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# Energy analysis of Jordan's commercial sector

J.O. Jaber*, M.S. Mohsen, A. Al-Sarkhi, B. Akash

*Department of Mechanical Engineering, PO Box 150459, The Hashemite University, 13115 Zarqa, Jordan*

**Abstract**

This article presents some insight into energy consumption in the commercial and public service sector (CAPSS) in Jordan. In this sector, space- and water-heating is dependent particularly upon the combustion of fossil fuels. Which thereby contribute significantly to air pollution and the build-up of carbon dioxide in the atmosphere. The results of a recent survey were used to evaluate the energy demand of the commercial and public service buildings. Diesel fuel, LPG and kerosene are mainly used for space heating, with diesel being the most popular fuel followed by LPG. Unvented combustion appliances, i.e. portable kerosene and LPG heaters, are still employed in this sector in order to provide space heating in unclassified hotels, some clinics and health centres as well as retail shops. These stoves, usually, produce high levels of combustion by-products that often exceed acceptable limits especially in a closed space. Consequently, the indoor air quality is degraded and may cause unnecessary exposure to toxic gases such as carbon monoxide and unburned hydrocarbons. Electricity consumption is relatively high due to the excessive lighting and heavy use of air-conditioning and ventilation systems during the dry and hot summer. It is estimated that about 15% of the annual consumption in CAPSS can be reduced annually with little investment. Consequently the corresponding annual $CO_2$ emissions reduction is approximately 1%, i.e. $160 \times 10^3$ tons, of the present total greenhouse gas emissions in Jordan.


*Keywords:* Energy consumption; Commercial sector; Efficiency; Jordan

## 1. Introduction

Unlike some other countries in the Middle East, Jordan is a non-oil producing country and is nearly fully dependent on imported oil from neighbouring countries. In 1999, the population of Jordan reached $4.9 \times 10^6$, with an average annual growth rate of about 3.6% (Department of Statistics, 2000). It is expected to be around $7 \times 10^6$ inhabitants by the year 2015 (National Population Committee, 2000). This is primarily due to the high birth rate and also because of political instability and military conflicts in the region, which have led to several waves of immigration into the country.

In recent years, concerns about energy consumption in Jordan have been growing, especially, in the CAPSS, which was probably affected the most by the economic and technological changes that the country has witnessed during the past three decades. For example, in 1970, there were 27 hospitals; a state university; and a total of 100 classified and unclassified small hotels, with a total number of available rooms of around 3000 (Department of Statistics, 1971). Thirty years later, the number of hospitals reached 84, of which 34 public hospitals; 20 state and private universities and about 422 hotels, of which 247 are classified hotels, with total accommodation capacity of 16,200 rooms (Department of Statistics, 2000). Such an enormous increase in the number of commercial and service enterprises and expansion in related activities have contributed to an increase in the indigenous energy and electricity demands. In 1999, Jordan consumed about $4.75 \times 10^6$ tons of oil equivalent (toe) compared with $4.49 \times 10^6$ toe during the previous year (Ministry of Energy, 2000a). While in 1980, the national energy consumption was $1.85 \times 10^6$ toe.

In this paper, a brief description of the Jordanian CAPSS and an overview of its energy consumption, as well as ways aiming to improve energy utilisation efficiency are presented. The analysis is based on a recent survey, on energy consumption in the CAPSS, which was designed and conducted in close cooperation with the Ministry of Energy and Mineral Resources

*Corresponding author. Tel.: +962-5-382-6600; fax: +962-5-382-6613.

*E-mail address:* jojaber@hu.edu.jo, jojaber@yahoo.co.uk (J.O. Jaber).

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(MEMR) during 1998 (Ministry of Energy, 2000b). This includes the collection of detailed data about the type and quantity of energy used for various needs, type of establishment and building characteristics, as well as the potential of using renewable energy as an alternative source. In total, 5565 establishments working on commercial basis or providing services to the public were surveyed, covering all provinces of Jordan. This investigation has resulted in new information for Jordan and considered as leading of its kind within the neighbouring Arab countries.

