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ENERGY EFFICIENCY WORKS AT THE AIRPORTS

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Abstract- Nowadays, new projects are taken into consideration to use energy sources efficiently. Design of Buildings, appliances and etc. are mainly give priority to energy efficiency. In order to obtain efficiency, first energy consumption should be measured for devices and equipment. In terms of automatic meter reading system, it becomes possible to follow energy instantly so then any control need becomes available for the user. Within this concept, in order to observe the contribution, an automatic meter reading system has been installed within the terminal building of Esenboga Airport, Ankara, Turkey.

Keywords: Energy Efficiency, Esenboga Airport, Automatic Meter Reading System.

I. INTRODUCTION

Nowadays, due to increase of energy demand in all over the world, it becomes mandatory in Turkey as well to give more importance and start relevant studies to be able to get more energy efficiency routes. Energy needs increase in result of developing technology. Therewithal, technology provides more energy efficiency. In order to get full control over the energy expenses, primarily the usage of energy have to be analyzed, measured and monitored. It is not possible to control anything which cannot be measured, so all data should be measured and compared with previous ones.

Before starting energy efficiency studies at Esenboga Airport, the energy had to be followed in a certain order. For this reason, ISO 50001 Energy Management System was established primarily.

The ISO 50001 Energy Management System is being set up to ensure that the work on energy efficiency is followed and controlled in a specific order. The ISO 50001 Energy Management System has been developed taking into account the recommendations of staff from more than 60 countries. This standard primarily requires that energy be followed up, followed by the setting of energy targets, the creation of action plans to reach these targets, the determination of energy indicators, the continuous monitoring of legal responsibilities and legislation, the inclusion of all personnel at work and awareness-raising activities. In the light of the results, the scope of the work to be done within the scope of a specific program and keeping records for improvement is covered. The ISO 50001 Energy Management System standard was published on 9 June 2011. The standard is designed to integrate with management systems such as ISO 9001 – Quality Management and ISO 14001 – Environmental Management.

If we look at in terms of monitoring the energy 4.6.1 Monitoring, Measurement and Analysis under the heading, "The organization should identify measurement needs and should review it periodically. The equipment used in monitoring and monitoring the key specifications should provide real and repeated data. Records of calibration records and other verifiable and reproducibility detection tools should be kept."[1].

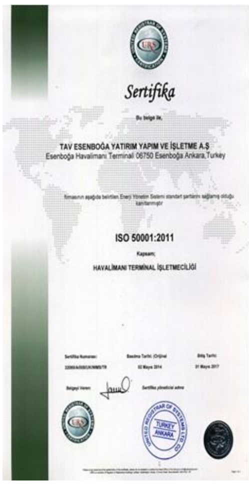

Figure 1. Esenboga Airport ISO 50001 Certificate [2]

As it can be understood from the standard; it must be able to be measured and monitored so that energy can be managed. The necessity of installing an automatic meter reading system in the framework of this system has arisen and these properties become fully possible by installing and using automatic meter reading systems.

The advantages of automatic meter reading systems are counted as following up instantaneous power usage, recording all historical data, reaching to as many as possible points within as short time as possible, monitoring easily any leakage losses and any other advantages etc.

As a conclusion of the above mentioned advantages and reaching to maximum energy efficiency, it is decided to buy and install an automatic meter reading system in Esenboga Airport Terminal Building. Also, it is observed how much it contributes and adds value to the energy efficiency program.

Following, the detection of high consumption points, an energy management program is composed by considering the consumption analyses and projects as replacing existing lightings with the LED lightings, windbreak design, using time relays at the electrical panels, awareness training for the personnel, using energy efficiency posters, etc. are designed in terms of energy efficiency. By means of investments implemented in line with the projects, remarkable reduction of green-house gas emissions is obtained.

