Potential of energy savings in the hotel sector in Jordan

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A B S T R A C T
This paper presents some insights into Jordan’s energy consumption in the tourist accommodation sector. The results of a recent survey on environmental performance in the tourist accommodation sector in Jordan were used to evaluate energy conservation in hotels. A survey was designed and distributed to hotels’ managers and departments’ supervisors in order to understand the environmental performance in the tourist accommodation sector in Jordan during the period 10–17 August 2006. Also some field visits were conducted to fully understand hotels’ interaction regarding the environment, in addition to help interpreting the results of the survey. The study is limited to all classified hotels in Jordan. It was found that lighting hotels’ main building and outside areas, and air conditioning consume more electricity compared to other departments. The results show that few classified hotels already installed energy saving equipments, though, it was noticed that managers of one star hotels were not really willing to make such changes in their hotels, on the other hand, other classified hotels (2–5 star hotels) have shown a high willingness to make changes in their hotels to reduce the consumption of different types of energy. Hotel’s classification played a significant role in explaining variations in most of the results, particularly when it comes to long-term investments to reduce energy consumption by using energy efficient appliances. Five and four star hotels were the most hotels willing to use energy efficient appliances to reduce energy consumption. The study suggested some strategies to help reduce the negative impacts of high energy consumption in hotels. These strategies include better insulation, and enhanced insulation for the hot water reticulation system. Moreover, enhancing and increasing the level of awareness among all hoteliers through a directed and well-designed campaign. Also offer interest free loans; and activate precise standards and specifications for new hotels.

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1. Introduction

Environment has three functions: resources depot, waste repository, and habitat. Thus, using an ecosystem for one function may damage its ability to complete one or both of the other two effectively [1]. Presently, finite energy supplies occupying attention of researchers in the area of energy management and other related disciplines. The current energy system is named hard path, which leads to the possibility of ending up an energy disaster. It is suggested by many researchers that societies have to change from the hard path to soft path in order to avoid the energy disaster. This means that societies have to entirely restructure the energy system by adopting the soft path which depends on two primary principles, efficiency and other the renewable energy resource [2].

The great development that has been witnessed in Jordan in the last decades, and the growth of different economic sectors (including tourism); all are interrelated with the continuously increasing consumption of energy and its resources. Jordan imports most of its energy in the form of petroleum products. Therefore, energy conservation means less reliance on energy imports and, thus, less greenhouse emissions. In 2005, oil and natural gas imports cost was approximately 58% of the total domestic commodities exports and about 24% of the gross domestic product. Primary energy resources consumed in Jordan include crude oil, natural gas and solar energy. However, imported crude oil and petroleum products constitute more than 97% of the annual rate of energy consumption in 2005. A good portion of this oil is used in electric generation. The domestic natural gas resource, which is used to fuel 5 × 30 MW gas turbines for electricity generation, satisfies less than 3% of the annual energy demand. The annual primary energy demand in 2005 was 7028 million toe. Energy consumption in Jordan is divided into three major sectors, namely, transportation, industrial
and residential. The energy consumption among these sectors is presented in Fig. 1, the term “others” in this figure refers to other major types of sub-sectors, such as agricultural, street lighting, and commercial, which includes hotels [3].

2. Tourism accommodations in Jordan

The number of tourism accommodation types has been growing over the past few years. They include now a big variety in terms of size and services they provide.

Jordan will face major challenges in trying to meet the growing energy need and, especially, electricity demands. While, concurrently, developing the energy sector in a way that ensures reducing the adverse impacts on the economy, the environment, and social life. According to Department of Statistics (DOS) [4], classified hotels reached a total of 222 hotels, these were distributed as follows: 21 five stars hotels, 23 four star hotels, 56 three star hotels, 53 two stars hotels and 69 one star hotel. Moreover, statistics of Ministry of Antiquities and Tourism (MOTA) [5] shows the existence of other types of accommodations: 122 hotel apartments, 137 unclassified hotels, 2 hostels, 1 motel and 8 camping areas. All these numbers reflect a significant growth in Jordanian accommodation sector. Although of the considerable positive impacts of these accommodations as great generators of income and job opportunities; the negative impacts they cause can not be ignored. In general, these accommodations, particularly hotels, overuse fresh water sources for several purposes, such as swimming pools, golf courses, irrigating green areas, and personal use of guests. They also contribute to the generation of waste water and solid waste. In some cases, they result in producing toxic waste because of overusing of chemicals, as in laundry [6].

