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Towards a UTAUT-Based Model for the Intention to use Solar Water Heaters by Libyan Households

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ABSTRACT: Among the most fundamental features to ensure the success of a new technology introduction is citizen acceptance. Based on a unified model, called the Unified Theory of Adoption and Use of Technology (UTAUT), this paper provides new insights into predicting adoption and identifying of the factors that may prompt people to accept and use of Solar Water Heaters as a concrete step toward using Renewable Energy Resources, and offer guidelines for energy saving for the Libyan government and that will contribute to the economy of the country.

Keywords: Solar Water Heaters; Technology Acceptance; the Unified Theory of Adoption and Use of Technology (UTAUT); Libyan Household
JEL Classifications: D10; Q20; Q42; Q48

1. Introduction

Renewable Energy Sources (RES) have received considerable attention recently with rising concerns regarding environmental problems and a greenhouse gas effect as well as the limits on existing fossil-fuel reserves (Lloyd and Subbarao, 2009). RES have the potential to make a large contribution to sustainable and independent energy future. Solar energy is one of the main sources of renewable energy that are environmentally friendly in providing electricity, it can be used as a clean alternative energy that will replace conventional energy sources and will allow us to maintain the demand levels of energy consumption (IEA, 2009).

In particular, many technologies already exist that have proven its viability, environmentally-friendly, available and affordable, including Solar Water Heating (SWH). For these technologies to have a significant impact on the economic level, it requires the householders' acceptance to use these innovations.

The uptake of SWHS remains low in Libya and households are still not realizing the practical of using these technologies, due to the low cost of electricity which is almost fully subsidized by the government (Zaidan, 2012). The utilization of renewable energy is not a matter of using non exhausting source of energy, but also as economical and environmental issues. The Libyan householders are not concerned about the conservation of energy, as long as they are paying a very low tariff for electricity. However, the concern of the people will be very high when the government subsidy for electricity will be terminated in the near future; therefore the possibility of shifting towards Solar Water Heaters will provide great benefits for government and Libyan households.

The objective of this paper is to present a proposed model to understand and explain more about the level of acceptance to convince households to install SWH. This paper aims to modify the unified theory to best fit the perspective of a Libyan context.

2. Unified Theory of Adoption and Use of Technology (UTAUT)

One way to ensure success of a new technology introduction is to predict adoption and identify variables that may prompt people to use this technology. Researchers have used a set of technology acceptance models including, the Theory of Planned Behavior (TBP) (Ajzen, 1985), Theory of Reasoned Action (TRA) (Fishbein and Ajzen, 1975), Technology Acceptance Model (TAM) (Davis, 1989), and Diffusion of Innovation Theory (DIT) (Rogers, 1995) to measure these variables and assess individual behavioral intentions.

Instead of empirically testing technology acceptance models in an attempt to arrive at a comprehensive understanding in explaining why individuals adopt a new technology, Venkatash et al. (2003) proposed a Unified Theory integrating acceptance determinants across several competing models.

The UTAUT is considered the most powerful predictive model that relies on behavioral models from a number of acceptance theories which were developed to predict technology adoption. The key benefit is that the UTAUT offers a helpful means for managers to measure the households' behaviors towards the acceptance of a new technology that will be adopted and assists them to take preventative measures to improve acceptance (Anderson et al., 2006).

The UTAUT model will be used in this paper due to its strong theoretical foundation, comprehensiveness, and high explanatory power. Additionally, UTAUT was able to explain 70% of technology acceptance behavior, whereas other technology acceptance theories are explaining 40 % acceptance only (Davis et al., 1989; Venkatesh et al., 2003). Therefore, UTAUT application will have a positive impact and an extremely immense contribution towards solar energy systems adoption.

3. Potential of Using Solar Water Heaters in Libya

Libya is located in the middle of the North African region, with a population of 6 million distributed over a total area of 1,750, 000 km^2. It has a significant geographical location as it is laying in one of the highest solar radiation regions in the world, with a daily average of the sunshine duration of more than 3500 hours per year, and more than 8.1kWh/m^2 per day(Saleh, 2006), The climate is bitterly cold in winter with temperatures below 0° C (LMD, 2000). Libya is an oil exporting country and as is the case with some Middle Eastern countries, suffers from a lack of appropriate national policy to the energy conservation, planning, and numerous economic problems such as reliance on oil and gas revenue as the main source of national income (Zaidan, 2012), but even though the country's overdependence on oil and natural gas poses seriously on economic and environmental problems, solutions do exist.

