ELECTRICITY SAVINGS FROM EARLY DAYLIGHT SAVING TIME

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Synopsis: There is no clear evidence that electricity will be saved from the earlier start to daylight saving time on March 11, but the 7 p.m. peak load will probably drop on the order of 3% for the remainder of March, lowering capacity requirements. This could be negated by a new morning spike as it was in Australia in 2000, but that appears unlikely. In any event, capacity constraints usually do not occur in March and early November.

Summary: In 2000 and 2001, the Energy Commission created simulations to model what would happen to electricity use if Daylight Saving Time (DST) began early. The simulations examined how electricity use would respond to newly darker and cooler mornings using cool dark winter mornings as a reference point, and how electricity use would respond to lighter and warmer evenings by looking at those in the summer. Implicit in the model is the assumption that people maintain their daily schedules rather than change wake-up or work hours in response to either changing seasons or Daylight Saving Time.

We found that if people do maintain their daily schedules then spring and fall Daylight Saving Time extensions would probably cause a 2 to 5% drop in the evening peak load. Meanwhile, morning electricity use would grow some, but probably not enough to offset evening savings. The net effect is small and uncertain: a best guess of total net energy savings is on the order of ½ of one percent, but savings could just as well be zero. Moreover, our statistical analysis leaves us with one chance in four there could be a very small increase in electricity use.

The possibility of an increase in electric use is not just academic. A recent study of the impact of DST in the state of Victoria Australia found that when DST came 2 months early for the 2000 Olympics, residents of Victoria experienced a sharp morning spike in electricity use resulting in an overall increase in consumption and peak load.

There are reasons, however, to question the applicability of Victoria's experience to California. Victoria advanced DST to late August (like our late February) , so Victorians were awakening on darker and probably colder mornings than Californians will experience in mid March. This will create more demand for early morning lighting and possibly room heating.

In addition, Victoria already showed a small morning peak during normal DST transition times, something California has not shown. So it seems Victorians are naturally more likely to peak their electricity use in the morning than Californians are – possibly starting their work hours more uniformly because they have shorter commutes. Meanwhile, Californians have dropped their evening peak load during normal DST transition times, as have Victorians.

In summary, it seems very likely that our peak load will drop in the evening, possible that we will save a fraction of a percent of total electricity use, and possible but not very

likely that we will see a morning electricity spike that would negate evening savings. Still, California might want be prepared for a possible morning mini-peak as it makes forecasts for electricity needs. Victoria's failure to prepare for its morning peak caused morning price spikes.

Technical details follow.

If Schedules Change with Clock Time

Insofar as people keep the same wake-up and work schedules in winter and spring, we can predict their energy use on the newly dark and cool March mornings caused by early DST, based on how much energy they use on similarly dark and cool January and February mornings. We use statistical analysis to find how energy use relates to warmth and light at each hour of the day, and apply the results to predict energy use during the newly cool and dark morning hours or the newly warm and light evening hours.

Using this approach, we find that for the weeks of March newly subjected to Daylight Saving Time, evening peak will drop between 2 and 5 percent. During the winter and early spring, businesses are still open when darkness and cooling temperatures cause people start to start turning on residential lights and heaters, and street lighting goes on. Electricity is used doubly – in homes and businesses – creating an evening spike in electricity use that lengthening days will dampen. Daylight Saving Time can hasten that dampening. This is why simulations for March Daylight Saving Time show a reduced evening peak (Figure 1):

