Available online at http://www.journalijdr.com

International Journal of
DEVELOPMENT RESEARCH

IJDR

ISSN: 2230-9926

International Journal of Development Research
Vol. 5, Issue, 01, pp. 3025-3029, January, 2015

Full Length Research Article

REPLACING FOSSIL FUELS WITH SOLAR ENERGY IN AN SME IN UK AND KURDISTAN, IRAQ: KANSAS FRIED CHICKEN CASE STUDY

[1]Azad Azabany, [2]Khalid Khan, [1]Ari Azabanee, [1]Dara Ali, [4]Handren Azad and [3*]Waqar Ahmed

[1]Lancashire Business School, University of Central Lancashire, Preston PR1 2HE, UK
[2]School of Forensic and Investigative Sciences, University of Central Lancashire, Preston PR1 2HE, UK
[3]School of Medicine and Dentistry, University of Central Lancashire, Preston PR1 2HE, UK
[4]American University Sulemanyah, Kurdistan, Iraq

ARTICLE INFO

Article History:

Received 04th October, 2014
Received in revised form
28th November, 2014
Accepted 07th December, 2014
Published online 26th January, 2015

Key words:

Fossil fuels,
Management,
Commitment,
Micro-business,
Requirements.

ABSTRACT

Energy management and analysis are more common in large companies since they have the resources and commitment to assign such tasks to employee compared to SMEs. Only a very small proportion of the overall business costs pertains to energy requirements and therefore SMEs pay little attention to energy analysis and management. Fossil fuels, which cause issues related to global warming, can viably be replaced with renewable energy sources such as solar energy. Trends in solar cell development are likely to yield a potential solution to problems generated by an over reliance on fossil fuels. Solar solutions are relatively simple to implement in SMEs than in large corporation and the combined impact small businesses is likely to be much greater. A micro-business has been utilized as a cases study for the purposes of illustration in the UK and Kurdistan-Iraq. Even though Kurdistan-Iraq is abundant in oil and gas, its climatic favour the implementation of solar cells which can replace the existing use of non-renewable fossil fuel. Our comparative study suggests that solar can replaced a reasonable amount of the energy needs even in the UK and a much higher amount in Kurdistan-Iraq. Using 20% efficient solar, can replace 23% and 70% of the energy requirements of the microbusiness in UK and Kurdistan-Iraq respectively.

INTRODUCATION

Most of the world's energy comes from fossil fuels such as oil, gas and coal produced from crude oil and residues from the ground. The USA uses 25% of the world energy consumption with only 5% of the population worldwide (Ewing and Rong, 2008). The Middle East figure are opposite with 5% of the world's population and about 66% of world's oil reserves and 43% of world gas reserves, (Tsui, 2011). The developed countries use (Al-Ghandoor *et al*., 2013) electricity and gas originating from non-renewable fossils fuel sources. The technology (Cucchiella and Adamo, 2013 and Baines and Bodger, 1984), infrastructure and transport for generating and delivering these are well developed. Long-term consequences will result in substantial damage to the environment and will run out in the near future (Al-Ghandoor *et al*., 2009).

***Corresponding author: Waqar Ahmed**
School of Medicine and Dentistry, University of Central Lancashire, Preston PR1 2HE, UK

The demand for energy is increasing rapidly due to the desire for modernization and better lifestyle and rising population. Over reliance on fossil fuels is causing major environmental and economic issues such as global warming, this has arisen due to rapid industrial developments, rising population and dependency on fossil fuels and depletion of the ozone layer (O_3), burning of fossil fuels and use of CFC is also causing the depletion of the ozone layer above the earth's surface. The layer is becoming thinner and has holes in it. The ozone layer protects humans and other living species from harmful radiation of the sun causing skin cancers and other health issues. Researchers have estimated that over the last 100 years a temperature increase of 0.6^{o}C, which has caused sea levels to rise by 20 cm with severe consequences. Greenhouse gases production is stimulated by rapid growth in population, transportation and economy and the alarming rate of deforestation. Excessive global warming will cause disturbing changes to the climate causing ice caps to melt, rising sea levels and flooding having a severe effect on coastal settlements. In this paper, the feasibility of replacing fossil fuels sources of electricity with solar energy from the sun has been investigated. 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 Northern Iraq has been carried out together with an estimate of the reductions in harmful carbon emissions.

