ISO 50001 Energy Management System – Case Study

2023 Indonesia

I Gusti Ngurah Rai International Airport, Bali, The First southeast asia Airport to certify ISO 50001. The international terminal, domestic terminal, and the north side of the apron are all included in the scope of the energy management system deployment. The use of energy management can result in energy savings of USD 1,865,197 and reduce GHG emissions by 21,008 tons of CO_2. The uniqueness of this energy conservation program is the optimization Airport Operational System. In 2022, the number of passengers will increase by 70% from the previous year.

PT Angkasa Pura I

I Gusti Ngurah Rai International Airport, Bali, Indonesia

Case Study Snapshot	
Industry	Airport Building
Product/Service	Airport Services
Location	Bali, Indonesia
Energy Management System	ISO 50001 Certified in 2021 by TUV SUD
Energy performance improvement percentage (over the improvement period)	44 % improvement over 2 years
Total energy cost savings (over the improvement period)	USD 1,865,197
Cost to implement Energy Management System (EnMS)	USD 866,385
Total energy savings (over the improvement period)	26,592 MWh
Total CO_2-e emission reduction (over the improvement period)	21,008 Metric Tons

Organization Profile / Business Case

PT Angkasa Pura I is a state-owned enterprise (SOE) that **provides air traffic services and business airports in Indonesia, focusing on providing airport services by prioritizing compliance, service, safety, and environmental aspects**. PT Angkasa Pura I has been entrusted by the government of the Republic of Indonesia to **manage 15 airports, 2 project offices, and 5 subsidiaries** spread across various provinces in the Central and Eastern regions of Indonesia.

Motivation & Goal – PT Angkasa Pura I supports the deployment of energy management systems ISO 50001:2018 within the company's business structure in order to become a **corporate contributor to reducing greenhouse gas emissions in the transportation sector**. This is also one of our corporate missions—to make a positive contribution to the environment; moreover, this endeavor is a goal to create an eco-airport.

Strategy on Climate Change - I Gusti Ngurah Rai Bali Airport has developed a GHG emission reduction roadmap to support the ENDC (Enhanced Nationally Determine Contribution) Indonesian government's 2030 objectives and mitigation action plans, such as renewable energy, energy efficiency & conservation, and low-carbon fuel.

ACTION PLAN	PROGRAM	YEAR
RENEWABLE ENERGI	Construction of a photovoltaic plant at the	2022
	Build solar photovoltaic power stations with potential capacity up to 1,047 kWp	2024 - 2030
	Operation of Ground Power Unit (GPU), Auxiliary Power Unit (APU) at Garbarata	2024 - 2030
ENERGY EFFICIENCY & CONSERVATION	Application of Green Building Certification (New Building)	2024 - 2030
	Re-certification Energy Management System ISO 50001:2018	2025
LOW CARBON FUEL	a. Operation of Electric Vehicles at Airports	2024 -
	b. Provision of Public Electric Vehicle Charging Stations	2024 - 2030
	c. Use of Biofuels (Bio Diesel, Bio Solar) for tractors, runway sweepers, operational cars	2024 - 2030

Figure 1. mitigation actions the GHG emission reduction roadmap

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Support Energy Management - I Gusti Ngurah Rai Airport has measured GHG emission inventories through the ACERT (Airport Carbon Emission Reporting Tool) scope 1 and 2 methods, scope 1 fuel consumption from airport activities, and scope 2 airport electricity consumption.

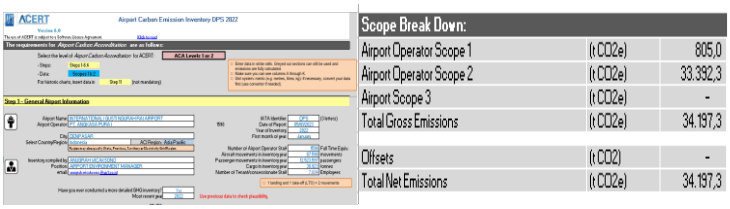


Figure 2. emission inventories through the ACERT

"Implementation of ISO 50001:2018 Energy Management System at Bali's I Gusti Ngurah Rai Airport is a real energy conservation and saving effort to support the realization Eco-Friendly Airport."

