IJIRR

International Journal of Information Research and Review
Vol. 2, Issue, 02, pp. 358-361 February, 2015

Research Article

REPLACING FOSSIL FUEL SOURCE OF ELECTRICITY WITH SOLAR CELLS IN AN EDUCATION CENTRE IN UK AND KURDISTAN

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ARTICLE INFO

Article History:
Received 27th November, 2014
Received in revised form
20th December, 2014
Accepted 30th January, 2015
Published online 28st February, 2015

Keywords:

Environmentally,
Manufacturing,
Non-renewable,
Implementation,
Microbusiness,
Requirements.

ABSTRACT

There is an urgent need to replace fossil fuels, which are causing damaging effects to the environment, with renewable and environmentally friendly sources such as wind, hydroelectric, solar and tidal energy. Of these alternatives solar energy appears to be the most promising candidate. The role of energy management has greatly expanded in many different industries. Efforts to introduce energy management in small and medium scale enterprises (SME) is however, very limited due to the lack of initiation, expertise and financial limitations. In manufacturing companies, energy cost is relatively a small portion of the total production cost, and therefore receives relatively little attention. Another problem is lack of understanding regarding the underlying principles involved in energy management. This study focuses on Kip McGrath Education Centre that can be classified as SMEs type of business by considering individual electrical instruments used. The feasibility of replacing its energy needs with silicon solar cells has been studied and will also contribute to the reduction in the carbon emissions. The methodology developed enables a comparison of a micro-business model to be achieved in the UK and Kurdistan-Iraq. Even though Kurdistan is abundant in oil and gasits climatic favour the implementation of solar cells to replace the existing use of non-renewable sources. Our study suggests that solar can replace a reasonable amount of the energy needed even in the UK and a much higher amount in Kurdistan-Iraq. Using 20% efficient solar cells 57% and 170% of the energy requirements of the microbusiness can be replaced in UK and Kurdistan-Iraq respectively.

INTRODUCTION

Developed countries use electricity and gas originating from non-renewable fossils fuel sources with well developed technology (Cucchiella and D'Adamo, 201; Baines and Bodger, 1984), infrastructure and transport. Long-term consequences are considerable damage to the environment and future depletion of these sources (Al-Ghandoor *et al*., 2009). The Middle East represents only 5% of the world's population with about 66% of world's oil reserves and 43% of world gas reserves, (Tsui, 2011). In the Middle Eastern countries wealth is unevenly distributed with some very rich families and has not lead to widespread economic development (Ross, 2001). The USA accounts for 5% of the world's population and is responsible for about 25% of the world energy consumption (Ewing and Rong, 2008), and related greenhouse gas emissions (Wilkinson *et al*., 2007).

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The world demand for oil and gas is increasing significantly each year due to rising demands from developing countries such as India and China where industrialization and the demand for consumer products is escalating at an unprecedented pace (Pachauri and Jiang, 2008). This means that the consumption of non-renewable energy is still rising.

If energy derived from fossil fuel sources can be replaced by solar energy then environmental damage can be reduced and energy can be generated at source without the need for an extensive infrastructure development for transporting oil, gas and electricity (Armaroli and Balzani, 2007). In this paper, energy analysis has been carried for a micro-business in the UK, which could be duplicated in Northern Iraq. Analysis of the available solar energy for such a business in both the U.K and Kurdistan, Iraq has been carried out together with an estimate of the reductions in harmful carbon emissions.

MATERIALS AND METHODS

The education centre uses simple equipment, which does not include intensive energy utilisation. It requires simple office equipment for its operation. The equipment used was noted to include 10 computers, 6 electric heaters, lighting, kettle, printer etc. Their power ratings were noted along with their usage. The amount of electrical energy used was calculated (Zhang and Shah, 2013). The data obtained was analysed to determine trends and explore various features. Using known and projected solar cell efficiencies the possibilities of replacing all or proportion of fossil fuel sources was investigated. A comparison between UK and Iraq made. The relationship between electricity usage and CO_2 was developed and calculations regarding the amount of CO_2 that can be prevented from entering into the atmosphere completed.

The amount of electricity used from a non-renewable source was measured in a Kip McGrath Education Centre, which was chosen as a business unit to investigate the system. This can be applied to any other micro-business units. The first step, was to evaluate and understand the tools and equipment used in the business process, and units that consumed electricity in the firm. The electricity used was taken from the main electricity meter. The electricity input was distributed into different components, tools, appliances and devices used in the business operation. An analysis of the usage of each equipment and device within the business was achieved by measuring the utilization time for each of tools and devices.

