



Energy Conservation Awareness among Residential Consumers in Saudi Arabia

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Abstract: Energy efficiency and conservation practices can significantly help governments to reduce electricity demand if well developed and utilized. Saudi Arabia boasts the world's largest proven oil reserves. The Saudi Arabia wealth of energy resources has allowed the country to keep domestic energy prices low, through a system of direct and indirect subsidies. However, Saudi Arabia is facing unrestrained energy consumption, which has increased by more than 30% since 2000. The inefficient consumption of energy is costing the country's budget heavily in subsidizing the sector. This study measures the Saudi residential sector awareness of energy conservation best practices and the challenges facing the energy sector in the Kingdom. The residential sector is the biggest sector in energy consumption. A questionnaire survey was designed and implemented. The survey quantitatively and qualitatively assessed consumers' awareness in billing, efficient appliances and lighting systems. The survey findings suggest that Saudi consumer behaviors in energy are influenced by economic, educational, social, and cultural factors.

Keywords: Energy Efficiency and Conservation, Public Awareness, Questionnaire Surveys, Saudi Arabia

1. INTRODUCTION

The Kingdom of Saudi Arabia (KSA) is located in the Middle East Region between the Red Sea and Arabian Gulf with a total area of about 2 million square kilometers [1, 2, 3]. The population of the KSA is about 30 million and has been growing at an average growth rate of 3.4% for the last four decades [2, 3]. About 80% of the Saudi population are living in urban areas of which there are five urban centers with a population of more than one million: Riyadh 5.2 million, Jeddah 3.4 million, Makkah 1.5 million, the Eastern area (Dammam, Al Khobar and Dhahran) 1.3 million, and Madinah 1.1 million [4-6]. The country owns the largest crude oil reserves in the world and is currently the largest crude oil producer [7-12]. The crude oil revenue has resulted in a major increase in country-wide standards of living and urbanization. Consequently, the country's modernization has resulted in ever increasing energy demand for residential, commercial and industrial sectors [9-12]. Currently, the Kingdom is largest oil consuming nation in the Middle East. The country has used approximately 3 million barrels of oil per day in 2012 [9-12]. The latest Saudi energy efficiency report mentions that Saudi Arabia's primary energy consumption per capita is 3.6 times higher than the world average, at an average per capita consumption of 6.7 tons of oil equivalent (TOE) in 2010. TOE is a unit representing energy generated by burning one metric ton (1000 kilograms or 2204.68 pounds) or 7.4 barrels of oil, equivalent to the energy obtained from 1270

cubic meters of natural gas or 1.4 metric tons of coal, that is, 41.87 gigajoules (GJ), 39.68 million Btu (MMBtu), or 11.63 megawatt-hours (MWh) [8].

The Kingdom of Saudi Arabia is known for its fast and population, economic, and industrial growth, mainly boasted by petrochemical and oil industry. The high growth rate has come with substantial growth in per capita consumption of energy. Recent studies showed that Saudi Arabia's "electricity consumption has been growing rapidly since 1990 at an average annual rate of about 6.2% and that surge was propelled by demand in the residential and service sector" [13-20]. The status has exerted substantial pressure on the country energy sources and economy. Furthermore, the potential environmental impact of high energy consumption added stress on the government to take measures to reduce energy demand [20-26]. In response to the population and economic challenges that face the Kingdom, the country launched a very comprehensive development policy; 'Vision 2030' aims to build the best future for the country. The Vision 2030 is based on three pillars that represent the unique competitive advantages of the Kingdom. The ambition is to create a more diverse and sustainable economy and will use the country's strategic location to build its role as an integral driver of international trade and to connect three continents: Africa, Asia, and Europe. The three pillars of the vision include a vibrant society, a thriving economy, and an ambitious nation. The National Transformation Program was developed to fulfill the vision's objectives

