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Energy Saving Analysis Through Eco-Design Factors: Airport Buildings

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Abstract

Eco- design impacts a building maintaining its sustainability. One of the most important outcomes of eco-designed buildings is saving energy. Energy conservation improved a lot over time with the involvement of eco- designing factors. There are many techniques that make a building sustainable, and they are decided through the eco- design factors that need to be considered in constructing a building. An airport has high demand in energy. In all of airport buildings an Airport Terminal has the highest demand of energy and resources. There are factors that are considered architecturally to achieve eco- design and save energy by considering these factors in design of airport buildings. The data of comparison of energy utilized with and without eco- design techniques is included to analyze the energy conserved with implementation of Ecological designs in airports.

Keywords: Ecological design, Energy conservation, Energy utility.

1. INTRODUCTION

The research paper aims to study the energy consumption of airport buildings and energy saved through implementation of eco-design factors. Ecological design of airport buildings includes the overall process of airport planning, design, construction, operation, maintenance, and material usage, etc.

Planning and designing an existing or new airport building should take into consideration. Through the eco design factors a terminal building, which intakes large amount of energy consumption can be taken advantage of to turn it into a green building which is sustainable and energy efficient. Airport sustainability combines economic, environmental, and social considerations into planning, design, construction, operations, and maintenance.

Passenger terminals are one of the basic facilities and services at the airports, they are most important part of infrastructures that deals with huge amount of population according to its footfall range. And over time as the increase in usage of airways as an easiest mode of transportation for large number of people, the scale of terminal buildings had been growing extensively. And as a result of the increasing demand for air transport, there is an excessive need to turn a terminal building sustainable. A building that deals with large amounts of population also has large intake of energy, material usage, water usage, electricity usage, and increase in carbon footprint. So there is huge scope of controlling of these factors, and creating a sustainable structures. Study of energy usage in terminals, and energy saved by using eco- design factors increase the usage of sustainable practices.

A. Aim and Objectives

This research is aimed to study the energy utilized of each type of building in an airport and study the energy required in airports that implemented the eco- design techniques (through previous studies and

comparative analysis of case studies).

B. Research Method

The research methodology involves the Study about energy required for buildings of airport, study of airport development reference manuals. Case studies of ecological airports, and the considerations taken to save energy. And finding the average annual energy consumption of each type of airport building and facilities in an average international airport.

2. ECOLOGICAL DESIGN OF AIRPORTS

Ecological design can be defined as any form of design that minimizes the environmentally destructive impacts by integrating itself with living processes, nature's own flows, cycles, and patterns.

Eco-design of airport buildings refers to consideration of green building standards if airport, with the sense of sustainability and efficient usage analysis of every inclusions in designing.

Ecological design deals with:

- ecological restoration and regenerative development
- whole system approach to ecological design
- appropriate water technology
- resilient, productive, and regenerative systems
- sustainable use of technology and energy.

This paper deals with sustainable use of technology and energy and studies about energy utilization and conservation.

Ecological design factors (in Airport Terminals):

- Location and Transportation
- Sustainable Sites
- Water usage efficiency
- Energy and atmosphere conservation
- Materials and resources
- Indoor Environmental Quality
- Innovation

3. ENERGY DEMAND IN AIRPORTS

Airports, as we all know, are large consumers of energy, but this also means that they have a huge potential to save energy.

Airports as a huge structures takes up lots of energy to their function. The airport is mainly zoned into terminal side and air side, where terminal side consumes more energy. The terminal building consumes a large amount of energy dealing with the electricity, water consumption, etc. to handle many technical events in order to create an efficient flow.

The most common energy uses at an airport are:

- Airport terminal: lighting, heating, and cooling (air conditioning) and appliances (baggage handling systems, terminal bridges).
- Airport airside: runway lighting, auxiliary power units (APUs) and aircraft ground energy systems (AGES), ground vehicles (from airport operators, ground-handling companies, and firefighting services) and airside facilities such as hangars.