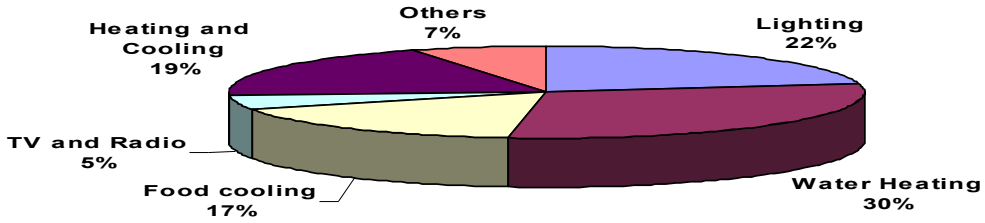
During the last quarter of the previous century, various sectors and economic activities in Libya witnessed rapid and significant development. This development led to the growth in electricity demand. Consumption per capita of energy has been multiplied more than six times during this period, where consumption per capita increased from 338 kWh in 1970 to 4360 kWh in 2008 (Ekhlat et al., 2009). Therefore, meeting this demand has become a significant problem of concern, and has an impact on the country economy. Thus, it is clear that Libya will face serious challenges as it attempts to meet the rising demand of energy, at the same time it seeks to decrease its dependence on short-lived and potentially volatile oil and natural gas to relieve the negative environmental impacts.

According to a recent report of General Electricity Company of Libya (GECOL), the residential sector represents the highest percentage in electrical energy demand; this reflects the importance of this sector in total energy use (GECOL, 2012). The data contained in this report indicates that electricity has been used heavily in heating and cooling. Water heating consumes 30% of the amount charged on household electricity bills, which accounts for just 12% of the total energy consumption in Libya as shown in Figure 1.

Of all the house appliances, an electric water heating (EWH) usually represents the biggest energy consumption (George and Associates, 2009). Thus, the current practice to heat water using EWH, is highly inefficient as energy is extracted from fossil fuels and then converted into electricity before it is transmitted across long transmission distances to the end user who eventually uses this electricity to heat water. Hence, domestic water heating represents a real and significant burden on the public network for electricity. This goes to raise the question of what is going to happen if the oil prices spikes to a high level or in view of the fact that the country approaches the end of the oil age. It is expected to be exhausted in 40 years if extraction continues at its present pace (Saleh, 2006), this

implies that the demand side management must be directed towards substituting appliances which consume large amounts of electricity with those that use alternative energy sources.

Figure 1. Electricity consumption in domestic sector,



Actually, electricity is strongly subsidized by the Libyan government, where the current electricity tariff for the residential sector in Libya is about 2 Libyan cents per kWh whereas the real price is 30 cents per kWh(GECOL, 2010). One of the main obstacles for shifting towards renewable energy measures is the extremely low price for oil and gas that are highly subsidized. These subsidies create some issues to the county, such environmental problems, and the 'over-usage of energy'.

Indeed, a recent article published on AllAfrica.com suggests that the abolition of subsidies for fuels and electricity would potentially release funds for a range of purposes. Such views are substantiated by the International Energy Agency, which believes that solar energy resources have massive potential as a credible source of sustainable energy in Saharan Africa.

Regarding to the subject of subsidies, on 29 May 2013 Prime Minister mentioned that the Libyan government will publish proposals on energy subsidy reform in October or November of this year, wherein it is thought that targeted cash payments for households will be established in combination with gradual phasing-out. Given this picture, people will go directly towards Solar Water Heating substitute electricity consumption. Consequently, this shifting will provides great benefits to government and Libyan households.

SWHS are appliances that utilize the sun's energy directly to heat water and provide it to households, hotels, factories and other recipients (Karagiorgas et al., 2003). Widespread SWHS not only help in bridging the gap between demand and supply of electricity during peak demand but also save money in the long run. Thus, a typical family can save 350 USD a year on electricity bills (Philibert, 2005).These technologies reduce reliance on traditional fossil fuels that provide electricity for water heating systems.

Many countries in the world have used SWHS to replace ordinary electric water heaters for example, in Greece and Palestine almost 80% of the houses using SWHS as a way to heat water. Currently, the use of solar energy systems to heat household water in Libya is extremely limited. The usage of solar water heaters started in the early 1980 by installing a pilot project of 30 units installed in the southern part of the country. This pilot project was not successful due to a lack of obvious policy or serious plans to establish such technology. This was followed by some other projects implemented in the city of El-Marge and the town of Al Burayqah. There are all together about 2,000 units spread out in different parts in the country (Siala and Abdurhaman, 1995). However, despite the large potential that offered by these technologies, the country continues to rely heavily on conventional fuel as well as electricity for water heating. As such, there is considerable scope to increase the application of SWHS in the country.

The use of SWHS for the Libyan householder will be reflected on his electric bills by 30% and for the country economic by 12%. Yet the use of SWHS has not been widely used due to many factors that will be analyzed in the following methodology which will promote the use of the SWHS.

4. Methodology

Although the advantages of using SWHS are very clear yet this technology has no public acceptance due the following factors.