The energy used by each devices and other units such as the bulbs, appliance, music centre, computer, printer was measured. The timer was started as soon as the business started. A stopwatch was used to measure the time. The timer was kept on until day business complete. The time used was then noted. Several factors keep the devices, tools and appliances for longer period of time such as sleep mood technical problems. The same procedure was repeated for all other devices and tools. Calculation of the amount of electricity used been put down which is use of total time measured and the power rating of the devices and tools been used to for the job. There are other items, which they use electricity included: bulbs (including 100W and 60W), kettle for coffee and tea, music centre, heater and fridge. The music centre, lighting, printer and computer were on for the whole opening business amounting to 4 hours a day.

For each devices and tools which they consumed electricity can be use the calculation of:

$$Energy\ consumed = power\ rating \times time$$

$$E = P \times t$$

where the energy consumed is given in Joules, power rating in Watts and time in seconds.

RESULTS AND DISCUSSION

The power used by the devices and tools is given Table 3.1. This was used to determine electricity used for each devices and tools, which used in a Kip McGrath education centre business.

The education centre uses simple equipment, which does not include intensive energy utilisation. It requires simple office equipment for its operation (Wasilewski *et al.*, 2012). The weekly electrical energy used is given in Table 3.1.

Table 3.1. Devices, power ratings and electrical energy used per week

Equipment	Power rating (kW)	Weekly time (h)	Electricity used (kWh)
Computer 1	0.27	20	5.4
Computer 2	0.27	20	5.4
Computer 3	0.27	20	5.4
Computer 4	0.27	20	5.4
Computer 5	0.27	20	5.4
Computer 6	0.27	20	5.4
Computer 7	0.27	20	5.4
Computer 8	0.27	20	5.4
Computer 9	0.27	20	5.4
Computer 10	0.27	20	5.4
Printer 1	0.25	5	1.25
Printer 2	0.25	5	1.25
Total	3.20	210	56.50

The annual electricity consumption for equipment used to delivery educational programmes over the 40 weeks the centre is open is 56.50 x 40 = 2260 kWh. The annual cost is thus given by assuming 2260 x 20p per unit is £452.00 for computers and printers used. The number of days open during the year 2012 is given in Table 3.2.

Table 3.2. Days centre was open in 2012 and electricity used

Month	Days	Electricity used (kWh)
Jan	21	268.8
Feb	14	179.2
Mar	22	281.6
Apr	14	179.2
May	23	294.4
Jun	21	268.8
Jul	14	179.2
Aug	0	0
Sep	20	256
Oct	23	294.4
Nov	15	192
Dec	15	192
Total	202	2585.6
Mean	16.83	215.47

The daily use of electrical energy with heating, lighting and small appliances gives 2585.6/202 = 12.8 kWh opening 4 hours a day and using an average of 3.2 kWh from Table 3.1. Hence, the overall amount of electricity used in 2012 is 2585.6 kWh equating to annual amount at 20p per KWh to be 2585.6 x 20p = £517.12. Hence, 2585.6kWh/202 days = 12.8kWh per day and therefore using number of days open for January for example gives 12.8 kWh per day x 21 days = 268.8 kWh and repeated for the year 2012 (see Table 3.2.).

The data is plotted in Figure 3.1. below:

To explore the relationship between the number of days open and electricity the data was normalised and plotted on to of one another. A direct relationship is postulated. The plot is identical hence shown as a bar chart to illustrate.

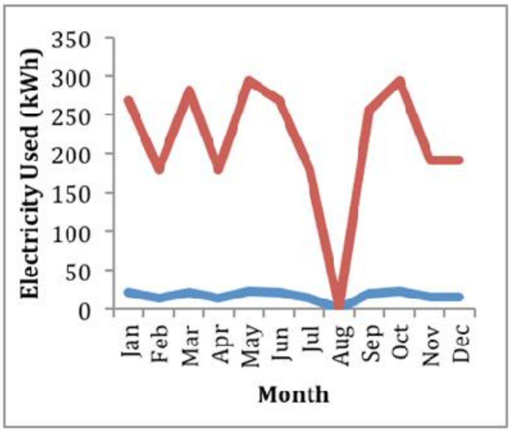

Figure 6.16. Electricity used and days the centre is open

Table 3.3. Normalised values of days open

Normalised days	Normalised electricity
1.2478	1.2475
0.8318	0.8317
1.3072	1.3069
0.8318	0.8317
1.3666	1.3663
1.2478	1.2475
0.8318	0.8317
0	0
1.1884	1.1881
1.3666	1.3663
0.8913	0.8911
0.8913	0.8911

The relationship between the electricity used is dependent in the number of days the centre opened. This is shown in Figure 3.3. Clearly there is a strong positive correlation between these two parameters as expected.

