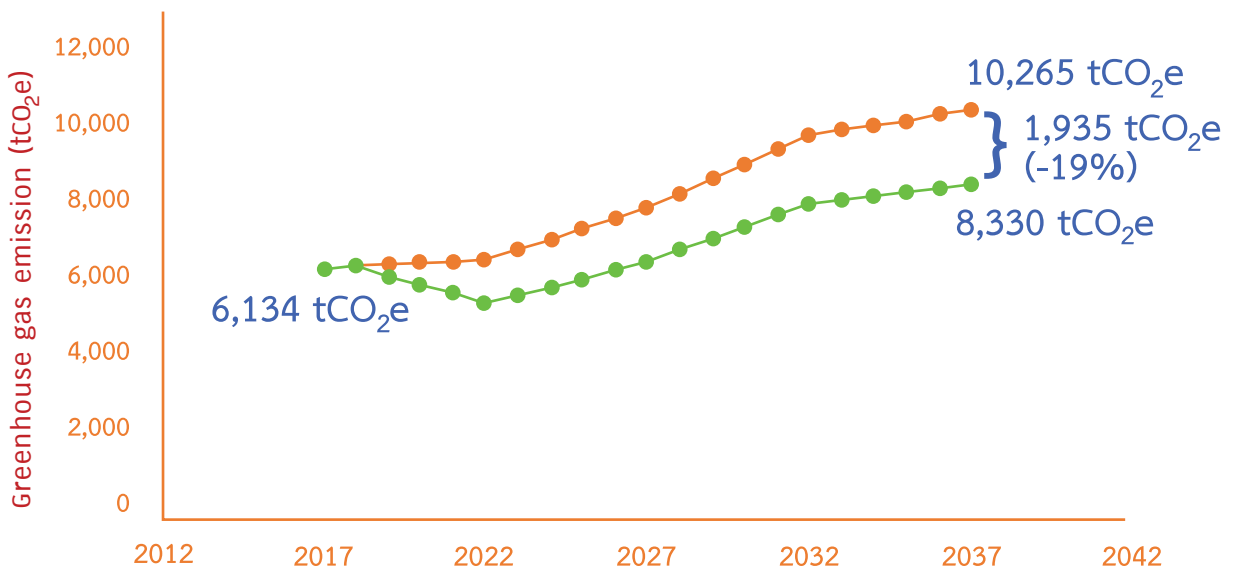


The appropriate implementation of the action plan is expected that in the 20 years (2037) energy consumption of Samui airport will be reduced from 3,242 toe to 2,615 toe (reduced 627 toe) and emissions greenhouse gases from 10,265 tCO₂e to 8,330 tCO₂e (reduced 1,935 tCO₂e). It is equivalent to 19 percent and 19 percent respectively when compared to the baseline (BAU).