and to identify the challenges faced by the governmental bodies in the economic and development sectors. The program has established strategic objectives that are based on the vision's aims and has addressed its challenges through 2020 by specific targets. Energy conservation is a key challenge and highly specified in the Vision 2030 and on the National Transformation Program [27, 28]. Residential awareness, one of the key challenges facing the nation, is crucial for the successful implementation of conservation programs [20]. The Saudi resident awareness of electricity conservation has been rarely investigated. Samar et al [29] have conducted research in 2014 to investigate the reasons behind the lack of energy efficiency practice amongst Saudi Arabia's consumers and how consumer behavior may be changed to reduce energy waste and increase efficiency. Their study was based on survey questions mostly with open ended where some respondents might find it hard to express their answers.

This study aims to understand the status of energy conservation practices in the Kingdom. The first part highlights the key initiatives undertaken by the government to enhance energy conservation practices. In the second part, a questionnaire survey was designed with the aim to assess the level of awareness among Saudi residents to energy conservation practices and to identify the reasons behind the high level of energy consumption from residential sector in the kingdom of Saudi Arabia. This research explores what could be changed about Saudi consumer behavior that may help increase energy efficiency, reduce energy consumption and cut on (CO₂) emissions. It also explores the effects of enhancing energy efficiency practice on energy security in the country.

2. ENERGY EFFICIENCY INITIATIVES

The government of Saudi Arabia has taken strong measures towards improving energy efficiency practices in the recent years. The government has introduced many initiatives and programs in this direction. These initiatives are planned, implemented and followed up mainly by the Saudi Standards, Metrology and Quality Organization (SASO) and The Saudi Energy Efficiency Center (SEEC).

A. The Saudi Standards, Metrology and Quality Organization

The Saudi Standards, Metrology and Quality Organization (SASO) have issued the regulation of energy efficient label in 2010 according to the Third, Fourth and Ninth Articles of SASO regulation issued by Royal Decree No. 216 on 06.17.1431. The regulation aims to rationalize the consumption of electric energy towards preserving the national economy as well as reduce consumption of the average consumer. The regulation provides a scientific and practical means to average consumers based on standards, with taking advantage of the international best practices. It also sets areas of standardization in the service of all interested parties, especially the average consumer who needs a practical, simple and reliable way from a neutral party to compare

different electrical products in terms of efficiency in the electric consumption by the label attached to each appliance. This will give the consumer the ability to acquire appliances with high efficiency in electricity consumption without incurring conformity expenses by testing, or the need to go into the standards technical details. The technical details and testing will be handled by (SASO) on his behalf [30]. The energy efficiency label for electrical appliances is a label to educate the consumer attached on the electrical appliances such as (air conditioners, refrigerators and other) includes clarification of the appliances' performance and efficiency as shown in Figure 1. Applying this label will contribute to rationalize the electricity consumption on the country and the consumer in general, which leads to reducing the burden of monthly expenses.

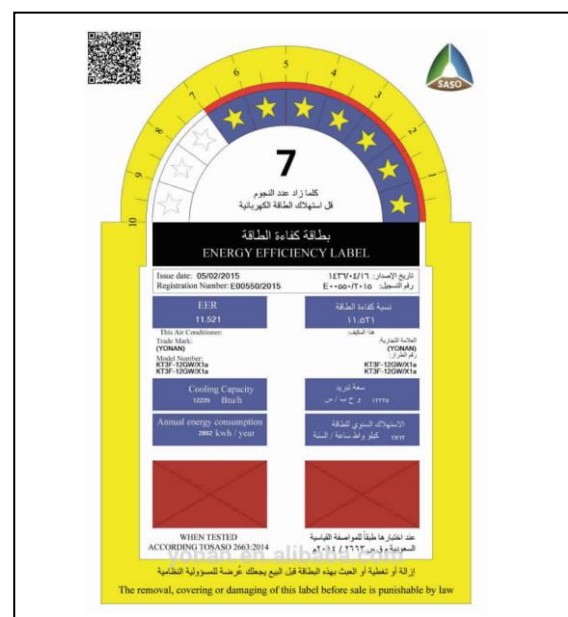


Figure 1. A sample of energy efficiency label used in Saudi Arabia [31]

