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INTELLIGENT BUILDINGS AND THEIR USE IN AEROSPACE INDUSTRY

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Abstract: The article discusses about intelligent buildings in aviation industry. In the introduction the term of intelligent buildings for basic understanding of the issues is defined. The definition of intelligent building can be different by/ based on a lot of criteria. For that purpose, the first part contains fundamental concepts of definition. The aviation industry is one of the first which uses knowledge and innovative solutions. Currently, the most frequently solved issues are relating to the need for security, increasing energy prices and the increasing environmental awareness. Next part gives essential information about airports around the world which are among the first in the concept of green energy. The last part is the most important part for the fulfilment of the main aim of the research. This section contains the current technological options available at airports and their applicability under current conditions. The aim is the analysis of the energy performance of buildings at the airport and the suggestion of relevant opportunities for saving electricity. Suggestions are listed for improving energy intensity also with specific advantages and disadvantages.

Keywords: Intelligent Building, Airport, Certification, Renewable Sources of Energy, Technology

1. INTRODUCTION

The concept of intelligent buildings has been much discussed over the last 25 years. The main purpose of these discussions has been to define what exactly the term means. Defining of the term intelligent building is not easy, because there is still no universal definition of intelligent building. There are many definitions of the term intelligent building. Different definition is preferred in Europe, Asia and America. Although there is no one general definition, any intelligent building must meet attributes such as comfort, safety, high energy efficiency, individual control and automatic control of operational technologies.

If the building wants to be intelligent, the condition of its environmental friendliness must be fulfilled. If the condition is not fulfilled, then it cannot apply for the SMART label, even if the building is full of modern technologies and systems. However, if the building is intelligent, the savings relate to two important areas, namely energy and capital. For this reason, all new commercial buildings and probably luxury residential buildings are designed with the common goal of becoming smart buildings. It doesn't matter if it is large or small building, whether it is a family house, school, shopping centre, hospital or office building, anywhere is space for using intelligence.

Main goal of research was not to find or discover new technology or complex technological solutions, but to propose how to use current ecological and economically appropriate technologies with an emphasis on the sustainability of an intelligent building. The content of the proposal describes relevant solutions to reduce electricity consumption at airports through renewable technologies. The main methodology used for this was the comparison of available technologies with real energy requirements at the airport. Based on these, the basic advantages and disadvantages of each solution were defined.

2. INTELLIGENT BUILDING

The term of intelligent building was first time used in the 80^{s} of the 20$^{th.}$ century in the USA by the Intelligent Buildings Institute. The definition of intelligent buildings over the last 30 years has changed significantly. In different cultures, definition of intelligent building is different. Albert So and Alvin Wong So Albert and Alvin Wong summarized the basic definitions relating to the concept of intelligent building.[1]

The first definition, coined by the Intelligent Buildings Institute, defines an intelligent building as *one which provides a productive and cost-effectiveenvironment through optimization of four basic elements: structure, systems, services and management, and the interrelationship between them*.[2], [3]

In Europe, the European Intelligent Buildings Group coined a new definition stating that an intelligent building "creates an environment which maximizes the effectiveness of the building's occupants while at the same time enabling efficient management of resources with minimum life-time costs of hardware and facilities.[4],[5],[6]

The Asian definition is one of the most universal definitions which includes the key factors. There are eight modules of environmental quality , including:

- environmental friendly – health and energy conservation;
- space utilisation and flexibility;
- life cycle costs– operation and maintenance;
- human comfort;
- working efficiency;
- safety - fire, earthquake, disaster and structure etc;
- culture;
- image of high technology.

The assessment if the building is intelligent must be objective and quantifiable assessment prepared by an official accredited institution. The outcome of the assessment is an international certificate. The most famous global certification systems are the English BREEAM, the American LEED, German DGNB and Canadian SBTool. [7]

3. AIRPORT INFRASTRUCTURE

Airport infrastructure and related ground facilities are an essential part of the airport system. Airports must have the infrastructure to ensure efficient operations in accordance with safety in order for the airport to operate efficiently and reliably.

An airport is the meeting point between the users of air transport (passengers and cargo carriers) and the services of the various entities involved in the process. This is where traffic begins and ends, where decisions are made about its quality and efficiency.

Big airport infrastructure is extremely energy intensive and represents a significant burden to the environment. A large airport can consume the same amount of electricity as a city of 100,000 people. Heating, cooling, ventilation, and lighting is more than 80% of energy consumption for the airport. [8]

For example, in 2005, Brisbane Airport was one of the top ten electricity consumers in the state of Queensland with electricity consumption of 110 GWh. The annual electricity budget for Seattle - Tacoma International Airport is USD $6 million. Frankfurt Airport consumes 216 KWh at check-in more than 5 million passengers and 2 million tonnes of cargo. That's more than 40 kWh per passenger, it means a daily consumption of hundreds of fridges. International Airport in Denver has the same values. Another reason the energy intensity is that the airport complexes are situated on many hectares. Brisbane Airport covers a total area of 2 700 hectares.