According to the Eco- building South Asia annual analysis of Average Annual Energy Consumption in Airports: The Airport terminal building consumes 63% of the whole energy consumption in airports, which is 98,159,140 KWh/Year in total base line energy consumption of whole Airport i.e., 156,561,840 KWh/Year.

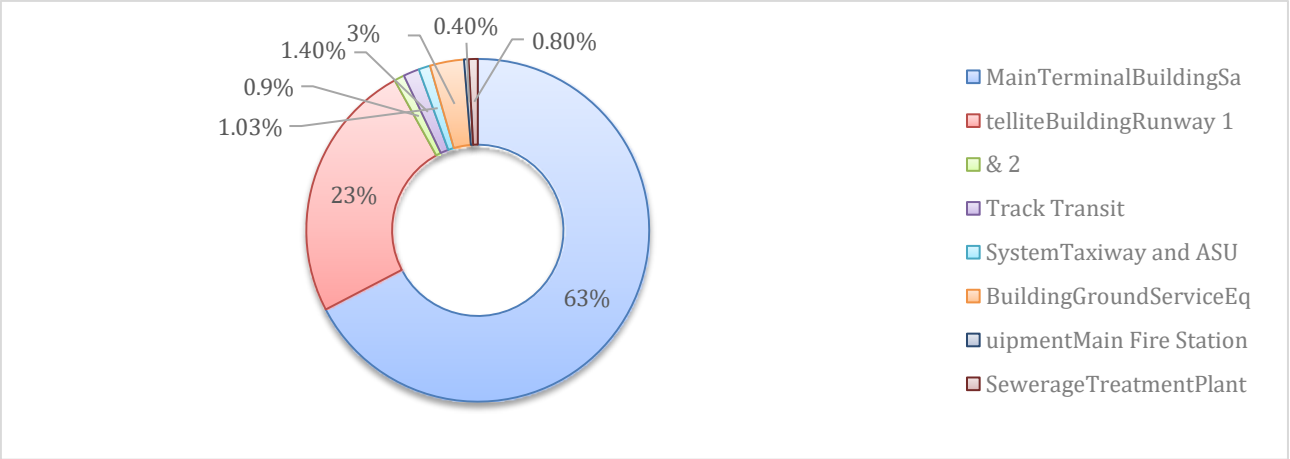

Chart 1 : Energy consumed by Airport buildings.
Source: Eco- build south Asia,2014

A. Energy Consumption in Airports

Airport operators have a global goal to reduce CO2 emissions by 50% by 2050 from their levels in 2005. In order to achieve this, they need to implement the best possible energy management strategy.

Energy usage in airports is divided into approximately 2 parts, 70% for electricity and 30% for heat. Airports consume up to 180M kWh per year in electricity with terminals consuming about 60% of this. The remaining 40% is allocated to airfield lighting, hangars, parking decks, workshops, and other ancillary buildings.

Chart 2: Energy Consumption in Airport Buildings KWh/year
Source: Eco Build South Asia, 2014.

In the survey conducted by eco- build South Asia, 28% of energy is saved with the implementation of Eco- design factors in the Average Annual energy consumption data. (This survey included the data of the following eco- designed airports: Austin Bergstrom Airport, Boston Logan Airport, Indianapolis Airport, Hyderabad International Airport, Indira Gandhi International Airport).

