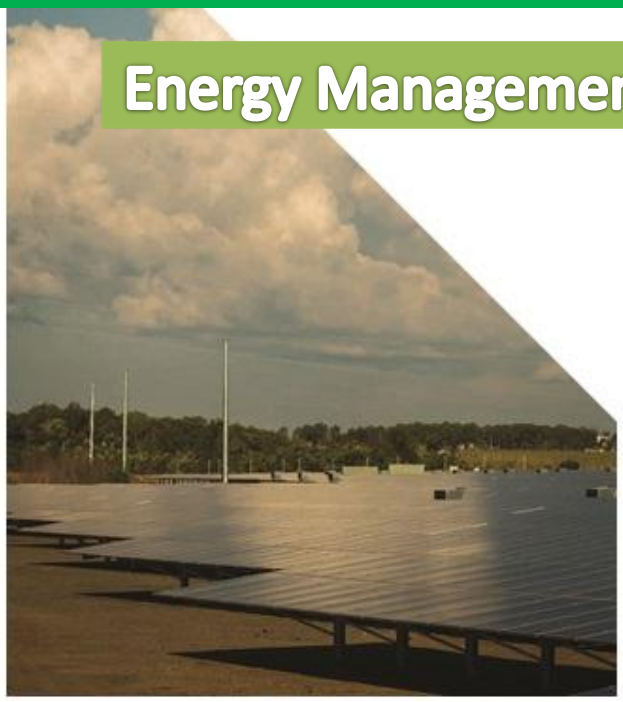
ACI Asia-Pacific
GREEN AIRPORTS RECOGNITION 2017

Energy Management



ACI ASIA-PACIFIC
GREEN AIRPORTS
RECOGNITION

Disclaimer

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June 2017
ACI Asia-Pacific

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Introduction and Acknowledgements

The Green Airports Recognition was established by ACI Asia-Pacific with the support of ACI Asia-Pacific Regional Environmental Committee. The Recognition's objective is to promote environmental best practices to minimize aviation's impact on the environment and to recognize ACI Asia-Pacific airport members who have outstanding accomplishments in their environmental projects.

For this year's recognition, ACI Asia-Pacific received a total of 16 submissions under the theme of Energy Management; these airport members represent 16% of the total passenger traffic in Asia-Pacific and Middle East region. 12 airports are now currently accredited under the *Airport Carbon Accreditation* programme. Most submissions were received from Australia and India with four airport members respectively, followed by three airports from Middle East, two from China, and one from Hong Kong, Malaysia and New Zealand.

The submissions were reviewed by the following Panel of Judges:

- Mr. Christopher Paling, Project Manager – Climate Change, Centre of Aviation, Transport, and the Environment, Manchester Metropolitan University
- Mr. Christopher Surgenor, Editor/Publisher, GreenAir Online
- Ms. Juliana Scavuzzi, Aviation Environmental Specialist, ACI World
- Dr. Panagiotis Karamanos, Aviation Environmental Consultant
- Mrs. Patti Chau, Regional Director, ACI Asia- Pacific

After collective grading with eight relevant criteria, the Panel of Judges concluded that recognition will be given to the following airports

Airports with 25 million passengers per annum and above:

- Platinum – Kuala Lumpur International Airport
- Gold – Indira Gandhi International Airport
- Silver – Hong Kong International Airport

Airports with less than 25 million passengers per annum:

- Platinum – Darwin International Airport
- Gold – Adelaide Airport
- Silver – Queen Alia International Airport

We would like thank all judges for their expertise and valuable time.

It should be emphasize that all the participated airports should be recognized because their partaking helps exemplify the spirit of this recognition which is to promote best practices sharing among airports and this document serves the same purpose.

Section 1: Energy Conservation

Abu Dhabi International Airport - Energy Conservation

In 2011 Abu Dhabi International Airport (ADIA) achieved Level 1 *Airport Carbon Accreditation*. ADIA is a wholly owned subsidiary of Abu Dhabi Airports Company (ADAC).

Since 2011 the company's vision has been to continue the accreditation process to Level 2 and ultimately to Level 3 status. The airport is currently pursuing Level 2 status for completion in 2017.

The airport is fully committed at the highest managerial level within the organisation to successfully implement carbon reduction, in doing so, demonstrating to its business partners and the surrounding community, the ability to constantly reduce utility costs whilst maintaining healthy air quality in the surrounding neighborhood.

The Chief Executive Officer endorsed the vision by issuing a clear statement of executive level commitment. (See project graphics section).

Abu Dhabi airport has grown considerably since the commencement of Level 1 witnessing a 90% growth in passenger numbers over the past 5yrs.

Through numerous initiatives, utility costs and usage has been retained at a level below that of the annual passenger percentage increase, maintaining and improving our overall cost effectiveness.

The airport seeks when opportunities present themselves, to bring about change in the introduction of new technology to generate greater efficiency, cost reduction savings in power usage, recycling, and significant savings through a reduction in OPEX.

The energy management achievements are:

- Diesel and petrol vehicles under the ownership of ADIA recorded a significant saving with petrol reducing from 238,443lts to 172,964lts a difference of 27.5%. Diesel consumption at 91,052 to 89,201 recorded a difference of 2%.

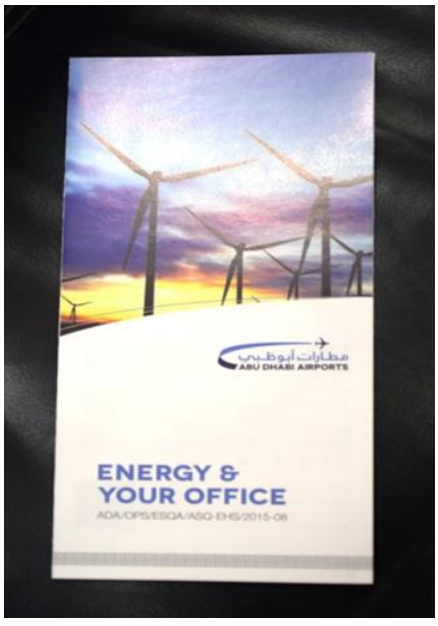
- The 2013 ADIA vehicle fleet (Diesel & Petrol) totaled 96. In 2014 this was reduced to 86 a 10.4% decrease in fleet management.

Project Graphics

Caption 1
Recyclable bags with energy saver lights distributed to staff.

Caption 2
Energy conservation light switch stickers posted.

Caption 3
Conserve/preserve stickers posted on computer monitors; laptops; paper shredder; photocopiers.



Caption 4
Energy conservation leaflets distributed to staff during EHS Awareness lectures and Safety Campaign events.

Chandigarh International Airport - Construction of New Integrated Terminal Building

भारतीय विमानपत्तन प्राधिकरण
AIRPORTS AUTHORITY OF INDIA

Adapting the mission and vision of organization "Airports Authority of India" "To achieve Highest standard of safety and quality in air traffic services and Airport management by providing state- of- art infrastructure for total customer satisfaction , contributing economic growth and prosperity of the nation" , one of the best and largest Airport infrastructure of north India (after Delhi) created for Chandigarh International Airport on time to cater need of the region in line with demand, creating real value to stake holders.

A well planned project with vision 2040, strategically located catering four states of India,(Punjab , Haryana , Himachal and part of Uttrakhand) beside tricity (Chandigarh , Panchkula & Mohali) & proximity of major industrial towns, & gateway of major tourist destination of North India, has created best environment for economic viability and sustainability .

The New Integrated Terminal building of Chandigarh International Airport is equipped with modern state of the art facilities, green and well developed landscapes and interior decorated with art, paintings and mural works.