— *Faik Fahmi, President Director of PT Angkasa Pura I*

Business Benefits

The benefits we get from implementing ISO 50001:2018 energy management system at I Gusti Ngurah Rai Bali International Airport are as follows:

Financial Benefit

Through the implementation of an energy management system, providing cost savings benefits up to 2022 of US$ 1,865,197, we measure energy performance by developing a basic equation to calculate energy performance by considering variables such as the number of flights or passengers.

Environmental Benefit

Energy Efficiency - The advantages of establishing an energy management system include **energy savings** of 26,592 MWh and a **reduction in CO2 emissions** of 21,008 tons (EnPi Level 1), **energy savings** of 14,350 MWh and a **reduction in CO2 emissions** of 11,336 tons (EnPi Level 2 Passenger), and **energy savings** of 10,806 MWh and a **reduction in CO2 emissions** of 8,537 tons (EnPi Level 2 flight number). If the cusum graph shows a positive number, energy performance is not achieved. However, if the cusum graph shows a negative number, energy efficiency is achieved.

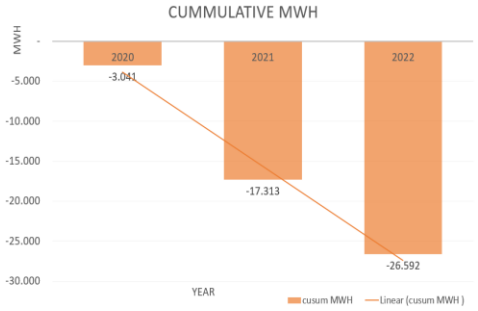


Figure 3. Cusum Level 1

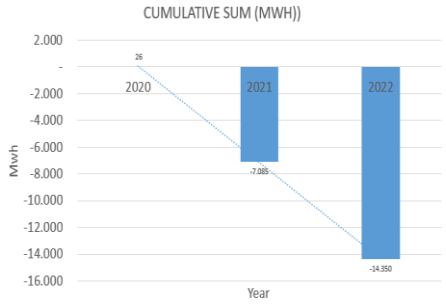


Figure 4 Cusum Level 2 at Domestic Terminal (passenger)

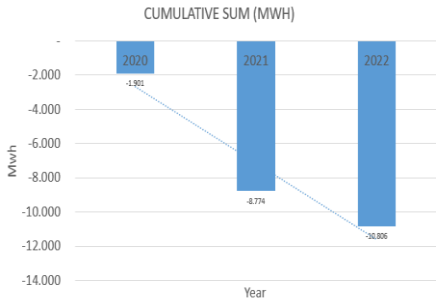


Figure 5. Cusum Level 2 at International Terminal (number of flight)

Other benefit Implementation Energy Management System - Reduce operating costs, improve brand image, increase employee engagement, and meet the expectations of society and shareholders in **contributing to the environment**.

Plan

Dedication and Engagement of Top Management - In order to support the **company's commitment** to contribute to environmental sustainability and energy conservation efforts, PT Angkasa Pura I remains committed to:

1. Carry out energy conservation activities in a sustainable manner through efficient.
2. Provide **optimal service while maintaining energy efficiency.**
3. Implement and **develop an energy management** system.

4. Encourage the use of **new and renewable energy.**
5. Carry out **procurement of goods and services by considering long-term energy efficiency.**
6. Encouraging **design activities** that pay attention to the principles of **energy efficiency.**
7. **Calibration and certification of tools** to support energy performance measurement.

Management commitment is presented in the figure below


Figure 6. Management Commitment

Energy Policy - The **environmental policy, including the corporate airport energy policy**, is also the leadership's commitment to building a sustainable business, preventing environmental pollution, and preserving the environment. Bali's I Gusti Ngurah Rai Airport started implementing its energy management system after obtaining the highest management commitment.

Energy Team - The General Manager of I Gusti Ngurah Rai Airport Bali, as part of **Top Management, arranges an energy management team involving airport technical** units to support energy management activities at the airport.

