Benefits of Integrating Green Buildings Smart Systems for Energy Saving to Satisfy Successful Investment

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Abstract: One of the most important challenges facing the scientists today is to design and create a green building design that can not only minimize the impact on the environment, but also remain practical, economical and comfortable for use. This paper introduces the results of the Albogary Plaza Mall project for saving energy by applying smart systems to access energy saving with economical benefits through investment period. The main object of the project is to achieve the most economic way for energy saving while satisfying all the mall requirements. Different techniques are used to fulfill that object. These techniques include applying smart systems, and solar energy, and saving in water resources. The project applies a good combination and harmony between different solutions to satisfy the highest rate of energy saving in a most economic way. The project results in saving 17.4% of energy with minimum additional cost. The mall can payback this cost in approximately 5 years through saving in energy and water consumptions.

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1. Introduction

Energy efficiency offers a powerful and cost-effective tool for achieving a sustainable energy future. Improvements in energy efficiency can reduce the need for investment in energy infrastructure, cut energy bills, improve health, increase competitiveness and improve consumer welfare. Environmental benefits can also be achieved by the reduction of greenhouse gases emissions and local air pollution. Energy security – the uninterrupted availability of energy sources at an affordable price – can also profit from improved energy efficiency by decreasing the reliance on imported fossil fuels [1].

Energy saving is a way of managing and restraining the growth in energy consumption. Something is more energy efficient if it delivers more services for the same energy input, or the same services for less energy input. For example, when a compact florescent light (CFL) bulb uses less energy than an incandescent bulb to produce the same amount of light, the CFL is considered to be more energy efficient. The growth and development of world's communities has a large negative impact on our natural environment. Green building, or sustainable design, is the practice of increasing the efficiency with which buildings and their sites use energy, water, and materials, and reducing building impacts on human health and the environment over the entire life cycle of the building.

Office buildings are considered as one of the most important sources of carbon emission as indicated by Figure 1. On the other hand these buildings consume a large amount of conventional energy. Many countries have developed future planes to reduce carbon emission and increase renewable energy consumption of these building.

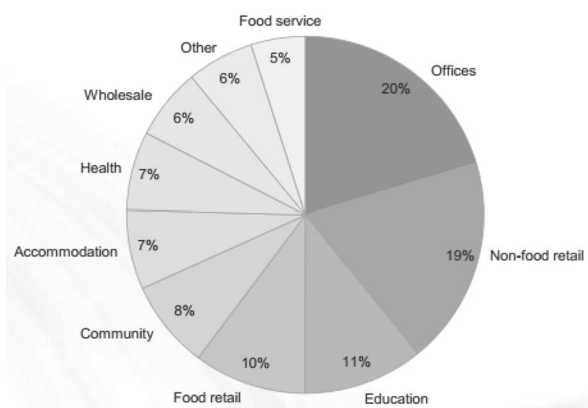

Figure 1: Emissions of existing commercial buildings [3]

UK plans to increase the renewable energy consumption of office building to about one-fifth of the non-renewable energy of present day designs by 2050 [2]. This can only be realistically achieved by the increasing use of renewable energy and a move towards more widespread use of natural ventilation and daylight.

Al Bogary Plaza Mall in Mecca (Fig. 2) was constructed as a Green building. It serves as shop and office building. The reduction of the building emissions has placed at the top of its priority list to keep the around area clean, healthy, and livable for posterity. Regarding Green building specification, the building plans to be one of the future green buildings. To achieve these goals, the building has to better meeting the challenges of building environments: energy and CO2 emissions; integration and smart comfort. In short, the building must achieve three critical traits: become more efficient, more livable, and more sustainable.

Many technologies are required to reach a perfect Green building. These technologies include: monitoring and sensor technologies, renewable energy and intelligent systems. Nodaway many large companies introduce integrated solutions to improve energy efficiency, financial performance and sustainability. Such solutions are exclusive to modern and wealthy company like Schneider-Electric [4]. Via realistic, measurable timetables and financial, almost any building can achieve a more intelligent scenarios. By honing on solutions that focus on their most acute pain points and taking a step-by step, system-based approach, Al Bogary Plaza Green building can implement strategies that deliver the immediate, visible, and measurable results they need. This paper introduces the results of the Albogary Plaza Mall project for saving energy by applying smart systems to access energy saving with economical benefits through investment period.

2. Energy Balance Calculations

The principle of the energy balance is described in terms of the energy needs, delivered energy and primary energy for all types of conditioning or all types of building service (Figure 3) (heating, cooling, ventilation humidification, lighting and domestic hot water supply). Each balance of energy flow follows the same procedure. The delivered energy is calculated from the energy needs of the building and the system losses due to control and emission, distribution and storage in addition to the losses due to energy generation for the individual conditioning modes. The primary energy is calculated from the delivered energy evaluated per energy carrier using factors relating to its environmental performance. In the following model, each step of the calculation is described only once. When using calculations in actual conditions, however, individual steps may need to be used several times.