In addition to these negative impacts, hotels use significant amounts of energy for daily operations and recreational activities [6,7]. This basically can be seen in building climate control and general services in the hotel. These are composed of passive cooling, energy management and control systems (EMCS), central cooling system, ice storage, desiccant dehumidification, in addition to laundry and kitchen equipments [8]. In many facilities, energy costs are the second-highest operational costs after payroll. Such considerable cost of energy is due to using technology and different sources of energy to provide comforts and conveniences to hotels’ guests. The vast majority of hotels and resorts meet their energy needs by purchasing energy produced through the burning of fossil fuels (coal, oil and natural gas), such processes are main contributors to different kinds of environmental problems, for example global climate change [6].

3. Energy consumption in hotels

A growing concern has been addressed regarding the high amount of energy that hotels consume for their operational purpose. Moreover, numbers of studies have been studying energy use and hotels environmental performance [9–14]. Such studies have been able to enhance hotels’ performance by achieving good operational practices in these hotels. The significant increase in the size of hotels sector in Jordan requires more environmentally friendly services. Therefore, adopting energy saving procedures will provide a significant tool for hotels to compare before installing, for example, energy saving appliances and after installing them. Moreover, efficiency usage of several types of energy sources is a core subject in environmental management [14,15]. In Sénégal Ndoye and Sarr [10] studied the effects of domestic hot water (DHW) parameters on the energy consumption of large buildings (residence, office and hotel). They concluded that electricity consumption, in these buildings, could be reduced by limitation of the DHW parameters values. On the other hand, Önüt and Soner [11] investigated energy consumption in 32 five star hotel buildings in the Antalya Region, Turkey. They concluded that occupancy rate and energy consumption have a strong correlation. In terms on being efficient in energy consumption 8 hotels considered to be efficient in their consumption while 24 hotels were inefficient. These results shed the light on the importance of exploring five star and other classified hotels to better understand their impacts on the environment. Five star hotels are considered to be number one consumer among other hotels with regard to energy use. Any effort to identify ways to reduce this consumption will affect positively the environment and ultimately national economy. Focusing on specific factors to save energy, Khemiri and Hassairi [9] investigated potentials of energy savings in Tunisian hotels. Based on a data collected in 1967, 1996 and 2002 the results confirmed the ability of Tunisian hotels to significantly decrease their energy consumption in two conservation measures. Lombard et al. [12] suggested two major conservation opportunities for thermal efficiency in the South African residential sector. These opportunities included better envelope insulation; and improved insulation for the hot water reticulation system. Moreover, Lombard et al. [12] addressed three future scenarios to help in reducing energy consumption. These scenarios centered on promotion and awareness campaign only; promotion and an interest-free loan as incentive; and promotion, loan and enforced minimum standard for new housing. They found that enforcing minimum standard for new housing, is the most effective scenario.

Electricity and thermal energy are the main energy forms used in the tourism facilities for necessary services. Electricity is used throughout the tourist accommodations for several tasks, including lighting, water heating, air conditioning, laundry operations and desalination. The thermal energy is mostly used for hot water in guestrooms, kitchen and the laundry [16]. Electricity energy can be provided through grid connection, diesel generators, gas turbines, photovoltaics, wind electric systems, hybrid systems and solar thermal systems. The thermal energy sources include petroleum-based fuels, solar water heating, waste heat/cogeneration, hot water storage and seawater active/passive [6]. Since such energies are depending directly or indirectly on burning fossil fuels to run different kinds of operations, it means then a business expense through the cost of energy, and not less important a significant cause of degradation to the environment and to societies [7,8].

