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A Review of Energy Management Applicationina Commercial Office Environment in the GCC

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Abstract: The commercial sector is responsible for a large proportion of the consumed energy in the built environment. Increasing levels of CO2 emissions is one of the main environmental concerns of governments across the world today leading to strict governance, regulation and guidance for the management of energy consumption and efficiency in commercial buildings. This paper provides an understanding of the application of energy management in commercial office buildings in the UAE. It identifies tools, techniques, challenges, benefits and barriers that organizations come across when applying energy management. Literature review, case studies, fieldwork studies were carried out with key stakeholders within an FM organization in the UAE to analyze the current application of an energy management system. A survey was conducted to investigate awareness level and motivation within the workplace environment with regard to energy savings. 79% of the 121 employees participated in the survey. Energy management is present in the facility management industry where costs are driven down and businesses priorities the delivery of their services, forcing gaps in their own organizations and reducing investment and time to manage important activities such as energy management. Low cost and no cost initiatives are success drivers to reduce energy consumption.
Keywords: Energy Management; CO2 Emissions; Commercial Office Buildings; Energy Consumption.

1 Introduction

The UAE has seen a substantial increase in commercial building growth over the past decade, increasing the demand for energy and increasing CO2 emissions. GCC cities such as Dubai have the highest carbon emissions per capita in the world, three times higher than the United States and China, prompting the government to introduce strategies and regulations to construct energy conscious buildings for the future. New construction only accounts for 2% of total building stock. Therefore the reality is that the majority of existing buildings in this region are not state of the art energy efficient establishments. The commercial sector however is responsible for 40 to 45 percent of total energy consumed in the built environment (Balaras et al, 2002, 2003; Markis and Paravantis, 2007; Fayaz and Kari, 2009). Energy is consumed inefficiently predominantly due to inefficient operation and control of technical services such as mechanical, electrical, HVAC and lighting systems. Today managing energy is not a trend anymore but a necessity to reduce emissions and drive efficiency through changing the attitudes and behavior of the owner/occupiers. (Hanafy2012, Myrsalieva, 2012). As the global cost of energy is soaring and the reserves of non-renewable sources Such as oil, gas and coal are depleting, managing energy consumption efficiently is at the forefront of global discussion, and therefore managing energy effectively will help reduce the consumption of energy producing cost savings and reduced emissions. Building owners/occupiers have an obligation to improve the performance of individual buildings, raise the competitive profile of the sector significantly in order to achieve the GCC energy and environmental sustainability. Many commercial building owners/occupiers have not taken advantage of becoming more energy-efficient. Energy Management and investment in new technologies are not being taken up in the sector at the same rate as energy use. Energy is considered an overhead cost; energy consumption should be an integral part of the management process. Energy Management, if practiced efficiently is a proven strategy that will lower carbon emissions, reduce energy and cost. Energy efficient technology, knowledge and processes that have been developed and are available today provide organizations with the ability to reduce cost, extend the life span of assets (Epstein MJ, 2008), improve the operating performance of

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equipment and increase the comfort levels for the occupant. Barriers to implementing an energy efficiency strategy include issues of risk management, information gaps, short-term vision, and financial costs related to the investment. Despite these barriers, commercial building owner/occupiers can undertake an energy efficiency initiative that will benefit the building, the business organization, the occupants and the environment.

Inefficient use of energy in buildings is expensive and not stainable and the reduction of energy consumption in existing buildings is as important as the design of new energy efficient buildings (Harris, 2012). Energy efficiency can help extend energy supplies, increase energy security, lower carbon emissions and support sustainable economic growth (IEA 2013). This paper provides a review to a practical understanding of the application of energy management in a commercial office environment and identifies an overarching insight into the current understanding of energy management, the barriers, drivers, core challenges and solutions for everyday issues.

1.1 The Energy Problem

The change in global warming and the climate is evident from weather patterns, flooding, and rising sea levels (Filippin, 2000). In the past century man's prolific use of fossil fuels has caused the damage to the environment to such an extent that commitment to the management and security of energy is required for now and the future generations, (Lewry, 2012). The cost and demand of fossil fuels have risen globally over the last decade (Elsadig, 2005). Organizations are being urged to manage energy more efficiently and governments are strategizing to seek alternative sources of energy to save cost and the environment for future generations. Fuel sources such as oil, gas and coal are rapidly diminishing and the prices have doubled in the last decade. The reality is that at the current rate of the world's oil consumption the remaining reserves will be completely diminished by 2040.