Figure 2. Architectural design of Al bogary Plaza

A typical example is the case of assessing different areas of the building (e.g. personal offices and ancillary rooms in an administrative building). Other calculation steps need not be carried out if the building does not contain a specific building service (e.g. cooling in a school, domestic hot water supply in industrial plant, etc.). Delivered energy or primary energy balances are calculated for shorter periods, e.g. by day or by month.

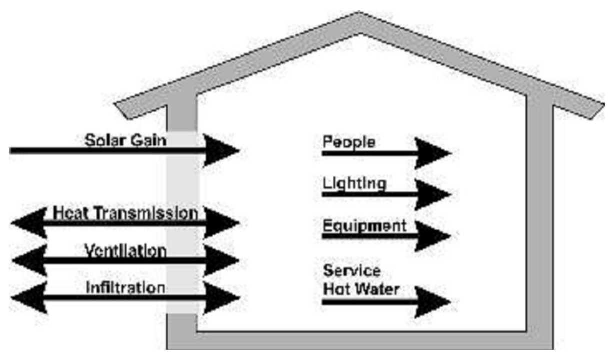

Figure 3. Typical Energy Loads

3. Design Procedure

Following are the main steps to design the proposed system applied to the Albogary Plaza Mall. The design is done according to DIN V 18599 series of pre-standards energy efficiency of buildings [5-13]

3.1. Setting the vision and roadmap

This vision should highlight the goals of the building for the long-term: where the building wants to be in 5–10 years in terms of efficiency, sustainability, and competitiveness. Create a pragmatic, step-by-step plan to create value over the long-term. The plan should address the most immediate pain points, building momentum and civic confidence in the overall vision. The plan should implement a series of initiatives over several years, with each initiative building on the others. One of the most important elements of setting an effective, achievable plan for a Green building is to make that an inclusive, collaborative process. It requires participation. Incorporating the ideas and thinking of suppliers helps to identify potential problems while also helping to ensure support and participation in the efficiency initiatives. Also to help set the vision and ensure that it meets the objectives of efficiency, livability, and sustainability. The Al Bogari Plaza Green building's goal is to create a comfortable and greener viable, sustainable community providing the highest quality of life, ultimately aiming to rely entirely on solar and renewable energy, with a zero-carbon. The main successful of the systems led to the expanded role of Green building vision and do details in to long-term goals by improving residential quality of life, driving behavioral change to promote, take advantage of, and appreciate a more intelligent solution in the long term.

3.2. Bringing in the right technology

When developing a Green building roadmap, the suitable technologies and solutions available today can be overwhelming. This makes honing in on the most acute pain points vital, and building will often find that solving one pain point opens up opportunities for improvements. Also the ability to identify pain points within buildings deploys integrated and scalable solutions with immediate results. This is necessary to design solutions effective in both short-term goals and in long term vision.

3.3. Integration

The use of information integration to create a Green building follows an evolutionary process as the building becomes more advanced in using technology to manage systems. The key first step in the process is deployment of sensors throughout building systems to collect raw data, which is then transmitted through communications networks, either wire line or wireless. Once the data is collected and available, real-time systems can use the data to automate management of building system, resulting in significant performance and cost advantages. Integration of isolated systems and sharing of data yields further performance benefits through coordinated actions and holistic management of the building as a system-of systems. Once all of these factors are in place, Al Bogary Plaza Green building can further leverage them to create value by applying advanced analytics tools to support optimization, as well as provide data back to building occupants through public services which improve their daily lives in the building. By measuring performance of building systems, the operators can identify problem areas and track the effectiveness of solutions in achieving the building's long-term goals. Recent advances in technology have greatly improved the ability to gather tremendous amounts of data about the building system.

The following equation is applied to calculate annual energy characteristic values:

$$Q_a = \sum_{j=1}^{12} Q_{mth,j} \quad (1)$$

where

Q_a is the respective annual energy characteristic value;

Q_{mth} is the respective monthly energy characteristic value.

Pervasive sensors enable building to collect measurement data about energy, water, and ventilation in real-time· Low-cost communications and new communications protocols greatly simplify and reduce the cost of gathering data collected by sensors. Protocols such as BACnet, also continued improvement in wireless and wire line communications technologies, enable building to affordably collect data from widely distributed networks of sensors· Real-time management systems automate the control of systems, improving the efficiency of system by optimizing performance.

Advanced analytics make use of the large amount of raw data collected in data center and translate it into actionable intelligence, which a building can use to improve the performance of the building. Focusing on pain points within these functions, the building implemented a SCADA system to improve and optimize its electric system; a CCTV surveillance system to improve community safety; and lighting solutions for comfortable. The building's intelligent management system forms an advanced level of intelligence, allowing a holistic view of all the building systems and the opportunity for continuous improvement based on data analysis.

3.4. Tapping Innovation

The revenue must first be allocated to essential operations and staff, and there is often little left over for upgrades, retrofits, and other improvement measures. But a large up-front investment is not a requisite for greener buildings. The most progressive Green building players are tapping innovative financial and business models to make efficient system a reality despite limited capital Advances in data analysis have enabled the mountains of data emerging from connecting building systems to be turned into actionable information.