Therefore, there are several benefits that can be gained through improving “environmentally friendly” energy consumption in hotels and other different tourism establishments. This can be reached by reducing resource consumption and reducing costs, customer loyalty and enhanced public image, attracting and retaining dedicated staff, avoiding sanctions from environmental authorities, improving competitiveness in the world markets, and long-term business benefits [8]. Such benefits to the business and more important to the environment, all make energy saving and management in hotels a vital requirement toward sustainable development.

Due to the high diversity of energy consumption in tourism and hospitality sector, most hotel facilities only monitor their energy expenditure without detailed attention to the specific consumption of the different end-use applications [17]. The typical energy loads and consumption in tourist facilities would be affected by a
number of operating conditions or factors, including, the size and luxury level of the hotel, climatic conditions, location (remote/rural or urban), guest profiles (visiting or vacation guests), and types of services/activities [8,17]. Other important factors are the age and condition of the energy systems, which affects their efficiency. Such operating conditions can be classified into three main groups according to ESCWA [8] and EU [18]:

(a) Facility characteristics including type of facility “urban hotels, vocational villages, restaurants, etc.”; and facility category (1–5 stars), and size (number of guest rooms) and the facility area.

(b) The facility site, the location of the tourist facility mainly affects: climatic conditions, consequently the peak load time and the level of energy consumption particularly for space climatization, and water heating. It also affects the types of the available energy supply options on or nearby the site.

(c) The facility zoning areas, a hotel can be divided to three distinct zones all serving distinctly different purposes and utilizing different forms and level of energy:
- The guest rooms area includes (bedrooms/bathrooms), individual spaces, which are often with varying energy loads according to occupancy rate and type of guests.
- The public area (reception hall, loopy, restaurants, meeting/banquette rooms, swimming pool, health clubs or gyms, etc.), with a high rate of heat exchange with the outdoor environment (high thermal losses) and high internal loads (occupants, appliances/equipment, and lighting).
- The service area (kitchen, offices, store rooms, laundry facilities, machine rooms, elevators and escalators) – energy-intensive areas typically requiring advanced air handling (ventilation, cooling, heating).

In this paper, we present some insights on the situation and current trends in energy consumption in the Jordanian tourist accommodation sector, identify energy consumption (electricity and fuel) among classified hotels, identifying attitudes, willingness and practices concerning applying sustainable environmental methods in the hotels, and suggesting some procedures to reduce energy consumption. This is based on the results of a recent survey on environmental performance in the tourist accommodation sector in Jordan, which is part of the GREEN-TAS project that is supported by the European Commission through its environmental instrument, the LIFE program.

The GREEN-TAS project mainly aims at dealing with the problems and impacts caused by the accommodation sector in Jordan. The assessment of these impacts will be based on using scientific methods as data collection and site visits, which will help in evaluating the situation of this sector. Consequently, a number of strategies and instruments will be developed and used to enhance the environmental performance of accommodations in Jordan, and hopefully the guarantee of a sustainable development in the tourism sector.

4. Methodology

A questionnaire was designed and distributed to hotels’ managers and departments’ supervisors in order to understand the environmental performance in the tourist accommodation sector in Jordan. Moreover, the study aimed at exploring current situation of accommodation sector in Jordan, as well as identifying attitudes, willingness and practices concerning applying sustainable environmental methods in the hotels. Also some field visits were conducted to fully understand hotels interaction regarding the environment, in addition to help interpreting the results of the survey. The study is limited to all classified hotels all over Jordan.

A questionnaire was designed to meet the objectives. The questionnaire was composed of three sections, the first section included information about the confidentiality and anonymity of the respondents in the survey. The second section documented information about the hotel classification, affiliation (chain), operation date, maximum occupancy, total area, built up area, number of rooms, and number of beds. The last section grouped a number of questions regarding current environmental practices, willingness to adopt environmental programs, awareness of environmental issues and initiatives, and willingness to change some current practices related to energy sources, consumption, wastewater recycling, light system, and air quality, and more important the consumption of energy sources and water, as well as waste generation.

The study was conducted using five field supervisors who were chosen to supervise the field work of 19 field interviewers (most of them are students from the Hashemite University). All participants were trained for one day followed by a pilot study, and the final collection of data was conducted during 10–17 August 2006.