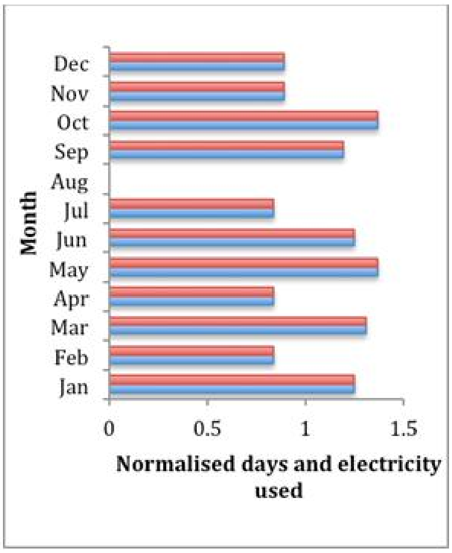

Figure 3.2. Normalised values of days open (blue line) and electricity used (red line). The zero value in August indicated that the centre was closed.

From the electricity bill the units used per annum were 3085 kWh and at 20p per unit the cost is £617.00. The difference between this value (£617) and the value of £517.12 calculated for 10 computers and printers of £99.88 is due to the cost of heating, lighting and computers in inactive modes when the centre is not open. There may be a very small element of using small appliances such as kettle, microwave and fridge.

In the final analysis the computers and printers use relatively small amount of electricity. In Kurdistan instead of heating the climate requires the use of air conditioning.

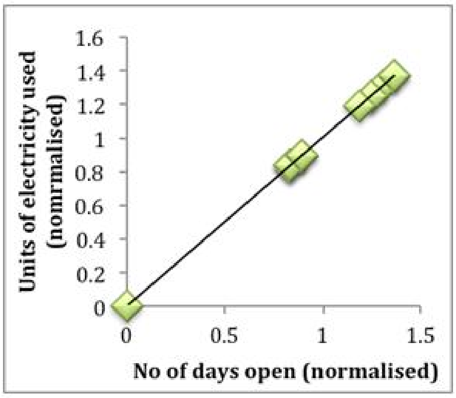

Figure 3.3. Amount of electricity used and the number of days a centre is open during the months of the year

The CO_2 emission from Kip McGrath Education Centre can be calculated. In the **UK 1kWh of electricity = 0.43 kg /CO_2.** The total amount of electricity used annually is 3,085 kWh, which yields 1,326 kg of CO_2 into the atmosphere to contribute to environmental problems such as global warming. For same of electricity used in Kurdistan using a conversion 1kWhr = 0.52 gives 3085 x 0.52 = 1,604 kg / CO_2 produced.

The 20% silicon solar cells when placed on the roof will generate 4.8kWh per day in the UK and 14.4 kWh per day in Iraq. Assuming that electricity not used immediately could be stored and used when required then annually 1,752 kWh and 5,256 kWh of electrical energy could be generated in UK and Iraq. Kip McGrath used 3,085 kWh kWh annually in 2012 hence 1,752/3085 kWh multiplied by 100 gives the percentage of electricity that can be replaced by solar energy which equates to 57%. However, in Kurdistan Iraq the value calculated 5256/3085 kWh multiplied by 100 gives 170%. As expected, Kurdistan is better suited for using solar energy to replace fossil fuels than UK. If the surplus energy was fed back into the grid then a handsome profit margin is achieved.

Conclusion

The Education Centre only uses computers and printers, which do not consume huge amounts of electricity. The study showed that in the UK 57% of the electricity usage could be replaced by solar energy compared to Kurdistan, which gave a Figure of 170% generating a surplus energy that could be fed into the national grid generating additional revenue stream for the business. CO_2 emissions released into the atmosphere show the education centre business being environmentally friendly.

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