Sustainable Methods used to reduce the Energy Consumption by Various Facilities in Airport Terminals

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***Abstract* :- The purpose of this article is to identify the energy challenges faced by airports especially with regards to the energy consumed by the terminal building and suggest suitable energy conservation techniques based on what has already been implemented in few airports around the world.**

We have identified the various facilities and systems which are responsible for a major share of the consumption of energy by airport terminals and we have suggested measures to effectively overcome these problems.

I. INTRODUCTION

Energy consumption has become a growing concern in today's world. This is because of the non-renewable nature of a major source of energy i.e., the fossil fuels and the pollution this energy source brings with it. Ozone layer depletion and increase of carbon dioxide in the atmospheric composition are among the few problems which arise due to burning of fossil fuels. There is an increasing demand to shift towards renewable and non-polluting energy sources such as solar and wind energy.

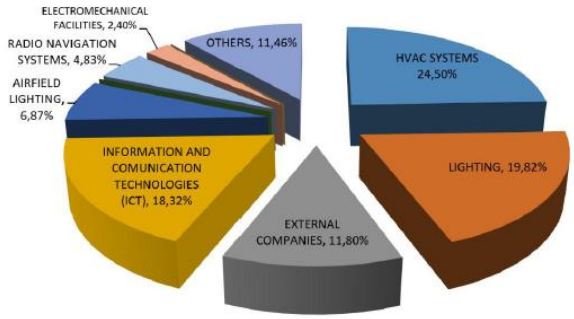
Airports are the cornerstones of the aviation industry. The functioning, maintenance and the facilities available in airport terminals are a matter of pride for the respective cities and countries they are situated in and help boost tourism and the global image of the place.They are iconic buildings that influence the *firstimpressions* of tourists who visit any country. So, naturally, a lot of funds are spent on ensuring that the passengers have a comfortable stay in the airport. This often means spending a lot of energy on systems which improve the ambience and the user experience.

A lot of airports around the world have adopted sustainable techniques and energy sources which do not compromise on the user experience. Some of these techniques have been successfully proved to reduce the ecological footprint of the respective airports.In the past few years, energy, or the lack thereof, has become a growing concern among people. Tremendous amount of research and investments have been carried out to develop technologies which are energy efficient.

An airport consumes hugeamounts of energy, this includes energy consumption for both airside and landside applications.Airside refers to the areas which caters to the needs of the aircraft like runways, hangars, control towers etc. Landside refers to the areas which cater to the needs of the passenger ensuring their smooth and safe passage,namely, the terminal buildings, parking lots etc.

In an airport, the terminal building represents the major share in consumption of energy. According to an article by Sergio Ortega Alba and Mario Manana [1], more than 75% of the total energy is consumed by the terminal building in the Satander airport in Spain [fig: 1]. One could expect a similar if not the same trend in other airports.This energy is used for lighting, HVAC,baggage handling systems etc.Fortunately terminal buildings provide a multitude of opportunities for sustainable operations. Everything from sustainable source of the energy to efficient HVAC systems and sustainable lighting has been employed in airports across the globe.

Figure below shows the energy consumption by the facilities in Satander airportSource: Energy Research in Airports (Airport Seve Ballesteros-Santander) [1].



II. SOURCE OF ENERGY

The best way to address the energy consumption problem would be to draw energy from a renewable, non-polluting source. Both the Cochin International Airport in India and the Galapagos Ecological Airport in Ecuador are standing examples of airports which have completely switched to renewable energy for their day-to-day operations. The Galapagos ecological airport became the world's first green airport in December 2012. About 35% of the airport's energy

is produced by photovoltaic panels and the remaining 65% is produced by strategically placed windmills around the site [2]. The Cochin international became the world's first airport fully powered by solar energy in August 2015 technically making it energy neutral [3]. It has 46,150 solar panels producing 50,000-60,000 units of electricity per day.After being commissioned, these solar power plants have so far saved more than 550MT of CO2 emission according to CIAL. The CIAL has estimated that over the next 25 years the project will reduce carbon emission by 300,000 metric tons [3]. Other airports in India have followed suit and have planned to go fully or at least partially solar. The Trivandrum international airport has planned to go partially solar with a 450 kW solar power plant [4] and the Raja Bhoj airport in Bhopal has also planned to switch to solar energy [5].

Using non-polluting energy sources such as wind and solar energy entails many advantages biggest of which is the lack of carbon emission. Many airports across the globe have tremendous potential for harvesting solar and wind energy especially the ones in the Middle East. But one main requirement for switching to solar energy like the Cochin airport is the availability of a large area of land around the airport which prevented the Trivandrum airport from going fully solar as they were limited to installing solar panels in roof-tops [4]. This problem would not arise if enough area is designated for installing solar power plants during the planning stage itself now that an airport has shown that it could be fully solar powered. Also initial costs for installing solar power plants is also fairly high with the solar power plant in Cochin international airport costing 9.5 million dollars[6] but this cost could be recuperated over time since the airport no longer needs to pay for power consumption[7].

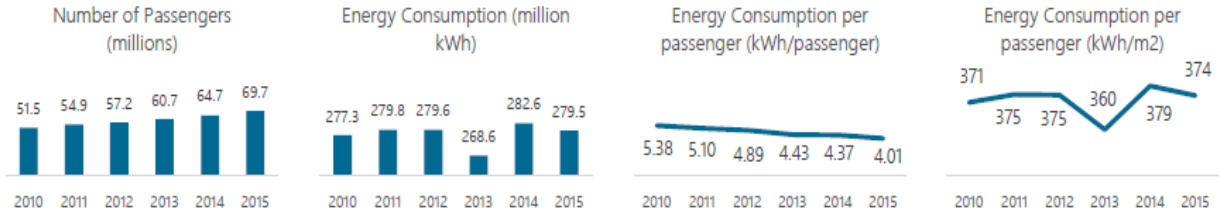
The cost of installation of solar panels may be high but it's a one-time investment that pays great dividends over time.In iconic projects such as airport design, it makes good business sense to invest wisely at the initial stages to reduce the running cost of energy year after year.

