



THE USE OF SOLAR RADIATION AS ALTERNATIVE SOURCES OF ENERGY IN SMES IN JORDAN

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ABSTRACT

This paper study the extent using of solar radiation as an alternative energy source in Small and Medium-sized Enterprises (SMEs) in Jordan. A questionnaire was distributed randomly to selected sample of SMEs from Amman province to collect the needed data and it is divided into three sections. The first section focused on the demographic and economic characteristics of entrepreneurs. The second section study the limitations that affects on using of solar radiation as an alternative energy source in SMEs. The last section focused on future expectations of this source and the facility mechanisms in the economic conditions of SMEs in Jordan. The results showed that SME economic conditions are below moderate levels, and the major obstacles of using the solar radiation as a source of energy are the wide roof space required for the solar cells. This study recommends the government to adopt plans for the solar unit's construction in industrial and service zones.

Keywords: SR (solar radiation), SMEs (small and medium-sized enterprises), limitations, energy.

INTRODUCTION

The transfer of traditional electricity sources to environmentally friendly sources is a significant global concern. Population increases in recent years have increased pressure on conventional power sources and increased pollution. Non-traditional sources of energy have been the solution that helped to mitigate pollution from traditional sources and identifying cheaper sources of electricity if used effectively. The impact of traditional sources on gas emissions and pollution have adversely affected the planet through the effect on climate change has highlighted the importance of other sustainable sources.

Solar radiation (SR) has been an alternative source to traditional sources. The availability of solar radiation for long periods makes it highly efficient for different purposes. Uses of solar radiation as a power source included the domestic, industrial, and service sectors. Opportunities for using solar radiation as an electricity source varied by sector. Moreover, the use of solar radiation is limited to the availability of space that required to solar cells place, the cost of solar systems, and the accessibility to these systems.

The electric energy storage systems will integrate the use of solar radiation effectiveness [1]. Small and Medium-sized Enterprises (SMEs) in industry and service sectors have virtually no rooftop space for the use of solar cells. Since the use of solar cells requires the availability of roofs to facilitate their use, in most cases SME owners cannot use such roofs. On the other hand, the cost of solar cells may affect their use as an alternative power source in SMEs. In Jordan, most SMEs in the industrial and service sectors are small-area stores that have an impact on roof accessibility for the use of these alternative energy sources. Moreover, the start-up costs of building such systems are very high, which may restrict their use in SMEs.

LITERATURE REVIEW

The international concern shifts to clean sources of energy. These attitudes became part of the sustainable goals. And most countries are directed to use clean sources of energy to avoid air pollution in one direction and to

mitigate the effects of climate change. Adeyemo (2013) discussed different challenges of the solar energy projects in Nigeria [2]. These challenges range from social, political, economic, technological, legislative, and environmental ones. Zarte and Pechmann (2017) have reported the possibility of using the SR as an alternative source of energy in SMEs in Germany. They indicated that the use of SR depends on the cost and practicality of use in SMEs. Moreover, the legislation and facilitations introduced would encourage the distribution of solar thermic systems in SMEs [3]. The Sustainable Business Institute (2013) has shown that the success of using SR in SMEs in developing countries depend on the financial aids and support introduced to this economic enterprises to use SE as alternative source [4].

Akuru and Okoro (2009) discussed the limitations of using solar energy (SE) in developing nations. They discussed the effect of using SE on elevating poverty in the developing countries by finding the cheaper cost of electricity. On the other hand, they reported that the decrease of expenses on electricity production will improve the growing domestic production (GDP) of the countries [5]. Many authors related the use of conventional electricity sources to the availability of crude oil [2, 5, 6, 7]. The replacing of using SR to replace traditional sources was related to economic aspects. The other arguments dealt with the replacement as a tool to preserve the environment [8]. The interest and care for SR are concerned with both the economic and environmental directions. For SMEs, the use of alternative energy sources was considered a vital tool for the development of this economic sector [9]. Different countries to do so adopted strategies to develop the use of alternative energy sources in SMEs [7].

