

Case Study

Evaluation of green management in the office buildings of Khuzestan

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ABSTRACT:

The study explores material consumption (water, paper and chemicals) and energy carriers (electricity and natural gas) and also architectural factors in Khuzestan environmental conservation administration to achieve implementing green management system and material and energy efficiency in the official buildings. The results show that paper consumption has decreased by 7% less than last year as a result of implementing semi-mechanized system. Also, because of the warm weather and increase the amount of drinking, the results demonstrate that water consumption has an increasing trend from early summer. Besides, cooling section is the greatest consumer having 51% of total consumption, afterward experimental equipment having 14% share, administrative section with 12% share and finally the lighting share with 10%. At last, the study suggests some strategies to increase productivity with environmental considerations that decrease an average of 360.000 KW of energy consumption and 123.327 cubic liters of water and 165 kg of paper in the period of one year.

Keywords:

The environment, Water, Energy management, Save, Economy.

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INTRODUCTION

We can consider an organization in the community as "green organization" when it continues in the optimum use of resources and materials without waste on a sustainable basis (Jafar *et al.*, 2009). In this context, many studies have been conducted and several same research show the dimensions of the issue. Studies conducted by Barker (1996) shows that the main factors affecting the performance and energy efficiency of buildings including architectural design, mechanical design, electrical installations and behavior of residents and these factors can increase energy consumption up to ten times in a research conducted by Harvey (2009) to evaluate the energy savings by optimizing the shape and form of the building, alternative energy systems, proper utilization of building system and the definition of energy-related features that include insulation of windows, walls, floors and ceilings, thermal resistance *etc.*, are studied. The results show that the highest amount of energy consumption is in heating and cooling systems and lighting services. The efficiency of these systems significantly is more than normal, in this case, the use of equipment with high efficiency and low energy consumption can significantly save the energy consumption of these buildings (Harvey, 2009). Also in study by Wu *et al.* (2012), it was demonstrated that energy consumption in buildings, industry and transport are respectively 50%, 25% and 25% and energy consumption in the building sector is as follows: a)

lighting 25%, b) heating and cooling 45%, c) equipment 15%, d) energy loss is 15%. A remarkable 50% of total energy consumption in buildings, 15% of which is wasted, on the one hand and the amount of 70% of consumption in lighting and heating and cooling on the other hand is important to be noted. To any extent to save these values will have a significant impact on overall energy consumption (Wu *et al.*, 2012). Moharamnejad and Azarkamand (2007) emphasized on the implementation of green management in the airline industry. The implementation of green management policies in each state and non-state organizations has social, environmental and economic benefits. The results showed that the water consumption of the company in the warmer months of the year due to the warm weather is rising. The amount of paper use in the company showed a higher expense to buy paper and paper towels and paper made 71% of the waste. (Moharamnejad and Azarkamand, 2007). In addition, a review on the various sources of water, energy, paper and solid waste in the national library of Iran and consumption management of these resources indicated that the amount of energy used in refrigerators in the national library of Iran was the largest; they produce CO₂, SO₂ and NO₂. The library's total water consumption for green space, kitchen and toilet is 45459 Liter/ year, which was the largest share as related to the irrigation of green spaces by 324711 L/year. In the solid waste and waste produced by various substances, based

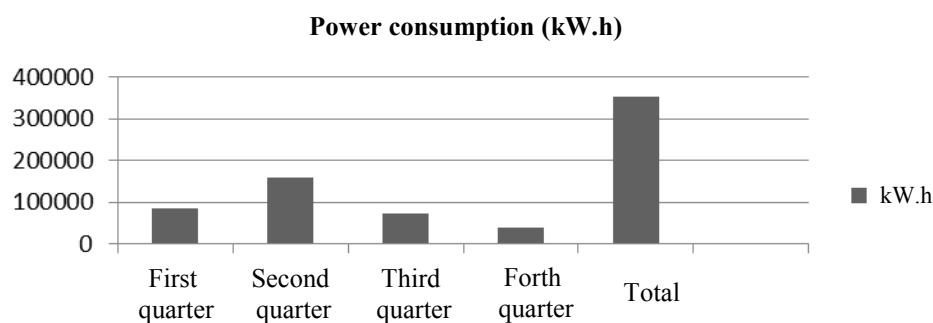


Figure 1. Trend of electricity consumption in the buildings of the directorate General of Environmental Protection, Khuzestan, (electricity bills for one year, 2011)