II. ESENBOGA AIRPORT

Esenboga Airport is composed of administrative, financial, operational and technical departments. Technical department involves mechanical systems, constructional maintenance & repair, mechanical installation, electronics & electrical works, logistics and contracts department, H&S and architectural departments. Operational departments especially deal with services for planes and passengers. Technical specifications for Ankara Esenboga Airport can be listed as below;

Capacity	:	10.000.000 passenger per year
Terminal Area	:	182.000 m²
Car park Area	:	108.000 m²
Duty Free Area	:	2.390 m²
Food Court	:	5.200 m²
Car park Capacity	:	4.069 vehicles
Passenger Boarding Bridges	:	23 units (18 units gate, 4 units bus gate, 1 unit CIP)
Check-in Desks	:	138 units (26 units self-check-in)
Passport Desks	:	36 units (18 departure + 18 arrival)
Baggage *Handling System*	:	8.000 baggage per hour
Carousels	:	9 units
Elevators	:	33 units
Escalators	:	38 units
Travellators	:	210 mt

Figure 2. Esenboga Airport, Ankara, Turkey [2]

According to the implementation contract signed between the company and DHMI until the end of the operational period, no changes are considered for organizational and operational boundaries (Built-Operate-Transfer Contract).

VIP services performed by DHMI and CIP services are held by different companies under the commercial contracts. Furthermore, cleaning and medical services are subcontracted as well. Due to contracts of all these services, electricity consumptions of these areas are under terminal company inventory.

The systems under mechanical responsibility of the airport are elevators, escalators, travellators, passenger boarding bridges and baggage handling system. In the terminal, thirty three elevators, thirty eight escalators, 210 meters of travellators, 4500 m handling system, 232 sorter tilt, 1 sorter and 64 shut are available. Six numbers of panoramic elevators provide the movement of disabled people, all passengers, and employees in the terminal comfortable and safe. There are eight service lifts used to move materials to duty free, restaurants, cafes and commercial areas. Intercom devices in the lifts are connected to the central intercom system. In case of emergency, the people in the lift can contact to the terminal operating center for 24 hours. Elevators, escalators, travellators are connected to the building automation system to monitor continuous failures and emergencies.

Totally 138 check-in desks are available. Total luggage capacity is eight thousand trunks per hour. By the automatic sorting system, baggage are sorted to the related pools. Pools are available and each used to collect baggage related to same flight. A high technology automatic scanning system is available for baggage security check before the aircraft. The automatic scanning system consists of seven X-ray devices and two DTM.

Eighteen passenger boarding bridges are available to transfer passengers between the terminal and aircrafts. The passenger boarding bridges are monitored for auto-level, failure and supply voltage conditions for twenty four hours. For monitoring system, the technical team immediately detects and corrects failures. So it withdraws the time of the failure to minimum. The auto-level information can be used to record time of usage and for automated billing.

Heating, cooling, HVAC, water installation system and fire system are under the responsibility of mechanical installations department. For heating; four boilers with total capacity of 18.000 kW and for burners with 84 kW are available. Circulation pumps to assist system have capacity as; 681 air m^3/h permanent + 425 air m^3/h reserve. Cooling tower total capacity is 17.000 kW and cooling groups are available with capacity of 15.000 kW.

III. ENERGY EFFICIENCY

Energy efficiency is a focus on providing energy security, decreasing the risks because of the import confidence, accomplishment the energy costs sustainable, increasing impact of changing the climate combat and environment protection. Recently, due to the importance of sustainable development is progressively understood, energy efficiency increases at the same rate besides the rate of the efforts guided.

Improving energy efficiency, avoiding senseless usage and dissipation, decreasing energy density and important elements of Turkish national energy policy in all stages coming from energy production and transmission to the final consumption are given in this framework [1].

As the Turkish economy grew at a rapid pace in the last decade, the energy demand of the country also increased rapidly to accommodate the growing economy. The total electricity demand of Turkey between the years 2001 and 2014 almost doubled from 122 to 251 TWh [3].

Accounting for this demand was no easy task especially when it is considered that Turkey doesn't have substantial reserves of conventional fuels. Most of the oil and natural gas demand and a share of the coal demand in the country have to be met by imported sources. The rapid increase in energy demand over the years only exacerbates the problem of import dependence. For the year 2013, around 56% of the electricity generation in the country was fueled by imported sources [4].

