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Short Communication

The impact of the daylight saving time on electricity consumption—A case study from Jordan

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ABSTRACT

The paper examines the impact of daylight saving time (DST) on electricity consumption in Jordan. Two types of analysis were done: the first analysis examines the impact of DST on the lighting loads based on a survey study made for residential and commercial sectors. The second examines the impact of DST on the over all electricity generation through analyzing the daily load curves (DLCs) before and after the DST onset and removal in 2000 and 2007. The results show that the application of DST during the year 2000 saves the electricity used for illumination by −0.73% but it increases the overall generation at the onset and removal of DST by 0.5% and 1.4% due to increase in the heating and cooling loads. The analysis of DLCs during the year 2007 shows similar effects as in the year 2000 except during the early morning period at the DST onset where DST decreases the demand during this time. The analysis shows that DST decreases the electricity demand at DST onset by 0.2% and increases it at DST removal by 0.3%. A possible decrease in the electricity consumption may take place if the DST is implemented from April to end of August.

1. Introduction

One of the biggest reasons behind changing the clocks to daylight saving time (DST) is that to save electricity. Generally, the demand for electricity for lighting homes is directly connected to when the householders go to bed and when they wake. With the implementation of DST in any country, the clocks are adjusted forward one hour starting from beginning of spring until autumn. Therefore, more daylight hours are obtained during the afternoon period while less daylight hours are obtained during early morning period. By adding daylight hours to afternoon time may help in utilizing the natural sunlight instead of electricity (Kissell, 2007). In spite of the long history of DST as a conservation policy in more than 70 countries worldwide, little research has been conducted to determine whether DST actually saves energy or not, the current research on the effect of summer time on electricity consumption suggests that the evidence up to date is inconclusive (Kotchen and Grant, 2008).

Kotchen and Grant (2008) used the residential micro-data approach to estimate an overall DST effect on electricity consumption in India. The results show that the application of summer time can save the electricity used for illumination only but it increases the electricity used for heating and cooling systems. Kotchen and Grant (2008) found that the latter effect is larger than the former effect with overall increase in residential electricity demand by 1–4%. This costs the Indian households an average of $3.19 per year in increased electricity bills which aggregates to approximately $8.6 million over the entire state. Kellogg and Wolff (2007) examined the impact of the extension of DST during the 2000 Sidney Olympic Games between 15th September and 1st October 2000. The results show that the DST extension increases the electricity consumption in morning and decreases the demand in the evening. Rock (1997) used an engineering simulation model and found evidence that DST might increase rather than decrease the electricity consumption.

Fong et al. (2007) used a simulation model to investigate the effects of DST on household lighting in Japan and found that DST causes a reduction in electricity consumption that varies from one location to another. Shimoda et al. (2007) conducted a similar experiment with the added consideration of DST's effect on residential cooling. The study showed that the implementing of DST results in a 0.13% increase in residential loads and an increase in the residential loads during the evening LT than during the morning LT. The implementing DST creates an additional hour of higher outdoor air temperature and solar radiation during the primary cooling times of the evening (Shimoda et al. 2007). California Energy Commission (Kandel and Metz, 2001; Kandel,

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2001) conducted a simulation-based study to examine the effects of DST on statewide electricity consumption. The results show that the implementation of DST between May and September does not reduce the electricity consumption but it increases it by 0.5%. A possible decrease in the consumption with a value of 0.15–0.3% may take place if the DST is implemented between April to October.

This paper investigates whether the implementation of DST in Jordan between April and September 2000 saves energy. Two types of measurements were employed in the analysis; the first was to determine the saving of the lighting loads (in GWh) in residential and commercial buildings due to utilizing the natural sunlight instead of electricity. The second analysis was to examine the impact of DST on the overall electricity consumption in the country through comparing the average daily load curves (DLCs) for several days before and after the DST implementation. The starting and ending dates of DST system for the period from 2000 until 2008 are summarized in Table 1. As shown in table, the DST onset during this period was always near the end of March and beginning of April (between 26th March and 1st April) while the DST ending varies from year to year which is between 26th September to 31st October 2008. Starting from 2003, the end of DST application was shifted from end of September to middle and end of October. The paper is organized as follows: Section 1 introduces the paper, Section 2 presents the measurement of daylight saving time durations and Section 3 presents the results and discussion followed by the conclusion.