Alsharif *et al.* (2018) reported that the use of alternative friendly energy sources is a governmental decision. They enforced that the increase of opportunities will increase if the government programs encourage the use of alternative sources in different economic sectors [10]. Oghogho *et al.* (2014) reported that the use of SE as an alternative source requires a governmental road map that



facilitates its use, especially in SMEs in Nigeria [11]. Ali *et al.* (2014) showed that the conversion to the use of alternative energy sources requires a national policy that draws the map road to convert to friendly energy sources overtime [12]. They reported that the conversion should be based on a gradual transfer policy to use alternative sources. Efficient energy systems have been shown to encourage the transfer from traditional sources to alternative sources. The governmental policies will facilitate the use of such powerful and efficient systems through the adoption of a comprehensive policy of conversion. Zimmermann (2017) raised the distribution of awareness as a success factor to distribute the usage of alternative energy sources in SMEs [13]. The Hotel Energy Solutions Official Partners studied another aspect related to the feasibility of using renewable energy in SME hotels. The study showed that the use of alternative friendly sources is very feasible for SME hotels if the designs and the capacity of the system were efficient for hotels' needs [14].

The Opportunities of Using SR in Jordan

Jordan is one of the countries that suffer from the availability of traditional sources for electricity generation (European Union, 2015) [15]. So, the use of traditional sources for electricity generation depends on the imports of crude oil from other countries. The cost of electricity generation and its effect on national growth depends on the international prices of oil [6]. On the other hand, Jordan is characterized by a high number of sunny days in the year. At the same time, Jordan is working hard to accomplish the sustainable development goals related to providing reasonable and accessible sources of energy for all. Also, the attitudes concerned to take serious actions to minimize the release of green gases to help protecting the global environment to reduce climate change.

The government's insistence to minimize the use of electricity called for the adoption of national programs. Some of the governmental actions in 2019 and 2020 to help the poor families to use SR for water heating to minimize the use of electricity. On the other hand, another program cared for the placement of electricity generation in agricultural farms areas. This project serves for saving the electricity using of non-traditional sources as well as minimizing the farms' electricity expense which lead to maximizing the farmer's profit.

METHODOLOGY

This paper aimed at studying the extent of using solar radiation for electricity generation in SMEs in Jordan and the limitations that stand behind its usage. The high number of SMEs in Jordan is (> 90%) create the importance of this subject in the short and long run. And to reach the objective of this research, the questionnaire was used as a tool to collect data. The questionnaire was prepared in three parts. The first part was designed to collect information about the business and owner, while the second part designed to collect information about the challenges facing the use of SR alternative in SMEs, and the third part designed to collect information about the opportunities to use the SR as alternative sources in SMEs. The

questionnaire was distributed on a pilot sample composed of 30 enterprises to measure the validity and reliability of the questionnaire. The collected notes were reflected on the questionnaire before the final distribution to increase validity. On the other hand, the reliability was measured for the questionnaire. The result in Table-1 showed that Cronbach's alpha was more than 0.6 indicating that the questionnaire is reliable and can be used to accomplish the research objectives [16].

Table-1. The reliability analysis of the questionnaire using Cronbach's alpha.

Variable	Cronbach's alpha
Limitations of using SR as an alternative source of energy in SMEs	0.91
Opportunities of using SR as an alternative source of energy in SMEs	0.93
Total	0.95

Five Likert scales were used to collect the attitudes of the respondents for the opportunities and limitations. The 5 scales were given for the high limitation or high opportunity, while 1 was given for the lowest limitation or opportunity.

A simple random sample was used to collect data from the SMEs enterprises. This simple random sample is composed of 1500 enterprises in both industrial and services sectors in Jordan. The collected data was entered on SPSS (Ver. 21). Frequencies and percentages were used to measure the characteristics of businesses and owners. Means and standard deviations were used to measure the trend of SMEs' owners for the limitations and opportunities to use SR as an alternative source of energy in SMEs in Jordan.

RESULTS AND DISCUSSIONS

The SMEs in Jordan are characterized by male's ownership. The results showed that the percentage of male owners reached 95.35% compared to 4.65% females. The business owners of SMEs especially those working in technical, and services of low education compared to more specialized businesses. The results showed that the highest percentage of respondents have less than high school certificate (75.25%). These people according to field notes are owners of small vocational stores. The percentage of high school diploma education reached 13.10% of the sample. The percentage of B.Sc. educational levels was minor in the sample (10.60%) and the least educational level was for the graduate studies (0.85%).

The experience in businesses varied from low to high experiences (Figure-1). The least experience levels were recorded for the experience less than 5 years (45.32%). The second experience level dominant was for 5-10 years (24.31%). The third experience level was for the category 16 years or more (20.07%). The least experience category was for 11-15 years (10.30%) (Figure-1).