- Government subsidy and the very low tariff for electricity
- Lack of environmental awareness
- The SWHS high cost
- The house structure and orientation

These factors can be summarized in a modified model which is based on UTAUT model. The modified model offers a helpful means for managers to measure the households' behaviors towards the acceptance of a new technology that will be adopted and assist them to take preventative measures to improve acceptance. Understanding attitudes towards such innovations could be taken to develop effective interventions that will connect with those households improve sustainability of Libyan homes. One example might be that the attitudes towards usage are very low which may indicate that households feel that SWHS are too costly and they do not have the resources to purchase it. Another example may be that the effort expectancy may be low indicating that perceived ease of use could help the households feel more comfortable using the new tool and perhaps facilitate their acceptance.

The model which will be used to promote the wide use of SWHS will have a positive impact and an extremely immense contribution towards solar energy systems adoption. The extended and revised model was tailored to suit the nature of Libyan households by adding other factors such as attitude towards usage, awareness & knowledge and environmental concern as shown in Figure 2.

According to the enhanced model, intention to use SWHS can be determined by four factors which are performance expectancy, effort expectancy, social influence, and attitude towards usage. The four components of households' acceptance were moderated by awareness, knowledge, and environmental concern. The performance expectancy will measure how much households perceive a system, such as SWHS, it is useful in achieving the householders goals in terms of lowering their electricity bills, and contributing to reduce of using limited natural resources.The other predictor employed is effort expectancy, which explains how much individuals feel comfortable in using the system and ease to adopt, with this point in mind the Libyans are expected to adopt any new system. The third factor proposed of the intention to install SWHS is social influence, i.e. the individual's influence of others opinions about the acceptance and usage of new technology. Libyan households will be encouraged and favorable to use a new technology because of the perceptions of family members, or their neighbors influence. The last factor is the attitudes toward usage, i.e. the degree to which households' overall reacte to use a system. It is also clear that at least two other moderating factors are at play, will lead to provide new insights into the adoption of solar energy technologies. These additional factors are awareness, knowledge, and environmental concern.

The model presented in this paper is a modified UTAUT model to be used in looking at the acceptance of a particular technology in a unique context. The factors added in the model are attitude towards usage, awareness & knowledge, and environmental concern which can be used to promote using the SWHS for householders in Libya. This argument is justified by the fact that this paper focuses on the behavior of the citizen and the issue of acceptance level is of great significance in this case,and thus the shift from UTAUT model with some modifications. The acceptance of using SWHS has many outcomes on economic for both individuals and country, saving depleting sources of energy, and serve the environment issues.