5. Sample

5.1. Sampling frame

The frame of this sample is provided by ministry of tourism and antiquities. This frame contains the name, address and other information for each sampling unit (hotels and tour operators).

5.1.1. Stratification

The hotels are divided into five strata by the classification of each hotel; this stratification provides homogeneity within each stratum. The frame is divided into five strata as in Table 1.

A stratified sample was drawn from all classified hotels. Ninety classified hotels were selected to fill the survey, from which 80 hotels responded (83.3% as a response rate), these included 8 one star hotels, 15 two star hotels, 24 three star hotels, 18 four star hotels and 15 five star hotels, based on this, the data was weighted (Table 2).

6. Results and discussion

To achieve the main objective of this paper, the results will be presented to describe several variables related to energy
consumption in all classified hotels in Jordan. The data have been weighted; therefore we will present all the results using the weighted data. Information about utilities represents 12 months prior to the interview. Several variables were included to better understand hotels performance with regard to energy. These variables consist of hotel classification, affiliation (chain), maximum occupancy, total area, built up area, number of rooms, number of beds, total occupied rooms (room nights) in the hotel, total number of guests stayed in the hotel, total electricity cost (JD) consumed by hotel per year, total electricity consumed in the hotels’ departments (engineering, laundry, housekeeping, food and beverage), total electricity consumed by hotel per year kWh/year, total energy (fuel) consumed in the hotels’ departments (engineering, laundry, housekeeping, food and beverage), and total energy (fuel) consumed by the hotel per year (m³/year).

Since the consumption of energy in hotels depends on some factors as mentioned above, it was necessary to have a clear idea about some of the general characteristics that have proven to influence energy consumption in hotels; these include area, built up area, number of rooms and occupancy rates [9]. For the area, it was found that most of the Jordanian classified hotels have an area of 2500 m² or above (54.9%), also, a considerable portion of them was found that most of the Jordanian classified hotels have an area less than 500 m² (9.9%), Col % 8.5%. The area of 1000–1999 m² (6.0%) and 2000–2499 m² (6.4%) and 2500 m² and above (12.1%) and 3000 m² and above (5.4%) were found to be less common. The total built area of 2500 m² or above (34.2%) was found to be the most common. The total built area of less than 2000 m² (9.9%) was found to be the least common. The results of the survey show that most of these hotels have a yearly occupancy rate of 75% or above (59.6%), most of them are hotels of less than 50 rooms (60.8%) (Table 3).

### 6.1. Energy consumption in Jordanian hotels

One of the main problems facing hotels in Jordan is the high consumption of energy caused by heating, ventilation, and air conditioning systems (HVAC) and lighting, as well as other equipments in different departments; this is due to the lack of insulation techniques in most hotels, as well as the lack of motion sensors which are sensitive to the presence of individuals within rooms or any areas in hotels.

Another important issue in Jordanian hotels is the high consumption of energy and fuels caused by heating water and heating systems, as well as other operations. This is due to lack of insulation techniques as well as lack of using solar system and other types of renewable types of energy sources. Moreover, a serious issue is the absence of sub-meters in every department in hotels, and so energy is not accounted on individual operation basis.

Heating, ventilation, and air conditioning (HVAC) systems are usually seen as the largest electricity consumers in hotels. It was estimated that the amount of electricity used for running air conditioning systems is composing approximately 30% or more of total expenditures of energy consumption [8]. HVAC systems provide heating, cooling, humidity control, filtration, fresh air, building pressure control and comfort control [8]. After a number of field visits to different classified hotels in Jordan, it was found that some hotels do not use any kinds of sensors to control the usage of HVAC systems in guests’ rooms and other places. Also, the survey of this study showed that 59.4% of hotels have installed equipments to reduce energy consumption of heating, ventilation and air conditioning.

Although lighting is not a big consumer of energy in hotels, it still can hold a great opportunity to save energy [16]. Lighting seems to be more acceptable if compared to other devices using electrical devices. Most of lights used in most hotels in Jordan are of energy saving type, though; some hotels are still using inefficient energy types of light bulbs inside guest rooms, actually, 97.1% of classified hotels in Jordan are not using any renewable energy source like photo voltaic cells for lighting.