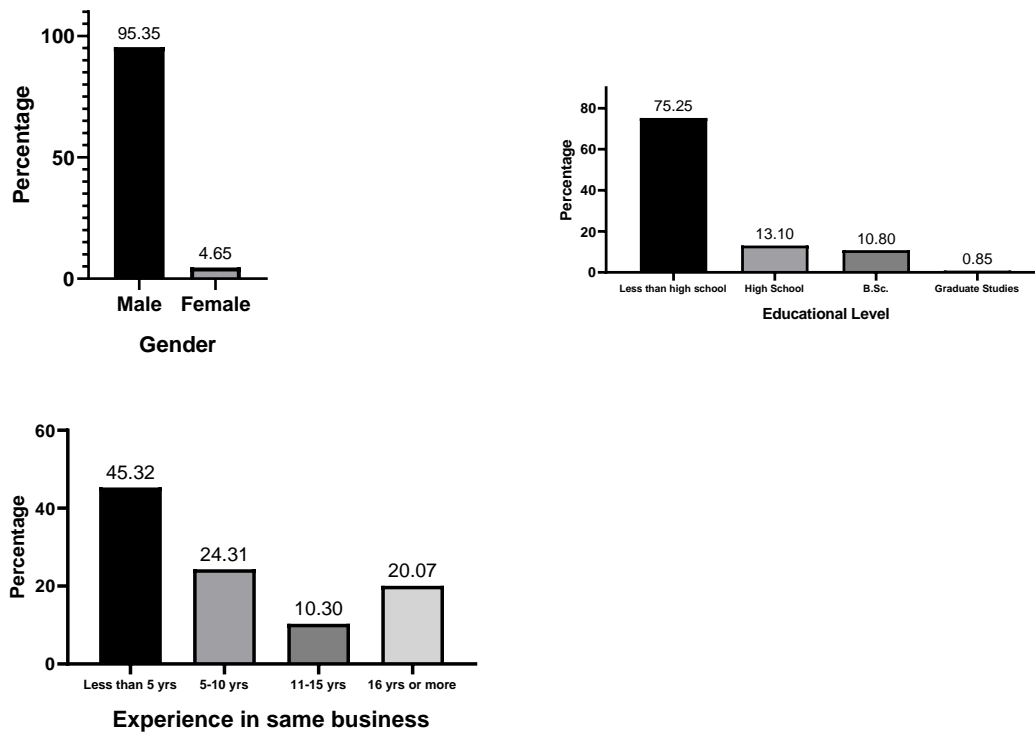


Figure-1. Characteristics of business owners (n=1500).

BUSINESS CHARACTERISTICS

A high percentage of enterprises in Jordan are classified under SMEs (>95%) (DoS, 2018). Consequently, most of the studies enterprises have registered capitals less than 2500JDs (62.12%) as shown on (Figure 2). As the registered capital increases the percentage of enterprises decreases in the sample. The second size of enterprises according to registered capital was 2500-5000JDs (20.13%), followed by 5001-7500JDs (10.20%, and the least was recorded for the registered capital 7501-10000JDs. The registered capitals reflect the small size of businesses the enterprises' practice.

Considering the time stay in the same place running the business, the results showed that the highest number of enterprises stayed in place for less than 5 years

(72.31%). This reflects the high turnover of renters of the sample place overtime. In the case of installing SR systems, the renter will overburden the cost of installation for moving from one place to another or by closing the business. The businesses that kept in place for 5-10 years was 21.29% which still represents a good percentage of the sample. The percentage of businesses that stayed in the same place for 11-15 years was 5.53%, while the least was recorded for the businesses that stay for more than 16 years in the same place (0.87%) (Figure-2). Most of the sample included in the study was from the industrial sector (77.69%), the rest of the sample representing the services sector. None of the enterprises have shown installed SR cells for the generation of electricity.