## 2. Energy consumption in Jordan

Jordan has abundant supplies of new and renewable energy sources, such as oil shale and solar energy. Nevertheless, crude oil has primarily dominated the Jordanian energy sector for the past four decades. It has been the chief energy source for economic and social developments. According to the results obtained from the latest survey, it was estimated that the annual rate of energy consumption in the CAPSS was approximately $422 \times 10^3$ toe, in 1998. This is equivalent to approximately 8.8% of the national primary energy consumption in that year (Ministry of Energy, 2000b). Table 1 shows the distribution of final energy demand for various types of petroleum products and natural gas that are consumed locally (Ministry of Energy, 1999).

In terms of an energy equivalent value, heavy fuel oil, diesel fuel and gasoline constitute more than 80% of all types of fuel consumed in Jordan. This is because heavy fuel oil is used in electric-power generation and large industrial plants. Diesel fuel is employed mainly for transportation, industry and to a lesser extent for space heating and agriculture. Final energy consumption, in Jordan, can be distributed among four main sectors: transportation, residential, industrial, and CAPSS—see Fig. 1. The term "others" in the figure includes agriculture and other minor sectors such as government and military consumptions. It is obvious that transportation is the largest energy consumer followed by the residential and industrial sectors. Energy mix used in the CAPSS is illustrated in Fig. 2.

Table 1
Fossil-fuels consumption in Jordan during 1998

| Fuel type | Consumption ($10^3$ ton)[a] | Primary energy equivalent ($10^3$ toe) | Percentage of total (%) |
|---|---|---|---|
| LPG | 242 | 271 | 6.0 |
| Gasoline | 530 | 552 | 12.3 |
| Jet fuel | 186 | 193 | 4.3 |
| Kerosene | 182 | 188 | 4.2 |
| Diesel fuel | 1233 | 1256 | 28.0 |
| Heavy fuel oil | 1991 | 1805 | 40.2 |
| Natural gas | $282 \times 10^6$ Nm$^3$ | 226 | 5.0 |
| Total | | 4491 | 100 |

[a] Except where shown.

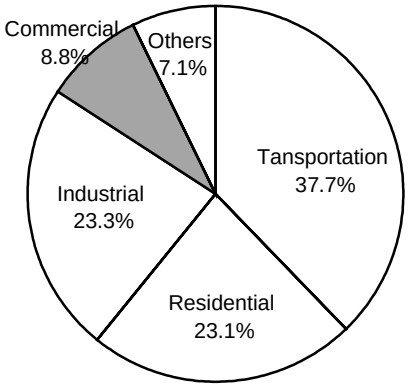


Fig. 1. Distribution of final energy consumption in main sectors.

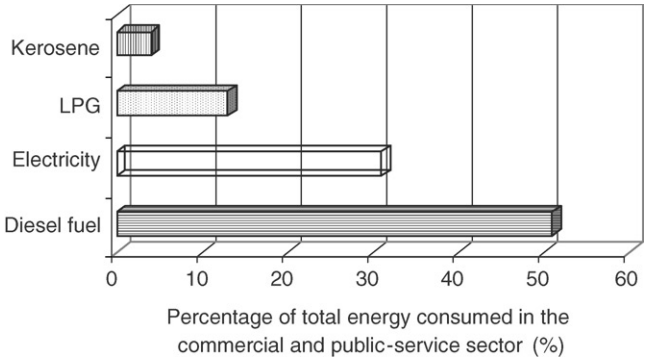


Fig. 2. Energy mix in the commercial and public service sector.

## 3. Description of the commercial and service sector

In 1999, there were about $4.5 \times 10^5$ buildings in Jordan, of which 6% being occupied for commercial and public service purposes (Department of Statistics, 2000; National Population Committee, 2000). This sector comprises of wholesale and retail trade; finance, insurance, real estate and business services; tourism and health care activities; and educational and training institutions. Around 20% of the total workforce in the country is employed in this sector (Department of Statistics, 2000; Ministry of Planning, 2000). The value added by this sector to the national GDP was about $1800 \times 10^6$US$, in 1998, representing 26% of the total GDP at producers prices (Central Bank of Jordan, 2000). The main indicators concerning Jordanian CAPSS are summarised in Table 2.

In 1998, full-time students formed more than one-third of the total population (Ministry of Education,

2000). Such a segment of the society is non-wealth creating, consumes significant resources, including energy, and requires the services of others. During the last three decades large developments occurred in the tourism, education and health care sub-sectors in terms of available capacity and the provided services, as presented in Table 2. On the other hand, this required huge financial investments, remitted mainly by the private sector and incurred adverse changes in land use.