MATERIALS AND METHODS

The power ratings for the equipment and time used were noted over a period of one month (Zhang *et al*., 2013). The data obtained was analysed to determine trends and explore various features. Using known and projected solar cell efficiencies the possibilities of replacing as much possible of fossil fuel sources was investigated. A comparison between UK and Kurdistan-Iraq was 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 Kansas Fried Chicken which been picked as a business unit to investigate the system. The first step was to evaluate and understand the equipment and units that consumed electricity in the business. The electricity used was taken from the main electricity meter. The electricity input was distributed into different components, appliance and devices used in the business operation. An analysis of the usage of each equipment and device within the business was resolute by measuring the utilization time for each machine.

The average and peak energy consumption of this business was examined. The energy used by each machine and other units such as the bulbs, appliance, music centre, Pressure fryer, open fryer, heated display, breading table marinator, wet heat bain marie, heated chip scuttle, and cooler were measured. The timer was started as soon as the appliance been started and used. A stopwatch was used to measure the time. The timer was kept on until the job complete. The time used was then noted. Several factors keep the appliance for longer period of time such as technical problems longer time need for cooking. The same procedure was repeated for all other appliance. The analysis of each appliance utilised. The same methodology was for all appliances. The timer was started as the appliance was operating to cooking. The timer was turned off as soon as the operation was complete. Calculation of the amount of electricity used was made by using the total time measured and the power rating of the appliance been used. There are other items, which these use electricity include lighting (100W and 60W bulbs, kettle for coffee and tea, music centre, heater and computer. The music centre, lighting and computer were on for the whole opening business seven days a week.

For each appliance the monthly electricity consumed is calculated using the formula:

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

$$E = P \times t$$

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

RESULTS AND DISCUSSION

Analysis of electricity consumption and costs

The power and time used by the appliance is given in the table 3.1. This was used to determine localized electricity used for each appliance, was needed in preparing the food.

Table 3.1. Weekly appliance electricity usage and cost

Machine	Power rating (kW)	Time (hr)	Electricity used (kWh)	Cost (£)
Pressure fryer	11.25	57	641.25	96.19
Open fryer	2.49	80	199.2	29.88
Heated display	4.5	114	513	76.95
Breading table marinator	0.276	114	31.464	4.72
Wet heat bain marie	1	114	114	17.1
Heated chip scuttle	1.35	114	153.9	23.09
Cooler	0.23	114	26.22	3.93
Total	21.1	707	1679.034	251.9

The amount of electricity used by equipment is shown in figure 3.1. The pressure fryer used by far the greatest amount of electricity followed by heated display.

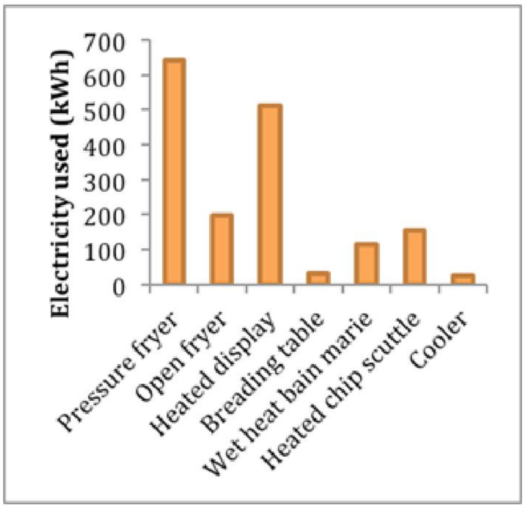

Figure 3.1. Electrical energy used by equipment in Kansas Fried Chicken

Since in this business there was little weekly variation these can be used to obtain the annual use readily by multiplying by 52. The electricity tariff is 15p per unit.

Table 3.2. Monthly and annual energy utilization and costs in 2012

Month	Units (kWh)	Cost (£)	Days Open
Jan	4580	680.59	31
Feb	5120	760.84	29
Mar	6520	966.55	31
Apr	6802	1010.56	30
May	6789	1015.09	31
Jun	6190	926.68	30
Jul	5580	833.59	31
Aug	4890	783.53	31
Sep	6332	998.48	30
Oct	6450	1012.91	31
Nov	6949	1092.83	30
Dec	8350	1150.64	29
Total	74552	11232.29	364

The weekly amount of electricity consumed by equipment was 1679.03 kWh and 15p per unit, the electricity charge is £251.86 per week, and therefore the annual when multiplied by 52 weeks gives £13096.72. Hence, £13096.72 / 364 = £36 per day from the calculation. When the actual electricity bill was considered it come to £11,232. The difference of £1864.2 between the amount of actual bill from the energy supplier and the figure calculated is due to fixed electricity costs of lighting, computer and other miscellaneous usage. The energy used and associated costs are shown in table 2.