Energy consumption in Samui Airport

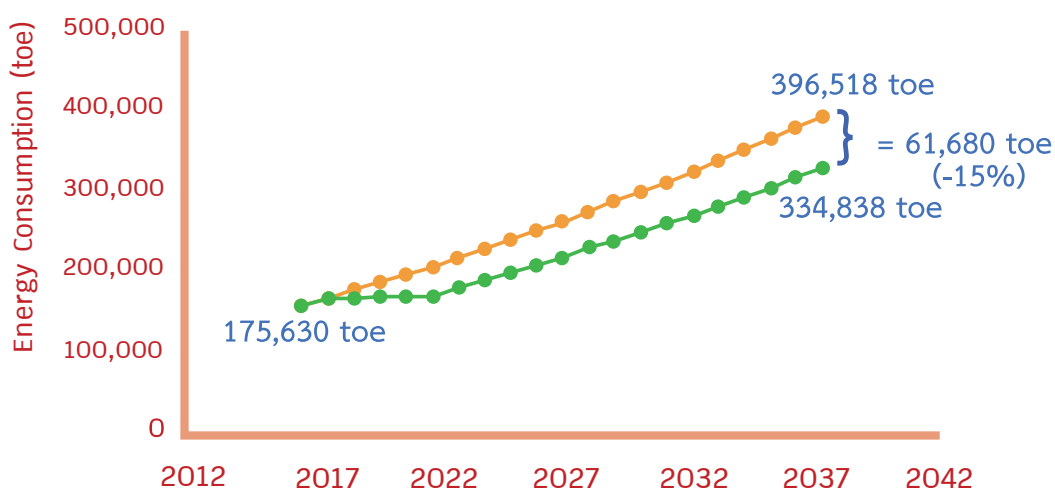


Greenhouse gas emissions in Samui Airport

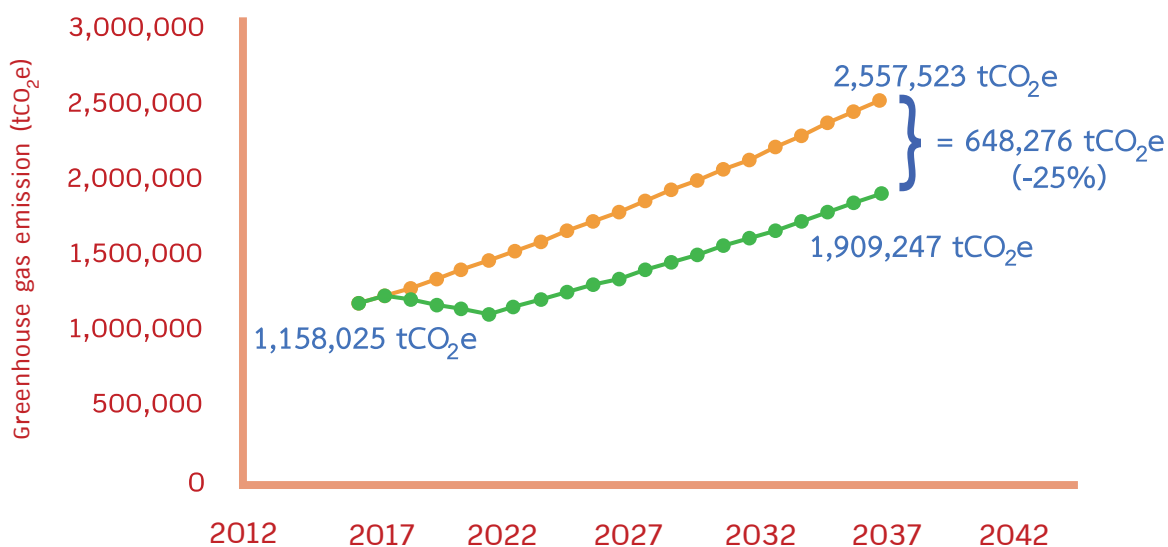


The implementation of the draft action plan is expected that in the 20 years (2037) energy consumption of airports throughout the country will be reduced from 396,518 toe to 334,838 toe (saved 61,680 toe) and greenhouse gas emissions from 2,557,523 tCO₂e to 1,909,247 tCO₂e (reduced 648,276 tCO₂e) or equal to 15 percent and 25 percent respectively when compared to the baseline (BAU).