1.2 Energy Management

Energy Management is a procedure that contains and reduces the consumption of energy (Jayamaha, 2007, Oung, 2013). Humans have become dependent on the use of energy since the start of the industrial revolution in the 1760's. Energy was gained from wind, water, tide and muscle (both human and animal) (Elsadig AK, 2005). Since the discovery of non-renewable fuels the development of industry, commercial growth, and population increase has been substantial, leading to the increasing energy demands and consumption. Throughout the world the challenges and barriers differ but the end goal remains the same, to reduce energy consumption and carbon remittance.

1.2.1 Energy Use in Commercial Buildings

Technology in the workplace has helped improve the efficiency and productivity of organizations. Commercial buildings are amongst assets causing the highest impacts on carbon emissions in the built environment (Calcedo et al, 2012). This is owing to the fact that commercial buildings rely on systems with high energy consumption rates such as heating ventilation air-conditioning (HVAC), lighting, pumps, motors, electronic systems and others (Aste & Pero, 2013). Lombard et al. (2007) explained that growth in population has put more demand on building services and levels of comfort as people are spending more time inside buildings and therefore the upward trend for energy demand will continue in the future. Aste & Pero, (2013) points out that emphasis should be on existing buildings to find ways of enhancing energy usage in commercial stock by retrofitting these buildings.

1.2.2Energy Efficiency in Commercial Buildings

The focus on improving energy efficiency in buildings has predominantly been on new construction (Hicks & Thesis, 2013). New construction can have energy efficient systems and solutions integrated into the design (Lewry, 2012) and governed by building regulations and industry guidance (Hartungi & Jiang, 2011). Current energy efficiency technology can reduce carbon emissions by 60% which by today's standards equates to approximately a billion tons of carbon and the conservation of consumed energy (Fayaz and Kari, 2009). Energy efficiency technology comes with a degree of investment with a good rate of return compared to the cost of wasting energy (Corta, 2014). A case study by Aste & Pero (2012) detailed a retrofit of an existing commercial building where the existing equipment in the building was replaced by energy efficient technology and the building envelope was improved. Using energy simulation models an analysis of energy performance was taken before and after the intervention and savings of 40% was achieved. Artificial lighting is another source of energy consuming equipment in a commercial building (Caicedo et al, 2013). Daylight adaptive systems provide effective methods of energy saving while providing the required levels of illumination (Roisin et al, 2008). Energy efficiency in commercial buildings does not only rely on technology to produce good consumption savings, (Hanafy, 2012) concluded that energy efficiency also considers the human factor introducing awareness campaigns to limit the amount of energy waste. For existing building owners the drive is there; the Dubai Supreme Council of Energy points out the new regulations in the UAE are pushing building owners to become more responsible for the energy efficiency, driving reductions in energy consumption and making existing building stock more sustainable for the future (Dubai Supreme Council of Energy, 2013). Comparing the same approach of the UK the climate

change act 2008 which sets a target for the UK to reduce its carbon emissions to 80% below the 1990 levels by 2050 (CRC Efficiency scheme). To help the government reach these targets the carbon reduction scheme (CRC) was born in 2010 committing organisations that have used more than 6000 MWh of electricity, equating to 500K spend will have to purchase and surrender allowances each year to cover their CO2 emissions (CRC, 2010).

1.2.3 Energy Management Policy and Legislation

Energy policy provides a framework to support the decisions that will be made with the Energy Management process (IEA, 2004). Such policy will help create the vision and set the objectives of reducing energy consumption, reducing operation cost, utilising effective resources, limiting waste and introducing a culture of energy management and continuous improvement. Policy measures are necessary to enable a building manager to initiate energy management improvements (Myrsalieva, 2012) argues experience has demonstrated that proactive policy instruments are necessary to change consumer behavior and willingness to adopt energy efficiency and technologies. The policy will have commitment to the environment and the organisation with the intention of reducing energy consumption, set out clear directives on individual responsibilities, timelines, targets in Energy Management and the reduction of greenhouse emissions (CRC, 2011)

1.2.4 Energy Management Techniques and Practices

Effective energy management systems can lead to cost reductions, increased comfort levels, lower maintenance costs, increased asset life cycle and a good reputation (Chuang & Gellings, 2008). Energy management requires a systematic approach (Jayamaha, 2007), forming a suitable team to achieve and maintain the organizations objectives. A successful energy management plan will begin with conducting an energy audit (Oung, 2013)

Energy Audit: It is an important tool for energy management that allows the organization to identify areas of improvement in energy management and energy efficiency (Myrsalieva, 2012). It also pinpoints areas of improvement and actions that will create savings or reduce energy. It is a process that consists of verification, monitoring and analysis of energy consumption (Myrsalieva, 2012).