B. The Saudi Energy Efficiency Center

The Saudi Council of Ministers has created The Saudi Energy Efficiency Centre (SEEC) in October 2010, based on a Royal Decree. The Centre mandate is the development of energy efficiency and conservation policies targeting all economic sectors. (SEEC) was created to provide particular services and solutions to reduce costs and enhance quality by setting up national program for rationalization and enhance energy consumption efficiency, as well the required plans [32]. SEEC is currently operating under the umbrella of King Abdul Aziz City for Science and Technology (KACST) and teamed up with major players such as ministries and other governmental entities as well main energy companies in the country. Currently, the program is establishing initiatives for the most important three economic sectors, which consume more than 90% of the total local energy consumption, i.e. construction, land transportation, and Industry sectors.



SEEC has also developed a comprehensive program to enhance residential energy consumption. SEEC has evaluated the best international practices to specify the standards which provide best energy efficiency in air conditioning, thermal insulation materials, lighting, and home appliances. The program has developed new systems and mechanisms to monitor air conditioning and insulation materials whether imported or manufactured in Saudi Arabia, to ensure compliance with the Saudi metrics and specifications. As far as the Saudi code concerned, the program, in coordination with the National building code committee have updated and simplified the standardized criteria and procedures mentioned in the code which related energy efficiency, in addition to setting mechanism that guarantee implementing the code. The program has developed initiatives for the new buildings, starting with the units being developed by governmental financing (Ministry of Housing: half million units, Aramco: 7000 units, SABIC: 4000 units) [31], and the new governmental buildings, including mosques, schools, and hospitals, and reaching the private buildings not being constructed yet, to ensure compliance with program’s objectives, and to be a role model for the people. In regard to the existing buildings, the program will execute some projects to modify some of the existing governmental buildings, and launch a lead to encourage people to modify their houses, and use high energy efficiency appliances to rationalize and enhance energy consumption efficiency.

3. METHODOLOGY

A. Outline of the questionnaire

A survey has been designed and distributed to assess the public awareness on energy conversation, and resident’s willingness and readiness to use energy efficient appliances in their houses. The survey distribution goal was to collect as much feedback from public as possible. The survey was distributed using two methods: online and in person. The survey was made available online (surveymonkey.com). A digital link was made available to the public and university employees through e-mail distribution. The same survey was conducted in person at a universities campus and shopping malls to ensure diversity of respondents. The survey consisted of a short description of the research topic, assurance of confidentiality (names, addresses and phone numbers), and the contact information for researchers. The survey mainly consisted of three parts: first of all, demographic questions; secondly, questions measuring the public’s knowledge of energy billing including tariff used and bill information. Thirdly, questions measuring the public’s willingness to start using energy efficient appliances in their houses.

B. Survey respondents characteristics

A total of 528 interviews were conducted, within habitant of the three major cities in the Kingdom, Riyadh city, the capital of Saudi Arabia, Dammam city in the eastern province and Jeddah in the western province. 58% of participants were in Dammam area as it is the

residing area of the research team, 28 % of participants from Riyadh area and 16% from Jeddah area.

The majority of the participants (60%) are in their early twenties to early forties as shown in Figure 2.