Energy efficiency is important not only because of the environmental concerns surrounding energy use, but also one of the important goals of sustainable architecture and Zero Energy Emission as an outcome [5].

IV. AUTOMATIC METER READING SYSTEM

The Meter Reading System, which has been in use for years, was carried out at the end of every month by calculating the consumption information by calculating the consumption information according to the first and last index information of a tasker by visiting individual counters and then multiplying by the tariff coefficient. This application has a single point reading system is inadequate considering the requirement for today's conditions.

The design of the Automatic Meter Reading System has been taken into assessment at Esenboga Airport within the principle of being able to measure at as many points as possible by the installed system coverage. Separate modules of system components are located into electrical rooms. Communication is done via network line laid in the electrical rooms by using TCP/IP. All client users are able to access to the system via username and password through integrated computers.

Within coverage of infrastructure, Cat-6 cable is used between cabinet and modules for communication and 2×1.5 inch cabling is laid between modules and electricity meters. Distance between modules and electricity meters are designed by not exceeding 800 m. While the design studies, optimization is taken into consideration by trying to spend minimum budget with a maximum energy efficiency gain beside.

A package of 31 units in total of module is used within the terminal area. 32 units of electricity meter connection are applicable to one module. In order to have vacancy in case of any additional meter needs in the future, enough free connection is spared at the modules. In total, system comprises 506 electricity meters.

Since the system is flexible and appropriate to add extra electricity meters, it can be adjusted and upgraded in accordance with future needs.

Consumption data can be collected respectively as indicated below from the automatic meter reading system;

0.9.2 Date
0.9.1 Time
T 1.8.0: Total Active Energy Consumption Taken From the Grid
T1 1.8.1: Active Energy Consumption Taken From the Grid Tariff 1
T2 1.8.2: Active Energy Consumption Taken From the Grid Tariff 2
T3 1.8.3: Active Energy Consumption Taken From the Grid Tariff 3
T4 1.8.4: Active Energy Consumption Taken From the Grid Tariff 4
T 2.8.0: Total Active Energy Quantity Injected to the Grid (Only 2-way electricity meters)
T1 2.8.1: Active Energy Quantity Injected to the Grid Tariff 1 (Only 2-way electricity meters)
T2 2.8.2: Active Energy Quantity Injected to the Grid Tariff 2 (Only 2-way electricity meters)
T3 2.8.3: Active Energy Quantity Injected to the Grid Tariff 3 (Only 2-way electricity meters)
T4 2.8.4: Active Energy Quantity Injected to the Grid Tariff 4 (Only 2-way electricity meters)
Ri 5.8.0: Inductive Reactive Consumption
Rc 8.8.0: Capacitive Reactive Consumption
P 1.6.0: Maximum Demand Taken From Grid
P 2.6.0: Maximum Demand Injected to Grid (Only 2-way electricity meters)
31.7.0: R Phase Current Value*
51.7.0: S Phase Current Value *
71.7.0: T Phase Current Value *
32.7.0: R Phase Voltage Value *
52.7.0: S Phase Voltage Value *
72.7.0: T Phase Voltage Value *
9.7.0: Total Active Power *
29.7.0: R Phase Active Power *
49.7.0: S Phase Active Power *
69.7.0: T Phase Active Power *
33.7.0: R Phase $\cos\varphi$ Value*
53.7.0: S Phase $\cos\varphi$ Value *
73.7.0: T Phase $\cos\varphi$ Value *

In addition, any failure or other data regarding the electricity meters can be monitored via system as below.