III. LIGHTING

Manana et al [1] shows that about 20% of the energy consumption in the terminal building in the Satander airport is due to lighting system. Many new methods andSustainable design solutions for lightingpresent an excellent opportunity to conserve energy. Energy research by Ortega Alba and Mario Manana have suggested conserving energy through sustainable design for lighting systems.

A good amount of energy could be saved if terminal buildings take advantage of daylight considering that sunlight produces lesser heat per lumen of light [7]. An airport which has made use of this is the Jeppesen terminal in Denver International Airport which has used a fabric roof which is translucent [8]. It was designed in such a way that the areas which are normally crowded with passengers like the Great Hall, baggage claim and ticketing and circulation spaces is illuminated by natural light throughout day thereby reducing the cost and energy required for lighting during the day[8]. The PTFE membrane has a high level of reflectivity (reflects about 76% of the incident solar radiation) reducing heat gain and in turn reducing the energy required for air-conditioning. 15% of the radiation is re-radiated as infrared light and the remaining 9% is transmitted into the building as visible light. Also, unlike conventional roofs the tensile membrane does not heat up or radiate heat into the space below [8]. But one requirement for taking advantage of day lighting is to have lighting systems which are capable of adjusting to the amount of day light available(this might typically require sensors) either by dimming the lights or by turning off a few lights according to the amount of light required.

Another way to conserve energy used for lighting is to replace conventional lighting systems with ones that consume lesser energy like LEDs. This has been done in the Hong Kong International Airport [9] where 100,000 lights were changed to LEDs which saved 18.2 million KW/year. The project took 4 years with the payback period estimated between 2-4 years. Also LEDs have reduced heat emission and longer lifespan than conventional lighting systems like fluorescent tube lights. In fact the Hartsfield-Jackson airport in Atlanta has its numerous taxiways integrated with LED edge and centerline lights[10] which is 50% more energy efficient than the previous incandescent fixture.



The above graphs are based on data received from the Hong Kong Airport engineering team and are for the terminal buildings only.

[Source: Energy Reduction in Airports [9]]

IV. HVAC SYSTEMS

Heating Ventilation and Air-Conditioning systems are used in airport terminals to provide decent indoor air quality and thermal comfort which includes systems like airconditioners, chillers, heat-pumps, furnaces and boilers [11]. A major quota of the energy consumption in airport terminals is due to HVAC systems. For example, in Bangalore International Airport, the energy consumed by HVAC systems accounts for 66% of the total energy consumption of the terminal [12] .Airports situated in places with a moderate climate can make tremendous use of the natural ventilation to improve the air quality inside the terminal like the Galapagos airport which has openings in the facade of the building for ventilation [9]. Variable Frequency Drives (VFDs) could be incorporatedinto the fans in HVAC systems which enable the motor to vary the speed according to the temperature requirements of the terminal. This has been implemented in Bangalore International Airport and has resulted in 809,159 units of energy saved annually [12].Mineta San José International Airporthas deployed the OptimumHVAC, a ultra-high performance HVAC software and it has saved 235,000 kWh of power in its first five months of usage [13].In fact the Chitose Airport in Japan devised a novel method whereby snow is collected during winters, stored in heat insulating materials (about 45% of the amount collected) and used to supply about 30% of its cooling system in the summer [12] [14].

V. BAGGAGE HANDLING SYSTEMS

Despite the factthat they do not consume a lot of energy in comparison to HVAC and lighting, the baggage handling systems also provide an opportunity to reduce energy consumption. One simple resolution would be to prevent the motion of the system if there is very less baggage, this could be implemented by using sensors. The terminal 3 in Bergen Airport has reduced the power required for startup by using two thin belts with the baggage trays moving at 1m/s instead of a conventional wide belt [9]. Also variable frequency drives can be used in baggage handling systems to reduce energy consumed.

VI. VEHICLES USED IN AIRPORTS

Terminals can also take a huge step forward in making the airport environmentally sustainable by changing the vehicles used for providing the various services in the airport. Existing vehicles using conventional fuels can be replaced by ones using alternate sources of energy. The existing airport taxis could be replaced by hybrid electric vehicles. In fact, such a move could be facilitated by installing solar panels in the roofs of the car park like the ones which are in Kochi airport [15]. This could ensure that the cars neither emit polluting substances into the atmosphere nor derive their electrical energy from sources which emit polluting substances (like thermal power plants). Also, other vehicles which are used for transporting goods and passengers between the flight and the terminal could be replaced by vehicles utilizing alternate sources of energy. As these vehicles are neither required to go fast nor travel long distances, these could be easily replaced by sustainable alternatives.

VII. CONCLUSION

Considering the current scenario in energy consumption and pollution, it is of at most importance that sustainable designs and techniques are adopted especially in airports as they consume a lot of energy.

It is evident from the above discussion that the challenges airport terminals face because of energy consumption can be mitigated fully or at least partially by adopting suitable sustainable practices which are already being implemented in a few airports around the world. These practices in no way reduce the over-all experience that an airport terminal has to offer, they rather boost the overall appeal of the airport.If a few of the aforementioned practices can be carefully implemented in tandem, the airports can definitely contribute towards a more sustainable future.

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