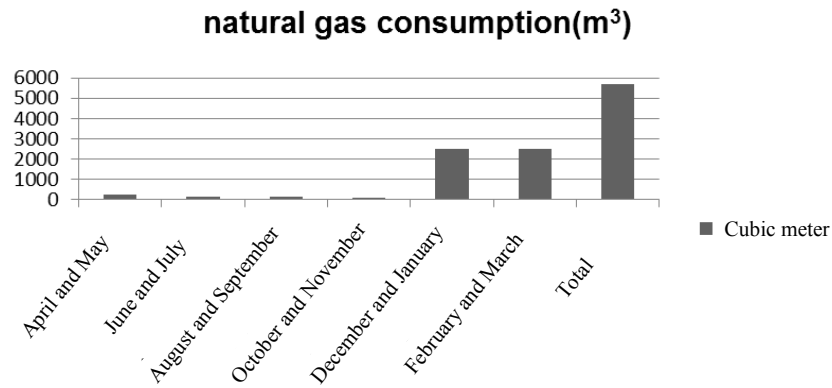


Figure 2. Natural gas consumption directorate general of environmental protection, Khuzestan, (annual gas bills in 1390 (2011))

on the results of thirty samples, maximum volume of waste were paper and aluminum (Jafar *et al.*, 2009). Therefore, in this study implementation of green management systems in the office buildings in Iran, and management material and energy consumption in the buildings were studied.

MATERIALS AND METHODS

This research aimed to examine and analyze the consumption of materials and energy resources in the office buildings, especially Khuzestan environmental protection administration building as a case study and as a trustee of green management. Information bank is produced through the collection of consumption materials (water and paper) and energy (electricity and

gas), chemicals and the factors affecting the architecture and specifications of the building were also noticed. Also by visiting of some sections (type and direction of windows and number of lamps) and assessing the department accounts payable, checklist was completed. The most important part of this information was the cost of inputs consumed during the April to March (2011-2012). To complete the information required in the case study where the filling of questionnaires was not possible, other methods such as environmental parameter measurements were carried out (temperature and amount of light) using the required tools and devices. Analysis of data was done by excel software through data classification, analysis of checklists and statistical data analysis. The results of the analysis were

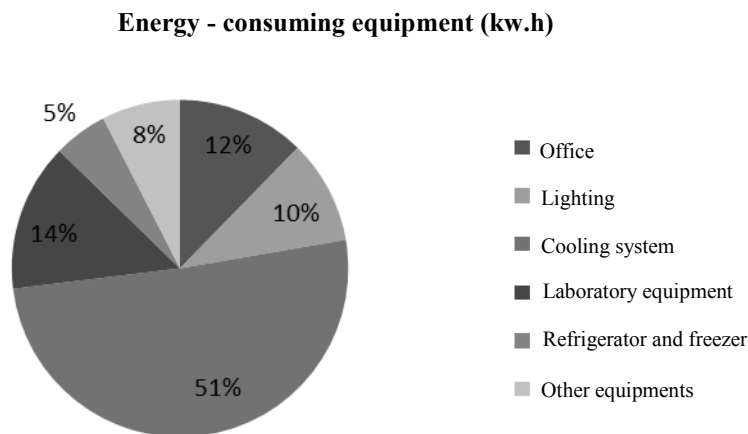


Figure 3. The share of energy-consuming equipment in the buildings of environmental protection directorate general in Khuzestan

Table 1. The volume of water waste from small leaks (Sandra *et al.*, 2002)

S. No	Water wasted per year (gal/year)	Water wasted per month (gal/month)	Water wasted per day (gal/day)	The number of drops per minute
1	52.2	4.3	0.14	1
2	262.8	21.6	0.72	5
3	525.6	43.2	1.44	10
4	1051.2	86.4	2.88	20
5	2628	216	7.20	50
6	5256	432	14.4	100
7	10512	864	28.8	200
8	15768	1296	43.20	300

*Paper weight is 2.5 kg

presented. In addition, strategies to improve the condition of the building in terms of energy and materials, from economic and environmental aspects were presented.

Building of directorate general of environmental protection, Khuzestan, has an area of over 2730 square meters and 5420 square meters is under construction; the area includes five interconnected buildings. Office working hours of 2011 was from Saturday to Thursday from 7: 30 to 14 hours respectively. It should be noted that in the months of July, August and September of 2011, weekdays were from Monday to Wednesday.