The energy management achievements are:

- Double insulated roofing system, double glazed unit & High performance glasses, cavity walls, energy efficient chillers with 6.3 coefficient of performance for HVAC, energy efficient gearless motors for elevators, variable-frequency drive for high capacity motors, led type electrical fixtures, Maximum use of natural sun light so that no artificial light is required during day time.
- Integrated Building Management System (BMS) and Energy Management System (EMS).
- 3MWp Solar Power Plant has been established on Renewable Energy Service Company (RESCO) model to reduce the dependence on conventional energy source and reduce the carbon footprint of 2700 tonnes/per annum.

Project Graphics

Caption 1
Use of fly Ash Bricks

Caption 2
Energy Efficient Chillers

Caption 3
600KLD Sewage Treatment Plant

Caption 4
Grid Connected 3 MWp Solar power Plant

Sydney Airport - Energy Savings Strategy

Our vision is to deliver a world-class airport experience and foster the growth of aviation for the benefit of Sydney, NSW and Australia. In delivering on our vision, we aim to drive responsible growth that balances social and environmental needs with our corporate objectives.

We acknowledge the impacts of the airport on climate change and have been working towards understanding and reducing these impacts, including energy use and carbon emissions.

We use a significant amount of energy to operate our facilities, with almost 80% arising from the purchase of electricity for heating, ventilation and cooling (HVAC) systems, lighting, baggage handling, lifts and elevators.

We have policies and strategies that drive us being a sustainable, energy smart business. These include a Sustainability Policy and Strategy and an Environment Policy and Strategy. In addition, Sydney Airport has an energy strategy entitled the Energy and Carbon Strategy 2013+, which includes nine strategic elements that form an energy roadmap. These elements structure and guide our sustainable energy use. We also have a savings plan, the Energy Savings and Carbon Reduction Plan 2015 - 2020. This complements our energy strategy and identifies new energy savings, greenhouse gas emission reductions and opportunities for greater energy efficiency.

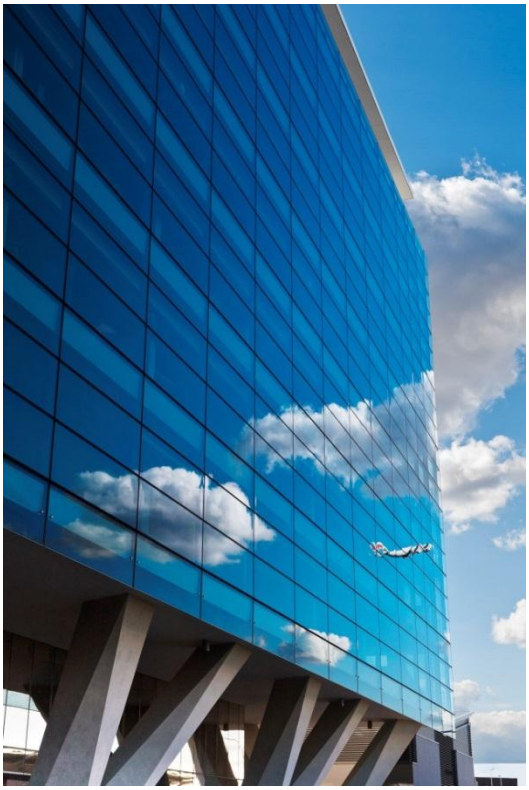
We support the Airports Council International's (ACI) position that the aviation industry should play a role in addressing climate change impacts. Sydney Airport actively demonstrates its contribution to the industry's voluntary action to reduce its impact on the environment, and grow sustainably. In recognition of this, Sydney Airport has achieved level 3 *Airport Carbon Accreditation*.

Our ongoing program of energy projects range from energy savings and efficiencies, to fuel switching to cleaner energy. These projects include large scale LED lighting retrofits, sustainable building development and deployment of electric buses. Since 2012, Sydney Airport has reduced its energy intensity by 14.8%.

Project Graphics

Caption 1
Sydney Airport's Electric Bus

Caption 2
Electric GSE at Sydney Airport



Caption 3
Sydney Airport's Green rated Office building

Section 2: Energy Management Program

Brisbane Airport - Energy Efficiency Program

Brisbane Airport (BNE), the premier gateway to Queensland, operates 24/7 accommodating 29 airlines flying to 76 national and international destinations. BNE is increasingly becoming the gateway of choice for discerning passengers with its domestic network providing unrivalled connectivity for business, education and tourism. It is a suburb in its right, the largest capital city airport in Australia by land size (2,700 hectares) and the third-largest airport in Australia by passenger numbers welcoming more than 22.5 million passengers a year.

Brisbane Airport, which is owned and operated by Brisbane Airport Corporation (BAC), consumes more than 170 GWh of electricity annually, of which BAC is directly responsible for 40 per cent.

In 2012, with the development of the ESAP (Environmental Sustainability Action Plan), BAC became increasingly focused on sustainability and energy management, resulting in the creation of the Energy Efficiency Program, which ran from 2012-2016.

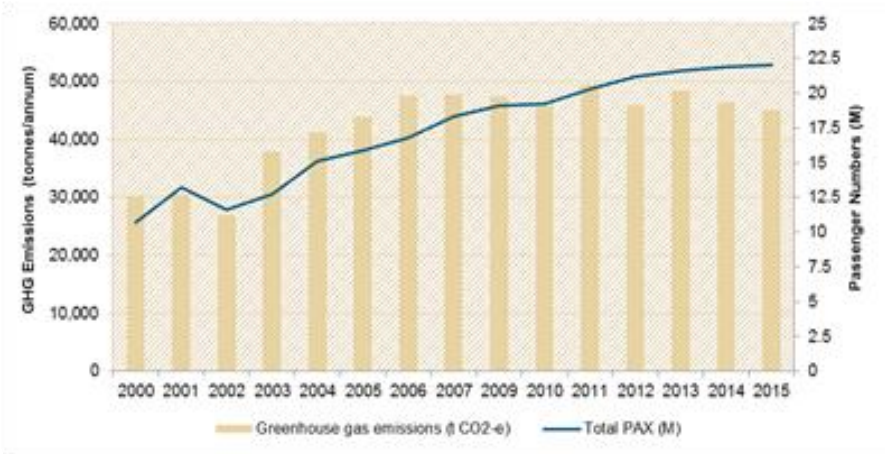
The project was initiated by a site-wide audit in cooperation with local universities. It was delivered through a series of retrofits, equipment upgrades and trials of new technology, based on a 5-year capital expenditure plan. Projects were from one of two categories: energy reduction initiatives and alternative energy sources. Energy reduction initiatives included lighting and HVAC optimization, lighting and chiller upgrades, and investigation of new lighting technologies.

The Energy Efficiency Program invested a total of $6 million AUD in 40 projects that led to more than 10 GWh of total electricity savings.

As a result of this program, BAC has saved $3.9 million AUD and avoided 25,000 tonnes of CO2 since 2012.

Project Graphics

Caption 1
Domestic Terminal Lighting Upgrade Photo



Caption 2
Energy Consumption vs Passenger Growth Comparison

Caption 3
Solar PV Panels on the Domestic Terminal Carpark Roof

Christchurch International Airport- Integrated Terminal and continuous commissioning Project

Christchurch International Airport Limited (CIAL) has set the strategic objective of becoming "Sustainability Champions" for Our Airport, Our City and Our Island. Key to our strategy is the management of our energy use, of which over 80% is sourced from renewable sources.

The Integrated Terminal Project (ITP), provided CIAL with the opportunity to install new energy efficient infrastructure. Upon completion, the ITP would include a new check-in hall, food court, domestic departure lounge and integration of the existing regional and international terminals with the aim of accommodating 40-50 years of passenger growth.