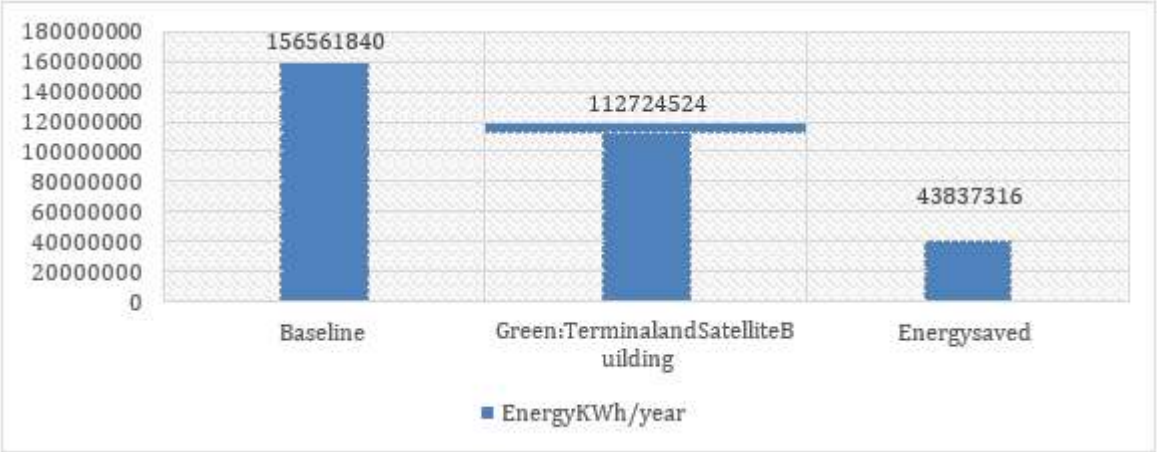

Chart 3: Energy saved through eco- design in Airport Buildings KWh/year
Source: Eco Build South Asia, 2014.

4. CASE STUDIES: ECO DESIGN AND ENERGY SAVINGS

A. INDIRA GANDHI INTERNATIONAL AIRPORT, Delhi.

Terminal 1 has received Leadership in Energy and Environmental Design (LEED) Platinum Level Pre-certification from USGBC/GBCI. The project has achieved 80 points out of 110 on the LEED Version 4.0 Standard. Out of 9 LEED categories, got 100% in 4 categories of Integrative Process, Water Efficiency, Innovation & Regional Priorities.

Terminal 3 earned a 'Leadership in Energy and Environmental Design New Construction' (LEED NC) gold rating. capacity to handle up to 34 million passengers a year.

Energy Consumption is total depended on electricity and fuel consumption. Electricity consumption takes up 97% of total energy breakout.

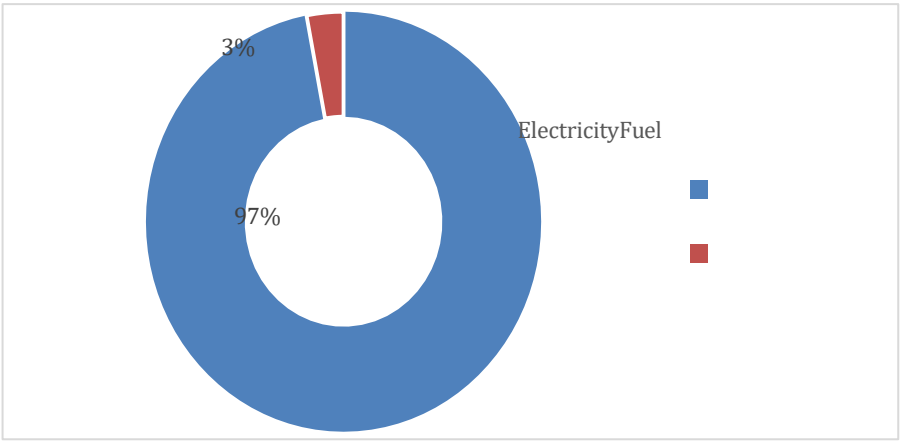

Chart 4: Energy Breakout in Indira Gandhi International Airport
Source: GAAR, Energy Excellence Journey of Delhi International Airport Limited (DIAL).