Table 1
The start and the end date for the DST system in Jordan during the period from 2000 until 2008 (http://www.timeanddate.com).

Year	Start date	End date
2000	Thursday, 30th March	Thursday, 28th September
2001	Thursday, 29th March	Thursday, 27th September
2002	Friday, 29th March	Thursday, 26th September
2003	Friday, 28th March	Friday, 24th October
2004	Friday,26th March	Friday, 15th October
2005	Friday, 1st April	Friday, 30th September
2006	Friday, 31st March	Friday, 27th October
2007	Friday, 30th March	Friday, 26th October
2008	Friday, 28th March	Friday, 31st October

2. Determination of the daylight saving durations induced by DST system

The DST system implies optimum utilizing of the natural light instead of electricity. This can be obtained by adjusting the clocks one-hour forward starting from spring until autumn. Therefore, more daylight hours can be obtained during the afternoon period while less daylight hours are obtained during early morning period especially during beginning and end of DST. The amount of the daylight saving due to this process depends on the sunrise and sunset time as well as on the time when the customers go to bed and when they wake in the morning which varies from one country to another. For Jordan case, the waking and sleeping time are assumed to be at 6:00 am morning and 23:00 pm night. Fig. 1 presents the sunrise and sunset times obtained from online time and date data for the year 2000 (http://www.timeanddate.com) with the proposed awaking and sleeping time are superimposed in the same figure. As shown in the figure, the implementation of DST system from beginning of April until end of September does not affect the length of daylight hours; only a jump of one hour occurs in the sunrise and sunset times during the implementation period. Fig. 1 shows that the daylight duration which is the duration from sunrise time to sunset time is shorter during winter months than during summer months. During the early morning periods, the assumed awaking time at 06:00 am intersects with the sunrise time. The difference between the two times varies from one month to another where it can be positive or negative. It is also shown that during the winter months including January, February, November and December, the awaking time occurs before the sunrise time while starting from April until September, the awaking time occurs after sunrise time except for few days after the DST implementation in April and before DST end in September as clearly seen in Fig. 1. Due to the one-hour jump in the sunrise time an increase in the night times hours is obtained

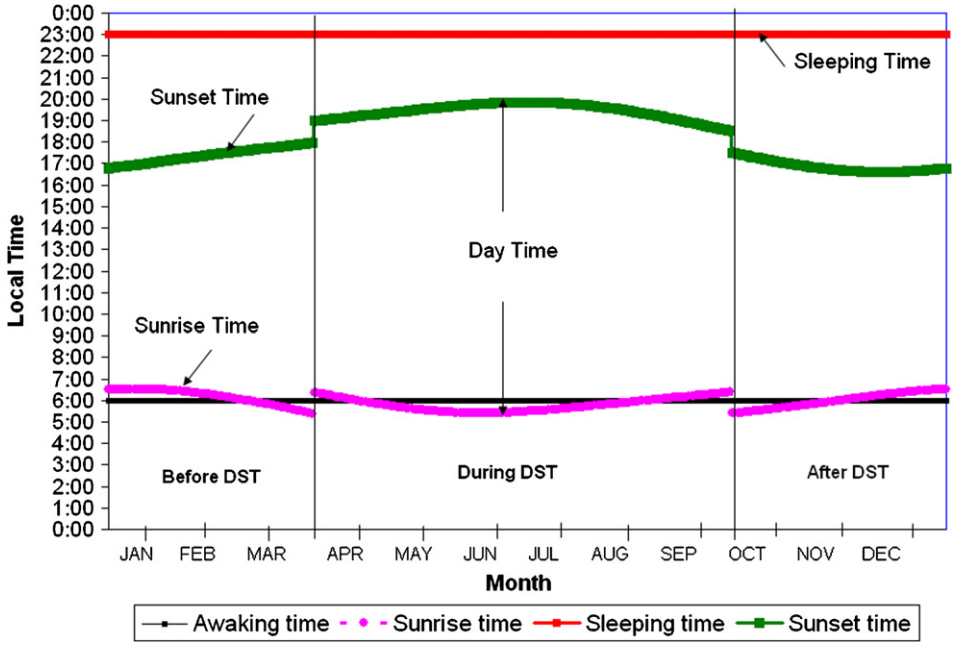

Fig. 1. The times of sunrise and sunset in Jordan before and after the DST implementation with the assumed time for awaking and sleeping householders.