Eager to lead innovation, CIAL sought to install New Zealand's first artesian sourced heat pump system responsible for the heating and cooling. This system draws groundwater (14°C) from the aquifer the airport sits above, which is used to assist with cooling water in a cold water loop (6°C) and extract and discharge excessive heat from the heated water loop (40°C). To achieve this, the system is comprised of a series of closed loop water circuits, heat exchangers, chillers and heat pumps. All water abstracted is contained in its own loop to prevent contamination and is discharged at a maximum of 21°C.

CIAL has entered into agreements with the Energy Efficiency and Conservation Authority (EECA) to refine the system and achieve further energy reductions reducing CIAL's dependency on electricity for cooling and consumption of fossil fuels to power boilers for heating. This has led to:

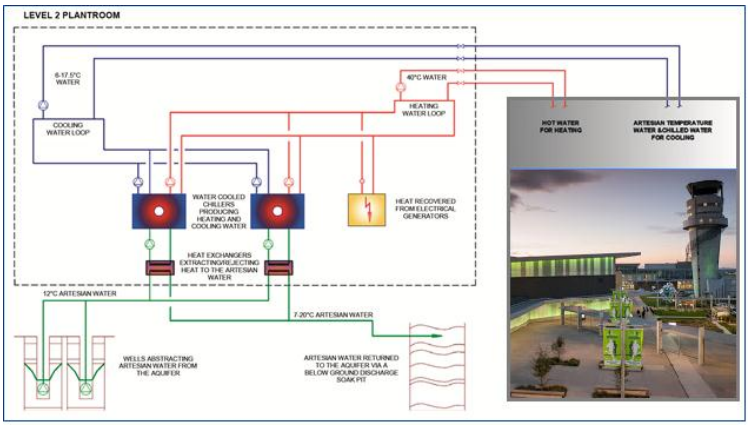
- Building Management System upgrades
- Changes to how air-handling units operate (fan speeds, run times etc.)
- Improved utilization of outside air for 'free' cooling

Since July 2012, the direct benefits of this project have been

- 12.8% total energy use reduction
- Average energy consumption per square meter reduction of 3.58kW/m2
- A reduction of 531.6 tCO2-e/p.a

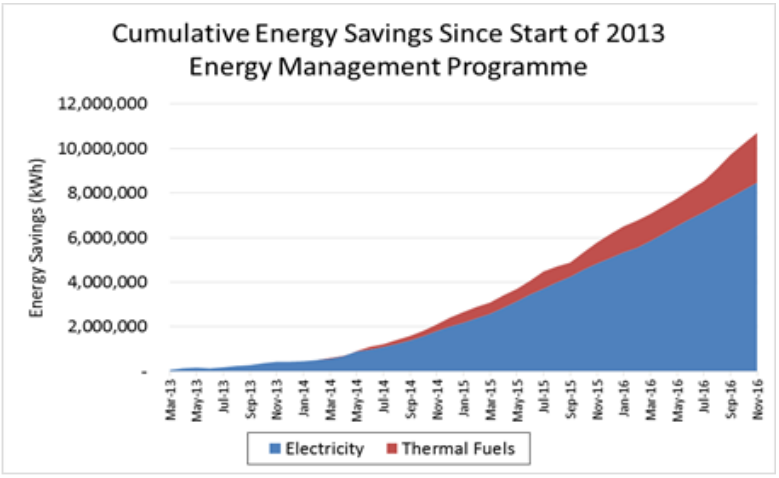
Project Graphics

Caption 1
Christchurch International Airport



Caption 2
Schematic of the Artesian heat pump system

Caption 3
Heat Pump plant room



Caption 4
Energy savings achieved initiating the Energy Management Programme

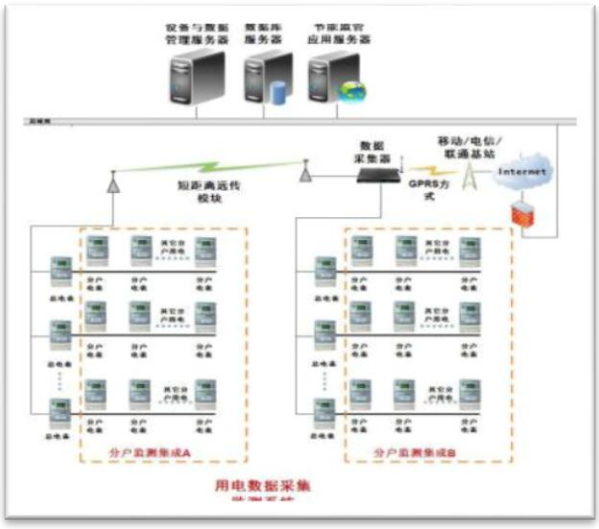
Haikou Meilan International Airport - Energy Management & Construction

Green development has evolved into a major trend in modern world, with many countries adopting the development of green industry as a key measure in boosting economic restructuring.

As a large-scale infrastructure as well as an image unit in Hainan, ever since its operation, Haikou Meilan International Airport has been reacting proactively as called on by government, attaching great importance to energy conservation and emission cut plus environment protection, structuring a green airport featuring Saving, Environment-friendly, Technology and Humanization by way of utilizing resources in an efficient manner and minimizing impact on environment.

Particularly as of 2013 when Civil Aviation Administration of China put forward the concept of constructing green airport, Haikou Meilan International Airport has been stepping up the establishment of organization structure, planning in energy conservation and emission cut and management over the set-up of rules and regulations, implementing projects like replacing APU with bridging equipment, modification in central AC for energy conservation and reuse of recycled water with the principal of building up energy monitoring system as guidance and the items concerning energy conservation plus emission cut as carrier which have helped achieve year-by-year increase in emission cut. In 2016, CO2 emission has been slashed by around 11,000 tonnes

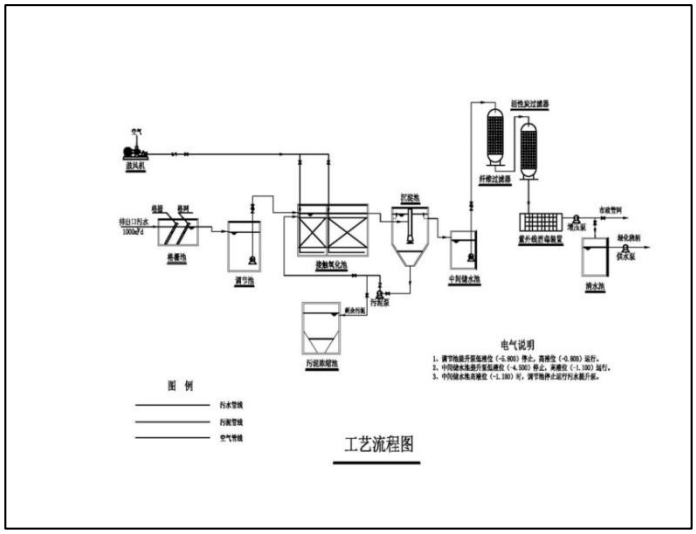
Project Graphics



Caption 1
Energy Monitoring System

Caption 2
Modification in central AC featuring energy

Caption 3
Replace APU with bridging equipment



Caption 4
Recycled water reusing equipment

Hong Kong International Airport - Energy Management Program

In 2010, Airport Authority Hong Kong (AAHK) and its business partners (BPs) pledged to reduce Hong Kong International Airport's (HKIA) carbon intensity by 25% by 2015 relative to 2008 level. Given over 90% of AAHK's carbon emission is contributed by electricity consumption, the pledge drives AAHK to develop a multi-dimension energy management program to enhance energy efficiency.

AAHK's Energy Management Program Roadmap:

AAHK has implemented various initiatives under the program. These include replacing more than 100,000 traditional lighting with LEDs in terminal buildings; enhancing the air-conditioning system by integrating the chilled water system. Major initiatives to reduce fossil fuel energy use include improving fixed ground power (FGP) and pre-conditioned air (PCA) units as alternatives to aircraft auxiliary power units (APU); introduction of electric vehicles (EVs) and establishment of the associated charging network.