The field visits to classified hotels have shown that some five and four stars hotels are using dimmers to reduce the amount of electricity in the case of using regular types of lamps, whether in guest rooms or lobby areas (as in the case of Movenpick hotels).

It was found through this study that 93.2% of classified hotels in Jordan are maximizing their use of natural light, 41.2% of these hotels to a great extent are promoting turning off lights when ever they are not in use among their staff and guests.

Unfortunately, most of hotels in Jordan use fuels in the first place, and electrical energy in few cases to heat water. According to the field visits, some managers are willing to and planning to use solar power to conserve energy. Though, some managers said that this kind of water heating is not sufficient, especially in the case of big number of rooms. However, by using proven energy-efficiency measures, it was found that hotels could cut energy costs by 20% or more by such implication [8].

#### 6.1.1. Electricity consumption

Energy consumption is one of the major concerns for all hotels particularly five, four and three star hotels. The results regarding electricity consumption reveal clear evidence that this is one of the important issues to be considered when addressing the possibility of energy savings in the hotel sector in Jordan.

It is clear that engineering and housekeeping departments have the highest averaged percentages for consuming this type of
energy (20.43% and 20.32%, respectively), although some other facilities including lighting hotels' main building and outside areas, air conditioning consume more electricity if put together and were compared to these two departments (Fig. 2).

Hotels can reduce their operations costs by adopting practical strategies such as upgrading controls or replacing outdated HVAC. In addition to other measures as insulating all heating and cooling lines using appropriate insulation thickness, roof cooling, efficient lighting, and optimal thermostat setting of temperature of air conditioned spaces, sun film applications, selecting high-efficiency units when replacing HVAC equipment. Although some high-efficiency units may be more expensive than average-efficiency units, the higher initial payment can be recovered through increased energy savings in a very short time.

Moreover, by installing new lighting technologies such as dimmers, photo sensors, occupancy sensors, and timers; it becomes possible to reduce both the amount of electricity and energy costs exploited in lighting. There are several types of lighting technologies that proved to be energy saving and affordable. The followings are some of them: energy-efficient fluorescent lamps instead of “conventional” fluorescent lamps, compact fluorescent lamps (CFLs) instead of incandescent lamps, installation of high pressure sodium vapor (HPSV) lamps for applications where color rendering is not critical, mercury vapor lamps, LED exit signs instead of incandescent, optimum usage of day-lighting in new designs, occupancy sensors which guarantee that unneeded lights do not remain on, devices that automatically detect the natural light level in a room, consequently the artificial light intensity will accordingly be adjusted. An automatic device, such as a key tag system, will improve housekeeping energy management. It will also help improving the load factor in the electrical system. Using a key-card system will make only occupied rooms consume energy; also most electrical appliances are switched off when the key-card is removed, this method is significant particularly when the guest does not stay for a long period of time in his room [17].

6.1.2. Diesel fuel consumption

For total diesel fuel used by different departments in hotels, it is clear that laundry department is considerably consuming more diesel for its operation (an averaged percentage of 53.4%); while other departments as food and beverage, housekeeping and engineering do not exceed 11% as a mean percentage for such consumption (Fig. 3). Laundry department relies heavily on heating water for its operations which depends on steam and hot water to clean cloths, linins and other items.

To reduce diesel consumption, hotels can evaluate and install as appropriate waste heat recovery systems on large generating units, as laundry. Solar water heating systems can be installed for guest rooms, swimming pools, and other services equipment. Setting water heaters thermostats at not more than 50–55 °C, for guest room water, using a booster heater for higher water temperatures for dishwaters and laundry equipment use, and adopting a regular boiler tuning program are also some possible procedures to be taken by managers and operators in hotels [8].