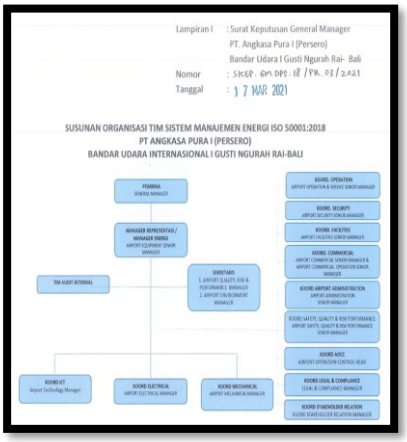


Figure 7. Energy Policy & Energy Team

Financial commitment & resources – **Top management commits to budgeting** for centralization and interconnection chillers, surveillance annually and recertification at the end of the validity period, the installation of solar power plants, and LED replacement. The financial commitment and resources realized through investment in equipment are as follows:

Year	Program	capital costs (US$)
2017	centralization and interconection of chiller	1,384,008
2022	a. Installation of Solar Power Plants 155 Kwp	199,402
	b. implement Energy Management System (EnMS)	866,385
	c. surveillance annually	2,405
	d. LED lamp replacement	434,936

Figure 8. Financial commitment

Data Quality and Review Energy - The implementation of EnMS was delegated to the Energy Team. PT Angkasa Pura I I Gusti Ngurah Rai Airport Bali Energy Team, **develops airport energy policies, guidelines, and related procedures** such as :

1. Provide risk assistance (inhibiting factors) and opportunities (enabling factors) that are relevant to the company's conditions and are also relevant to the company's energy performance improvement goals in the form of an **ECO List (Energy Conservation Opportunity)**.

2. Develop and implement **energy awareness**, namely a series of energy analysis processes, energy use, and energy consumption based on available data and information, which is aimed at identifying SEUs as well as opportunities to increase energy performance.
3. **Determine goals and targets related to energy performance**, as well as an action plan to achieve these goals and targets. Target **reducing electricity consumption by** 25% for the next 3 years. The action plan in this first phase is determined based on the following considerations: an action plan for significant energy users; an action plan that is easy to implement; and an action plan that can be carried out with a low investment cost.

The energy sources used by I Gusti Ngurah Rai Airport consist of electricity for use in **mechanical, electrical, and airport technology**. After knowing that the largest source of energy used at I Gusti Ngurah Rai Airport is electricity, the next step is to identify and determine SEU (Significant Energy Use). This stage is carried out for both the domestic terminal and the international terminal.

Significant Energy Use - SEU is determined based on users of energy sources that have large energy consumption and/or offer great potential for energy performance improvement. SEU can be a facility, system, process, or piece of equipment. To determine the SEU, there are several stages to the process. The first stage is to identify the users of each energy source. The following is a list of users of each of these energies. The second stage is dividing the level of determination of the SEU and analyzing consumption comparisons of energy. The determination of SEU at I Gusti Ngurah Rai Airport is separated into two levels :

1. SEU Level 1 based on unit or process (electrical, mechanical, and airport technology);
2. SEU Level 2 is based on the type of equipment in each process identified at Level 1.