0.0.0: Meter Serial Number
1.6.0: Max. Demand Taken From the Grid
1.6.0: Date of Max. Demand Taken From the Grid
1.6.0: Time of Max. Demand Taken From the Grid
0.8.0: Measurement Duration Max. Demand Taken From the Grid
0.1.2: Demand Reset Date
0.1.2: Demand Reset Time
0.1.0: Demand Reset Quantity
h01: Max. Demand Taken From the Grid (Last Month)
h01: Date Of Max. Demand Taken From the Grid (Last Month)
h01: Time of Max. Demand Taken From the Grid (Last Month)
h01: Total Energy Demand History Taken from the Grid
h01: Energy Demand History Taken from Grid Tariff-1

h01: Energy Demand History Taken from Grid Tariff-2
h01: Energy Demand History Taken from Grid Tariff-3
h01: Energy Demand History Taken from Grid Tariff-4
h01: History of Inductive Energy Taken from the Grid
h01: History of Capacitive Energy Taken from the Grid
34.7.0: R Phase Frequency
54.7.0: S Phase Frequency
74.7.0: T Phase Frequency
96.2.5: Calibration Date
96.70: Meter Open Date
96.70: Counter Open Time
96.71: Clamp Cover Open Date
96.71: Clamp Cover Open Time
96.71: Clamp Cover Opening Quantity

By means of using electricity meter, human resources could be minimized while work efficiency could be conveyed to other work points. For the easy control upon electricity meter, communication infrastructure is supposed to be composed at the beginning.

The biggest factor of maximizing the efficiency is the communication. To read the data coming from different points and collect them in one common center, the most effective method is to establish an IT infrastructure together with virtual server.

Within this coverage, a virtual server is supposed to be set. Virtual server is designed for the purpose of minimizing the investment costs and energy consumption quantities, saving time and avoiding data loss in case of any disaster.

Operating cost is getting increased if the set communication connection has a different type of license. Here at this point the most common technology is TCP/IP basis IP connection type.

For the purpose of minimizing the communication costs and strengthening TCP/IP infrastructure, the most efficient operating systems are being used. IP technology is proper here and keeps the operational costs at minimum level. Because of this, TCP/IP is preferred in order to obtain a communication via RS-485 port. The electricity meter used in this project converts the data at the RS-485 to TCP/IP. As per the ISO standards, TCP/IP communication protocol is selected as an IT infrastructure. Within IT protocol, the main point is to be under the terms of international standards. The base of this model is called OSI.

OSI is the first term of interface connection model of open systems. Its ISO standard depends on ISO 7498. OSI terms are being revised and upgraded from time to time. There are seven layers in use at defining this communication as per the recent parameters.

V. THE EFFECT OF ENERGY EFFICIENCY WORKS

Energy consumption becomes controllable following the installation of automatic meter reading system at Esenboga Airport.

The consumption quantity could be monitored and controlled via SCADA system. By installing the automatic meter reading system, the following goals are achieved;

- To monitor regularly the energy consumption and to analyze it according to energy reference point,
- To improve energy performance continuously,
- To obtain required data, technology, human resources in order to achieve the goals,
- To meet with the legal requirements in line with the energy efficiency program,
- To monitor the energy goals and review the program periodically and apply updates in accordance with needs,
- To consider energy efficiency while updating the systems, new making investments and new designs, purchasing materials & services during the operation of the airport terminal,
- To share energy policy of company with all personnel.

When Esenboga Airport is designed, it is designed to be able to take advantage of daylight and the lighting is homogenously placed.

Although overall illuminance in a space is important, it is the distribution of light in the field of vision that determines the quality of the lighting environment. Shading devices that are able to redirect and redistribute light throughout a space are thus especially useful. Such devices range from the light shelf to advanced glazing systems, and include blinds, reflective louvres, external fins and glass coatings. Their main function is to improve the uniformity of lighting levels. This may involve reducing excessive levels near the window, redistributing light to the rear of the space, or both [7].

Existing lighting has been replaced with state of the art LED lighting, resulting in significant energy efficiency.

Figure 3. Esenboga Airport Meeting Point [2]

Terminal interior lighting is controlled by BMS. In this way, contribute to energy efficiency by preventing unnecessary use of lighting is provided in vain. The terminal outside lights are controlled by the daylight sensor and the sonar system automatically switches on when the lighting falls below a certain level.