Airport energy consumption in Thailand



Airport greenhouse gas emissions in Thailand



Mornitoring Plan to follow up the Action Plan

Plan / project	Performance monitoring	Effectiveness of the project	Effect on energy conservation and reduction of greenhouse gas	Period	Agency
<p>1. LED lighting replacement in the airport</p> <p>1.1 Replacement LED in passenger terminal</p> <p>1.2 Replacement LED in airport office</p> <p>1.3 Replacement LED in the shop / tenant</p> <p>1.4 Replacement LED in parking area</p> <p>1.5 Replacement LED in airfield lighting (AFL)</p> <p>2. Improvement and high efficiency of air conditioning system</p> <p>2.1 Change the air conditioning system in the passenger terminal into a Package Water Cool Chiller.</p> <p>2.2 Change the air conditioning system in the airport office to the Split Type Inverter.</p> <p>3. Improvement of the wall and glasses of the building such as adhered the thermal film</p> <p>4. Promoting the arrival and departure at the airport by public transport</p> <p>5. EV Shuttle Buses use in the airside area</p>	<p>The success of the implementation of the plan</p> <p>The success of the implementation of the plan</p> <p>The success of the implementation of the plan</p> <p>The success of the implementation of the plan</p> <p>The success of the implementation of the plan</p>	<p>Electricity consumption from buildings and areas</p> <p>Electricity consumption from air conditioniners</p> <p>Electricity consumption of buildings</p> <ul style="list-style-type: none"> • Number of passengers and employees using public transport • Number of public transport vehicles • The proportion of people coming to the airport by public transport • Distance • Number of electric shuttle buses • Electricity consumption of electric shuttle bus • Driving distance • Number of passengers taking electric shuttle buses 	<p>Calculation of energy saving and greenhouse gas emissions reduction</p> <p>Calculation of energy saving and greenhouse gas emissions reduction</p> <p>Calculation of energy saving and greenhouse gas emissions reduction</p> <p>Calculation of energy saving and greenhouse gas emissions reduction (Based on the VKT estimation of the public transport passenger) If there various of transportation, inform as categorized.</p> <p>Calculation of energy saving and greenhouse gas emissions reduction (Calculated from fuel saving)</p>	<p>Annual</p> <p>Annual</p> <p>Annual</p> <p>Annual</p> <p>Annual</p>	<p>DOA/AOT/BA/DEDE</p> <p>DOA/AOT/BA/DEDE</p> <p>DOA/AOT/DEDE</p> <p>MOT (DOA/AOT)/BA</p> <p>Entrepreneur/ Airlines/ DEDE</p>

Mornitoring Plan to follow up the Action Plan

Plan / project	Performance monitoring	Effectiveness of the project	Effect on energy conservation and reduction of greenhouse gas	Period	Agency
6. Airport facility management for energy saving, such as automatic power-off control use / Motion Sensor	The success of the implementation of the plan	Electricity consumption	Calculation of energy saving and greenhouse gas emissions reduction	Annual	DOA/AOT/BA/DEDE
7. Construction of fuel stations and EV charging stations in Airside area	The success of the implementation of the plan	<ul style="list-style-type: none"> Number of fuel stations and electric charge stations The running distance of the vehicle in airside area 	Calculation of energy saving and greenhouse gas emissions reduction	Annual	DOA/AOT
8. Capacity building for the airport officer: <ul style="list-style-type: none"> Driving to save energy Repairing, maintenance of equipment, machinery, vehicles, and other equipment 	The success of the implementation of the plan	<ul style="list-style-type: none"> Fuel consumption data rate (energy) of vehicles Energy consumption data of machinery and equipment 	Calculation of energy saving and greenhouse gas emissions reduction	Annual	DOA/AOT/BA
9. Use of EV public bus for arrival and departure at the airport	The success of the implementation of the plan	<ul style="list-style-type: none"> Number of electric buses Electricity consumption of electric bus Running distance Number of passengers using electric buses 	Calculation of energy saving and greenhouse gas emissions reduction (calculated from fuel saving)	Annual	MOT (DOA/AOT)/ BA /DEDE
10. Roof construction for shuttle bus parking	The success of the implementation of the plan	Fuel consumption rate data (energy) of vehicles	Calculation of energy saving and greenhouse gas emissions reduction	Annual	DOA/AOT
11. Tracking system installation on vehicles and GSE equipment	The success of the implementation of the plan	Fuel consumption rate data (energy) of vehicles	Calculation of energy saving and greenhouse gas emissions reduction	Annual	Entrepreneur/ Airlines
12. Turning on and off the light when no operation	The success of the implementation of the plan	Electricity consumption in that area	Calculation of energy saving and greenhouse gas emissions reduction	Annual	DOA/AOT/BA

