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Energy analysis of Jordan's rural residential sector

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Abstract

This paper presents some insights into Jordan's energy consumption in the rural residential sector. 18% of the country's total energy is consumed by the residential sector. The rural residential sector share is only 16% of the country's residential energy consumption. Kerosene and bottled LPG are the main sources of energy in the rural residential sector. © 1999 Elsevier Science Ltd. All rights reserved.

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1. Introduction

Unlike some other countries of the Middle East, Jordan is a non-oil producing country with a small population of about 4 million [1]. It relies heavily on importing oil from neighboring countries. Considering the social, economical and technological differences, Jordan can be divided into two main parts, namely, urban and rural. The urban part is somewhat well developed, while the rural part is under developed due to a lower standard of living.

In recent years, a serious concern about energy consumption in Jordan has been growing. Probably, the residential sector was affected the most with the economical and technological changes that the country has been experiencing. For example, in the 1960 s and 1970 s, firewood and biomass products, in addition to kerosene were the main fuels for cooking and water heating in the rural areas of Jordan. Electricity was not widespread, and most dwellings did not have electrical appliances, such as refrigerators and television sets. Gas cookers and gas heaters were not common, particularly among low income families. Now, most people are

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more aware of energy conservation due to the direct effects and benefits that they gain from such savings. For example, solar water heating (SWH) is very common in most places, since it provides hot water for about 9 months of the year. Approximately 25% of the country's dwellings use SWH systems. In a recent study, SWH systems were compared to other water heating systems and found to be the most beneficial [2]. Locality and availability of fuels can create differences in energy consumption. Households with higher income need more commercial energy [3–5].

In this paper, an overview of Jordan's energy consumption in the rural residential sector will be presented. It is based on a survey made by the Jordanian Ministry of Energy and Mineral Resources (JMEMR), which was conducted during 1995 [6]. 1680 households were surveyed covering the rural parts of 11 counties of Jordan.

2. Energy consumption in Jordan

According to the JMEMR, the annual consumption of energy used in the residential sector of the country from different sources of fuel is approximately, 9000 GWh. It is equivalent to about 18% of all energy consumed in all sectors. Table 1 shows the distribution of energy consumption for different energy sources. In terms of an energy equivalent value, fuel oil, Diesel fuel and gasoline amount to more than 75% of all types of fuels. It is because these represent the main fuels that are used in electric power generation, industry and transportation. The total energy can be divided into three major sectors, residential, transportation and industrial. The distribution of energy consumption in such sectors is presented in Fig. 1. The term "others", in the figure includes other minor sectors such, as governmental, educational, military, etc. The transportation sector has the highest consumption of energy, with about 40%. The industrial sector is the next sector in energy consumption, with 22%.

3. Description of the rural household

The average family size is 7.49 members of which 31.8% are employed. Families with 6–10

Table 1
The 1995 Jordan main fuel consumption

Fuel	Consumption	Energy equivalent (GWh)	Percentage of total (%)
LPG	203 000 metric tons	2820	5.6
Gasoline	478 000 metric tons	6220	12.4
Jet fuel	244 000 metric tons	3175	6.3
Kerosene	215 000 metric tons	2779	5.5
Diesel fuel	1 033 000 metric tons	13 159	26.1
Fuel oil	1 620 000 metric tons	19 581	38.9
Natural gas	283 million m ³	2600	5.2
Total	—	50 334	100

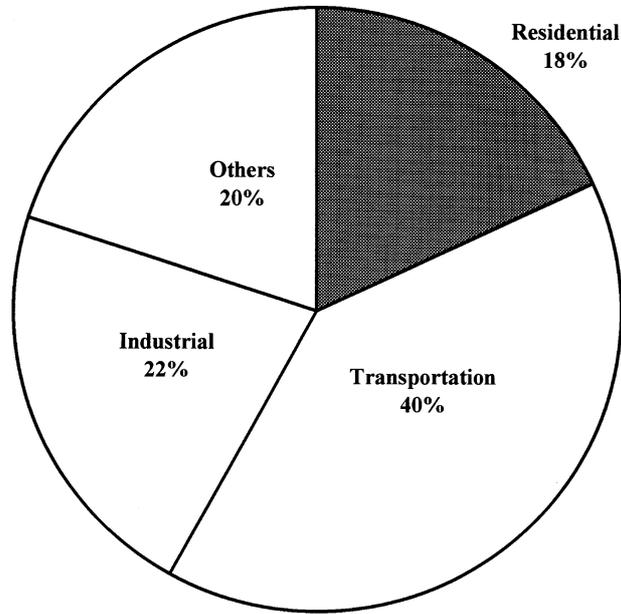


Fig. 1. Distribution of Jordan energy consumption in different sectors.

members represent more than 50% of the total. More than 70% of families have an average monthly income of 300 Jordanian dinars (J.D.) or less, 1.00 J.D. being equivalent to US\$ 1.40.