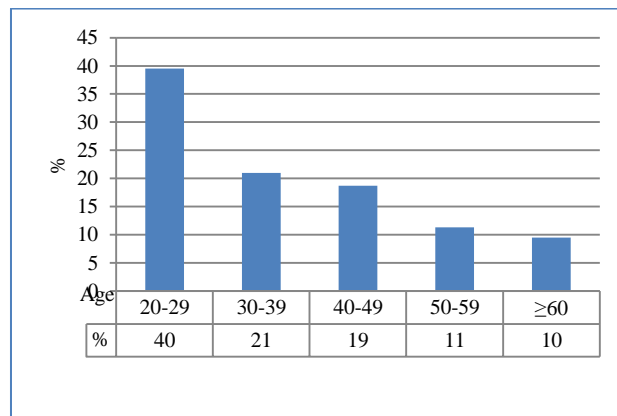


Figure 2. Survey Respondents Age Group

The vast majority of respondents are employed and have and have their independent incomes, with an average age of approximately 35 years. Figure 3 demonstrates the level of education for the participants, 19.7% of the participants hold a diploma, and 49.4% hold a bachelor’s degree and 8.2% have postgraduate degrees, which means that the sample is considered an educated sample and that matches the relatively high education level in the Saudi major cities.

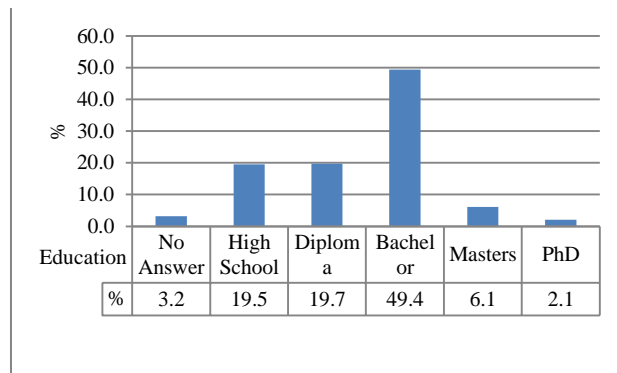


Figure 3. Respondents Education Level

The respondents have been asked about their housing status. 39% of the participants were living in rented houses, meanwhile 58% owned their own homes, and 3% gave no answer to this question as shown in Figure 4. The sample housing status represents the housing status in the Kingdom.

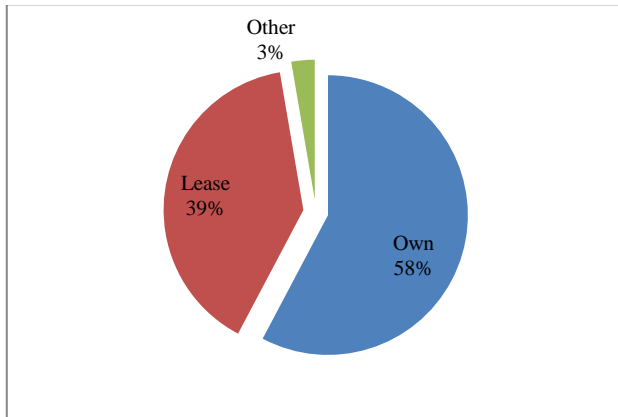


Figure 4. Respondents Housing Status

The annual income of the respondents is shown in Figure 5. The General Authority for statistics in Saudi Arabia reported that in 2013, the household monthly income was 13,610 Saudi Riyal [32]. After observing the results of this survey it was found that 46% of the sample has an income approximately equal to and higher than the average income of household in the Kingdom. This result shows that the respondent's income distribution is a good match with Saudi family income distribution.

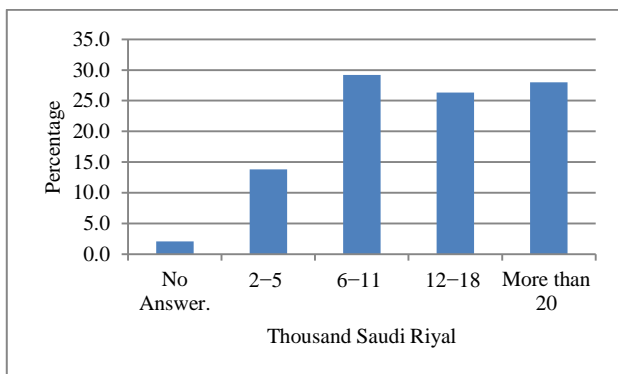


Figure 5. Respondents Monthly Income

The respondents were asked about their average monthly electricity bill. The respondents answer is shown in Figure 6. The Figure shows that 40% of respondents are paying up to 200 Saudi Riyals which is considered really cheap. While 31% of respondents pay between 200 and 500 Saudi riyals and 29% of respondents pay approximately more than 500 Saudi Riyals.