An example could be airports which establish measures for the development of airport infrastructure and environmental protection.

The greenest airport in the world is Seymour airport of Baltra in the Galapagos. Wood and other recyclable materials were used for rebuilding. It uses only solar and wind power, which ensures solar

panels and three giant wind turbines. The airport has no air conditioning because it is laid on huge rollers. In 2014 it received the highest existing certificate for permanent structures Lee Gold, awarded by the American Council for Green Building.[9]

Figure 1 **Airport Seymour of Baltra**
Source: [10]

The world's first solar airport is Cochin International Airport in southern India which derives 100% of its electricity from the sun. In 2013, the airport started a project to generate electricity from photovoltaic panels for its own use. It is now independent of the public grid. The project cost $9.3 million and it is estimated that this amount could be saved within six years at the latest, as the complex will no longer pay for electricity.[11]

Figure 2 **Airport in India**
Source: [12]

International airport Leonardo da Vinci-Fiumicino in Italy installed 15 000 LED lights in Terminal 1 and 2 and has saved 35% of energy. Airports that depend on their development include Milan Malpensa, London Heathrow and many other world airports, as well as some Slovak airports. [4]

Košice Airport is environmentally friendly and the main priority is to transform Košice Airport into a "green airport". This idea has been implemented through the use of alternative energy sources and energy-saving equipment. The green airport project started in 2013 with the installation of photovoltaic panels on the roof of the terminal. The next phase of the project is the energy recovery of grass waste.

Figure 3 **Detail of the photovoltaic panels at the Košice Airport**
Source: [13]

4. PROPOSED SOLUTION

Airports should be aware of their environmental impact and think about cost-saving measures. One way to save costs and increase energy efficiency is to use renewable energy sources. It is possible to get the energy you need from renewable sources in, on or close to the building. Renewable energy sources include, in particular:

- solar energy;
- hydropower;
- wind energy;
- biomass energy.

It is necessary to focus on areas such as heating, cooling, ventilation, hot water production and lighting in buildings that require large amounts of electricity and to see what opportunities there are to minimise it. Energy efficient technologies also have advantages and disadvantages that should be considered. In particular, potentially useful technologies for airports include photovoltaic systems:

- photovoltaic systems;
- solar cooling systems;
- wind turbines without a propellers;
- hydropower plants;
- biomass;
- LED lighting.

Table 1 Advantages and disadvantages of different equipment

Technology	Advantages	Disadvantages
Photovoltaic panels	• omnipresent potential • minimal environmental impact low operating costs • security and silence • the panels can be easily added to and improve the overall performance of the equipment • the panels are portable and can therefore be easily installed anywhere	• performance of dependent on seasonal climate and weather change • high investment costs
Solar cooling systems	• saving primary energy • low production of CO_2	• large volume and weight • low COP

Technology	Advantages	Disadvantages
		• the price
Wind turbines without propellers	• silent • has no rotating propellers • has no effect on birds • without emission • higher energy production • low costs of maintaining	• disturbing effect for radar stations • influence on the scene landscape
Hydropower plants	• long life cycle (70 and more years) • low operating costs • high appreciation of investments • high efficiency of conversion of primary energy into electrical energy • high operational reliability and its efficiency • fully automated process • low energy consumption of the whole process	• long return on the investment (10-15 years) • negative impact on the environment - requires a large land, changes in the hydrological and microclimate conditions
Biomass energy	• local energy source that is easily accessible • stable price • does not pollute the environment by excessive production of CO_2 • non-toxic • ash can be used as a fertilizer	• high investment costs • lower calorific value and energy density than fossil fuels • raw biomass is not suitable for long term storage
LED lighting	• low consumption of electricity and maintenance • higher light output • produce less heat • long life cycle • low production of CO_2 • immediate full performance • resistant against frost	• high investment costs

Solar energy is very important for airports and indeed there are many working examples of the utilisation of this form of energy in an airport environment. Solar energy can be utilised through photovoltaic cells, which produce electricity directly, and through solar thermal systems, which produce useful heat for heating water or spaces. They may also serve for solar cooling systems.

Many of the other Renewable Energy Technologies are dependent on geographical conditions that are not generally found near major airports.

Wind energy is an intermittent energy source that depends on the weather, time of day and season

Hydropower is dependent on access to water resources which are not found near airports.

Biomass energy provides many opportunities for airports and many airports have successfully applied this technology.