## 4. Discussion and analysis

Among the factors affecting the rate of energy consumption in the CAPSS are usually: whether the building is heated and/or air-conditioned; building type and working hours; location and orientation; construction materials used; and type of heating and/or air-conditioning system being employed. The present investigation attempts to analyse energy consumption and its trends in the CAPSS, in Jordan, with regard to the type and quantity of energy being used for different operations and applications. The distribution of the various energy forms consumed in the CAPSS, during the year 1998, is shown in Table 3. It is clear that tourism, education and health sub-sectors account for most of the annual rate of energy consumption in the CAPSS. The latter consumed about 7.7%, in 1988, compared with 8.8%, in 1998, of the entire annual primary energy demand in the country (Ministry of Energy, 1989; Ministry of Energy, 2000b).

Fig. 3 shows the overall commercial sector energy consumption for the years 1988 and 1998. It is obvious that electricity is the dominant source of energy for this sector. For example, in 1988, electricity sharing ratio, including street lighting, was about 48.2% increasing to reach 60.8% of the total consumption of this sector in 1998. Electricity in the CAPSS is mainly used for lighting, air-conditioning, food storage and to lesser extent in food preparation and water heating. The latter is mostly employed in unclassified hotels, cafés and restaurants. Table 4 shows percentage of the air-conditioned and heated areas in different sub-sectors.

In 1998, LPG consumption showed a sharp increase, i.e. about 2.5 times of that for 1988, while kerosene consumption remained almost unchanged. This was most probably due to the increase in the kerosene unit-price, under the national energy-adjustment programme initiated in 1993, in order to reduce the subsidies, and to reflect more accurately its true economic cost. Meanwhile, with higher kerosene prices and the expansion in, especially tourism and health care activities, LPG has emerged as a more attractive fuel, mainly for cooking and heating purposes especially in unclassified hotels and restaurants, due to its reliability and cleanness compared with kerosene. This explains the high rate of LPG consumption in the tourism sub-sector. Also, because of the relatively low diesel fuel unit price compared with other available alternative fuels,

Table 2
Selected indicators about the commercial and service sector for 1970 and 1998

| Indicator | 1970 | 1998 |
|---|---|---|
| Population ($10^6$) | 0.8 | 4.9 |
| *Education* | | |
| No. of schools | 1529 | 4478 |
| Governmental | 1388 | 2787 |
| UNRWA | 120 | 198 |
| Private | 21 | 1493 |
| Ratio of students to teachers | — | 21.6 |
| No. of universities | 1 | 20 |
| *Tourism* | | |
| No. of classified hotels | 55 | 247 |
| No. of unclassified hotels | 45 | 175 |
| Average annual occupancy (%) | — | 60 |
| No. of arrivals ($10^6$) | 0.69 | 4.76 |
| No. of departures ($10^6$) | 0.70 | 4.57 |
| *Health care* | | |
| No. of hospitals | 27 | 84 |
| Governmental | 12 | 34 |
| Private | 15 | 50 |
| No. of admissions ($10^3$) | 28.0 | 248.25 |
| Beds annual occupancy(%) | — | 73.7 |
| No. of pharmacies | 50 | 1470 |
| No. of public clinics and health centers | — | 1221 |
| No. of private clinics | — | 1500 |

Table 3
Energy consumption in the commercial sector of Jordan in 1998

| Energy source | Annual consumption ($10^3$ toe) | | Estimated distribution of energy consumption in the commercial sector (%) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | All Jordan | Commercial sector | Tourism | Health | Education | Offices | Retail | Others | Street lighting |
| Diesel fuel | 1256 | 123.1 | 11 | 14 | 12 | 13 | 1 | 49 | — |
| LPG | 271 | 31.2 | 81 | 4 | 3 | <0.01 | 2 | 10 | — |
| Kerosene | 188 | 10.9 | 5 | 4 | 13 | 9 | 20 | 49 | — |
| Electricity | 1751 | 256.4 | 20 | 15 | 11 | 18 | 3 | 16 | 17 |
| Total | 3292 | 421.7 | | | | | | | |