Energy Accounting: A system for recording, analyzing and reporting on energy consumption on a regular basis to improve energy efficiency. It can be effective when communicating information throughout the organization to control energy consumption (IEA, 2004). Energy accounting communicates valuable data to enable managers to improve energy management strategy (Oung, 2013).

Energy Balance: A technique that building owners/managers use to analyze utility bills. Mistakes do happen and often utility companies are not accurate when they read meters leading to organizations reclaiming excess payments. Energy balance can be used to quantify the flow of energy within the building; therefore the sum of all energy should equal the quantity of purchased energy (BSI, 2012). Initially the energy manager will require data from the building for the last 36 months to accurately estimate the energy balance based on an overview of the business function.

Energy Monitoring and Targeting: A systematic collection of operating data and energy consumption with a view to detecting or correcting anomalies in consumption or expenditure (Tully, 2011). Data collection is an essential element of monitoring and targeting (Harris, 2012). Analysis of the data will indicate and suggest areas of improvement and energy savings (Carbon trust, 2012). The information will be reported to produce continuous improvement in the process. In commercial buildings the factor that drives consumption is normally how hot or cold it is, this term is referred to as degree-days. Another tool of the monitoring and targeting model is the CUSUM analysis (ASHRAE, 2009). Data can be produced from utility bills, building management system data or simply by monitoring energy consumption.

Tariff Analysis: Energy is a significant cost in commercial buildings. DSM, SSM and DR are common practices around the world but are difficult to manage in the GCC because there is mostly one utility provider, making the negotiation of the cost of supply utilities difficult for the commercial building manager.

Energy Benchmarking: A procedure that measures the quality of an organization's policies, procedures and strategies (Cotts, 2010). When an organization has secured the cost of energy and it can be accounted for, the systematic process of energy benchmarking can be structured to continuously measure and compare (Oung, 2013). There are different approaches on how energy use is measured within an organization; these include EPA's (Energy Performance Rating System), Energy utilization index (Btu/square foot) or total energy cost/square foot (Greenauer, 2010). An effective benchmarking process should not be considered as a onetime energy improvement project but a continuous process within an organization that can lead to substantial savings in energy consumption (Brooks, 2009).

Changing Consumption Behaviour, People Aspects: Many commercial organizations believe that energy management is reliant on technology for success. Understanding the individual's awareness of saving energy and what motivates the individual to practice energy efficiency will help the organization understand and implement an awareness campaign to maintain effective energy management. A study was carried out on commercial energy consumption in New Jersey (USA) involving 40 business managers and owners, where business owners had difficultly identifying components of their energy costs. Five main themes were identified influencing consumption behaviour were identified as poor

information, no control, a belief that reduced consumption reduces building comfort, no responsibility and no visibility on actual energy cost (Payne, 2006). Behavioural changes are an important component of an energy management strategy (Jackson 2005, Moloney et al, 2010). Bin, (2012) conducted a series of case studies in the USA of behavioral programs in the work place on commercial buildings, the results were significant achieving savings from 4% to nearly 75%. The European Union adopted an energy efficiency directive to reduce energy consumption by 20% by 2020.

Energy/People Matrix: The matrix in Table 1 helps the organization monitor the progress in people solutions by scoring its performance against six key criteria. This will help the organization to define the areas of strengths and weaknesses, giving the organization areas to address. Each column will be considered by the employees and marked as a profile. The energy people matrix will give the organization a profile on the current situation detailing the high points and the low points, the peaks presenting the successes and the low points indicating needs to improve.

Awareness/Motivation Grid: Motivation is about providing incentives and working environments that enable people to perform to the best of their ability (Mullins, 2010). There are two key elements: awareness defining people's knowledge and motivation defining commitment of individuals to take action. An individual may have the knowledge, by turning off a light in a store room when they leave will save energy but do they have the motivation to take action. Conversely others may be highly motivated but do not have the awareness. It is important, therefore, for an organization to understand where staff fit into this model before a strategy is developed.

1.2.5 Effective Energy Technologyin a Commercial Office Environment

Effective Energy Technology: In the modern world, energy is a resource that organizations build into their annual budgets and companies would invest more to reduce this cost (Elsadig, 2005). However, research has demonstrated that building owners do not foresee the long-term financial benefits of investing in energy efficient technologies (Carbon trust, 2012). The investment property forum (IPF) carried out a study on energy efficiency improvements on seven commercial office buildings in 2009 identifying the benefits of investment and best financial returns. The study outlined that there is no specific process for these improvements as commercial buildings are not homogenous, and have different characteristics that influence energy consumption namely building age, building form, glazing and HVAC. Table 2 summarizes the reduction in CO2 emissions with the level of investment and shows the investment required in proportion to the cumulative percentage CO2 emission reductions (IPF, 2009). The survey was conducted over. It demonstrates that the higher the investment the greater the reduction in CO2 emissions.