LED technology is the best option for lighting public and non-public areas of the airport such as car parks, exterior and interior of the terminal, large screen displays used for advertising purposes or aircraft parking areas.

5 CONCLUSION

It is no secret that the airside of the aviation industry is a large contributor to greenhouse gas emissions. In addition, no significant improvements in energy efficient jet engine technology seem likely in the near future. Therefore, any immediate sustainability benefits are more likely to come from the landside of this industry. The path leads through renewable energy sources.

What will airports look like in the future? In the current state of technology and science, this is difficult to predict. Current technologies can only give partial answer to that. The list of current possibilities, resulting from the research is not universal and applicable to all airports and their conditions and requirements. Especially not for regional and small airports. However, the list shows the way and possibilities of what and how to do for a more economical and ecological development of the aviation industry in the future. The advantage will have airports that use the latest technology in the area of baggage transport, lighting, heating, air conditioning and information systems for passengers.

Thanks to a discrete and reliable security system, we will not have to wait in line at checkpoints. In addition, the airport will be transformed into a world adventure and a huge shopping mall. However, their operation will appeal more to sustainability and ecology. Flying will be green.

REFERENCES

[1]. So, A.T.P. - Wong, A.C.W. - Wong, K. (1999), *A new definition of intelligent buildings for Asia*, *Facilities*, Vol. 17 No. 12/13, pp. 485-491. https://doi.org/10.1108/02632779910293488

[2]. Osama O., (2018) *Intelligent building, definitions, factors and evaluation criteria of selection, Alexandria Engineering Journal*, Volume 57, Issue 4, 2018, Pages 2903-2910, ISSN 1110-0168, https://doi.org/10.1016/j.aej.2018.07.004.

[3]. Wong, J.K.W. - Li, H. - Wang S.W. (2005) *Intelligent building research: a review, Automation in Construction,* Volume 14, Issue 1, 2005, Pages 143-159, ISSN 0926-5805, https://doi.org/10.1016/j.autcon.2004.06.001.

[4]. Rowlings, A.J. - Walker, A.R. (2008) *Sustainable Energy Options for the Future Airport Metropolis. In Panagopoulos, Thomas and Vaz, Teresa N. and Antunes, Maria D. C. and Burley, Jon B., Eds. Proceedings 4th IASME/WSEAS International Conference (EEESD'08),* pages pp. 21-26, Algarve Portugal. [Online]. [cit. 2022-11-11]. Available at: http://eprints.qut.edu.au/13940/1/13940.pdf.

[5]. Peluffo, M. (2017) *Defining Today's Intelligent Building* [Online]. [cit. 2018-01-11]. Available at:: http://www.commscope.com/Blog/Defining-Todays-Intelligent-Building/.

[6]. Števo, S. (2013) *Inteligentná budova – čo to v skutočnosti znamená?* [Online]. [cit. 2022-10-12]. Available at: http://www.asb.sk/architektura/stavby/inteligentny-dom/inteligentna-budova-co-to-v-skutocnosti-znamena.

[7]. Ferreira, A. - Pinheiro, M.D. - de Brito, J. - Mateus, R. (2023) *A critical analysis of LEED, BREEAM and DGNB as sustainability assessment methods for retail buildings, Journal of Building Engineering*, Volume 66, 2023, 105825, ISSN 2352-7102, https://doi.org/10.1016/j.jobe.2023.105825.

[8]. Tang, H. & et al. (2023) *Unlocking ventilation flexibility of large airport terminals through an optimal CO2-based demand-controlled ventilation strategy, Building and Environment,* Volume 244, 2023, 110808, ISSN 0360-1323, https://doi.org/10.1016/j.buildenv.2023.110808.

[9]. The Queensland Cabinet and Ministerial Directory - Media Statements. *Brisbane Airport soars on Stanwell's first green energy contract.* [Online]. [cit. 2023-12-12]. Available at: https://statements.qld.gov.au/statements/96558.

[10]. Trend. *Takto vyzerá najekologickejšie letisko sveta.* [Online]. [cit. 2024-02-12]. Available at: https://www.trend.sk/spravy/takto-vyzera-najekologickejsie-letisko-sveta.

[11]. Routes. *How is the World's first airport fully powered by Solar Energy faring over time.* [Online] [cit. 2024-02-18]. Available at: https://www.routesonline.com/airports/5427/cochin-

international-airport/news/298663/how-is-the-worlds-first-airport-fully-powered-by-solar-energy-faring-over-time/.
[12]. Johnston, I. *India cancels plans for huge coal power stations as solar energy prices hit record low.* [Online]. [cit. 2024-01-13]. Available at: https://www.independent.co.uk/climate-change/news/india-solar-power-electricity-cancels-coal-fired-power-stations-record-low-a7751916.html.
[13]. internal documets of Airport Kosice

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