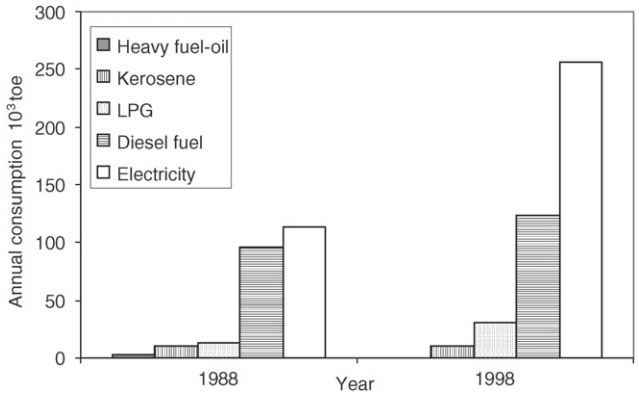


Fig. 3. Development of national consumption by the commercial sector according to the form of energy supplied.

Table 4
Air-conditioning and space heating in the main sub-sector

| Sub-sector | Surveyed area ($10^3$ m$^2$) | Air-conditioned area[a] (%) | Heated area[a] (%) |
|---|---|---|---|
| *Tourism* | | | |
| Hotels | 240 | 74 | 66 |
| Restaurants | 58 | 37 | 22 |
| *Health care* | | | |
| Hospitals | | | |
| Governmental | 110 | 18 | 98 |
| Private | 345 | 78 | 95 |
| Health centers | 42 | 5 | 55 |
| *Education* | | | |
| Universities | | | |
| Governmental | 829 | 0.07 | 74 |
| Private | 227 | 42 | 98 |
| Colleges | | | |
| Governmental | 197 | 0.01 | 39 |
| Private | 67 | — | 54 |
| Schools | | | |
| Governmental | 907 | 0.005 | 0.07 |
| Private | 15 | 0.08 | 51 |

[a] Represents that portion of the total area equipped with air-conditioning and/or heating systems.

especially heavy fuel oil, has become more popular during the last decade and energised central-heating systems for space and water heating, in the commercial and residential sectors. Its consumption increased, in absolute terms, and part of this increase was due to the substitution for heavy fuel oil, used to fuel steam boilers in some of the five-star hotels. However, diesel fuel sharing ratio dropped from about 40% to 29% of the overall consumption in the CAPSS, in 1988 and 1998, respectively. Heavy fuel oil utilisation also declined during the last few years because of associated problems with handling, storage and combustion of such a low quality fuel in relatively small boilers, as those used in hotels and trade centres.

It is obvious that a high percentage of hotels and a lower percentage of restaurants are heated during winter and being cooled in summer. But the use of air-conditioning and central heating systems in the tourism sub-sector are limited to those classified hotels and restaurants. While in the unclassified hotels or the widespread small restaurants, serving popular local food, it is rarely found that an air-conditioning unit or a central heating system being used. Nevertheless, conventional ceiling or wall mounted air-fans and portable LPG and/or kerosene stoves are widely used, during summer and winter respectively, in unclassified hotels and restaurants. Table 5 illustrates energy distribution within the tourism sub-sector.

In private hospitals the penetration of air-conditioning systems are high compared with those owned and operated by the state. In the latter the use of air-conditioning is limited to operation theatres, intensive care units and those hospitals located in hot regions, such as Aqaba and the Jordan valley. In these regions the average mean temperature during summer is about 35°C, however, temperatures of up to 50°C have been reported in the shade in mid-days of July and/or August (Meteorological Department, 1981-2000). On the other hand almost all hospitals are centrally heated as well as more than half of health centres and clinics. The remaining portion depends on portable LPG and/or kerosene space-heaters. LPG is mainly consumed in hospitals for food preparation and cooking—see Table 6. Similar explanation applies to the educational institutions. However, all public schools and those owned and operated by the United Nations' Relief and Works Agency (UNRWA), are neither heated during winter nor air-conditioned in summer. Moreover, some of the privately owned schools, and almost all universities, have reasonably good sports facilities, including in-door swimming pools, which are usually heated during winter season. Table 7 shows final energy distribution within education sub-sector.