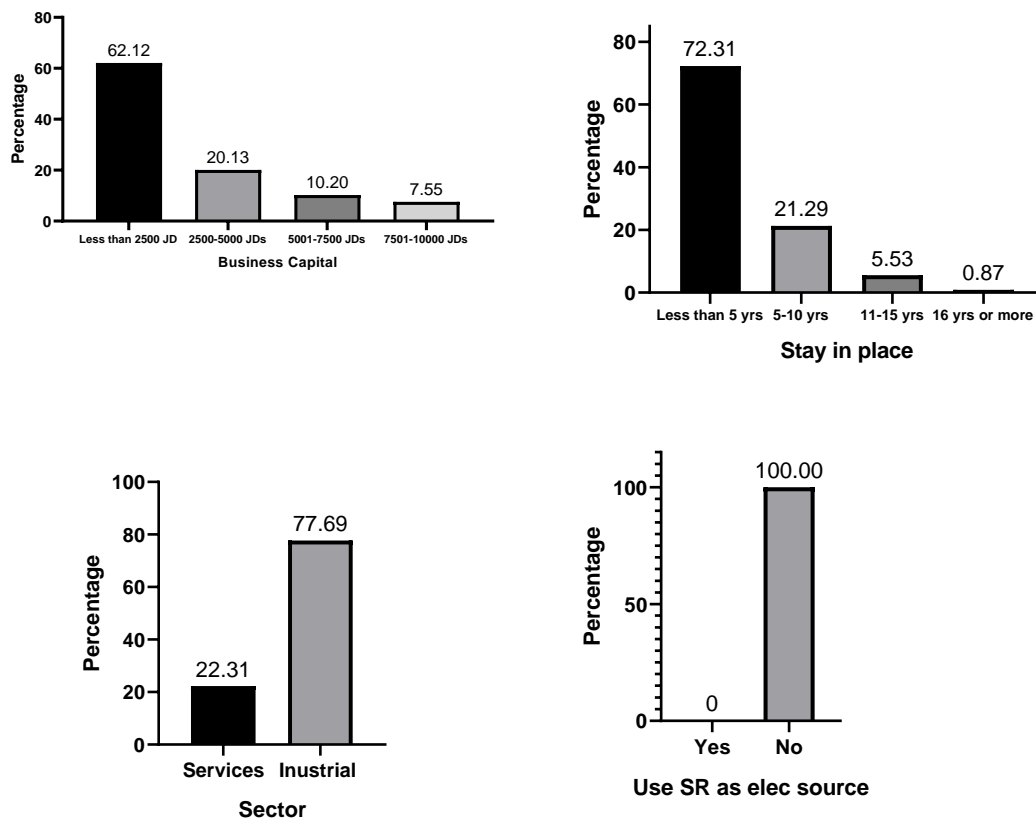


Figure-2. Characteristics of businesses (n=1500).

The Limitations of Using SR as an Alternative Source of Electricity in SMEs

The highest limitation of using SR as an alternative source of electricity is changing the place of businesses ($m=4.06$, St. Dev. = 1.00). The second variation of attitudes of business owners for the use of SR to be used as an alternative source of energy forms another important limitation for its use ($m=3.89$, standard deviation = 0.95).

The installation of SR units requires the availability of space exposed to sunlight. The availability of this space is one of the limitations for all stores that existed in one building ($m=3.86$, standard deviation = 1.04). This limitation decreased when the number of SMEs per one building decreased. Also, the type of business practiced forms a limitation for the use of SR as a source of electricity in business ($m=3.85$, standard deviation = 0.99). The cost of SR networks including their installation is considered an important limitation ($m=3.65$, standard deviation = 1.01). Hotel Energy Solutions Official Partners (2011) have shown that the cost is considered one of the constraints that limit the use of SR as an alternative source of energy. Of the same importance, the legislations are considered a

limitation ($m=3.65$, standard deviation = 1.01). These legislations include both the rent ones including the ability to use the roof and the legislations related to the use of SR in electricity generation. The Hotels Energy Solutions Officials Partners (2011) have shown that the regulations of the country in the field of energy is considered very important to facilitate the use of SR in businesses.

The least two positive limitations are related to the size of the business ($m=3.55$, standard deviation = 0.95) and the financial profits achieved by the business which is considered a limitation to use SR as a source of electricity ($m=3.52$, standard deviation = 0.97). Choudhary and Dahiva (2018) have shown that high-efficiency storage systems encourage SMEs to use renewable sources of energy [17]. Sustainable Business Institute (2013) has shown that the size of the sector and the capacity of SMEs is considered limiting factors to use alternative energy sources [4]. Calkin (2017) has shown that the use of renewable energy in SMEs could one of the innovative elements and would lead to innovation in the enterprise [18]. The increase of awareness of SMEs will facilitate the success of the use of renewable energy in SMEs in Jordan.