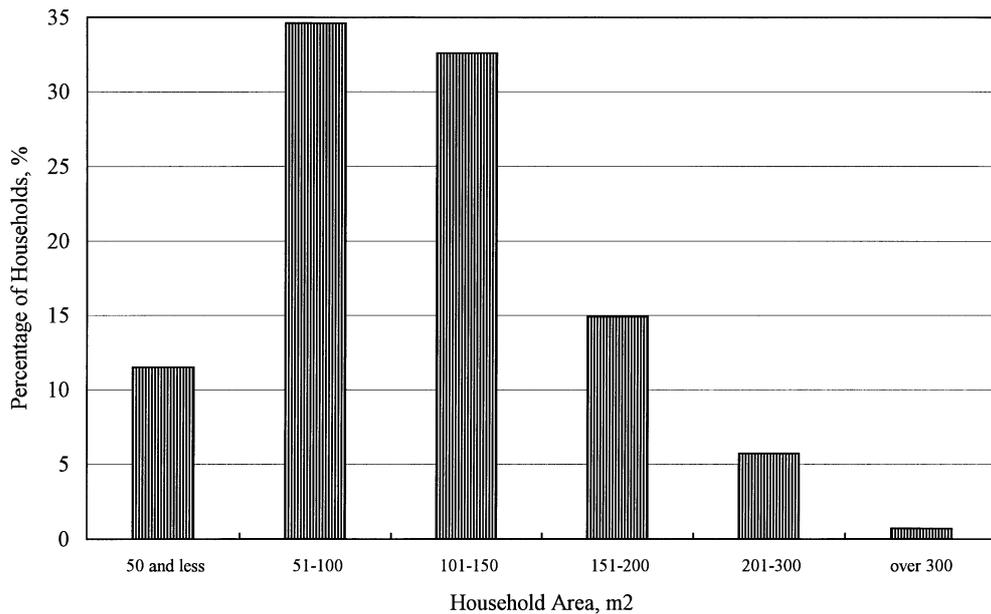


Fig. 2. Distribution of households according to area.

On the other hand, only 8% of families have a monthly income of more than 500 J.D. More than 80% of the population in urban communities have household areas that range from 50 to 200 m², as shown in Fig. 2. Of all residential households, only 7% are being rented, while the rest is self owned, or owned by a close relative that does not charge rent. Fig. 3 shows that approximately 90% of rented households have a monthly rental value of 50 J.D. or less. About 34.3% of families that own their residence pay a monthly mortgage, of which 86% of the total pay monthly installments of 100 J.D. or less, as shown in Fig. 4. The year of construction of dwellings is presented in Fig. 5. It is shown that more than 85% of residence were built in 1970 and later.

4. Analysis and discussion

The distribution of the main energy sources which were consumed in the residential sector of Jordan is presented in Table 2. It is clear that most of the country's residential energy consumption was not made by the rural sector. The overall energy equivalent for the rural sector is about 16% of the whole country. In terms of gross energy, bottled LPG is consumed more than any other source of energy when considering the entire country. LPG is used mostly for cooking and space heating. More than 188 000 metric tons of LPG is consumed annually in the residential sector of the country. On the other hand, when we consider the rural residential sector of Jordan, kerosene becomes the highest fuel to be consumed in terms of gross energy. About 43 000 metric tons of kerosene are consumed annually in the rural residential sector. It is primarily used in space heating and water heating, representing 22% of the kerosene consumed in the entire country's residential sector. The distribution of all energy