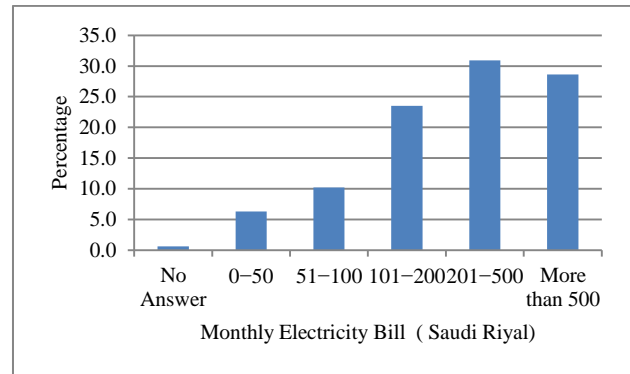


Figure 6. Respondents Average Monthly Electricity Bill

4. SURVEY RESULTS

A. Knowledge of electricity cost

To understand the Saudi public appreciation to their electricity bill, a few questions were developed and asked to the survey respondents. The respondents were asked to specify how they consider the electricity bill cost. The responds were as follow: 47.7% considered electricity is expensive, 30.1% think it is not, whereas 21.6% are not sure of their answers. Although electricity tariff in Saudi Arabia is among the lowest in the world due to the high government subsidy people got used to this rate for years and obviously they rely on government support. In spite of the fact that 47.7% of respondents considered electricity bill high, about 61% of respondents are not aware of the Saudi electricity block tariff system. Saudi Arabia has implemented strictly electricity block tariff system for calculating the electricity bill. This can tell that the high majority of respondents do not worry about their monthly electricity bill and the bill is not a huge burden to the Saudi family monthly budget. Furthermore, the respondents were asked if they read their electricity monthly bill thoroughly. The answer was as follows: 50.5% do look at their energy consumption in the electricity bill, whereas others do not. Obviously, those who do not look must consider the electricity price too cheap otherwise they would look and check the amount they have to pay. These findings about the knowledge of electricity cost questions highlight the need for intensive awareness program prior to implementation of any new electricity tariff or billing system. More importantly, it shows a great potential for adjusting the electricity tariff to match the international prices as planned in the Kingdom Vision 2030.

B. Willingness to use energy conservation

To understand the Saudi public appreciation to energy conservation practices and their willingness to install and use energy conservation equipment in their houses, few questions were developed and asked to the survey respondents. The respondents were asked if they considered electricity conservation important to them. 83.7% of the participants considered electricity conservation important, whereas for 16.3% of the participants it is not important. It is obvious that the majority of respondents are in favor of energy

conservation even if some of them do not apply it. This finding shall pave the road for the successful implementation of intensive energy conservation programs in the Kingdom.

Saudi Arabia has been implementing energy efficiency label system (Star Rating) since 2010. The respondents were asked about the system and their appreciation to its value. The respondent's feedback shows that 57% of participants are aware of the system and have never heard of it, whereas 42% having no idea. This indicates that 43% of the respondents are familiar with the system. When asking the respondents if they would check the appliances energy efficiency label before purchasing, 52% of participants said yes, they are looking at labels before purchasing, whereas 47% do not look. These findings highlight the need for additional work to increase the average Saudi consumer awareness and appreciation of energy efficiency and Star Rating System for energy conservation.