RESULTS

Evaluation of the electrical consumption of the building

According to the bills of electricity

consumption, electricity consumption in the office during study period was equal to 353,040 kW.h. According to Figure 1, the highest consumption was in July, August and September due to excessive use of cooling systems. The power consumption during this period was equivalent to 1,58,760 kW.h and according to the same statistics the lowest power consumption was in the last quarter of the year 2011, which was 38,760 kW.h.

Evaluation of gas consumption

The results of the amounts of natural gas consumption in Khuzestan directorate general of environmental protection showed that in 2011, over 5678 cubic meters of gas with bills at a cost of 9,075,996 million rials has been used. Natural gas consumption was descending during the months of April to November and from December to March it was

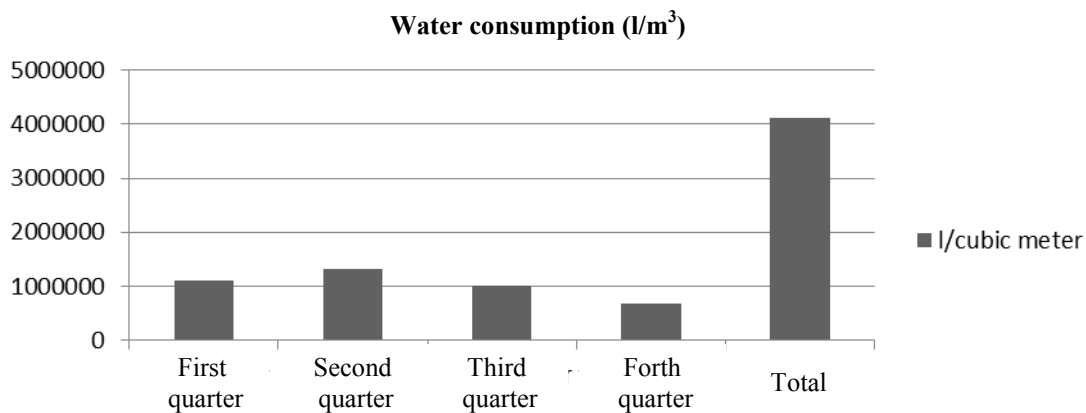


Figure 4. Water consumption profile at the directorate general of environmental protection, Khuzestan, (one-year bills)

Table 2. Estimation of paper consumption in Khuzestan directorate general of environmental protection

S. No		Consumption	
		Year 2010 (traditional)	Year 2011 (semi-automated)
1	Carton	57	53
2	Package	285	265
3	Sheet of paper	142500	132500
4	* Total Weight (kg)	712.5	662.5

ascending. The peak issue to use of gas stoves in the cold season (Figure 2).

Checklist of energy consuming equipment

The results of the checklist of energy consuming equipment in the building revealed that consuming equipment's in the building include cooling equipment, lighting, office, fridge and freezer, laboratory equipment and other electrical equipment (Figure 3). With respect to the power consumption the number of days and hours of use of equipment were determined. According to these results, the cooling with a rate of 183.946 kW.h and 51% is in the first place among other equipment, which can be due to geographic location and the climate of the region. Estimates of savings in cooling was calculated as follows: there are 10 window air conditioners in the building, which had 47.385 kW of energy consumption and it allocated 31 million rials from cooling consumption of 124 million rials. If this number of window air conditioner were replaced by 10 split air conditioner (18000) (18525 kW.h), 60% of consumption of window air-conditioners will be reduced, which equals to reduction of almost 18 million rials. At a cost of 170 million riyals to replace air-

conditioners (Enquiry from AZNA Sanat Parsian Company, 2012) 28431 kW.h and 8 percent in energy will be saved and returns on the investment is 9 years.

The potential of use solar air conditioners in the building was studied and it was found that by switching to solar air conditioners (n=56), 50 % in cooling consumption, 91.980 kW.h in cooling energy consumption, 26% of total energy consumption and 61 million rials of the total cost will be reduced. The total cost of replacing them is 1.140 billion rials and returns on the investment will be for 18 years.

Then the laboratory was in second place with 51 536 kW.h and accounted for 14% of the energy consumption; it can be due to multiple experiments daily, and in particular air pollution evaluation system. This high-power devices, were used 24/7 basis, which accounts for 85 percent of laboratory energy consumption. Administrative unit accounted for 12% of the electrical energy consumption and was considered at the next place. Computers accounted for 76% of expenditures in this section. Merely by applying the software settings (windows hibernation), 87% of energy consumption of computers in the office, equivalent to 29.971 kW.h per year and 67% in energy consumption of administrative division and 8% in overall energy consumption was saved (Iran Energy Efficiency Organization, 2004). In addition, because the handful of monitors are CRT, instead of using them, LCD monitors were proposed. LCD monitors use almost 50% less than CRT monitors.