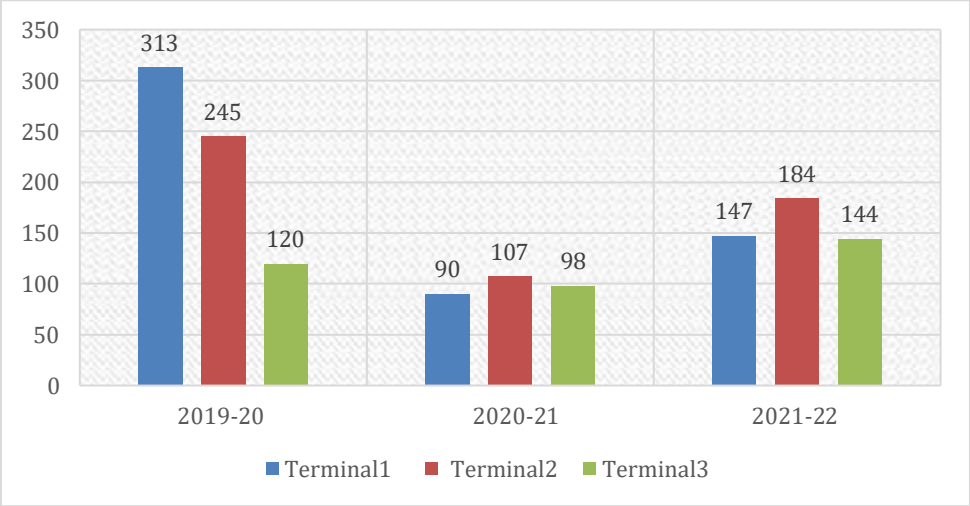

Chart 5: Energy Consumption in Terminals in KW/hr

Source: GAAR, Energy Excellence Journey of Delhi International Airport Limited (DIAL).

Eco- Design features incorporated to maximize Energy Saving:

Highlight of Solar radiation control Film & Coating over roof (Terminal 3):

- 3439 sqm of Sun control Film installed on Passenger Boarding Bridges at Terminal 3.
- Sun control Film ensure total solar energy rejection up to 49%.
- Thermal coating of approx. 4302 Sq. M of area done on PBB Rooftop.
- Thermal coating provides good insulation properties by reducing temperature up to 6 degrees.
- Thermal coating installed has various features such as UV resistance, Corrosion Resistance, waterproof, moisture resistance.

The features that earned the terminal the rating:

- Storm water drains were constructed to control erosion and sedimentation.
- Parking facility has 215 electric charging stations.
- Water supply for landscaping is supplied by recycled water from the sewage treatment plant.
- Radar sensors that control lifts and escalators 1,200 energy-efficient LCD screens are used to display passenger information.
- More than 95% of the construction waste was sold for recycling.
- 100% of the departure level is lit by natural light during the day.
- All housekeeping chemicals are eco-friendly and biodegradable •300 rainwater harvesting stations, up from 50 in 2008.
- Roof insulation R (resistance the insulation has to heat flow) value = 4.09 sq.m-K/W.
- Lighting Control and Monitoring System.
- Water cooled centrifugal chiller with a full load efficiency of 0.665 Kw/Ton (Co- efficient of Performance= useful energy output over the energy input; a COP of 5.4 at ARI (Air Conditioning and Refrigeration Institute) conditions).
- Cooling tower with VFD (Variable Frequency Drive).
- A Variable Air Volume (VAV) system with 4 inches of static Fan. The Airport is currently running on 100% Renewable Energy