Kansas Fried Chicken was open 7 days a week except Christmas day and boxing day. Hence, the business is open maximum possible days in the year. There is only a variation of 2 days throughout the year of 2012 which using 74552 kWh of electrical energy. Hence, assumed that the calculated monthly electrical cost was £13096.20 and the actual electric bill was 11232.29. The differences between the theoretical and actual value was: £13096.20 - £11232.29 = £1864 annually. Hence the daily differences between the theoretical and actual electrical energy used was about £5 per day. As a percentage of the daily rate, which the amount can be calculated as

$$\% \, difference = \frac{5}{36} \times 100 = 13.89\%$$

The efficiency of solar cells has been increasing as new materials and architectures have been developed. One of the major objectives of this study is to investigate the feasibility of replacing electricity generated from non-renewable fossil fuels with solar energy (Green, 1987)

Figure 3.2 shows the number of units of electricity used was analysed and plotted. Appears to be no correlation between the units used and the days the outlet is open. This relationship is examined closely by plotting normalised data.

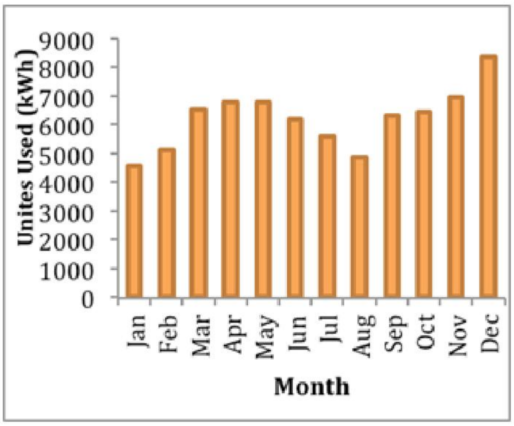

Figure 3.2. Units of electricity used during 2012

The relationship between the number of days open, units of electricity consumed and cost was explored by normalizing the data with the mean values see table 3.3 and figure 3. The number of days the Kansas Fried Chicken is open is fairly constant throughout the year with a variation of about 2 days, which reflect the calendar in 2012. When the units used and costs are examined the two normalised lines are almost on top of one another indicating a direct and close relationship as expected. This was confirmed by plotting cost again units used. A linear trend line is indeed seen in figure 3.4.

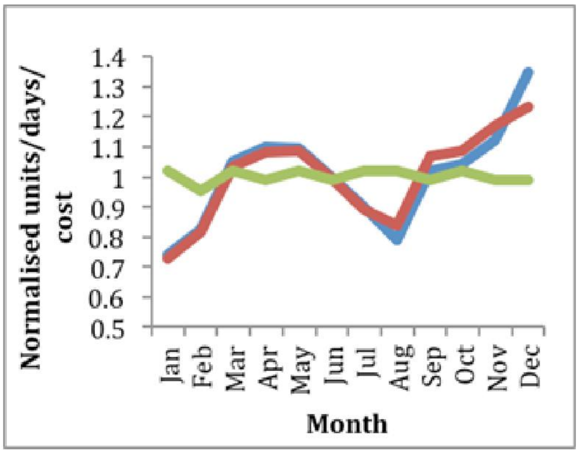

Figure 3.3. Normalised plots of days open (green line), units used (blue line) and costs (red line)

Table 3.3. Data obtained for 2012 which showing normalised of opening days, units of electricity consumed and the costs

Month	Normalised Units	Normalisd Costs	Normalised Days open
Jan	0.7372	0.7271	1.0191
Feb	0.8241	0.8128	0.9533
Mar	1.0495	1.0326	1.0191
Apr	1.0949	1.0796	0.9862
May	1.0928	1.0845	1.0191
Jun	0.9963	0.9900	0.9862
Jul	0.8982	0.8906	1.0191
Aug	0.7871	0.8371	1.0191
Sep	1.0192	1.0667	0.9862
Oct	1.0382	1.0821	1.0191
Nov	1.1185	1.1675	0.9862
Dec	1.3440	1.2293	0.9862