1.2.6 Key Energy Efficient Improvements for a Commercial Office

The following is an overview of energy efficient techniques/technologies that are beneficial to an existing commercial office.

Quick fixes: These are low cost/no cost solutions that actively reduce consumption. Consumer behaviour is important in reducing energy consumption. There is a gap in the commercial sector with awareness, motivation and attitude towards energy efficiency (Payne, 2006, Bin, 2012). An energy awareness campaign is a very successful low cost/no cost option for an organisation e.g. water faucet reducers, waterless urinals and managing set points to building occupancy times. In the UAE, to demonstrate simple low cost techniques, Pacific Controls conducted a case study in 34 buildings in the Emirates Energy star programme by analyzing the occupancy of the building, start stop times of the HVAC, switching off lighting in unoccupied areas of the building and monitoring Kw/h consumption. (Pacific Controls, 2009).

Power Factor Correction: Modern office buildings contain equipment that operate with electronic components that makes electrical loads resistive (Jayamaha, 2007), making it expensive. The initial rate of return of investment for this technology (IRR) in a commercial office building is between 9% and 12% (IPF, 2009). The benefits of improving power factor as outlined by Khan (2009) are: Reduced consumption/reduced utility bills, increased internal electrical capacity, improved voltage drop at the point of source, improved voltage regulation and improved system efficiency.

Variable speed motor/pumps: One third of the world's energy is consumed by electric motors. Variable speed drives (VSD's) also known as variable frequency drive (VFD's) are great solutions for energy reduction (Oung, 2013). VSD/VSF controls are designed to accommodate technology, and in the right situation the variable speed drive will achieve an initial rate of return of investment of 12% to 15% (IPF, 2009).

Energy efficient lighting: One of the most effective methods of energy saving techniques in commercial buildings. Roisin et al, (2008), observed the energy requirements of a building based on the needs of the building occupants. The occupants of the building required a minimal luminance to prevent eye strain and headaches. In an office environment LED and high efficiency lighting offer good initial rates of return on investment (IRR) of 42% with a general payback of three years (IPF, 2009).

Renewable technologies for the office environment: Photovoltaic systems, solar heating, ground source heating and wind energy are examples of low cost renewable energy systems available that are good energy efficient measures for a commercial building and initial rates of

return on investment for renewables range from 5% to 12% (IPF, 2009).

2 Benefits and Barriers of Energy Management

Benefits: The majority of literature focuses on the environmental benefits of sustainable energy management. Managing energy is a good way of managing organizations resources. The main benefits of good sustainable energy management starts with cost savings as conserving energy consumption saves money (Oung, 2013). Another known benefit is non-renewable fuels of which investing in renewable sources of energy and governments enforcing legislation will lower carbon emittance and preserve non-renewable sources are diminishing at the current rate of use. Companies sources for future generations (IEA, 2013). In addition, reducing pollution by reducing the amount of CO2 in the air. Reducing harmful gases will help reducing global warming and climate change. Further benefits comes through legal compliance with regulations. The working environment – operating a building correctly and efficiently will lead to a good working environment. Human beings are more productive and motivated if the working environment is adequate for their requirements. Poor management of buildings assets will lead to increased energy consumption (Barney, 2003). Another benefit can be obtained via environmental performance. Asset life cycle – a good benefit of an effective energy management system is the cost savings. A good maintenance strategy will extend the life expectancy of the equipment. Finally, renewable technologies– solar generated heating, solar powered lighting and wind generation is all of benefits.