6.2. Willingness to adopt energy efficient procedures

Suggesting energy consumption strategies requires readiness from hotels to adopt and implement such strategies. The survey includes several questions to measure the willingness of hotels to apply environmentally friendly procedures to save energy. The results show that few classified hotels already installed energy saving equipments, though, it was noticed that managers of one star hotels were not willing to make such changes in their hotels, on the other hand, other classified hotels (2–5 star hotels) have shown a high willingness to make changes in their hotels, and so to reduce the consumption of different types of energy. A very good example can be seen in the case of energy saving light bulbs. According to the results of the survey, only 8.5% of hotels in Jordan have already installed these bulbs, while 54.1% of these hotels managers were very willing to do so (Fig. 4).

Reducing energy consumption is number one priority for all hotels. The results show a high level of willingness among all hotels to do so. On the first hand, more than 80% of hotels expressed their willingness to use energy efficient appliances. This could be due to increasing prices for electricity and petroleum products in general, in addition to the high level of awareness among hotels to protect the environment. Other results show that 95.2% of the five star hotels are willing to great extent to undertake a comprehensive environmental program in their hotel; 82.6% of the four star hotels; 83.8% of the three star hotels; 52.8% of the two star hotels; and 49.3% of the one star hotels. On the second hand, 5.8% of hotels mentioned that they are not willing to use energy efficient appliances to reduce energy consumption (Fig. 5).

Establishing environment performance monitoring and data collection system is one of the main procedures to gain a successful environmental management system in any establishment. In the case of Jordanian classified hotels, it was noticed that 16.35% of these hotels already installed such systems, mainly characterized...
by three, four and five star hotels. Unfortunately, 30.8% of them were not at all willing to take such procedure, especially one star hotels; the case though was different for the five and four star hotels which were so willing to apply such systems, even though, the classified hotels which were willing to do so did not exceed (17.2%) of the total number of hotels in Jordan (Fig. 6).

Using renewable energy sources is one of the core methods to reach sustainability, particularly in energy use issue. The results indicate that Jordanian hotels do not use renewable energy to reduce their reliance on fossil fuels energy sources. Only 9.9% of hotels are using renewable energy sources while 59% are using energy from fossil fuel sources and 30.6% are using both sources. The results also show that one, two and three star hotels are using renewable energy sources. More than 75% of the hotels are not using solar water heaters while 22.9% mentioned that they are using solar water heaters (Fig. 7). These results point to the need to utilize the use of solar energy as an alternative to domestic hot water production by electricity among the accommodation sector in Jordan.

7. Conclusion

It was found that lighting hotels’ main building and outside areas, air conditioning consume more electricity compared to other departments. For total diesel fuel used by different departments in hotels, it is clear that laundry department is consuming more diesel for its operation (an averaged percentage of 53.4%), while other departments as food and beverage, housekeeping and engineering do not exceed 11% as a mean percentage for such consumption. Laundry department consumes significantly more fuel for its oper-
ations because it relies heavily on heating water for steam and hot water to clean cloths, linins and other items.

The results show that few classified hotels already installed energy saving equipments, though, it was noticed that managers of one star hotels were not really willing to make such changes in their hotels, on the other hand, other classified hotels (2–5 star hotels) have shown a high willingness to make changes in their hotels to reduce the consumption of different types of energy. More than 80% of hotels expressed their willingness to use energy efficient appliances. Moreover, most of the five star hotels are willing to great extent to undertake a comprehensive environmental program in their hotel while around 50% of one star hotels expressed their willingness to do so.

Hotel's classification played a significant role in explaining variations in most of the results particularly when it comes to long-term investments to reduce energy consumption by using energy efficient appliances. Five and four star hotels were the most hotels willing to use energy efficient appliances to reduce energy consumption. Around third of the hotels are using both renewable and nonrenewable energy sources. Moreover, 77.6% of hotels are not using solar water heaters, which requires an intensive work to utilize the use of solar energy among the accommodation sector in Jordan.

Many specific strategies will have a significant impact on reducing energy consumption. These strategies include better insulation, and enhanced insulation for the hot water reticulation system. Moreover, enhancing and increasing the level of awareness among all hoteliers through a directed and well-designed campaign. Also offer interest free loans; and activate precise standards and specifications for new hotels.

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