Lighting equipment with a share of 10% of the consumption of electrical energy is in the fourth place.

Table 3. Consumption management in the office and commercial buildings (Iran Energy Efficiency Organization, 2004)

The annual energy consumption (kW.h per square meter)	Status
Less than 100	Very well
100 to 200	Acceptable
200 to 300	There are problems
300 to 400	Productivity problems in the building
More than 400	Ineffective

According to the observations made in the various floors of the office buildings, there are 690 CFLs and fluorescent bulbs which accounts for 36064 kW.h. According to the calculations, the cost of replacing these bulbs with LED bulbs, equal to 89.7 million rials. Since the amount of energy used by these bulbs (LED bulbs - 3 kW), is 2070 kW.h replacing these lamps reduces 94%, equivalent to 33,900 kW.h energy consumption of lighting and 9% of overall energy consumption will be saved. Returns on the investment is approximately four years. The use of devices such as photocells can reduce energy consumption in the lighting. According to the observations made in the various floors of buildings and the number of lamps and their placement in the floors, the number of zones and photocell required in each zone, 24 photocells in 14 zones were proposed. With this system, 30% of building lighting, 3% of total energy consumption and 10819 kW.h energy will be saved. Returns on the investment will be 2 years.

Checking the status of architectural factors affecting energy consumption of the building

The results showed that effective architectural factors in the building were recorded in separate sections and spaces. Given that in building design, when the surface to volume ratio reduces (more compact buildings) the less energy is wasted (Abdorreza, 2005). As a result, the building is not quite ideal in term of form. Also, because in the design of the buildings, the best way of orientation for proper utilization of the light and heat of the sun, was east-west direction (in this case, the building is located on this direction and south wall in winter obtain the greatest amount of energy and in summer it can be protected by canopies). As a result the building orientation of northwest to southwest is not proper orientation (Abdorreza, 2005). On the other hand, single-glazed windows with aluminum frames and steel rather than wood and fiberglass frame windows in most buildings, causes heat in the gloss of about 20

percent in winter and 75 percent of cooling in summer was through the glass, and an increase of 10 percent of heat dissipation by frames (Abdorreza, 2005). The lack of canopies in most of the windows, led to a decrease in performance. It is one of the major weaknesses in building energy waste.

It should be noted that the presence of native trees on the west side of the building, to control the sunlight and to create shading to outer shell of the building, was one of the most important and effective ways in reducing the heat in the summer and leads to 20 percent reduction of wind penetration from the cracks in winter (Abdorreza, 2005).

Estimates of savings in the architectural factors of the building indicated that the total of single-glazed windows in the building was 86.162 square meters that consist only 3 percent of the building's infrastructure. Since the total energy consumption in the buildings (total energy of heating and cooling), was 412,659 kW.h, by a reduction of 40-45 percent (Abdorreza, 2005), 165,063 kW.h will be saved and it reduces 101 million rial of costs, and returns on the investment will be 2.5 years.

Evaluation of water consumption in the buildings

Consumptions of water in the building was in the sections of health services, laboratory, for drinking, irrigation of green spaces, and cleaning the yard, and in the kitchen and the pantry. According to the bills related to water consumption, water consumption during 2011 was 4118000 cubic meters at a cost of 31,642,000 million rials. As shown in Figure 4, water consumption from the beginning of the second quarter (July, August, and September) due to overheating climate of province was ascending. It can be due to increased drinking water consumption and irrigation of green space. Estimates of saving on water consumption in the office was done by following three modes *viz*:

First: Because the average time required for hand washing and ablutions is 60 seconds and the

amount of water needed for this purpose is 6 L; Assuming the number as 2 times of washing, consumption of water per person per day is 8 L (Jafar *et al.*, 2009). If only smart valves replace existing valves, in this case the per capita consumption of water per person will decrease to 4 L. It saves 4 L of water a day per person. In conclusion, the monthly savings for the entire staff will be 7800 liters and 93600 liters annually.

Second: According to the surveys, there are 20 toilet tanks with a capacity of 4 L. By using twice each day, the volume of water will be 160 L daily. If the volume is reduced from 4 L to 2 L, daily consumption of 80 liters of water would be saved. This amount is equivalent to 2080 L per month and 24960 L per year.