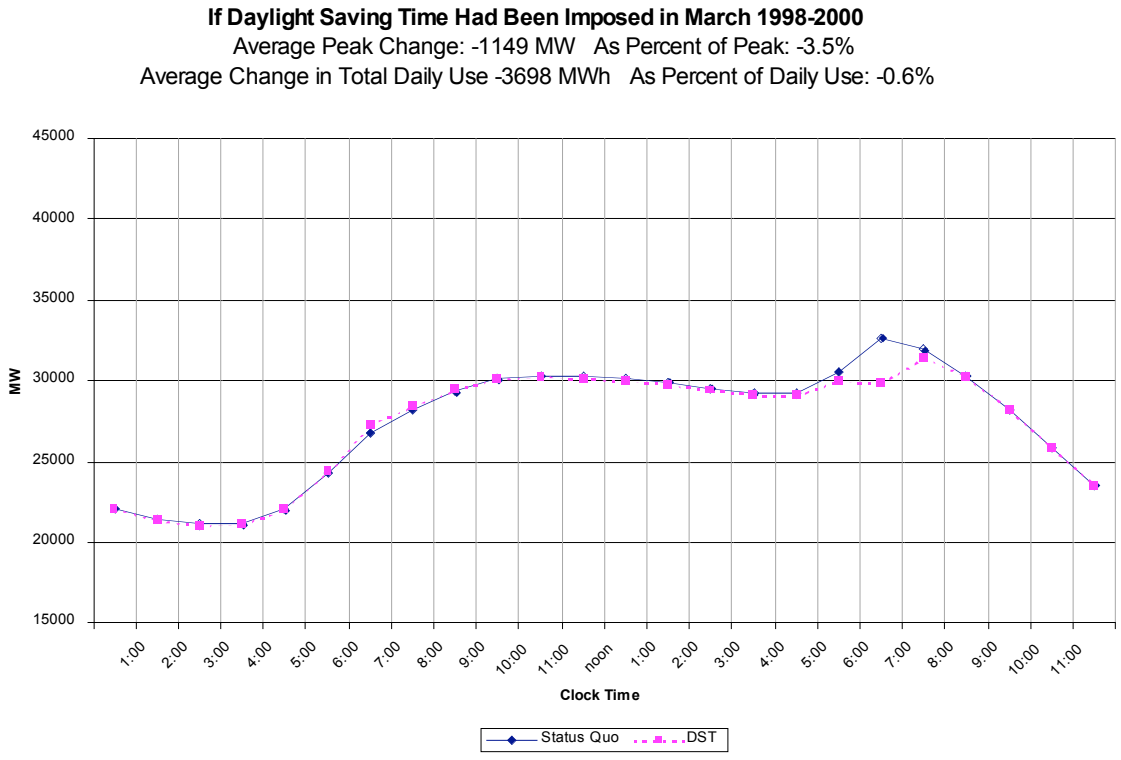

Figure 1. Simulation for March Daylight Saving Time. The pink dotted line shows simulated load shape under early Daylight Saving Time.

Extending Daylight Saving Time a week into November would have similar but smaller results, perhaps a 2.5 percent rather than 3.5 percent drop in peak.

While the evening peak would drop, effects on total electricity use are uncertain, statistically. The point estimate of savings is 0.56% but we are only 52% confident the total electricity change is nonzero. Furthermore, 95% confidence intervals around electricity use stretches from 2.2% savings to a 1.1% increase.)

When the state of Victoria in Australia advanced spring Daylight Saving Time by two months in 2000 to accommodate the Olympics, people created a new morning peak load that negated all benefits of the reduced evening peak load (Kellogg and Wolff, 2007). Figure 2 compares South Australia without the change in DST on the left to Victoria with the change in DST on the right. The red curve on the right representing Victoria in 2000 shows a new morning spike. (The spike is not caused by the Olympics: Kellogg and Wolff removed times and locales associated with Olympics activity in their statistical analysis.)

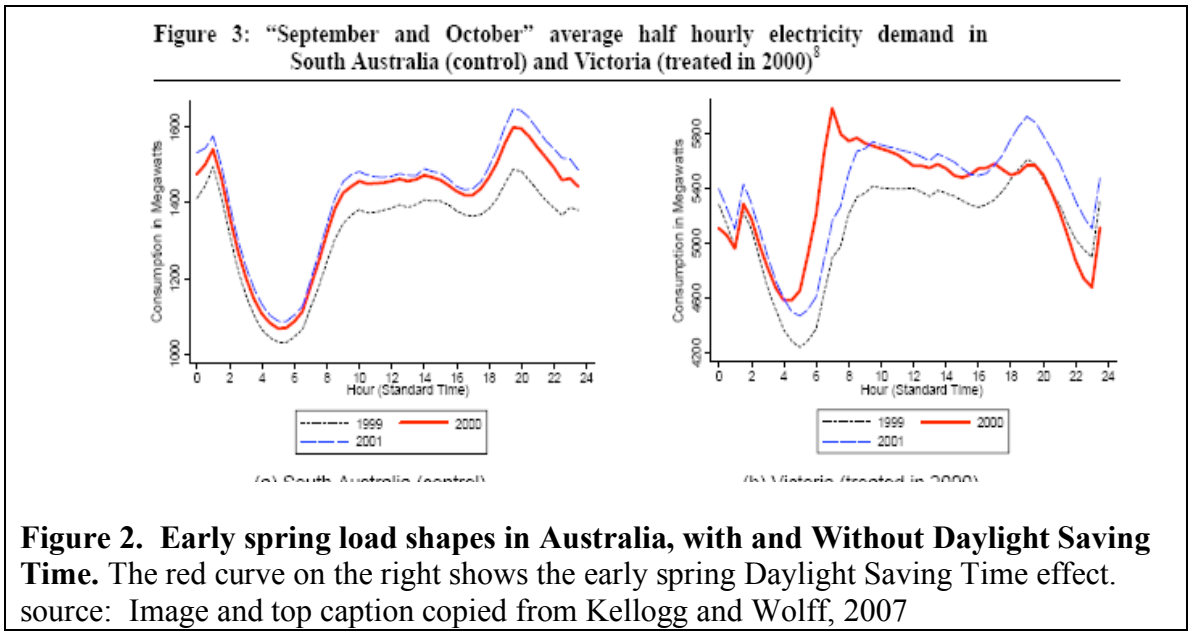

Figure 2. Early spring load shapes in Australia, with and Without Daylight Saving Time. The red curve on the right shows the early spring Daylight Saving Time effect. source: Image and top caption copied from Kellogg and Wolff, 2007