In November 2016, an Energy Policy was endorsed by AAHK's CEO. AAHK is currently developing ISO 50001 compliant Energy Management System (EnMS) which is expected to be certified in Q1 2017.

BPs Engagement:

To equip BPs with the energy management knowledge, AA organized training to introduce best practice such as ISO 50001 EnMS and the use of electric ground support equipment (EGSE), of which - Jardine Air Terminal Services, who has introduced 10 solar-powered passenger stairs and five electric lower deck loaders was the pioneer.

Conclusion:

As a result of these measures, the airport community has achieved significant energy savings and the carbon pledge, reducing carbon intensity by 25.6% from 2008 baseline despite an average annual increase in airport throughput of 4.5 %.

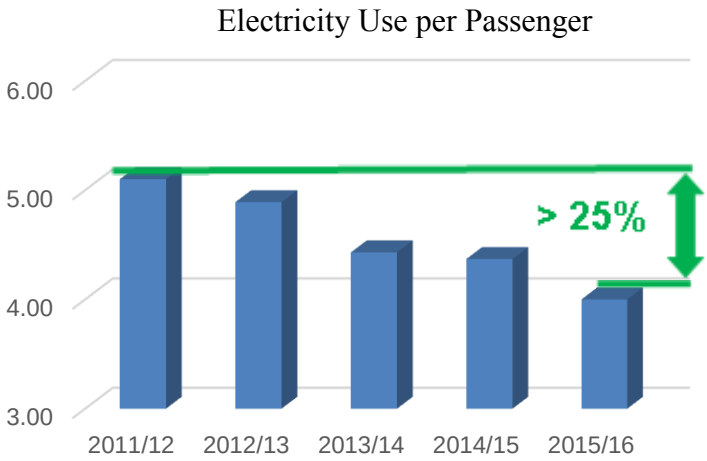
In November 2016, AAHK set a new pledge to further reduce the airport-wide carbon intensity by 10% by 2020 based on 2015 levels. Looking forward, AAHK will implement a series of new measures including optimizing the energy consumption at Midfield Concourse and replacing LEDs.

Project Graphics

Caption 1
Lighting – LED Replacement Work in which 100,000 lighting were replaced with LEDs.

Caption 2
Hong Kong-made EV Quick Charger

Caption 3
Apron Special System – Improvement Works for Fixed Ground Power (FGP) Units and Pre-conditioned Air (PCA) Units



Caption 4
AAHK Electricity Use (kWh) per Passenger from FY 2011/12 to 2015/16

Section 3: Heating, Ventilation and Air Conditioning (HVAC)

Beijing Capital International Airport – Group controlling Model to Save Energy in Airports

Today, more and more airports have recognized the importance of energy saving. For most airports, the energy consuming systems mainly include lighting system, air handling system and integrated service system.

The energy saving about the lighting system is simpler and more widely practiced. Meanwhile, the energy saving about the air handling system has been ignored because we mainly save energy by replacing the equipment of air handling system and such practice is expensive, low-efficient and risky.

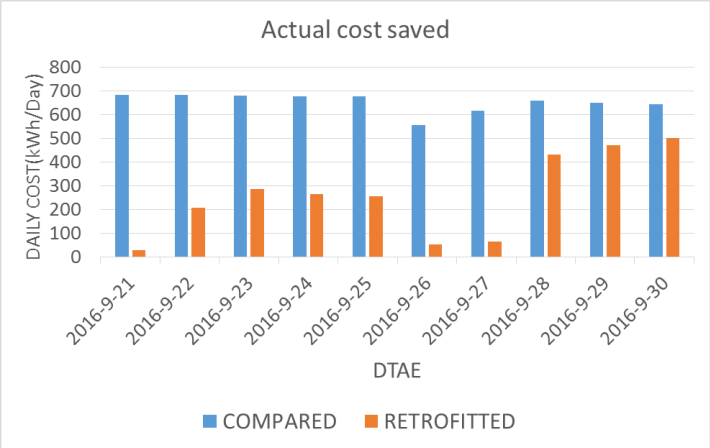
We have noticed that the air handling systems vary in different airports, but it is common that multiple air handling units work in one large space. Therefore we considered whether it was possible to improve the efficiency and reduce the energy consumption only by optimizing the economical operation strategy of air handling systems.

We decide to choose the air handling system in Terminal One as a pilot project. We focus on relationship between air flow regulation and water flow regulation, then study the linkage among different air handling units in the same space, which is the key of the whole project.

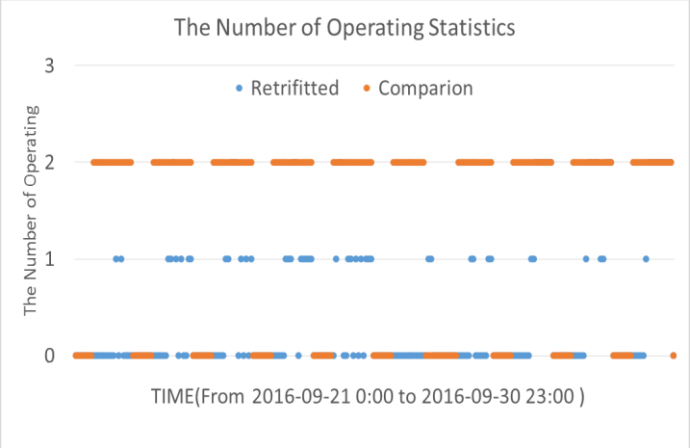
Based on these results, we come up with a complete set of strategies for group-controlling air handling units in a large space for ultimate energy saving purposes. These strategies include units control mode and the air/ water flow regulation totally different from common practices.

At the same time, we establish the online monitoring and control system and achieve automatic and fine management of air handling systems, making the systems more stable, efficient, and safer. And a group-controlling model is established for the air handling units. Its application indicates that we have made remarkable progress and such practice proves effective in energy-saving.