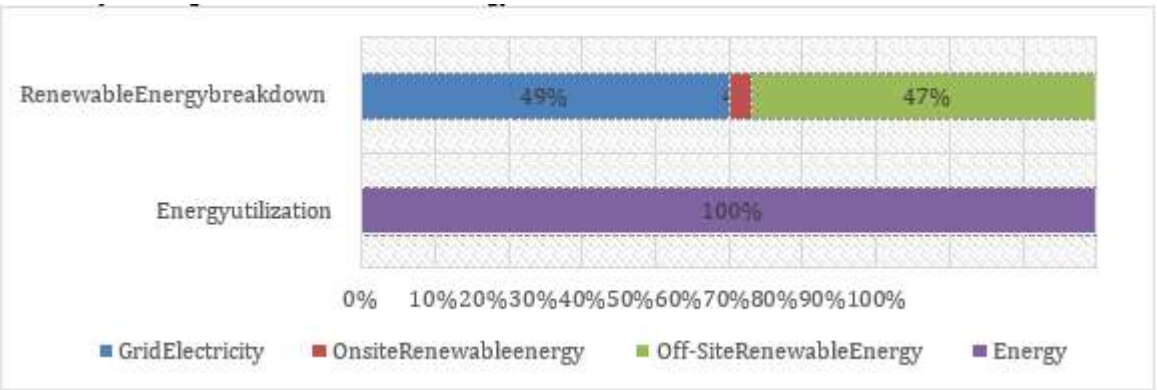

Chart 6: Energy Breakout in Indira Gandhi International Airport
Source: GAAR.

B. RAJIV GANDHI INTERNATIONAL AIRPORT, Hyderabad.

Design Capacity of the Terminal is 12 million Passenger Per Annum and Cargo is 1.5 Lakh MT /Annum respectively. Present the Terminal is operating 21+ Million Passenger Per Annum (Pre-COVID) and Cargo -1.5 Lakh MT /Annum respectively. Currently under Expansion of 40 MPPA & 2.5 Lakh MT/Annum.

Savings (25% in energy and 30% water) has inculcated a discipline within the organization to preserve the environment. RGIA is one of the few airports in the world to achieve green status. The airport reuses 100% of the treated wastewater generated in the site for landscaping, air conditioning make up water and flushing requirements. With good day lighting which helps in the 'reduction of lighting energy consumption'. Energy efficiency is achieved by a host of measures like the use of high-performance glass with excellent thermal properties, high efficiency chillers, insulated walls and roof and variable frequency drives for the pumps. In addition, the application of skylight and fenestration strategy with integration of high-performance glass, which allows daylight and to achieve energy efficiency, together with high efficacy chillers, insulated wall minimizes internal heat gain in maintaining overall comfort condition. The RGIA is one of the few airports where the indoor air quality is monitored on a real-time basis. The differential CO2 levels at any point of time is maintained at levels below 530 ppm.

Some of the green features of airport include:

- Conservation of topsoil.
- Electric charging refueling stations in the parking lots.
- 100% Rainwater harvesting and 100% Grey water treatment.
- 23% reduction in energy consumption as against ASHRAE baseline.
- Use of efficient chillers, lighting controls and a lighting power density of 0.9 watt/ sq. ft as against a norm of 1.3 watt/ sq. ft.
- Use of materials with high recycled content.
- Fresh air purging to maintain good indoor air quality.
- Use of greenhouse-keeping chemicals.
- Over 34% in Net KW/hr of Solar contribution. Solar PV technology of 10 mW capacity are installed onsite (for electrical energy purposes), which generates 10.37 million KW/hr.

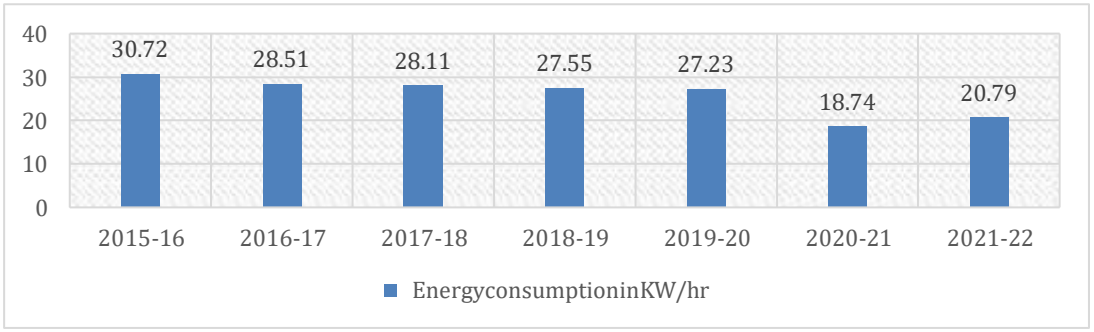

Chart 7: Energy Consumption in Terminal in Rajiv Gandhi International Airport
Source: GAAR, Energy Management GMR Hyderabad International Airport Ltd.