A recent study was conducted in close-cooperation with a specialised energy consultant in order to investigate energy-thrift in the Hashemite University, showed that a net saving of between 15% and 20% of the annual energy consumption could be achieved by implementing economically justifiable measures (Energy Management Services, 2001). These include better thermal insulation, lighting replacement, boilers' tuning-up, better control and optimisation, operation and maintenance improvements. Most of these energy efficiency measures incur little or no capital-costs with an average simple payback period of less than 18 months. It is believed that the outcome of this study agrees fully with previous investigations carried out during the 1980s and 1990s, which concluded that up to

Table 5
Energy consumption in hotels and restaurants

| Source | Hotels | | Restaurants | | Total |
|---|---|---|---|---|---|
| | Classified | Unclassified | Classified | Unclassified | |
| Diesel fuel (ton) | 12,571 | 289 | 249 | 40 | 13,149 |
| Kerosene (ton) | 17 | 115 | 179 | 209 | 520 |
| LPG (ton) | 5585 | 66 | 4646 | 12,339 | 22,636 |
| Electricity (MWh) | 68,283 | 3351 | 21,294 | 87,227 | 180,155 |

Table 6
Energy consumption in the health care sub-sector

| Source | Hospitals | Health centers | Medical labs | Clinics | Total |
|---|---|---|---|---|---|
| Diesel fuel (ton) | 15,804 | 1127 | 26 | 147 | 17,104 |
| Kerosene (ton) | 24 | 388 | 2 | 37 | 451 |
| LPG (ton) | 1114 | 4 | 11 | 29 | 1158 |
| Electricity (MWh) | 124,636 | 14,836 | 1050 | 881 | 141,403 |

Table 7
Energy consumption in education sub-sector

| Source | Universities | Community colleges | Schools | Total |
|---|---|---|---|---|
| Diesel fuel (ton) | 11,856 | 1088 | 1362 | 14,307 |
| Kerosene (ton) | 17 | 48 | 1302 | 1367 |
| LPG (ton) | 205 | 52 | 504 | 761 |
| Electricity (MWh) | 58,235 | 4420 | 4750 | 67,405 |

20% of the consumption of the commercial sector could be saved (Ministry of Energy, 1991; Jaber et al., 1993; Aburas, 1989). At present rates of the national consumptions and crude oil prices, this ratio corresponds to a minimum of about $15 \times 10^6$US$ annually, excluding conversion and distribution costs. Such an energy saving ratio can be higher when advanced energy systems, e.g. combined heat and power (CHP), are employed locally. Although, the estimated savings are not high as compared to other sectors, such as transport or industry, but these can be considered as nearly guaranteed, because of the easiness and financial attractiveness of the proposed energy efficiency measures. Equally important is the limited number of large consumers, such as hotels, hospitals and universities, which would make the implementation and follow up processes straightforward.

Electricity consumption, in this sector, is considered to be relatively high due to the excessive lighting and heavy use of air-conditioning and ventilation systems as a result of the hot and dry climate during summer. For example, it was found that the artificial lighting intensity range between 30 and 50 $W m^{-2}$, compared with average acceptable level of about 10–20 $W m^{-2}$ for such buildings (Energy Management Services, 1997). The vernacular ways of cooling buildings, by means of natural ventilation increasingly have tended to be ignored, recently. This can be attributed to the fact that attention has been focused on the visibility and facade of buildings rather than the optimal and passive designs. More importantly, the low unit price of electricity and lack of technical knowledge and public awareness encouraged designers and builders not to apply energy conservation and management techniques (Jaber, 2001). It is important that we should return to using the traditional means of achieving thermal comfort.

One of the most crucial findings of the commercial and public services energy survey is that advanced energy systems, such as CHP, heat pumps, thermal storage and energy management systems in buildings, are not used in Jordan, yet. These when employed properly can significantly reduce the primary energy use per unit of energy consumed by the final user, with consequent reductions in pollutant emissions. For example, effective and economic modern systems, in Europe, are testament to the popularity and environmental benefits of such technologies that are available in the market (Ager and Newborough, 1998; Building Research Establishment, 1998a-e). Hotels, hospitals, sports and social clubs, commercial centres and universities are excepted to have good potential for CHP and other energy efficient technologies. However, this requires specific energy studies in order to evaluate the feasibility of such systems, considering the prevailing local conditions including energy prices.