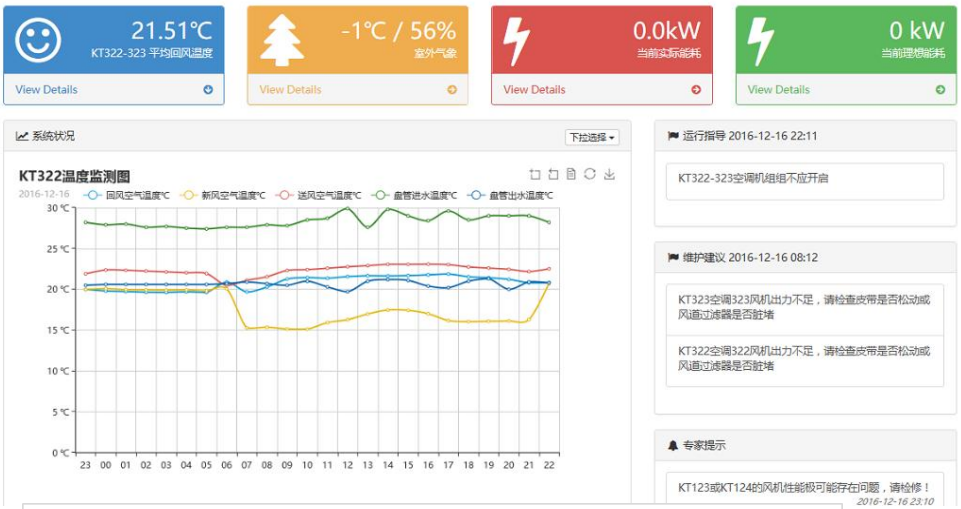
Project Graphics



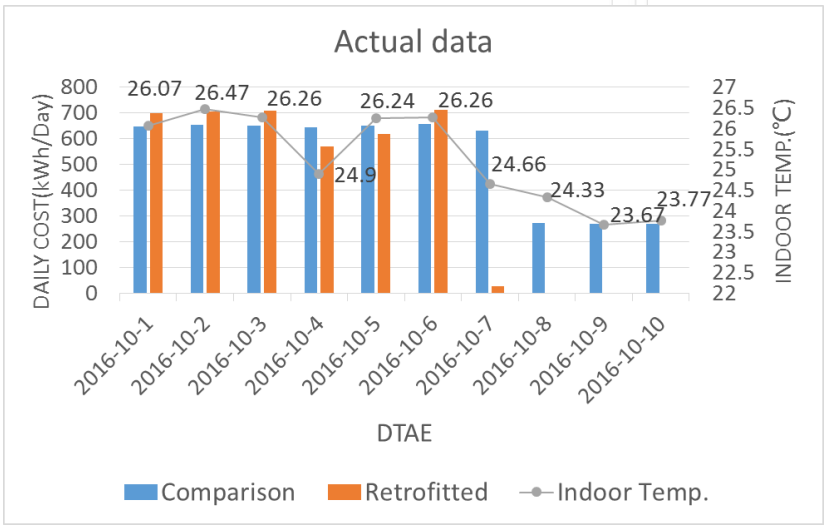
Caption 1: Actual cost saved



Caption 2: The number of operating statistics



Caption 3
System interface & the maintenance advices



Caption 4
Energy cost and indoor temp statistics

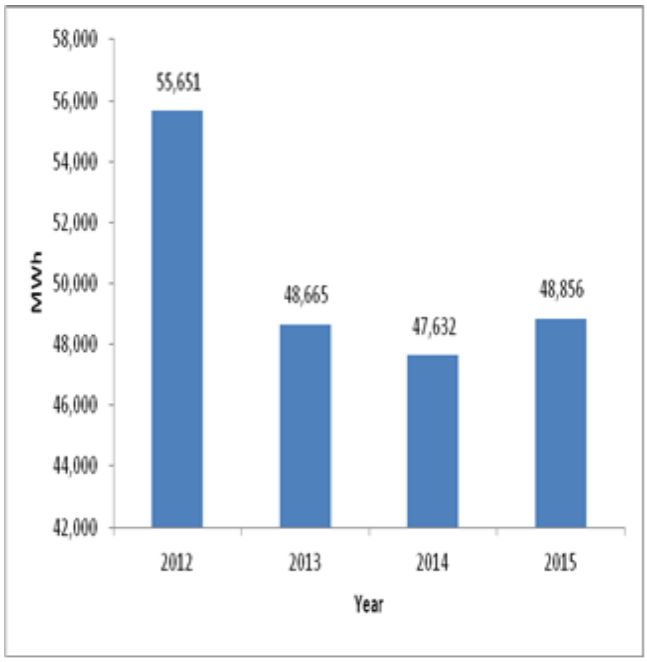
Indira Gandhi International Airport - Energy Conservation Approach for Airport HVAC Systems

Delhi International Airport (P) Limited (DIAL), a GMR Group led consortium that Operates and Modernize Delhi Airport. DIAL has brought various global reorganization to Delhi Airport in service quality and environment sustainability, including ACI's World No. 1 Airport for last two consecutive years in 25-40 MPPA categories in Service Quality, 1st Carbon Neutral Airport in Asia-Pacific region as per ACI's *Airport Carbon Accreditation* and 1st Airport to get ISO 50001:2011 accreditation globally.

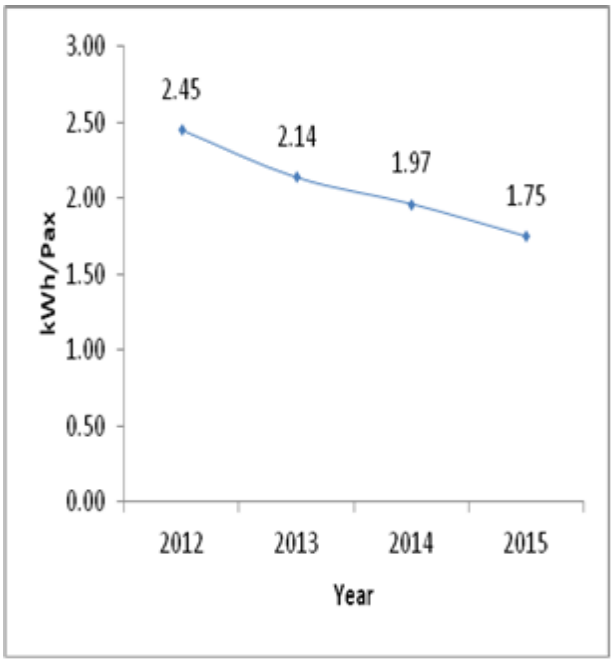
Delhi Airport, the sole airport of the National Capital Region (NCR) of India is handing >50 million passengers/year with notable growth. At DIAL, energy management is identified as one of the key material aspects in terms of operating cost and environmental requirements. It takes a large share of 26% in overall airport operating cost and has been a major focus for management to reduce its consumption by adopting focused team, system, use of renewable energy. Through Energy Management System, various energy conservation opportunities were identified. The HVAC system is a major energy hotspot, which contributes to more that >45% of overall energy consumption.

Further to assess the implementation; Business Excellence approach was adapted in HVAC system. It follows two principles, management of process (by Approach, Deploy, Learn & Integrate) and management of outcome (Level, Trend, Compare & Integrate). Energy consumption trend of sub-systems of HVAC was analyzed on variable parameters such as operation, occupants and ambient conditions. Analysis was carried out to arrive at the root causes, simulation was carried out and buildings with similar operating philosophy were also referred to use best practices. After implementation, team achieved 12% reduction of overall energy consumption at HVAC system, 5570 tCO2 reduction and energy cost by INR 64.5 Million, in spite of 8% CAGR of passenger number.

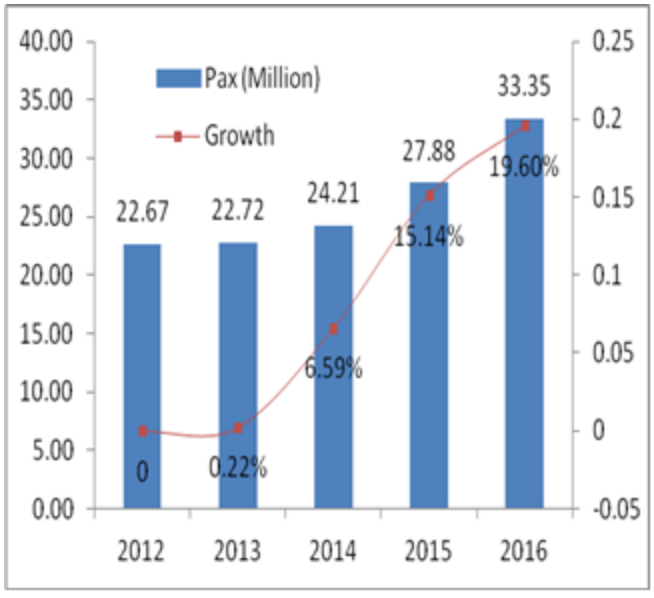
Project Graphics



Caption 1
Total yearly energy consumption of T3 Energy Consumption



Caption 2
Specific Energy Consumption of Terminal 3 HVAC System



Caption 3
Pax growth trend of Terminal 3 (2012-2016)

Caption 4
Accreditations and Awards

Rajiv Gandhi International Airport - Energy conservation by Inverter type air conditioners

At Hyderabad Rajiv Gandhi International Airport (RGIA), air conditioning (A.C.) systems consume 60% of the overall electricity. Various options have been explored to reduce the energy consumption of air-conditioning. A pilot study was conducted on Inverter Technology type A.C.s in the early 2016 and found a significant amount of electricity saving and reduction of operational cost.