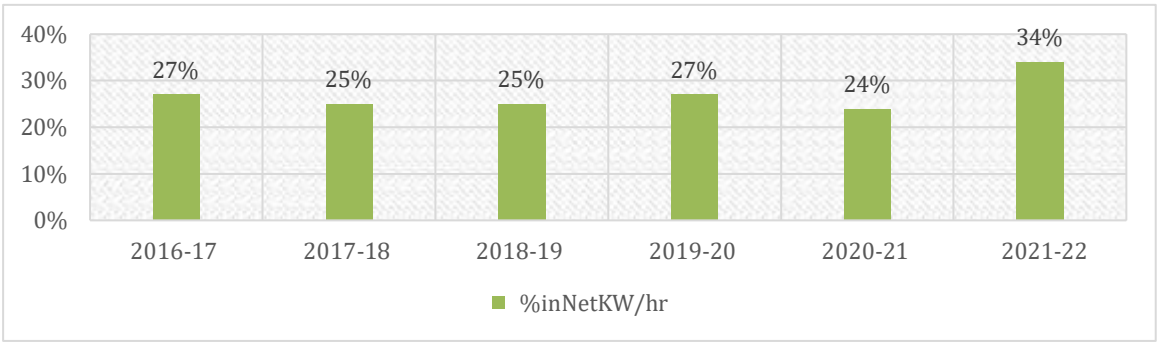

Chart 8: Solar contribution in Net Energy in Rajiv Gandhi International Airport
Source: GAAR, Energy Management GMR Hyderabad International Airport Ltd.

Inferences

Analysis of energy saved through energy saving eco- design projects from the discussed case studies i.e., Indira Gandhi International Airport, Delhi and Rajiv Gandhi International Airport, Hyderabad.

Conclusion

Year	Investment (INR Million)	Energy Saving (Million KW/hr)	Savings (INR Million)
INDIRA GANDHI INTERNATIONAL AIRPORT			
2019- 20	160	7.8	72.1
2020- 21	33.47	1.9	17.4
2021- 22	**58.6**	**8.3**	**13.8**
RAJIV GANDHI INTERNATIONAL AIRPORT			
2019- 20	23.8	0.78	5.72
2020- 21	73.2	3.14	22.95
2021- 22	**62.91**	**1.79**	**13.25**

Table 1: Inference table: Energy saved in Airports with Energy saving Eco- designs
Source: GAAR

The emergence of sustainable passenger terminals is a response to the environmental, technological, and social changes of the current era, and in order to improve the reality of achieving sustainable passenger terminals, the urgent need to redesign or rehabilitate passenger terminals that meet the environmental,

psychological and economic reasons, for operators and users is necessary. To obtain international environmental assessment certificates suiting the local climate to reach environmentally sustainable passenger terminals, the required accreditation must be designed to meet its requirements, whether the design and implementation of a new terminal, operation and maintenance of an existing terminal, or interior design and construction.

The previous studies and presentations formed the diversity of knowledge associated with the design aspects of sustainable passenger terminals and achieved a basic information base for building a comprehensive theoretical framework for different aspects, which was identified in three main vocabularies: Ecological design factors, Conservation of Energy and quality and passenger satisfaction of design.

The results of the application showed the million Watts of energy is saved with the Eco- design techniques incorporation in Airports and specifically in Airport Terminals. Ecological design factors must be implemented in Construction or redevelopment of Airports to minimize the energy wastage or provide environmental cooperative facilities for the supply of Energy to the Airports.

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