Third: According to the surveys, the number of defective tanks was 5 and 5 valves were defective. Water drops per minute is 1 drop (every 4 tanks and 3 valves) and 5 drops (2 valves and 1 toilet tank). According to Table 1, the amount of water wasted from the 10 leaks, equal to 1261.2 gallons per year. This is equivalent to 4283 liters a year. In fact, only a small leakage repair saves about 4283 L per year and the water losses can be avoided.

The paper consumption in Khuzestan directorate general of environmental protection

According to certain studies, the paper use in 2010 was traditional. Then in 2011 with the launch of semi-automated system (GHAM software) paper consumption equals to 265 packages per year (132.500 A4 sheets or 66.5 kg) (equivalent to approximately 9.5 cut trees, respectively). In fact, the cost of purchasing paper, (45,000 rials in the year 2011), (taking into account price quotations from the Finance Bureau), equals to 11.925.000 million rials. According to Table 2, consumption in the year 2011 reduced by 7 percent compared to 2010.

Estimation of paper consumption indicated that since the average consumption in 2011 equals to 500 sheets and if only half of consumed paper (250 sheets)

was used in both sides, about 125 sheets per day, equivalent to 66 packs per year (equivalent to 165 kg) will be saved.

Evaluation of chemicals in the directorate general of environmental protection, Khuzestan

Chemical substances split into two parts: chemical detergents and laboratory ones. Detergents used in kitchen and pantry, toilet and floor include dishwashing liquid, liquid soaps and laundry detergents and bleach chemicals. The study showed that, this material is particularly cleaners and bleach which were used on a daily basis and has a variety of hazardous chemicals such as phenols, hydrochloric acid, chlorine and ammonia, which directly enter into the sewer. Laboratory chemicals include materials used in the routine testing of quality of river water and industrial waste water of the city of Ahvaz and other cities of the province; daily as average of six to seven experiments were performed in the laboratory. Wastes of these tests directly enter into the municipal sewage without treatment as hazardous substances. Monthly average of 5000 cc enter into the municipal sewage through the laboratory of directorate general of environmental protection, Khuzestan.

It is necessary to separate laboratory waste and other waste due to the presence of heavy metals including cadmium, mercury, lead as well as other materials that are harmful to the environment and send them to the treatment and recovery units. In this regard, using biological methods such as bacteria and wastewater treatment plants were recommended. Treatment of waste water of other parts of the office makes it suitable for agricultural use and can be used for the irrigation of the green space area.

DISCUSSION

In order to improve the efficiency of energy consumption of a building, one must first determine the situation in terms of energy consumption; the easiest

way is the use of billing of energy consumption, including electricity, gas, *etc.*, collected during the year. All energies should be converted to kW.h and added together: then the amount of energy consumed per square meter of the building is achieved (Iran Energy Efficiency Organization, 2004). Total energy consumption in the buildings of Directorate General of Environmental Protection, Khuzestan, including the total gas consumed for heating and cooking (each with a cubic meter of natural gas is considered equivalent to 10.5 kW.h) and electricity of building is 412 659 kW.h. Considering the total area of the building (5420 square meters), per capita energy consumption of the buildings was 76.13 kW.h. Building capita in the Table 3 shows that building energy situation is very good.

In terms of water consumption, since the beginning of the second quarter (July, August, September), due to over-heating climate in the province, consumption was ascending; it can be due to increased consumption of water for irrigation of the green space and drinking water. It was also found that per capita water consumption was 207 liters per day per cubic meter. Per capita consumption is equivalent to 150 liters per person (Iran Newspaper, 2005).

According to the studies conducted in paper consumption, it was shown that paper consumption in 2011 compared to 2010 decreased by 7%; because they changed the paper use system from the traditional to semi-automated (GHAM software) method.

The implementation and deployment of green management system and using the corresponding strategies such as 1. Replacement of window air conditioners 2. Using solar air conditioners 3. Software settings on the computer 4. Substitution of single-glazed windows with double-glazed windows 5. Using light sensors and 6. Use of LED light bulbs 360,000 kW.h can be reduced. In addition using strategies such as 1. The use of intelligent equipment 2. Repairing leaks in water 3-Reducing water flow of toilet tanks, 122.843

liters/cubic meters of water consumption in the building can be saved. Using double-sided printing, 165 kg will be saved in paper consumption.

CONCLUSION

Finally, management of material can help to reduce costs in an organization and since the proper management of these resources prevents misuse and loss of them, it is possible to ascertain the preservation of the environment.

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