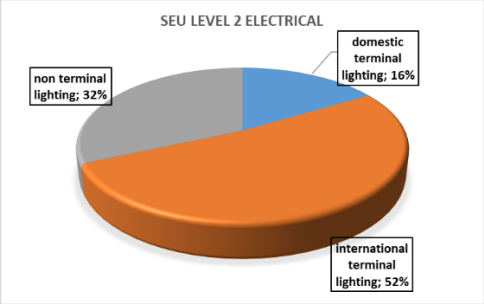


Figure 9. SEU Level 1 based on unit or process

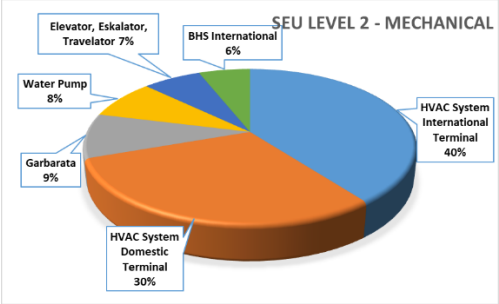


Figure 10. SEU Level 2 Mechanical

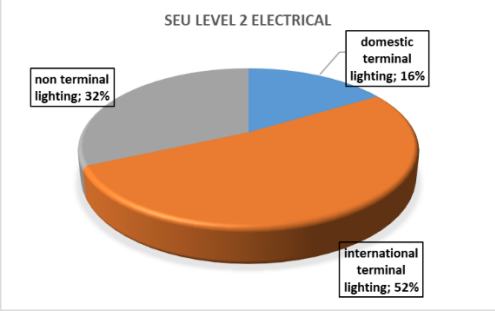


Figure 11. SEU Level 2 Electrical

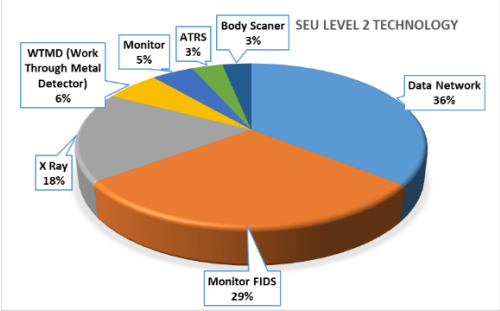


Figure 12. SEU level 2 Technology

EnPI & EnB - To determine the variables on the Energy Performance Indicator and Energy Baseline, **a linear regression equation is calculated by considering variables that are relevant to energy performance at airports**. Based on the preparation of the regression equation, the relevant variable for the Domestic Terminal is the number of passengers, while for the International Terminal it is the number of flights.

Based on the process of testing the regression equation, EnPI can also be determined for the implementation of SMEs at PT Angkasa Pura I Gusti Ngurah Rai, as shown in the picture beside.

EnPI	Regression Equation	R2 (intercept)	X (variable)
Level 1	y = 334,97x + 2.637.813,03	0,87	number of flights
Level 2	Domestic Terminals y = 2,04x + 1.314.997,32	0,84	number of passengger
	International Terminals y = 396,07x + 1.618.543,07	0,9	number of flights

Figure 13. EnPI Level 1 & Level 2

The two regression equations have an R2 factor > 0.75, a positive intercept / coefficient x value, a positive constant or baseload, thus, it can be concluded that an energy baseline that is representative and valid is used to measure energy performance. The following is a graph of the Enpi Level 1 and 2 linear regression equation below

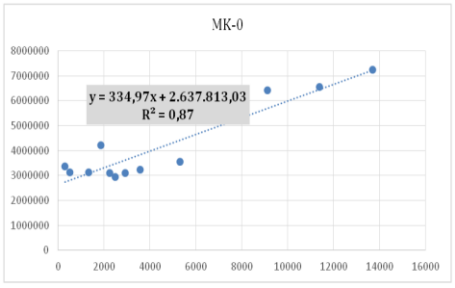


Figure 14. Baseline Level 1

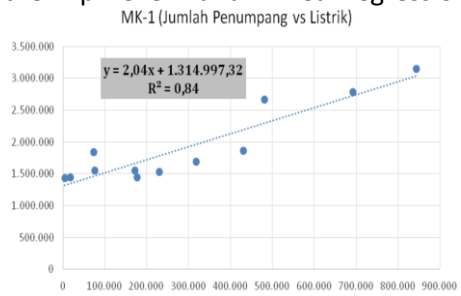


Figure 15. Baseline Level 2 area Domestic Terminal

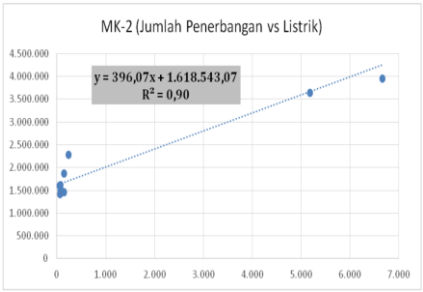


Figure 16 Baseline Level 2 area International Terminal.

"All the efforts to implement ISO 50001 are expected to provide tangible benefits for the environment in a sustainable manner at Bali's I Gusti Ngurah Rai Airport." *— Faik Fahmi, President Director of PT Angkasa Pura I*

Do, Check, and Act

Top Management support - The General Manager of I Gusti Ngurah Rai Airport issued an Environmental Policy and an Energy Policy as support for environmental management to reduce GHG emissions. The General Manager issues a General Manager's Decree regarding the formation of an Energy Management Team to support the implementation of an energy management system at airports, which includes energy managers and other technical units such as facilities, safety operations, commercial, legal, and environment.