Conventional Air conditioners (A.C.s) (split type) - These A.C units were installed 8 years ago at the Airport and consume 30% more electricity than newly available Inverter Technology A.C.s.

Inverter Technology A.C.s. - We have identified various options available in the market and found that the invertor technology based A.C. units have high potential of energy saving than existing model.

Further, 192 numbers of new invertor A.C.s were installed in place of conventional A.C.s. Based on the encouraging results of the pilot study, all the A.C. units have been replaced with invertor technology and are operational since July, 2016. The Project achievements and the environmental benefits are as follows:-

- 92160 kWh of electricity saving per month
- INR 0.645 million per month of the cost saving
- Reduction of 74649 kg of carbon emissions per month

The details of this energy management project are given in the rest of the application.

Project Graphics

Caption 1
Energy efficient invertor A.C.s (inside view)

Caption 2
Energy efficient invertor A.C.s (outdoor view)

Existing 2 Star A.C.s				**Inverter Model A.C.s**				**Net Savings**
Meter Opening Reading	Meter Closing Reading	Temp (℃)	Units Consumption	Meter Opening Reading	Meter Closing Reading	Temp (℃)	Units Consumption	Kwh / unit for 24 hrs.
37048	37099	22	51	36850	36885	24	35	**16**

Caption 3
Electricity consumption comparison between conventional (existing) A.C.s and Inverter Model A.C.s

Section 4: LED Lighting

Chhatrapati Shivaji International Airport - Conventional Lights to Highly Efficient LED Lights

Mumbai Airport is operational since 1958 and was operated by Airports Authority of India (AAI). As per the government policy, Mumbai International Airport Pvt. Ltd (MIAL) took over the management and development of Chhatrapati Shivaji International Airport (CSIA) Mumbai in 2006. CSIA is one of the world's busiest airports, located in heart of Mumbai city. CSIA handled 41.67 million passengers in 2015-16 in spite of being a land constrained airport (total area of airport is 802.03 Ha only).

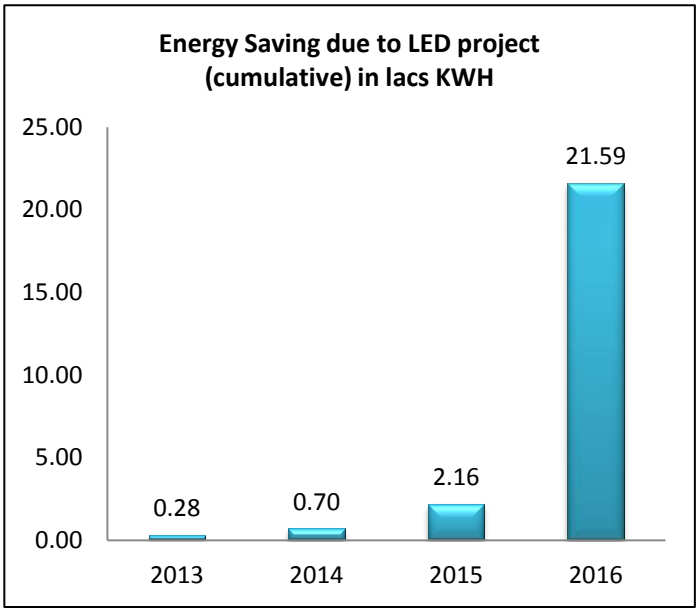
CSIA, as a responsible corporate citizen, aims towards sustainable airport development and accordingly several sustainable initiatives in the areas of energy, water, solid waste and operational efficiency have been taken up.

Airport operation being energy intensive, we give utmost importance to the conservation of energy. Energy consumption has been optimized through efficient energy management measures which are implemented through Energy Management System-ISO 50001 and are in line with MIAL's Energy Management Policy. MIAL is also certified with Environmental Management System (ISO 14001), GHG emission & removals (ISO 14064-1). Energy Management program of MIAL reflects a strong intent towards combating the challenge of climate change.

"Replacement of Conventional Lights with Highly Efficient LED Lights" is one such initiative which is a combination of multiple small projects of LED installations completed in phased manner to ensure minimal service disruption. LED lighting is the latest and most energy efficient but costlier technology in the market compared to earlier available technologies.

Under this project, MIAL has replaced / retrofitted approximately 9000 LED bulbs and was able to reduce 700 KW load on the grid and achieved total energy savings of 2.16 million units which resulted in saving of INR 21.60 million. (0.32million USD)

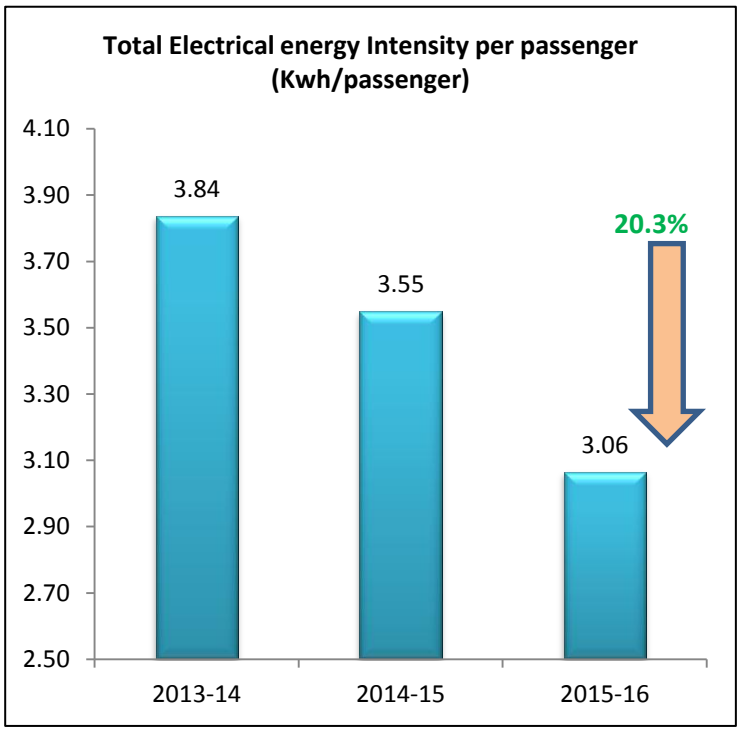
Project Graphics



Caption 1
Energy Saving due to LED project (cumulative) in lacs KWH

Caption 2
LED light fittings in Terminal 2 arrival corridor

Caption 3
LED light fittings in Airside areas



Caption 4
Total Electrical energy Intensity per passenger (Kwh/passenger)

Queen Alia International Airport - South Runway LED lights installations project

Airport International Group

QAIA (Queen Alia International Airport) was inaugurated in 1983, the airport extends across 19 million SQMs and includes two parallel runways 3,660 meters in length, 61 meters in width and with a separation of 1,446 square meters.

In November 2007, through a 25-year concession agreement, Airport International Group (AIG) became the Jordanian company responsible for the operation of (QAIA), the rehabilitation of the airport's facilities, and the construction of the new passenger terminal.

Apart of the new terminal construction and the additional passenger capacity which reaches 12 Million passengers, AIG launched initiatives to enhance environmental management at the airport which entitled QAIA to become the first airport in the Middle East to achieve ACI's *Airport Carbon Accreditation* level 3, optimisation in April 2016.

In 2013 an internal assessment conducted on the south runway operational and infrastructure status, which included the existing equipment, frequency of corrective maintenance, power failures and energy consumption rates of the old halogen lights.

The project implementation started in quarter 3 of 2014 and ended in December 31st 2016 covering the Centerline, Touch Down Zone, Edge lights, Threshold and Approach lights.