To get further in-depth on the status of electricity conservation practices in the normal Saudi households, the respondents were asked to specify the star rating of their appliances that they currently used in their houses appliances efficiency card including their refrigerator, oven, microwave, washing machine, dryer and dishwasher. Table 1 shows the respondents percentage response to different appliances with stars rating from one to seven. Unfortunately, the answers show that 53 to 81 % of appliances used by respondents do not have efficiency cards. This simply means these appliances are not energy efficient. The remaining percentages of star usages mainly range from one star to 5 stars. Six and seven stars' appliances are too low. The highest number of respondents having star labels in their home are using refrigerators which represent 47% of participants. Once again respondents careless about their appliance's rating system reflect the relatively low electricity prices implemented in the Kingdom and highlight the need for additional measures to enhance electricity conservation in the Kingdom.

TABLE 1: PERCENTAGE OF PARTICIPANTS' RESPONSE TO APPLIANCES

No. of Stars	Refrigerator	Oven	Micro-wave	Washing Machine	Dryer	Dish-washer
None	53.0	72.7	75.0	68.2	76.3	81.8
1	14.0	6.1	5.7	7.0	6.3	4.9
2	1.5	2.3	2.7	1.1	0.6	1.9
3	6.4	4.4	6.6	4.0	4.4	2.8
4	11.4	6.1	4.9	9.7	5.5	4.2
5	11.6	7.8	4.0	8.5	5.5	3.6
6	1.7	0.4	0.6	0.9	0.6	0.6
7	0.4	0.4	0.6	0.6	0.8	0.2

To draw a full picture of energy conservation practices in the Kingdom, the respondents were asked about their knowledge and usage of efficient lighting system in their houses. The respondents were asked if

they have an efficient lighting system used in their homes and what type of lightings are using such as fluorescent tubes, compact fluorescent tubes (CFL), light-emitting diode (LED) and motion sensors. The findings are presented in Table 2 and show that only 4.4 % of respondents are using motion sensors. The results also show that 20 to 38% are using fluorescent tubes, CFL and LED. However, a high percentage of participants 61.7 to 79.7% had no answers at all which can be considered as no answer. This is a very interesting fact and proves the very low awareness of the respondents towards efficient lighting systems and again reflects the impact of relatively low electricity tariff system in the Kingdom.

In Conclusion, the survey results show a very low awareness and appreciation of the survey respondents to electricity conservation practices in their houses and highlight the need for more effective and comprehensive measures to improve conservation practices in the kingdom.

TABLE 2: USAGE OF EFFICIENT LIGHTING SYSTEM

	Fluorescent Tubes	CFL	LED	MotionSensors
No Answers.	72.0	79.7	61.7	95.3
Yes	27.8	20.1	38.1	4.4
No	0.2	0.2	0.2	0.4

5. CONCLUSION AND RECOMMENDATION

The Kingdom of Saudi Arabia has witnessed a rapid economic and population growth of the last four decades boasted by the crude oil revenues. This growth has resulted in high increase in urbanization and standards of living. Accordingly, the demand for electricity and energy supply has increased dramatically. The country is also expected to see similar growth over the coming years based on the well developed country development vision 2030. This will add additional pressure on the country electricity and energy resources. Conservation can help in alleviating such pressure. This study attempted to assess Saudi residents' awareness and behavior towards energy efficiency. A review of government initiatives towards energy conservation was presented and questionnaire survey to assess the Saudi public awareness of energy conservation practices was developed and implemented. A total of 528 interviews were conducted, with inhabitant of the three major cities in the Kingdom, Riyadh city, the capital of Saudi Arabia, Dammam city in the eastern province and Jeddah in the western province.

The survey results show a very low awareness and appreciation of the survey respondents to electricity conservation practices in their houses and highlight the need for a more effective and comprehensive measures to improve conservation practices in the kingdom. It is recommended to focus on consumer education through SEEC and media, market efficiency for people at work, schools, universities and mosques. It will be good idea to add it to school curriculum to educate children about



energy efficiency. Energy efficiency programs must be accelerated and promoted by government. Finally, this research recommends that the country may use a balanced system of energy subsidies which were reduced early this year (2017), resulting in higher tariff. However, the new tariff is still considered cheap compared to other countries in the region. The government plan to regularly review the energy price over the next 5 years, is a necessary measure that have been long awaited.

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