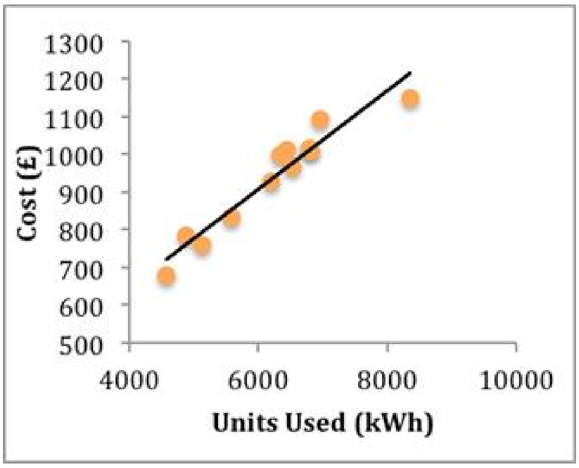

Figure 3.4. Relationship between costs and units of electricity used

Feasibility of replacing fossil fuels with existing silicon solar panels

By replacing non-renewable source with solar panels we can prevent CO_2 from being released into the atmosphere to cause global warming and other environmental disasters. With millions of small businesses exist worldwide this will have a significant long-term impact. Solar cells rely on sun light for their mode operation it is useful to compare UK with Kurdistan- Iraq.

Table 3.4. Electricity consumed and the carbon dioxide generated

Month	Units consumed (kWh)	UK Carbon dioxide produced (kg)
Jan	4580	1969.4
Feb	5120	2201.6
Mar	6520	2803.6
Apr	6802	2924.86
May	6789	2919.27
Jun	6190	2661.7
Jul	5580	2399.4
Aug	4890	2102.7
Sep	6332	2722.76
Oct	6450	2773.5
Nov	6949	2988.07
Dec	8350	3590.5
Total	74552	32057.36

The annual consumption of electricity was 74552 kWh, which can be equated to the amount of CO_2 released into the atmosphere, which equates to 32057.36kg of CO_2.

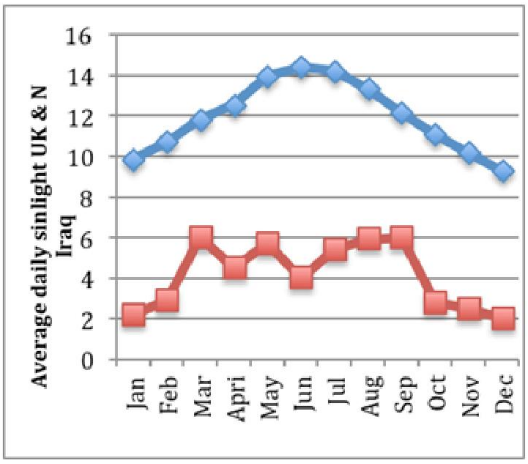

Figure 3.5. Shows a comparison between average daily sunshine in Kurdistan-Iraq compared to UK in 2012

The daylight hours are shown in Figures 3.5, the UK in the winter the average amount of sunlight per day is about 2 hours equating to about 60 hours per month whereas in the spring, autumn and summer it is about 5 hours, which is about 150 hours per month [14]. When this compared to Kurdistan, Iraq the figure are 10 hours and 14 hours respectively per day. Hence, it not surprising that the weather conditions in Northern Iraq are more conducive to solar cell technology than the UK.

The expected electricity generated using solar panels can be calculated as follows:

$$Electricity = A \times 1000 \times \xi \times t$$

A is the area of solar panels, ξ is the efficiency and t is the

hours of sunlight to give the electricity generated in kWh per day. Assuming the Kansas Fried Chicken and can calculate the amount of electricity that can be generated daily in UK and Iraq. The physical dimensions of the roof are 6 x 2 = 12 m^2 and about 50% of it is available for installation of silicon solar cells. Hence, an area of 6m^2 is this available for solar cell installation. The amount of electricity generated in a typical day UK is

Electricity (UK) = 6 x 1000 x 0.2 x 4 = 4,800 Wh/day = 4.8 kWh/day

The efficiency was assumed to be about 20% with daylight of 4 hours typical an average in the UK in 2012 and the amount of electricity generated per day would be 4.8 kWh/day. Compared with Northern Iraq the calculation involves longer hours of daily sunlight and the intensity of sun is also much higher hence repeating the calculation gives. In Kurdistan-Iraq the amount of electricity generated for an equivalent business unit using the same solar cells 14.4 kWh/day electricity can be compared to the UK value of 4.8 kWh//day due to better weather conditions and therefore use of solar energy is much more attractive. This is 3 times more electricity generated in Northern Iraq compared to the UK making it more attractive as an environmentally friendly technology solution for energy production.