The doors used by the vehicles carrying luggage in the BHS area at the apron inlet and outlet are automatic spiral doors and the heating-cooling out of the interior is minimized. Terminal heating and cooling systems are controlled by BMS. A windbreak system is installed on the inlet and outlet doors to prevent the hot and cold air inside the terminal from escaping.

There is a tri-generation system to meet terminal electricity, heating and cooling needs. Electricity is obtained from natural gas with the generators in the tri-generation power plant. In addition, the waste gas in the high temperature is passed through a winner and the hot water requirement of the summer terminal is met. In winter, it absorbs the absorbed chiller and contributes to the cooling of the terminal.

Provide trainings, conferences and seminars throughout the terminal to raise awareness of energy efficiency and to reduce energy efficiency and greenhouse gas emissions for all personnel. In addition, posters related to what to do before leaving the office are hanged at certain locations throughout the terminal.

Near the end of the day, the text automatically appears on the computer screen to remind you of energy efficiency.

Figure 4. Esenboga Airport Meeting Point [2]

Figure 5. Esenboga Airport Tri-Generation Plant [2]

A. Reference Point

A reference path is created by the time the Energy Management System is established. It is obvious that current status has to be determined in order to be able to set a proper energy management program. Accordingly, the energy (electricity and natural gas) consumption data of the year 2013 is deemed to be a reference path. Therefore, a proper monitoring could be established and any variance could be detected as well, then this makes fully possible to implement continuous improvement schedule as per the status.

Esenboga Airport achieves remarkable carbon emission reduction since 2008 by making detailed studies during this period. It has been receiving certification since 2008 from ACA department who is established under ACI organization. The certification levels of ACA briefly as follows;

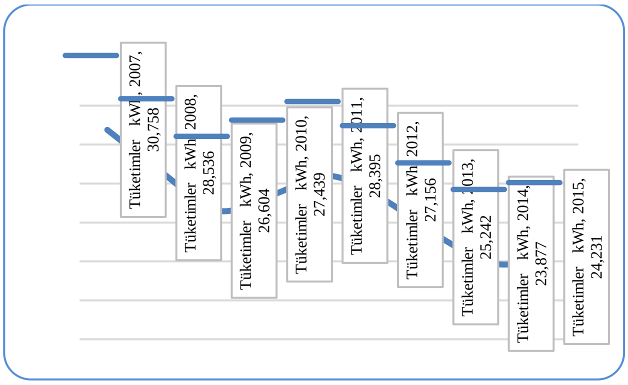

Figure 6. 2007-2015 electricity consumption (MWh) [6]

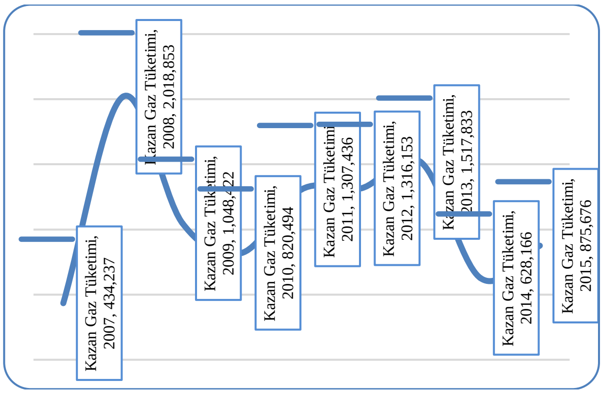

Figure 7. 2007-2015 boiler natural gas consumption (m³) [6]

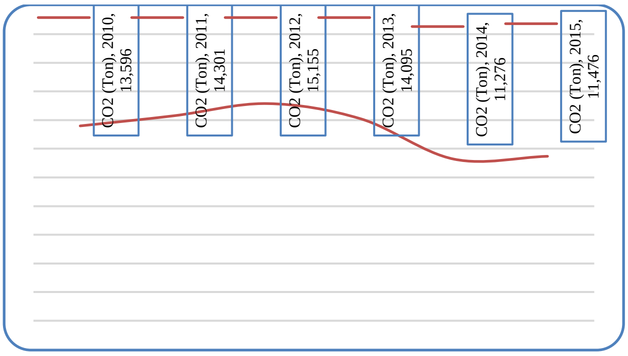

Figure 8. 2010-2015 GHG emissions (metric tones CO_2) [6]

Level 1: Mapping: This level comprises the calculation of the Carbon emissions.