Identified and implemented a plan that improve energy performance - The I Gusti Ngurah Rai Airport Energy Management Team has identified an energy conservation program to

Project	Action Plan	Energy-consumption equipment	Actual Energy Saving (MWh)	Carbon Reduction (Ton CO2/MWh)
2021	**Energy Management System**			
	HVAC System (centralization and interconection of chiller)			
	reduction of operating hours of domestic HVAC terminal systems (adjustment of operating hours at the beginning of operation and the end of operation), Carry out the interconnection of water chiller lines from CRB 3 to	Chiller , AHU, FCU	10.059	7.947
	Aviobridge			
	Implementing a "No Idling" policy that requires generators and air	Garbarata,	1.293	1.022
	Water Pump			
	Mapping the water volume requirement zone according to the number of passenger density in various areas, installation of water meters in each distribution line & water meters at each tenant and non-tenant location and their use.	Water Pump	1150	908
	Baggage handling system			
	Automatic System in all BHS sections with the PLC System Model in the form of installing sensors in several sections.	Baggage Handling System	862,2	681
	Escalator, Elevator, Travelator			
	Operating Settings Area and Equipment Hours of Operation, Stop and Go Operation , and Settings for Variable Speed and Stop Mode.	Escalator, Elevator, Travelator	1006	795
	Lighting			
	Operating Settings Area and Equipment Hours of Operation, Stop and Go Operation, and Settings for Variable Speed and Stop Mode.	Lighting	1731	1.367
	Airport technology			
	Optimizing the operation of equipment and facilities by setting operating hours according to airport operating times or flight schedules.	Airport technology facilities (XRAY, WTMD, ATRS dan Body Scanner)	1212	957
	Actual Energy Saving in 2021		**17.313**	**13.677**
2022	**Energy Management System**	HVAC System, garbarata, Water pump, BHS, escalator, elevator, travelator , lighting, airport technology	26.444	20.891
	Renewable Energy - installation of a solar power plant with a capacity of 155 kWp	Lighting	148	117
	Actual Energy Saving in 2022		**26.592**	**21.008**

Figure 17. energy conservation program

support the energy management system ISO 50001:2018.

Renewable Energy, energy conservation program - Operation of a photovoltaic power plant with a capacity of 155 kWp to supply electricity in the parking building of the domestic terminal, international terminal, and toll gate. producing 148 MWh of clean energy and reducing CO2 emissions by 117 tons of CO2.

Figure 18. photovoltaic power plant and electricity monitoring

Baseline and reporting periods - This baseline energy data refers to airport electricity usage statistics in 2020 and energy management system reporting from 2021 to the present.

Energy baseline and the organization energy baseload – The EnPi level 1 energy baseline is constructed using a linear regression equation, namely the number of flights vs. electricity consumption. EnPi level 2 is created using a linear regression equation, namely the number of flights vs. power consumption for the international terminal and the number of passengers vs. electricity consumption for the domestic terminal. **Base loading is due to the mandatory minimum airport operations**, which must operate 24 hours a day. Among them are terminal lighting and HVAC. To manage the energy base load, prepare standard operating procedures for managing HVAC system operations and terminal zoning.

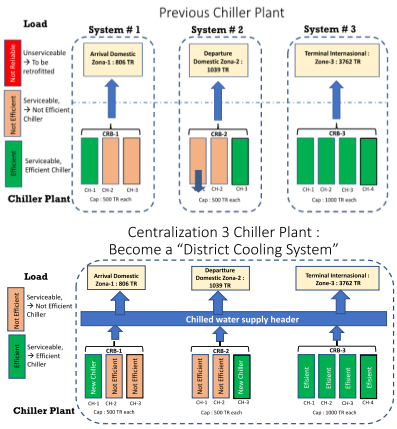
Indicators used to monitor and assess energy performance improvements - The energy baseline EnPi level 1 is built using the linear regression equation, namely the **number of flights vs electricity consumption**. Energy performance monitoring can be carried out by comparing **actual electricity consumption to baseline electricity consumption, so that CUSUM is negative where electricity consumption decreases and energy savings are obtained**.(refers to page 2)

Relevant variables affecting energy consumption - variables that affect the consumption of electrical energy, such as the number of passengers (kWh/passenger), aircraft movement (kWh/aircraft movement).

Method(s) to ensure normalization - Baseline development methodology through linear regression equations will be used to identify variables that affect energy consumption at airports and will be developed with an energy model. If **the optimal number of passengers has been attained in accordance with pre-pandemic conditions**, the energy baseline must be normalized using data from 2019.

Engage employees in energy management - employee involvement to support energy management through energy saving campaigns, the installation of energy saving stickers on equipment to change the energy saving behavior of each employee, energy management awareness training, and energy manager training.