**Table-2.** Attitudes of the SMEs' owners for the limitations of using SR as an alternative source.

Item	Mean	St. Dev.
Place of business instability is a limitation of using SR as a source of energy	4.06	1.00
The variations of attitudes of business owners form a limitation for use SR as an alternative source	3.89	0.95
Lack of enough roof spaces will limit the use of SR as a source of energy	3.86	1.04
The type of business activity works a limitation of SR use as alternative sources	3.85	0.99
The cost of the SR network system affect its use	3.65	1.01
The legislations is a limitation for the use of SR as an alternative for electricity in businesses	3.65	1.01
The size of business limit the use of SR as an alternative source of electricity	3.55	0.95
The financial profit of business limits the use of SR as an alternative source	3.52	0.97

The Opportunities of Using SR as an Alternative Source of Energy in SMEs

The results showed that there are opportunities to use SR as a source of alternative energy. Friedrich-Elbert-Stiftung (2016) showed that the use of renewable sources of energy in Jordan is very promising [19]. The first effort that should be made to use SR as an alternative energy source is the governmental programs that manage and organize the use of SR in SMEs in Jordan ($m=4.61$, standard deviation $=0.62$).

European Union (2015) performed a project to replace the traditional energy sources with SR in Jordan Valley in Jordan. The program showed that highly successful results due to the governance arrangements for the campaign in the agricultural sector [15]. The first encouraging factor that facilitates is the financial support of SMEs which will minimize the initial and the installation cost of the SR network ($m=4.32$, standard deviation $=0.71$).

The results showed that if the SR adoption by the owner of the building and the business owners will utilize these units through the building owner, this will facilitate the of SR as an alternative source of energy in Jordan ($m=4.22$, standard deviation $=0.49$). Also, this attitude will help in solving the problem of continuous changing of business place by business owners.

If the regulations will change to make it a condition to use the building for trading purposes is to install SR networks, this will facilitate and distribute its use by buildings owners ($m=4.18$, standard deviation $=0.40$). The high number of sunny days in Jordan makes it feasible to use the SR network as an alternative source of energy ($m=4.11$, standard deviation $=0.42$).

The business owners agreed that the use of SR as an alternative source will minimize the expenses of the stores on electricity ($m=4.06$, standard deviation $=0.41$). The governance arrangements for financial aids for buildings owners and business owners will facilitate the use of SR as an alternative source of energy ($m=4.01$, standard deviation $=0.45$). The ability to use SR networks for groups of businesses in the neighborhoods will facilitate its use ($m=4.04$, standard deviation $=0.65$). Chen *et al.* (2009) have shown that the use of high potential facilities will improve the economics of the use of alternative energy sources [1]. The least positive agreement was for the adoption of the installation of SR by buildings owners ($m=3.90$, standard deviation $=0.81$). European Union renewable energy project (2015) has shown that the regulations and arrangements are very important to encourage the use of alternative renewable sources of energy especially if it is led by governmental programs.

**Table-3.** Attitudes of the SMEs' owners for the opportunities of using SR as an alternative source.

Item	Mean	Standard Deviation
The organized governmental program would encourage the use of the SR system	4.61	0.62
Receiving financial support for SR cells construction would encourage its use as a source of energy	4.32	0.71
The adoption of buildings' owners of SR constructions will minimize the obstacles of changing workplace	4.22	0.49
The installation of SR network as a condition of leasing business places will facilitate its use	4.18	0.40
The high number of sunny days through the year encourage the use of SR as an alternative to traditional electrical sources	4.11	0.42
Using SR to replace traditional electric source will save electricity expenses	4.06	0.41
The governmental arrangements with business owners and lease owners concerning financial supports will facilitate SR use as an alternative source	4.01	0.45
Groups networks will facilitate the use of SR as an alternative source of energy	4.04	0.65
The adoption of buildings owners of the construction of SR units will encourage its use	3.90	0.81

CONCLUSIONS AND RECOMMENDATIONS

The objective of this research is to investigate the limitations and opportunities of using SR as alternative energy in Jordan. The high pressure on energy and the lack of traditional sources for the generation of electricity in Jordan increases the demand to use renewable energy sources. The high concern to use renewable energy initiated its use in households to SR for some purposes to decrease the pressure on traditional sources. Also, other projects were directed to the agricultural sector to use renewable energy for electricity production. These two experiments and through the availability of sunlight as an alternative source of energy opens the door for its use in other sectors.

This study revealed that the use of alternative energy sources in industrial and service sectors for SMEs is null. The limitations of its use are related to the cost of construction, maintenance, the low stability of business, and the infrastructure required for installation. The results of this research showed the possibility of using renewable energy for use in SMEs in Jordan. The results revealed that its success is connected to the existence of government programs, in the long run, to ensure the transmission to non-traditional sources. The study recommended that the government should adopt a long run program to include SMEs in using renewable energy sources.

FUTURE WORK

Future research should concentrate on both the legislations that facilitate the use of renewable sources of energy as well as the attitudes of building owners to construct and use SR as a renewable source for electricity production if they receive financial support and are included in governmental programs.

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