Level 2: Reduction: This level comprises calculating the emissions as well as with targeting and reducing emissions.

Level 3: Optimization: This level comprises calculating the emissions plus targeting/reducing emissions plus carbon management plan together with stakeholders.

Level 3+: Neutralization: This level comprises level 1+2+3 and neutralization of all emission quantity.

In 2015, Esenboga Airport has been granted with level 3+ certification following the intensive studies on this field, as being the 1st airport at this level in Turkey. Besides reducing continuously the total energy consumption, Esenboga Airport has neutralized the rest emission quantity by supporting a Hydro-electric generation plant.

If the present condition is observed in international area; Esenboga Airport has placed at the top ranking list, as being the 17th airport in all over the world, coming after some airports of the European countries Sweden, Norway, Italy and Holland.

VI. CONCLUSIONS

The effect of automatic meter reading system upon the energy efficiency is investigated in this paper. As an example of implementation; Automatic Meter Reading system installed at Esenboga Airport is analyzed in details herein. Following those analyzes, a remarkable positive impact is observed in case of an automatic meter reading system exists. At full reconstruction existing or at building of electricity transmissions 0.4 kV in rural electric networks it is necessary to pass to other systems of an electrical supply reducing influence of asymmetry, improving quality of electric energy and reducing power losses. Automatic Meter Reading system is also preventing power losses for the system [8].

System is working and communicating through TCP/IP internet protocol via Ethernet. The reason of the selection of this communication protocol is to protect the system from other external harmful sources.

In the future studies, by inserting GPRS module, an external instantaneous monitoring via internet may also be possible. By means of this facility, all energy consumptions could be monitored and be controlled at any time. In case of an increase detected at any energy consumption point, it can be controlled and resolved/corrected/fixed by being informed via this beneficial system.

In addition; by the evaluation of the data collected by Automatic Meter Reading System, the future plan could be assessed and composed accordingly. An "artificial intelligence" module could be integrated into automatic meter reading system which enables the user to realize any variation beyond the tolerance between any two compared figures. This would make the system much more efficient as well.

The installed automatic meter reading system is supposed to be easy and understandable for the client users. Otherwise, analyzes could not be done properly.

The importance of the energy efficiency in Turkey is getting increased day by day. The first step of energy efficiency program is, for sure, to measure the energy consumption and to take it under the full control. Once something is measured, then it will become automatically controllable.

With the developing economy of Turkey, energy need is increasing from time to time rapidly. In case of a huge demand amount, sometimes, established generation power capacity becomes insufficient to meet with the total demand when also leakage losses become an additional load beside. Because of this as well, such automatic mechanisms should be on board in order to be able to overcome this problems.

NOMENCLATURES

H&S: The number of water units
DHMI: General Directorate of State Airports Authority
VIP: Very Important Person
CIP: Commercially Important Person
DTM: Detection Tomography Machine
HVAC: Heating, Ventilating and Air Conditioning
TWh: Terra Watt Hour
CO_2: Carbon dioxide
TCP: Transmission Control Protocol
IT: Information Technologies
IP: Internet Protocol
OSI: Open Systems Interconnection
ISO: International Organization for Standardization
SCADA: Supervisory Control and Data Acquisition
MWh: Mega Watt Hour
ACA: Airport Carbon Accreditation
ACI: Airports Council International
GPRS: General Packet Radio Service
CCTV: Close Circuit TeleVision
UPS: Uninterruptable Power Supply
GHG: Green House Gases
LED: Light Emitting Diode
BMS: Building Management System

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BIOGRAPHIES

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