Solar water heating systems are popular in Jordan and the solar domestic water-heating industry is well

Table 8
Assessment of energy saving opportunities and their direct costs

| Opportunity | Expected savings ($10^3$ ton) | Estimated cost ($10^6$US$) | $CO_2$ reduction potential ($10^3$ tons $yr^{-1}$) |
|---|---|---|---|
| Efficient street lighting | 2.5 | 5.0 | 8 |
| CFL lighting | 20.0 | 10.0 | 65 |
| CHP | 10.0 | 9.0 | 30 |
| Boilers' efficiency improvement | 8.0 | 0.1 | 25 |
| Modern energy management systems and control | 10.0 | 1.0 | 30 |
| Total | 50.5 | 25.1 | 158 |

developed. By 1998, about 25% of dwellings, i.e. $2.3 \times 10^5$ homes, had been fitted with individual solar water-heaters (Ministry of Energy, 1999). Although, only a limited number of commercial enterprises are equipped with solar water heating systems. This is mainly because to date little effort has been made locally in order to exploit the free and clean solar insolation. Under the government's adopted energy-pricing policy there is no special arrangement or privilege for investors to encourage the use of renewable energy. Thus, even the most cost-effective local renewable energy source is not competitive compared with equivalent conventional systems. So, in addition to the use of fossil fuels for water and space heating, renewable energy technologies should be considered for all sectors, where their financial attractiveness is rising compared with other conventional energy systems. Such an approach has several advantages: the diversity of energy source, less dependence on imported oil, decrease pollutant emissions to the environment and help the economy to grow at higher rates.

Many opportunities exist to improve the energy efficiency, in Jordan, both on the supply and the demand sides. In the latter, improving the designs and choice of boilers, air-conditioning systems, temperature controls, thermal insulation and lighting represents a major opportunity for reducing energy consumption in the CAPSS. The preliminary estimates of introducing energy efficiency options showed that it would be possible to save at least 10–15%, i.e. approximately $50 \times 10^3$ toe, of the annual energy consumption in this sector—see Table 8. The basic assumptions used in this abstraction from reality are:

- Prices are fixed with zero inflation and fuel prices are current prices in the local market.
- Local electricity tariff is unchanged.
- No considerations, such as political, legal or ethical issues, would affect the current analysis.
- Published government's energy policy remains unchanged, especially with relation to energy conservation and development of renewable energy sources.
- CHP units and advanced energy management systems will be installed in large hotels, hospitals, commercial centres and clubs, where their financial performance are very attractive.

Of such estimated savings about 50 MW of the maximum electricity demand can be avoided, as a result of lighting and air-conditioning improvements as well as implementation of a range of demand side management options. This will reduce demand during peak periods and help in postponing and/or minimising future planned expansions in power stations. In general, it is a proven fact that the investment in energy saving is much more cost effective than that for adding the same requested capacity. But this requires carrying out a series of detailed energy audits for different types of existing commercial buildings in Jordan. The prime objective of these field studies should be concentrated on defining the most suitable energy efficiency enhancement measures and estimate both the possible savings ratio as well as investments needed.

## 5. Future demand and energy management

Energy demand can either be closely linked to macroeconomic activities or based on detailed inventories of consumption for specific energy technologies. It may be inaccurate to relate any increase in energy and/or electricity consumption to economic growth. Because the Jordanian economy does not rely predominantly on the industrial sector; it is more dependent on tourism, provision of services and transfers from abroad, which are subject to stability within the region. For example, during the last 2 years the number of tourists dropped compared with mid 1990s. The main reason behind this is the political and sometimes armed conflicts in the Middle East. Thus, it is hard to predict the exact growth rate of the national energy and electricity consumption.