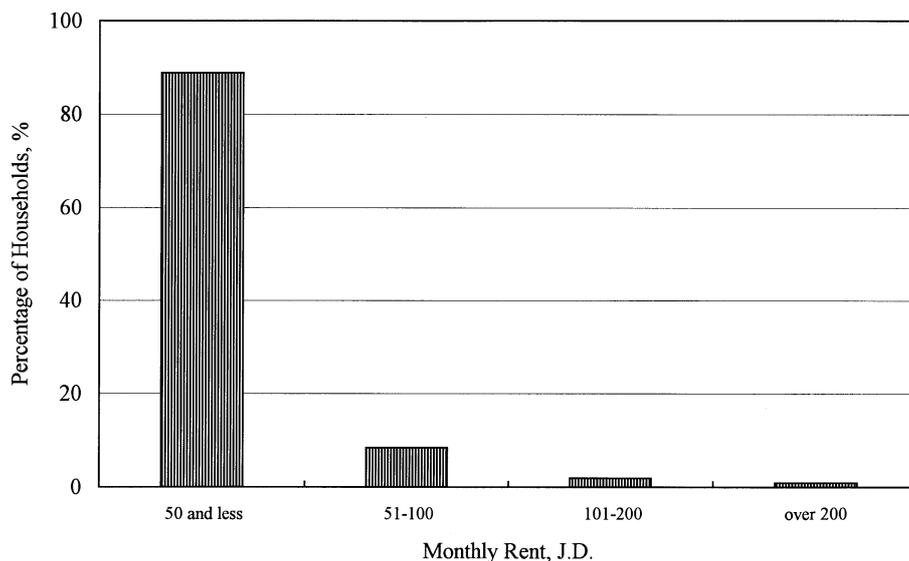


Fig. 3. Distribution of rented households according to monthly rent.

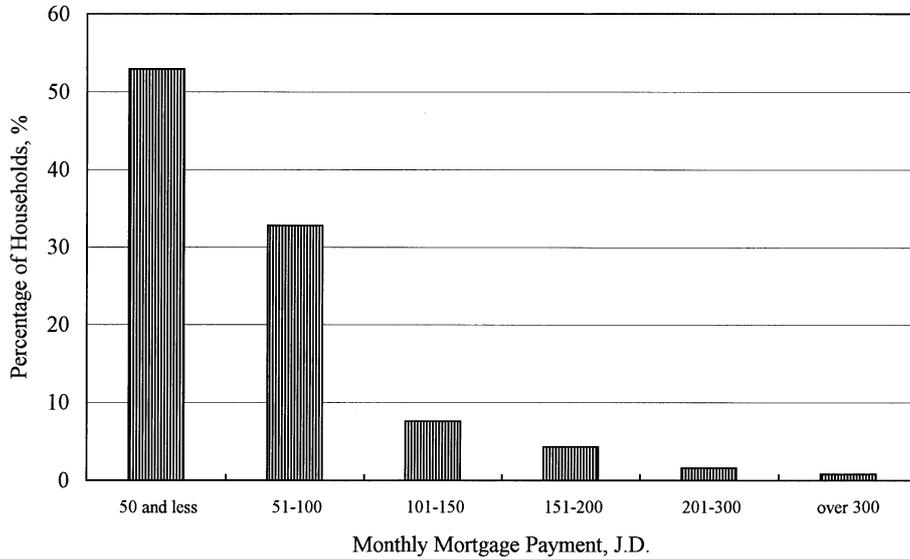


Fig. 4. Distribution of households according to monthly mortgage.

sources that are used in different applications is listed in Table 3. Portable kerosene heaters are very popular in Jordan; with about 84% of rural households using this system for space heating. Bottled LPG portable heaters are also popular, with over 20% of rural households using it for space heating. Both kerosene and LPG heaters are popular because they are considered to be inexpensive and convenient. Safety is not being considered here.

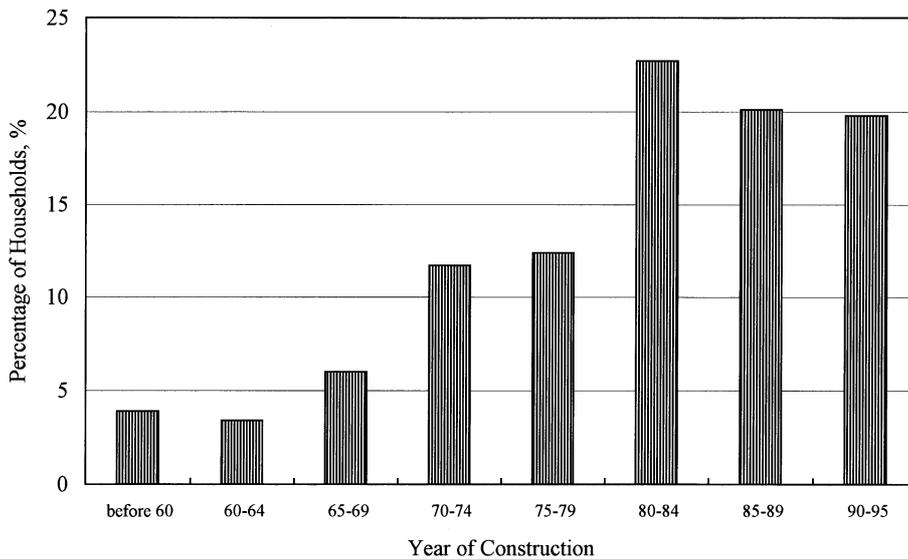


Fig. 5. Distribution of households according to year of construction.