Implement operational control - I Gusti Ngurah Rai Bali Airport seeks to control the daily operations of the Significant Energy User (SEU) in order to remain in an efficient energy condition and ensure that its energy performance increases. Operations control efforts through the centralization **and interconnection of chillers (district cooling zones), domestic terminal chillers, and international terminal chillers. Chiller plant with Basic Idea Centralization.** With the **modification of chilled water supply piping and the addition of a motorized valve, the distribution of chilled water supply from each chiller plant is interconnected.** Through centralization, cold water supply from the chiller plant can be distributed to international and domestic terminals, and the number **of chiller sets in operation is reduced from 3 to 2.** When one set of chillers is not in use, energy consumption is reduced not only for the chiller but also for the chilled water pump, condenser water pump, and cooling tower. Energy savings achieved by implementing centralization (the district cooling concept) from energy calculations = 16% from centralization and 33% from total savings (plus chiller retrofit). The following chiller centralization pattern is presented in the image below.



Result of Centralization of Chiller

CONFIG	CHILLER PLANT 1 (TR)	CHILLER PLANT 2 (TR)	CHILLER PLANT 3 (TR)	TOTAL LOAD (TR)	BEFORE CENTRALIZATION (NUMBER OF CHILLER OPERATE)	AFTER CENTRALIZATION (NUMBER OF CHILLER OPERATE)	REDUCED CHILLER
1	500	500	2000	3000	4	3	1
2	500	500	2000	3000	4	3	1
3	1000	500	2000	3500	5	4	1
4	500	1000	2000	3500	5	4	1
5	1000	1000	2000	4000	6	4	2
6	1000	1000	2000	4000	6	4	2
7	500	1000	3000	4500	6	5	1
8	1000	500	3000	4500	6	5	1
9	1000	1000	3000	5000	7	6	1

Figure 19. centralization 3 chiller plant

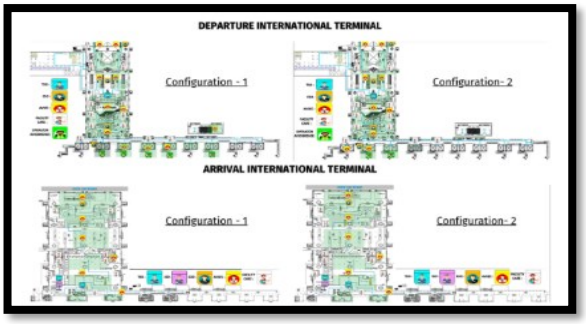


Figure 20. Terminal operating zoning

Management of Traffic at Terminal and Apron are program that Bali airport do to optimization area and increase effectiveness of equipment utilization. The main idea are Bali Airport re -Arrange of airport operating areas and equipment operating hours at the airport based on number of passenger, flow of passenger and aircraft parking location. Through the arrangement and configuration of aircraft movement, aircraft parking at Apron and passenger movement at Terminal so area that used can be reduced and Number of Equipment that are operated be decrease and controlled, so energy consumption at Terminal and Apron can be reduced.

Bali Airport conducted an **energy audit** in 2021 and 2022 due to the **preparation of a Surveillance Audit** every year, including an Internal Audit to support the Implementation of the Energy Management System. The Internal Audit address nonconformities by making corrections, and by taking corrective action and preventive action, which will be discussed in Management Review Meeting to Follow up on the findings.

Transparency

a. **Online Energy Management Reporting** (POME), which is a program of the Ministry of Energy and Mineral Resources (ESDM), is done every year. https://simebtke.esdm.go.id/sinergi/company
b. **Reporting of GHG emission reduction and mitigation actions in the Transportation Sector**, which is a program of the Ministry of Transportation (MoT).
c. Company Sustainability **Report submitted to the Financial Services** Authority of Indonesia.
d. **Publication in mass media** and on the website https://ap1.co.id/en/information/news/detail/realizing-eco-friendly-airport-angkasa-pura-airports-receives-iso-500002018-energy-management-system-certificate-for-i-gusti-ngurah-rai-airport-in-bali
e. **Publication in social media** Instagram @bali_airport https://www.instagram.com/reel/Ck7z9XZvLak/?igshid=YmMyMTA2M2Y=

What We Can Do Differently

a. It is necessary to **identify and evaluate significant energy use** at all airports managed by PT Angkasa Pura I so that the effectiveness of energy utilization that supports airport operations can be identified.
b. **Calibrate airport equipment** regularly to improve energy performance.
c. Increasing the integration of energy monitoring systems and **expanding the boundaries from landside and airside** of the energy management system on the at the airport. (through all the airport).