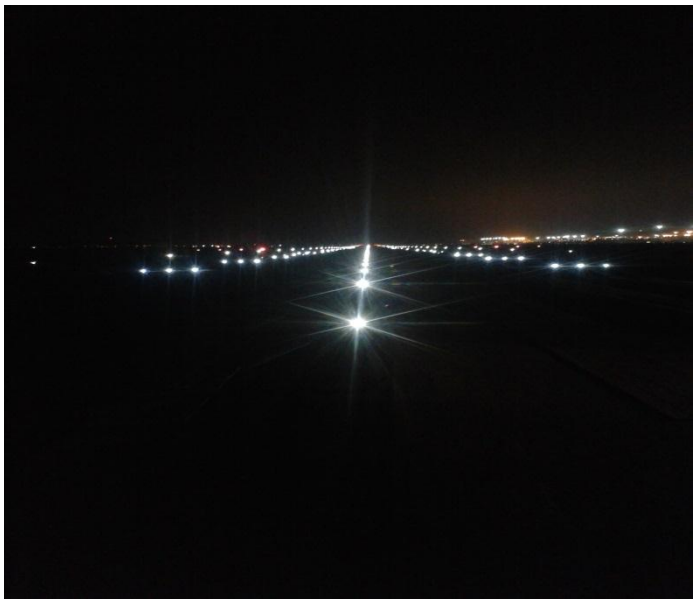
The challenge encountered during the project implementation was the installation of 816 different units with their accessories without hindering the runway operations. Since this runway is the only runway currently operational at QAIA, accordingly, the works were scheduled to be under permission of the ATC and within two hours runway closure slots during which AIG's high caliber maintenance teams were replacing the Airfield Ground Lighting units from Halogen to LED including lights, transformers, connecting kits and constant current regulators (CCR).

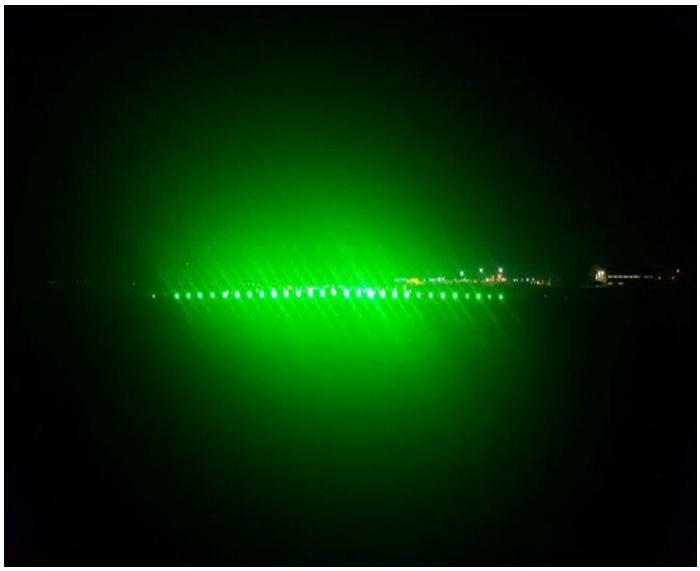
In addition to becoming the second airport in the region to have an LED lit runway.

AIG will be reducing carbon emissions by 495T annually, electricity consumption by 779,454 KWH and saves around 136,130 US Dollars annually.

Project Graphics

*No captions provided from airport





Section 5: Solar Energy

Adelaide Airport - Car Park Rooftop Solar PV

Adelaide Airport Ltd (AAL) completed construction of a 1.17MW solar PV installation on the multi-level car park roof in March 2016. It is the largest rooftop system, and second largest overall, in South Australia. It is also the largest rooftop installation at any Australian airport and one of the largest private, commercial (non-utility scale) arrays of any kind in Australia.

The system is expected to generate over 1.730MWh per year, which equates to approximately 10% of AAL's total electricity consumption. Between April and November 2016, AAL's retail metered electricity consumption was 10,873MWh and the solar PV system had generated 860MWh or 7.3% of overall use. System output will increase significantly in the upcoming summer months relative to consumption, and is on track to meet the 10% target.

Such a large-scale solar PV system was pursued for a slew of financial and non-financial benefits, notably:

- meeting the airport's corporate carbon targets and thereby supporting ACI *Airport Carbon Accreditation* status
- reducing risk exposure to increasing electricity prices
- enhancing the airport's reputation and environmental credentials
- meeting investors' environmental, social and governance (ESG) risk expectations
- improving potential rental returns from future surrounding commercial development
- investment toward energy self-sufficiency

A number of project elements are worthy of particular attention:

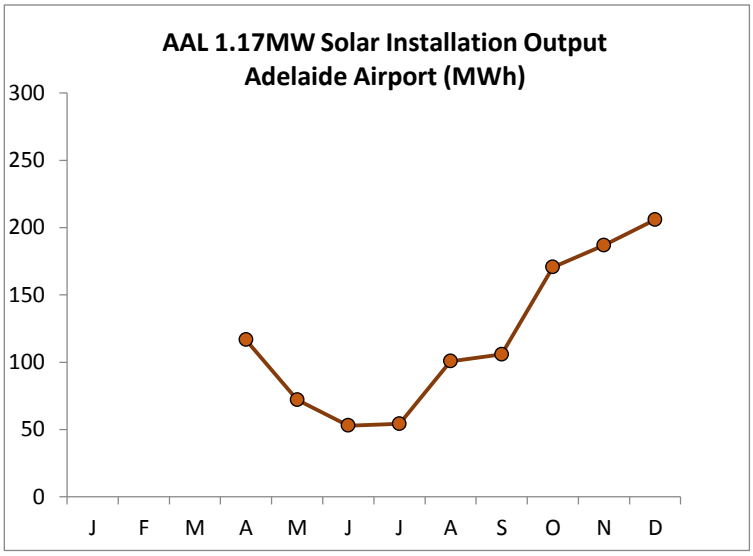
- this system was funded entirely by AAL, with no government support
- the project was one of the first globally to use SMA 60kW inverters – a larger commercial-scale unit – which resulted in a reduction in the inverter room footprint of 75%
- DC optimized (TrinaSmart) panels were used, reducing the performance limitations caused by shading and providing the best mitigation strategy for fire risk
- The contractor, Solgen Energy, committed to using 70% local labour and invited tertiary vocational students to participate in the system commissioning phase.

Project Graphics

Caption 1
Adelaide Airport 1.17MW Solar Installation

Caption 2
Rooftop View of Adelaide Airport Solar Installation

Caption 3
Inverter Room



Caption 4
Adelaide Airport Solar Generation (Apr-Dec 2016)

Darwin International Airport - Solar Project

Northern Territory Airports has made a long-term commitment to using renewable energy across its three airports in Darwin, Alice Springs and Tennant Creek. The organisation is mindful of the contribution the aviation industry makes to greenhouse gas emissions, and is keen to lead the way for other airports – both national and international – by reducing its carbon footprint. This continued focus aims to minimise the airport's impact on the environment, optimize airside land use, increase non-aeronautical revenue and showcase new solar technologies, for the benefit of the organisation, stakeholders, community and the environment.

The series of solar power facilities across its three airports lead the way in development, innovation and investment. Northern Territory Airport's flagship facility, Darwin Airport Solar Project, is the largest airside PV (photovoltaic) solar facility in the world. It is also Australia's most northern multi-megawatt PV array and the largest BTM (behind the meter) system designed and built for a single building/facility in Australia.

The project was developed in two stages resulting in an impressive 5.5 megawatt facility. The development was managed entirely by the airport from beginning to end. This includes feasibility, design, construction and operation. Darwin Airport consumes all the solar power generated for its own use.