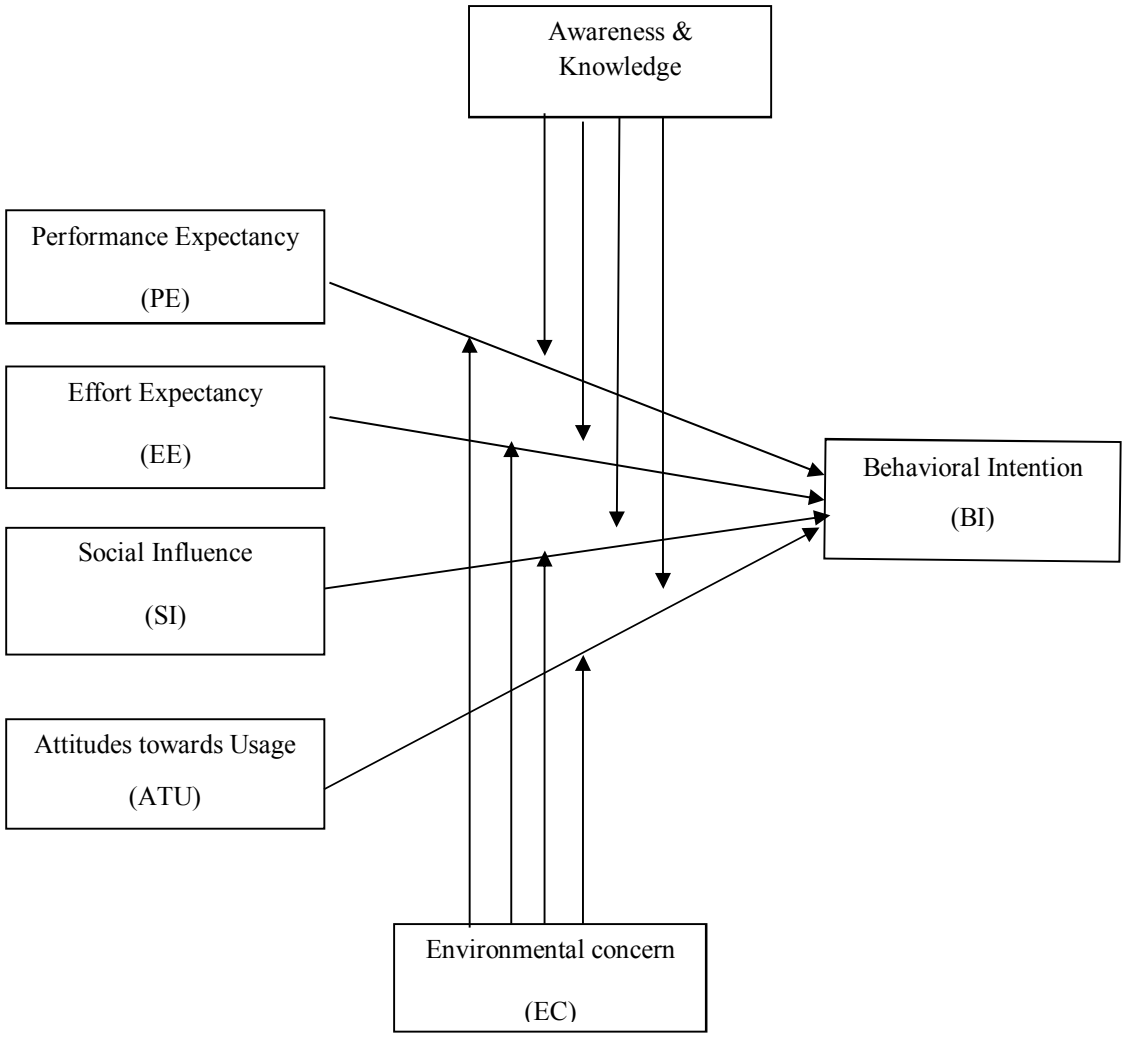
5. Discussion and Conclusion

In Libya the use of electric heaters consumed 30% of the electric consumption of individual householder i.e. 30% of the electric bill, while overall country electric energy consumption used for water heating is 12% i.e. replacing all the electric heaters by Solar Water Heaters will save the country 12% of the total energy and that means shutting down 12% of the power generated capacity (Agha, 2013).

According to a recent report released by the Renewable Energy Authority of Libya (REAOL), the demand for electricity is growing rapidly with an increase of 7% per year and, if unchanged, continue grow alarming rate. For example, in 2012 it is estimated that the energy consumption of the water heaters will 4,077GWh out of 33,980 GWh the total consumption energy (GECOL, 2012). As of the real cost of the electric energy this means saving 1.223bLD(0.94m$). In 2020 the total electric

energy demand is expected to be 55.660GWh, while the water heating is 6,679GWh , with today's cost of electricity that will be 2.0bLD(1.5 b$), and that will be more if the price of oil goes up dramatically, the issue will be if the price will go up is the government will continue to burn oil to generate electricity !,this will lead to convince the house holder to use SWHS as a way to heat water instead of electric heaters.

Figure 2. The Modified Model



Under this modified model, the next step after the theoretical framework has been established is to test the theory; the following have to be completed: Designing questionnaires; development of Hypotheses; and designing appropriate methods to measure the constructs of the research model and collection and analysis of data for model validation

The way to move toward Increasing the adoption of SWHS by individuals householders and decrease depends on oil in the Libyan energy mix will make a growing contribution to Libya's economy. To assure the wide use of SWHS and set a national plane toward this goal, we suggest following recommendations:

- The Libyan government should move cautiously and determinedly, with an eye to securing a long-term and successful subsidy transition.
- Subsidies for fuels and electricity should be reduced step by step until that does not make the Libyan poor worse.
- To avoid negative social effects of higher fuel prices there should be a compensation for households through a direct payment by the government.
- To avoid negative reactions the cutting of electricity subsidies need to be accompanied by an effective public campaign. If those householders are aware of the compensation mechanism and their income is higher than energy prices, in this case, they may be more easily accepted.

- The Libyan government should provide financial support for households who plan to install solar water heaters.
- To encourage households' acceptance of SWH, the government should promote the system' s usefulness (performance expectancy), its ease of use (effort expectancy), and these systems are safer than existing systems and contribute to conservation of energy(attitudes towards usage) more than promoting the resources needed to use the system (facilitating Conditions).

The acceptance of a new technology by individuals in many countries may not be that easy, and it is more difficult in underdeveloped countries, in Libya the use of SWHS has no wide acceptance for many reasons in spite of it's important for the country economy. To promote using SWHS by Libyan householders a set of factors has been presented by this paper to form a modified model from UTAUT model, the model can be used to predict household's behavioral intention to use a SWH technology, diagnose why this technology is not adopted, and finally provide guideline to the government to implement the use of SWHS as it is planning to remove the subsidy on electricity.

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