Mornitoring Plan to follow up the Action Plan

Plan / project	Performance monitoring	Effectiveness of the project	Effect on energy conservation and reduction of greenhouse gas	Period	Agency
13. Promoting use of Electric Vehicle (EV) for arrival and departure at the airport	The success of the implementation of the plan	<ul style="list-style-type: none"> • Number of electric vehicles coming to airport • Driving distance • Number of passengers taking electric vehicle 	Calculation of energy saving and greenhouse gas emissions reduction (Calculated from fuel saving)	Annual	DOA/AOT/BA
14. Provision of sufficient car parking space and parking management system	The success of the implementation of the plan	Parking time (Or find a parking space)	Calculation of energy saving and greenhouse gas emissions reduction (Calculated from fuel saving)	Annual	DOA/AOT
15. Raising awareness in the organization regarding environment and energy efficiency	The success of the implementation of the plan	Total energy consumption (electricity, fuel)	Calculation of energy saving and greenhouse gas emissions reduction	Annual	MOT (DOA/AOT)/BA/DEDE
16. The determination on proper service life and use of vehicles and GSE equipment in Airside.	The success of the implementation of the plan	n/a	n/a	The first year that has been completed	MOT (DOA/AOT)
17. The study on alternative energy in the airport	The success of the implementation of the plan	n/a	n/a	The first year that has been completed	DEDE
18. The study on the concept of green building design in the airports for energy saving	The success of the implementation of the plan	n/a	n/a	The first year that has been completed	DEDE

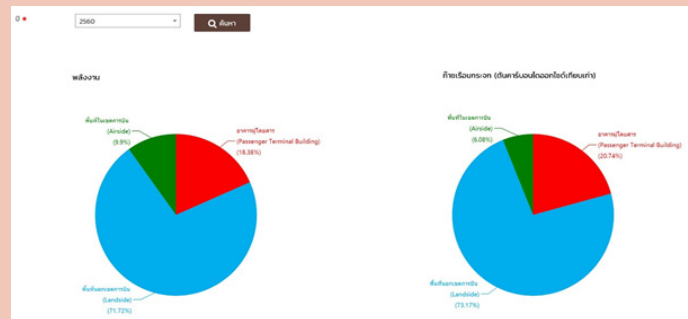
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Database System

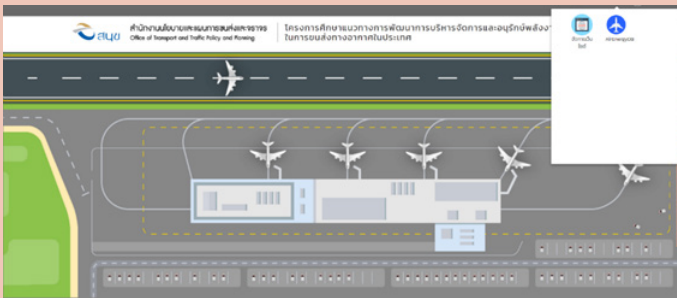
The prototype energy database of air passengers and cargoes is developed as a Web Based Application. There are categorized details by developing the activities. The system evaluates the amount of energy consumption and greenhouse gas emissions at the airport from input data, and then compares with energy consumption and greenhouse gas emissions as BAU to follow up the trend of energy consumption in the future. Also the system displayed as an evaluation table and pie chart. The database system is available for analyzing the information of all airports in Thailand and was used as a tool for following up the action plan to decrease energy consumption. The example of log-in to the system, filling out the input data and reporting evaluation are as follow :

กิจกรรม/รายงาน	ระหว่างประเทศ (International)		ภายในประเทศ (Domestic)		รวมทั้งสิ้น		พลังงาน (toe)	ก๊าซ CO ₂ (ตัน)
	toe	CO ₂	toe	CO ₂	toe	CO ₂		
1. อาคารผู้โดยสาร (Passenger Terminal Building)	717,571	4,869,268	83,042	541,731			800,613	5,411,000
2. พื้นที่จอดรถด้านใน (Landside)							7,464	50,992
2.1 สนามจอดรถ/จอดรถโดยสาร (Parking)	3,732	25,496	3,732	25,496				
2.2 สนามจอดรถผู้โดยสาร					37,298	254,794	37,298	254,794
2.3 สนามจอดรถขนส่งผู้โดยสารจากท่าอากาศยาน					3,732,268	19,234,500	3,732,268	19,234,500
3. พื้นที่บริการด้านใน (Airside)								
3.1 Ground Service Equipment (GSE)					379,247	1,215,315	379,247	1,215,315
3.2 Air Traffic Control (ATC)					51,020	333,586	51,020	333,586
รวม (Total)							4,427,909	26,500,187