This facility generates 25 per cent of the airport's overall energy needs and meets 100% of the daily peak demand. Not only do the environmental benefits manifest with a 25% reduction in carbon emissions from stationary energy, the significant investment of capital towards this project, enables Darwin International Airport to hedge the exposure of the airport to fluctuations in electricity prices thus providing greater certainty for the broader airport community and interested investors, partners and stakeholders.

Project Graphics

Caption 1
Darwin Airport Solar Project Stage 1

Caption 2
Darwin Airport Solar Project Stage 1, before and after

Caption 3
Feature in Territory Q magazine

Caption 4
View from tower

Kuala Lumpur International Airport - Solar Photovoltaic (PV) Power Generation System

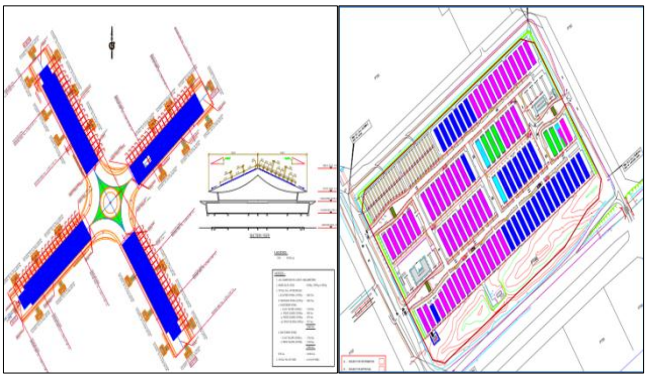
Engineering Division Malaysia Airports Holdings Berhad (MAHB) has continuously and rigorously strive on improving the business and service by leveraging on the latest technologies on Energy Management. Malaysia Airport energy policy was established in 9th January 2012 with the main objective of this policy are to improve energy consumption efficiency, reduce utility cost, optimize capital expenditure for energy efficiency and strive to become a world-class energy management in airports industry. One of Malaysia Airports' core values is to take great concern care on the environmental sustainability, with the elements of energy and carbon reduction through the establishment of Carbon Management Plan (CMP) by reducing total direct emission by 10% in 2020.

In continuation of CMP establishment, MAHB has performed a study on the commercial opportunity for development of Photovoltaic (PV) Solar Power Plant Facilities at Kuala Lumpur International Airport (KLIA) on April 2011. As a results of the study, a total of 14MW Photovoltaic (PV) Solar Power Plant has been proposed to be developed at Roof Top Satellite Building and Long-Term Carpark of KLIA. This project has been completed through concessionaire method and fully commissioned by November 2013.

This report provides an analysis and evaluation of the performance and contribution of Solar Photovoltaic (PV) system at Kuala Lumpur International Airport (KLIA). Method of analysis included the reduction of fuel-based electricity dependency, contribution of solar generation for KLIA electricity grid, reduction of carbon dioxide (CO2) emission and total operational expenditures reduction. Based on the data analyzed show that the dependency on the electricity grid has been reduced by 7% yearly equivalent to 18,638 MWh and 13,811 tCO2 per year. In total, Solar PV contribute to 55,857 MWh from January 2014 until November 2016 which is translated into 41,390 tCO2.

Project Graphics

Caption 1
Installation Works



Caption 2
Overall Layout

Caption 3
Roof Top, Satellite Building KLIA (4MW)

Caption 4
Long Term Car Park KLIA (10MW)

Sharjah International Airport - Green Parking

مـطـار الـشـارقـة الـدولـي
Sharjah International Airport

By inspiring from UAE Vision 2021 and its national target to replace 27% of conventional energy sources with clean energy sources Sharjah International Airport Management decided to introduce clean energy sources at the Airport as a part of its “Go Green” Policy.

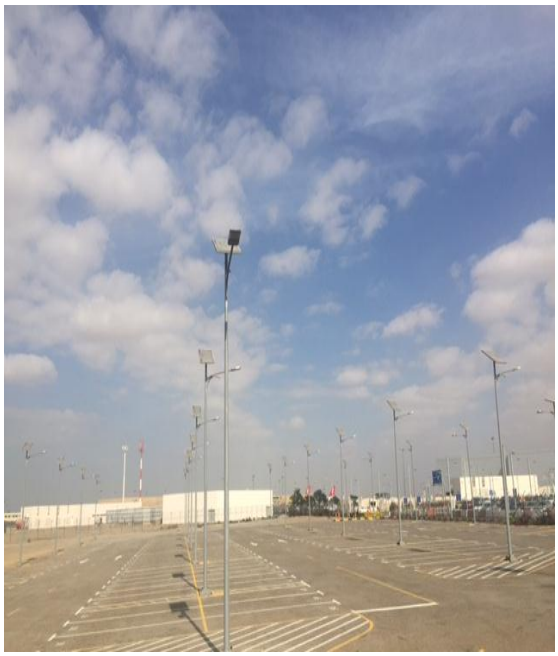
The “GREEN PARKING” Project was implemented at three locations in the airport. The project includes the installation of Solar lighting system at two newly build car parking’s and pedestrian walk way in departure car parking. By choosing solar energy for lighting system for these areas Sharjah International Airport manage to avoid a marginal amount of energy consumption from conventional sources and replace it with clean energy sources.

The newly build car parking are new rent a car parking and Sharjah Airport Authority (SAA) management car parking. New rent a car parking located next to arrival car parking near the passenger terminal which planned and build to provide permanent parking facility to the cars belongs to rent a car companies operating at Sharjah International Airport. The new management car parking located next to SAA Building and designed to provide parking facility for Management staff at Sharjah Airport Authority and Department of Civil Aviation. The third area covered under “GREEN PARKING” project is the pedestrian walk-way from departure car parking to terminal building which provides easy access to passengers from departure car parking to departure terminal.

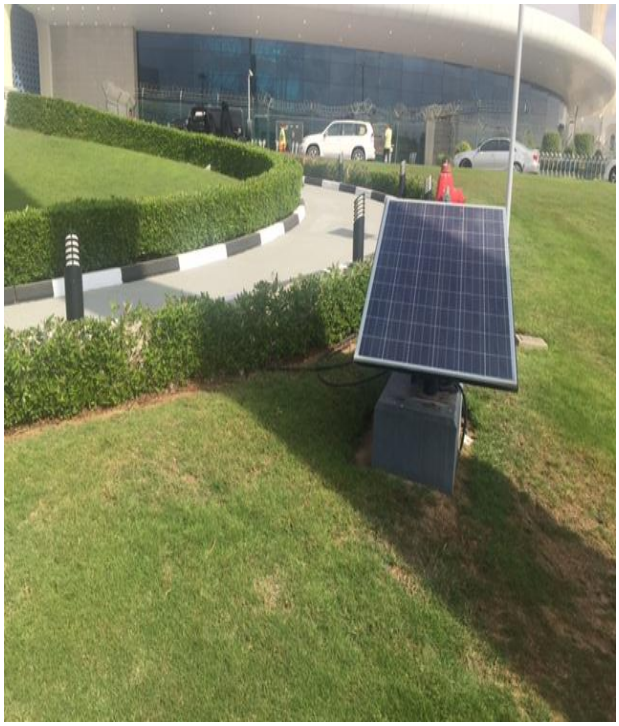
All three area’s together cover a total area of 7773 M2 with 33 solar panels installed across. A total of 30 numbers of street lights with 60 watt capacity and 20 number of street light with 9 watt capacity and 61 fluorescent lamps with 9 watt capacity connected to these panels to provide sufficient lighting from walk-way from the parking area. The total capacity of Solar panels installed is 8270 watts per hour.

Project Graphics

Caption 1
Rent a car parking



Caption 2
Rent a car parking



Caption 3
Management Car parking

Caption 4
Pedestrian walk-way in departure parking

ACI Asia-Pacific Green Airports Recognition 2017

ACI ASIA-PACIFIC GREEN AIRPORTS RECOGNITION

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