This new morning spike was *not* predicted using the simulation method we applied for California, which Kellogg and Wolff tested on Australian data. Contrary to simulation assumptions, people did seem to awaken earlier in the spring than the winter, or at least use more early morning energy in the spring than they would in comparably dark and cool winter mornings. Therefore, the fact that our simulation showed no morning peak does not guarantee Californians will experience no morning peak when we advance DST to March 11 this year.

That said, we have no evidence that Californians will experience a morning peak like Victorians did. Unlike Californians, Victorians already experienced small morning peaks after DST normally ended (Figure 3). Californians have not created a morning peak in past transitions to Daylight Saving Time (Figure 4), even though our transitions have been earlier in the spring than Victorian transitions.

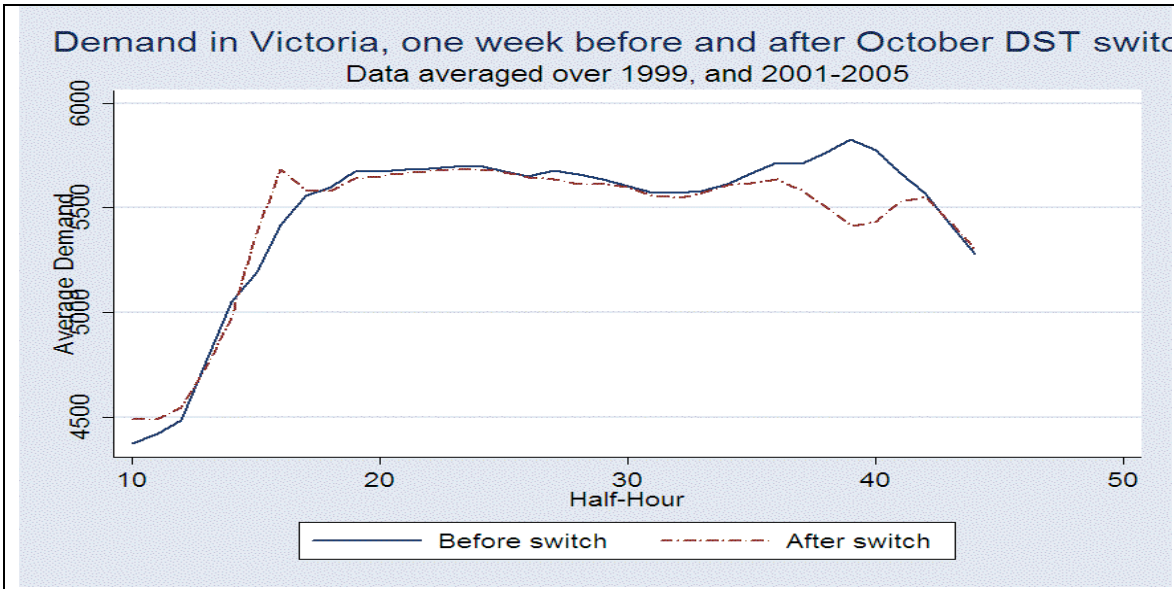

Figure 3. Early spring load shape in Victoria, Australia before and after normal switch to DST. Prepared by Ryan Kellogg.