3.5. Driving collaboration

Just as a building is the sum of its systems parts, the effective development and execution of a Green building roadmap requires collaboration from all occupants. Each unique Green building plan and roadmap requires collaboration with companies' global technology providers as Schneider electric, and local organizations best suited for the specific system improvements needed. This means sharing information across building departments as well as local providers and occupants, who know their buildings the best.

4. Structure of the Applied System

In the applied system we use a new technique to satisfy the main goal with energy saving and green building satisfaction [14]-[19]. We are focusing on integration of all systems used through studying the nature of building and all working hours through one year. Existing solutions are used and merged with the techniques of value engineering and cost reduction [20]-[22].

4.1. Building Management System

Building management system describes the advanced functionality provided by Schneider-Electric. A building automation system (BAS) is an example of a distributed control system. The control system is a computerized, intelligent network of electronic devices designed to monitor and control the mechanical, electronics, and lighting systems in a building.

4.2. Video Surveillance

Video Surveillance system use of video Pleco cameras to transmit a signal to a specific place, on a limited set of monitors which have special specifications and types in outdoor and indoor of the buildings, the system includes digital video camera commonly employed for surveillance network and accompanying Video Management Software.

4.3. Access Control System

Access control system is the selective restriction of access to buildings. The act of accessing may mean consuming, entering, or using. Permission to door access a resource is called authorization, locks and login credentials are two analogous mechanisms of access control.

4.4. Lighting Control System

EIB Lighting control system is a raised source of light on the buildings, which is turned on or lit at a certain time every night. The system can also dim the light related to flux density measured by sensors. The system can reduce energy consumption by controlling a circuit of lights or even individual lights with specific ballasts and network operating protocols. These may include sending and receiving instructions via separate data networks at high frequency over the top of the low voltage supply or wireless.

4.5. Energy Monitoring System

Energy monitoring system is a system of computer tools used by operators to monitor, control, and optimize the performance of the energy consumptions also to provide real-time feedback to homeowners so they can change their energy using behavior.

4.6. IP Television

IPTV is defined as multimedia services such as television/video/audio/text/graphics/data delivered over IP based networks managed to provide the required level of quality of service and experience, security, interactivity and reliability. IPTV is distinguished from Internet television by its on-going standardization process, also to deployment in subscriber-based telecommunications networks with high-speed access channels into end-user premises via packets of data.

4.7. IP Telephony

IP telephony system encompasses the general use of equipment to provide communication over distances, specifically by connecting telephones to each other. The technology is associated with the electronic transmission of voice, fax, or other information between distant parties using systems historically associated with the telephone, a hand-held device containing both a speaker or transmitter and a receiver.

4.8. Fire Alarm System

Fire alarm system is designed to detect the unwanted presence of fire by monitoring environmental changes associated with combustion, Automatic fire alarm systems are intended to notify the building occupants to evacuate in the event of a fire or other emergency, report the event to an off-premises location in order to summon emergency services, and to prepare the structure and associated systems to control the spread of fire and smoke.

4.9. Public Address System

Public address system is announcement speakers with widely used to make announcements in public, buildings and locations, have microphones in many rooms allowing the occupants to respond to announcements.

5. Results and Discussion

By Integrating and analyzing all possible resources we can beat the problem of high cost in case of energy savings technologies and encourage a general direction to apply it in every activity. By studying the nature of building and all working hours through full one year and analyze the high loads which consume higher energy with maintain all additional cost can payback through 10 years investment period. Many solutions are available and by applying the proposed system the total annual power consumption are reduced from 10,539,179 kWh to 8,709,784 kWh, which means 17.4% saving in cost as explained by Table 1. The total cost of installing smart systems and solar energy system is about 2500000 SR. Concerning only the energy savings, the installation cost can pay back in about 4.8 year as shown in Table 2. For the traditional system; the costs of harming environment are not included.

Table 1 Results for amount of energy saving

	Traditional Solution		Solution by the applied system
Total Annual Power Consumption, kWh	**10,539,179**		8,709,784
Total Annual Power Cost, SR*	**2,740,186**		2,264,544
% age Saving		**17.4%**	

* SR= Saudi Riyal ≈ 0.27 $

Table 2 Final economical results due the applied solutions for energy saving

Item	Best solutions used	Cost +	payback	Saving amount
Energy saving	Smart systems & Solar energy	**2500000** SR	4.8 years	513236 SR

6. Conclusions

This paper introduces the results of the Albogary Plaza Mall project for saving energy by applying smart systems to access energy saving with economical benefits through investment period. The project applies different solutions to satisfy the highest rate of energy saving in a most economic way. These techniques include applying smart systems, and solar energy, and saving in water resources. The project results in saving 17.4% of energy with minimum additional cost. The Mall can recover this cost in 4.8 years through energy savings only, without taking into account the environmental benefits resulting from the proposed system.

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