In aggregate, CAPSS is responsible for about 9% of the total energy used in Jordan. But it consumed approximately 15% of electricity generated and it is responsible for a significant ratio of the system's peak demand (National Electricity Co., 2000). These ratios are expected to rise following any increase in the commercial activities, especially in retail shops, tourism and health care services. Currently, it is hard to make assumptions regarding the future consumption due to prevailing unstable political conditions within the whole region. However, in general terms, electricity will continue to be the major source of energy in this sector. Thus, the effect on the system load profile will become

more noticeable. Also, there is no specific regulation regarding working hours for all types of shops. Furthermore, all enterprises classified as commercial do not pay any charge, in their monthly electricity bill, due to working during peak demand periods. Having a low base to peak load ratio system is very expensive because of the extra generating capacity, which has to be installed to satisfy peak demand, is under-utilised for most of the day. At present, there is an additional reserve of about 25%, i.e. 300 MW, but as the commercial demand is increasing at high rates, there will be a need for new generating units in the near future. Thus, the MEMR and all electrical companies, working in the generation and distribution, should consider implementing a range of demand side management options. With the prime aim of reducing the system's maximum demand in order to postpone and/or minimise future planned expansions in the capacity of power plants. It is a proven fact that the investment in energy saving is much more cost effective than that for adding the same requested capacity, especially when it comes to lighting.

Energy savings are almost impossible to achieve when inexpensive energy prices prevailed. Currently, the national unit electricity price is relatively low compared with international retail price standards, but can be considered acceptable in relation to average income. While, at present, there may be little incentives for commercial enterprises to conserve energy, it would be possible that those who actually need to reduce monthly electricity bills, may be more responsive to energy conservation and demand side management programmes. The best way is to adopt targeted programmes for energy thrift in specific areas, such as thermal insulation, passive design of buildings, utilising solar heating, boilers' air–fuel ratio calibration, efficient lighting, thermal storage, advanced energy systems and introducing energy management systems accompanied by cost-reflective energy tariffs. This is because incentives are very important in achieving significant energy and environmental improvements. Finally, access to more efficient lighting and appliances, which is usually more expensive to buy, can benefit the electricity demand profile and contribute towards a cleaner environment. For example, energy saving lamps can be purchased in the local market with a first cost of between 6 and 10 times of equivalent incandescent pulps. Therefore, again the MEMR as well as electricity distribution companies should provide financial and technical assistance to encourage energy end-users, in all sectors, to employ the latest technologies. It has been estimated that the CAPSS was responsible for generating about 5.5% of the national $CO_2$ emissions, during 1998, due to energy use, i.e. as a result of burning fossil fuels for various applications. In the future, this ratio will rise following any increase in energy consumption in this sector if current conditions and technologies remain unchanged.

Energy efficiency should be promoted at the highest decision-making level in order to meet long-term energy demands and a comprehensive energy-thrift strategy must be established as a main element in the national energy plan. This should take into account the fuel mix and technologies being employed in the different economic sectors. It should include also periodic auditing studies, create incentives to encourage energy conservation programmes, introduce technical training and public awareness programmes and encourages private-sector participation to invest in energy conservation and renewable-energy programmes.

## 6. Conclusions

The total energy consumed by the CAPSS accounted for about 8.8%, in 1998, of the final energy consumption in Jordan. In addition to electricity, the main fuels that are used in this sector are diesel, LPG and kerosene. These sources of energy are primarily used for lighting, air-conditioning, running various types of appliances, space and water heating and cooking. Diesel is the most popular fuel for space heating, while LPG is mainly used for cooking, in restaurants and hotels, and to lesser extent in portable and unvented stoves. Tourism, health care and education sub-sectors are major consumers of various forms of energy that are used in the commercial sector.

At present, there is no information available regarding energy consumption and performance of the individual or different types of commercial buildings. But it is expected that many opportunities exist to improve the energy efficiency in this sector, with a net saving ratio of about 10–15%. These include primarily, and not limited to, improving the design and selection of boilers, air-conditioning and ventilation systems, temperature controls, thermal insulation and lighting. The advantages of such schemes include: reducing the burden on the economy through raising the efficiency, creating more jobs for engineers and the skilled workforce, decreasing emissions to the environment and less capital investment being needed for future energy supply projects. Also, energy savings programmes would increase profitability of commercial enterprises due to reduced energy bills. However, there is an urgent need to conduct detailed energy audits for various types and usage of existing commercial buildings in Jordan. The prime objective of such field studies should be concentrated on defining the most suitable energy efficiency enhancement measures and estimate both the possible savings ratio as well as needed investments. Finally the authors believe that this analysis has resulted in new

information for Jordan and can be applied to similar sectors in the neighbouring countries.

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