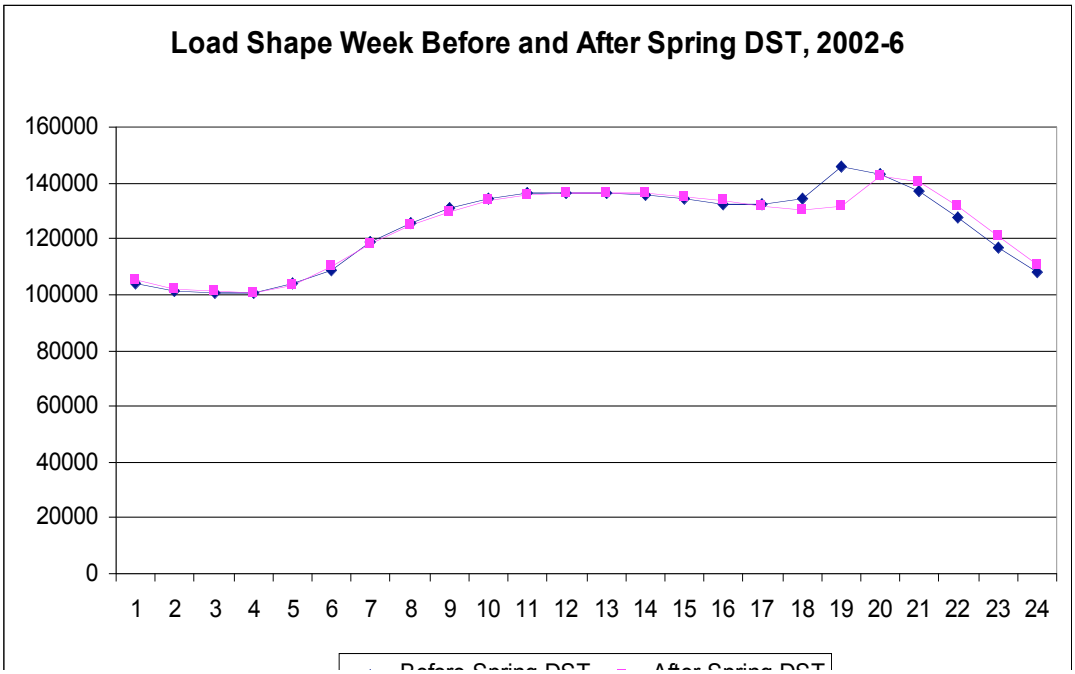

Figure 4. Early spring load shape in California before and after normal switch to DST.

In addition, the Victoria "experiment" moved DST to when the sun was already rising as late as 6:50 a.m. (their late August, like our February). Suddenly the sun was rising at ten minutes to 8 and almost everybody had to turn on their lights. Temperatures were likely still cool early in the morning, and people may have turned on electric room heaters rather than keeping central heating systems on all day and night. In contrast California residents will be facing 6 to 6:30 a.m. sunrise during a warmer period before March 11 DST hits and delays that sunrise to 7 to 7:30 a.m. Visibility precedes sunrise by over half an hour, so fewer Californians than Victorians will need to turn on lights. In addition, a comparison of the load shape graphs above suggests Victorian load increases and peaks earlier in the day than Californian load, perhaps in part because Victorians spend less time commuting.

Population Center	Latitude	DST Begins Normally			Changed DST Beginning Time		
			Sunrise (a.m.)	Sunset (p.m.)		Sunrise (a.m.)	Sunset (p.m.)
Melbourne	37°34'S	29-Oct	7:10	7:52	27-Aug	7:51	7:22
Sacramento	38°34'N	1-Apr	6:51	7:20	11-Mar	7:24	7:09
Los Angeles	34°5'N	1-Apr	6:41	7:29	11-Mar	7:10	6:58
San Francisco	37°46'	1-Apr	6:55	7:33	11-Mar	7:27	7:13

Table 1. Sunrise and Sunset (standard time) in California cities vs. Melbourne Australia. Melbourne is at a similar latitude to San Francisco, with similar sunrise and sunset times during the normal DST transition. The "changed DST beginning time," however, is more radical than ours will be, starting 2 months early instead of 3 weeks.

Table 1 above shows sunrise times just after DST begins as well as during the Olympics experiment in Australia and the coming March 11 DST in California. Because March 11 Daylight Saving Time will cause some people to rise to less sunlight than usual, we cannot rule out the morning spike the Australians saw. We can expect it to be less steep if it materializes, however.

Meanwhile, what can the California comparisons of electricity use before and after Daylight Saving Time transitions tell us? On average, from 2002 to 2006, Californians used 0.8 percent less electricity in the first week of spring DST and the last week of fall DST, as compared with the Standard Time weeks adjoining them. They also had an evening peak 7 percent lower. These numbers should be viewed more as upper bounds of savings than estimates for two reasons: 1) day length changes by 15 minutes over the 2-week period used in the comparison, and 2) the sample size of 5 springs and 5 falls is too small for meaningful statistical inference.

References

California Energy Commission Publication 400-01-013, May 2001, "Effects of Daylight Saving Time on California Electricity Use", written by Adrienne Kandel and Daryl Metz. http://www.energy.ca.gov/reports/2001-05-23_400-01-013.PDF

Kellogg, Ryan and Hendrik Wolff, January 2007. "Does Extending Daylight Saving Time Save Energy? Evidence From an Australian Experiment." Center for the Study of Energy Markets Working Paper 163. University of California Energy Institute. http://www.ucei.berkeley.edu/PDF/csemwp163.pdf