Table 2
The 1995 Jordan energy consumption in residential sector

Energy source	Entire country		Rural	
	Consumption	Energy equivalent (GWh)	Consumption	Energy equivalent (GWh)
Diesel fuel	188 000 tons	2395	10000 tons (5%) ^a	127
Kerosene	193 000 tons	2496	43000 tons (22%)	562
LPG	188 000 tons	2613	40000 tons (21%)	559
Electricity	1270 GWh	1270	182 GWh (14%)	182
Total	—	8774	—	1430 (16%)

^a Values in parentheses represent percentages of energy consumption of rural residential sector divided by energy consumption of residential sector of the entire country.

In terms of water heating systems, rural households prefer to use kerosene. It is an inexpensive fuel and easily found. Some households take advantage of the 300 sunny days that Jordan enjoys throughout the year. 14% of rural households have a SWH system installed.

Rural communities still use firewood and biomass products for cooking, water heating and space heating. It is due to the availability of such fuels and the socio-economics of rural population. In some rare cases, these fuels are considered the most convenient if not the only fuels available.

The electric appliances that are used in rural households are listed in Table 4. Television sets, refrigerators and clothes washing machines are the most common appliances that are found in most residence. Because of the mild summer with low humidity that Jordan usually has, the number of residents with air conditioners is small (less than 3%). However, ceiling and portable fans are popular, with over 50% of households using fans for space cooling and comforting. Some of the appliances that are popular in developed countries can be not so popular in developing countries. For example, microwave ovens and electric cookers are considered to be very rare commodities, with less than 0.5% of households using these kinds of appliances. It is due to the lower standard of living and the relatively high cost of electricity.

Table 3
Percentage of rural households use of energy sources for different applications

Energy source	End use			
	Space heating	Water heating	Cooking	Lighting
Diesel fuel	15.8	3.7	—	—
Kerosene	83.7	38.9	3.2	13.1
Bottled LPG	20.7	17.4	97.4	2.0
Electricity	2.3	14.9	0.4	97.5
Firewood	6.3	7.8	9.6	—
Biomass	0.8	2.9	2.0	—
Solar system	—	17.9	—	—

Table 4
Percentage of appliances used in rural households

Type of appliance	Percentage of households (%)	
Cloth washing machines		86.7
Regular washing machines	70.4	
Full automatic/semi-automatic	18.0	
Washer and dryer	0.3	
Dishwashers		0.1
Refrigerators		80.2
Regular refrigerators	54.6	
No-frost refrigerators	23.7	
Freezer	1.9	
Fans		58.5
Ceiling fans	28.0	
Portable table fans	30.5	
Air conditioners		2.9
Portable electric space heaters		2.3
Electric water heaters		14.9
Electric cookers		0.3
Microwave ovens		0.1
Electric irons		70.3
Vacuum cleaners		9.5
Stereo/cassette recorder		63.2
Television sets		93.1
Colored TV	69.7	
B/W TV	23.4	
Video cassette recorders		7.5
Hair dryer		18.4
Electric water pump		7.2
Personal computers		0.7

Dish washers are also very uncommon, with only about 0.1% of residents of rural communities using them. It is mainly due to both the high cost of electricity and the scarcity of fresh water.

5. Conclusions

The total energy consumed by the residential sector of Jordan amounts to 18% of the total energy consumed by the country. About 16% of that portion of energy is consumed by the rural residential sector. In addition to electricity, the main fuels that are used by a rural residential household are kerosene, bottled LPG and Diesel fuel. These sources of energy are primarily used for space heating, water heating, cooking, lighting and running of large appliances.

The most popular fuels are kerosene and LPG. Kerosene is the most popular system in water heating, followed by SWH. LPG and electricity are mainly used for cooking and

lighting, respectively. In light of this work, the authors believe that this analysis can be applied to other rural residential sectors of neighboring countries with the same standard of living.

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