Barriers: The main barriers to effective sustainable energy management are as follows:

Management commitment and time barriers – commitment from senior management is very important in an effective Energy management model. Brown, (2006) describes energy management as an unspoken objective in organizations because it is desirable to reduce operating costs but often not important enough to justify financial investment and commitment. Poor commitment from senior management will result in poor energy performance in any organization, producing a lack of awareness and employee motivation (Thorne and Fisher, 2005). Time barriers are natural results of a very competitive and money-driven business world. Policy-based barriers – a policy will be effective if there is commitment among all members of the organization (Tartir, 2010). This includes all levels of management and commitment from the stakeholders to carry out policies related to energy management. For the organization to overcome policy based barriers staff need to be made aware of the importance of policy as staff actions will have a direct effect on decreasing cost and increasing

Table 1: Energy / People Matrix

Level	Commitment	Awareness	Motivation	Promotion	Training	Momentum
5	Active commitment from senior management supporting a comprehensive strategy to save energy through people	High Awareness levels throughout the organisation	All users at every level self-motivated to save energy	All users at all levels motivated to svae energy	Ongoing comprehensive internaltraining initiatives tailored to identified needs with evaluation	People solutions fully intergrated into all management systems which sustain momentum and continuous improvement
4	Formal policy and strategy but lacking senior level commitment	Most major issues aware of potential and opportunities to save energy	Most major users motivated to save energy	One off energy campaign tailored to the organisation	Internal training targeted at major users following a training needs analysis	People solutions partially intergrated into existing effective management
3	Outline strategy drafted but lacking commitment from key people and lacking integration into mainstream	Some awareness of energy saving potential and how to achieve it	Some motivation by a few major users	Some use made of organisations information channels to promote energy savings	Occasional internal training for selected people required	People solutions have a temporary impact and lose momentum
2	Commitment by a few people to some unwritten ideas	Awareness in places but patchy	Motivation restricted by enthusiasts	Energy savings promoted by informal contacts and published awareness literature	Occasional use of external specialist courses for some technical people usually at their request	Energy saving initiatives regarded as a passing phase by most end users
1	No interest, initiative or commitment to saving energy through people	No awareness on how to save energy	No motivation to save energy	No motivation to save energy	No energy training	No initiatives therefore no momentum

Table 2: Cumulative savings from CO2 emission reductions

Cumulative Saving %							
	Office1	**Office2**	**Office3**	**Office4**	**Office5**	**Office6**	**Office7**
Market Improvement	25%	26%	25%	25%	0%	30%	24%
$25/m2 budget	37%	39%	35%	35%	14%	47%	39%
$50/m2 budget	47%	46%	46%	42%	28%	51%	50%
$75/m2 budget	59%	52%	48%	46%	29%	55%	51%
$150/m2 budget	54%	58%	54%	54%	36%	63%	54%

Therefore, employees must be given responsibility in improving energy efficiency or conservation. Financial barriers – these are developed by the business and can be very difficult to manage. Depending on the strategy and the set budget of the organization, the level of investment will be determined by the business owners (Tartir, 2010). Unfortunately with energy management there is capital investment and often short-term profits and financial goals are more appealing to the organization. Technological barriers and infrastructure– Many organizations operate with electronic components such as computers and other inductive loads that rely on conditioned power to operate efficiently. This will affect tariff charges as an inefficient power factor correction unit will not indicate inefficiencies on the utility bill, just additional Kw/h(Oung, 2013). Voltage fluctuations and regular power outages will affect business continuity and asset life span (Tartir, 2010).

3 Conclusions

The subject of energy management is important for the built environment to continually improve energy consumption and environmental sustainability for future generations. Prolific use of non-renewable sources has driven the built environment to manage and preserve the limited resources that we have today. Governments across the world are aware of the damage that greenhouse gases are doing to the environment and are concerned for the wellbeing of future generations. This has encouraged governments to place environmental strategy, policy and taxation to reduce the amount of consumed energy. The commercial sector of the built environment is one of the main consumers of energy, consuming 40-45% of energy consumption. Energy management is the proactive control and use of consumed energy. Organizations have policies and energy strategies in place to practice energy management. There appears to be a lack of communication within organizations, information and direction is not being communicated at every level. Missed opportunities are significant when energy management is not practiced correctly. There have been many techniques and practices that are proven to decrease the consumption of energy reducing consumer cost. Consumer behaviour forms a large proportion of the managerial barriers to conduct efficient energy management. The benefits far outweigh the negatives, bringing reduced cost, carbon emissions and Increase asset life.

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Marting Stevens 'Technically qualified Engineer with a Master's Degree in Facilities Management. Successful in managing complex contracts and resolving issues with forward thinking strategic views of an operation. An experienced natural leader that understands the benefit of a motivational approach to all employees, from various cultures across multi-geographical and global locations has ensured that respect and productivity is driven throughout, knowing that your greatest asset in contract. management is the ability of people's performance, coupled with strategic management of the client. Productive in environments where I can

offer my ground in experience as an engineer, ensuring quality, value and operational uptime is sustained, creating positive change while being mindful of profitability and budget management. A passionate advocate of health and safety ensuring Safety is at the forefront of every contract or project managed.'