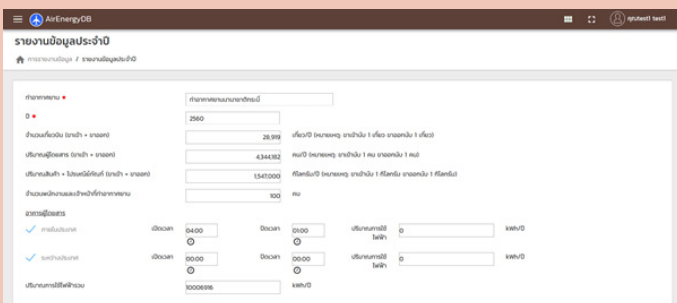
Summary Table of Energy Consumption and Greenhouse Gas Emission



Graph showing the proportion of energy consumption and greenhouse gas emissions by activity area



Log-in to data base system via website of the OTP



Example of the annual energy input data record screen for each airport



Graph showing the energy consumption and greenhouse gas emissions by 20-year forecasts

Project Publicity

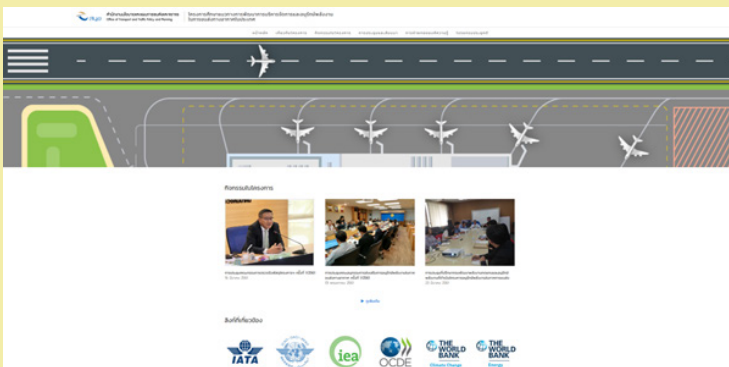
The study has distributed the information about the project during the implementation and also created various media to publicize and distribute information about the project.

(1) Website of the project.

(2) Project Brochure.



Public Relations Website



Public Relations Website



Project Brochure

Suggestions for Next Step Operation

The Study of Guidelines for the Development of Energy Management and Efficiency of Air Transportation in Thailand is a project that studies about energy consumption and greenhouse gas emissions from various activities occurring inside the entire airport area. There are landside area, terminal area and airside area, covering all airports in Thailand under the administration of government agencies, state enterprises and the private sector, namely, Department of Airports, Airports of Thailand Public Company Limited and Bangkok Airways Public Company Limited. There are the anticipation of energy consumption and greenhouse gas emissions in the 20 years, the action plan improve the energy management and efficiency of air transportation, causing reduction for energy consumption and greenhouse gas emissions.

There is a database development for this study as a web application for evaluating energy consumption and greenhouse gas emissions of airports. All airport operators, government agencies, state enterprises, and the private sectors can make to input their own basic data because the system is designated to cover all activities available in the airports and easy to use. Also, there are precise report and database of anticipation of energy consumption and greenhouse gas emissions in 2017 considered as a base year for the next 20 years (year 2037) as BAU case. This anticipation graph is utilized to evaluate to each airport for the coming year. The database input by the officers will be continuous graphs and then determine whether there would be higher or lower energy consumption and greenhouse gas emission at those coming year, when compared to the BAU.



Project suggestions aiming to implement the measure plans require a consistent follow-up to use as the assessment for this study.

Moreover, the practical plan or project that need high investment or much concentration are to overcome the delay because it takes the time to conduct the energy saving plan in 2037 to accomplish the target. The responsible agencies have a source of funding asking for the support from the Energy Efficiency Promotion Fund from the Ministry of Energy.

To Implement the project/measures in the action plan by the responsible agencies, OTP, a central policy agency can participate in collecting data from the responsible agencies. OTP also follow up the data of energy saving and greenhouse gas emission reduction from implementation plan to the Ministry of Energy. There is a specific sector called the committee of integrated policy on energy conservation in the transportation sector by Air Chief Marshal. Prajin Chantong, Deputy Prime Minister.