Table 3.5. Comparison between the UK and Northern Iraq for 20% efficient solar cells and corresponding amount of reduction in CO_2

Silicon Solar cell efficiency (%)	UK (kWh)	N. Iraq (kWh)
20	4.8	14.4
Annual (363 days)		
20	1742	5227
Annual CO_2 reduction (kg)		
20	749	2718

Clearly calculations for the replacement of fossil fuels with solar cells show that the carbon emission will be decreased and reduce damage to the atmosphere. The benefits in Iraq would be much greater due to more sunlight and a about 3.6 times the reduction in CO_2 emissions can be achieved in Northern Iraq compared to UK. This is also applicable to other countries in the Middle East. For the UK we calculate the percentage of electricity generated from 20% efficient solar cells compared to fossil fuels to be as follows:

$$\%E(replaced) = \frac{E(solar)}{E(fossil)} \times 100$$

$$= \frac{1742}{\mathbf{74552}} \times 100 = 2.3\%$$

However, for the same business in Northern Iraq with 20% efficient silicon solar cells and longer day light hours we can calculate the percentage of electricity needs that can be replaced with solar cells.

Table 3.6. Comparison of the percentage of current electricity requirements that can be replaced with solar energy using with silicon solar cells

Solar cell	% Energy requirements replaced with solar in the UK	% Energy requirements replaced with solar in Northern Iraq
Silicon solar cells (20%)	2.3	7

The calculations above using the solar panel with efficiency of 20% can replace only 2.3% of the total electricity required to run Kansas Fried Chicken in the U.K. The replacement of fossil fuels with solar cells will also reduce the carbon emission into the atmosphere and reduce damage to the environment. However, in Northern Iraq due to longer daily and annual daylight hours we can replace 7% of the energy needs with silicon solar cells.

Conclusions

A comparison between a micro-business in the UK and Kurdistan-Iraq for energy utilization has been done. For existing solar cells we can replace 2.3% and 7% of the energy requirements of the microbusiness in the UK and Northern Iraq respectively. The impact of fossil fuels on the environment in terms of carbon emissions could be reduced dramatically when summed over all such micro-businesses within the countries.

REFERENCES

Ewing, R. and F. Rong, 2008. "The impact of urban form on US residential energy use," *Housing Policy Debate,* vol. 19, pp. 1-30.

Tsui, K. K. 2011. "More oil, less democracy: Evidence from worldwide crude oil discoveries*," *The Economic Journal,* vol. 121, pp. 89-115.

Al-Ghandoor, A., M. Alsalaymeh, Y. Al-Abdallat, and M. Al-Rawashdeh, 2013. "Energy and exergy utilizations of the Jordanian SMEs industries," *Energy Conversion and Management,* vol. 65, pp. 682-687, 1//.

Cucchiella, F. and I. D'Adamo, 2013. "Issue on supply chain of renewable energy," *Energy Conversion and Management,* vol. 76, pp. 774-780, 12//.

Baines, J. T. and P. S. Bodger, 1984. "Further issues in forecasting primary energy consumption," *Technological Forecasting and Social Change,* vol. 26, pp. 267-280.

Al-Ghandoor, A., J. O. Jaber, I. Al-Hinti, and I. M. Mansour, 2009. "Residential past and future energy consumption: Potential savings and environmental impact," *Renewable and Sustainable Energy Reviews,* vol. 13, pp. 1262-1274.

Zhang, D., N. Shah, and L. G. Papageorgiou, 2013. "Efficient energy consumption and operation management in a smart building with microgrid," *Energy Conversion and Management,* vol. 74, pp. 209-222, 10//.

Green, M. A. 1987. "High efficiency silicon solar cells," in *Seventh EC Photovoltaic Solar Energy Conference*, pp. 681-687.

****