How Much Can a Campus Save on Utility Bills By Turning a 5-Workday Week Into a 4-Workday Week?

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ABSTRACT

The recent budget cuts campaign mandated by the governor's office had all state agencies in Texas looking for ways to reduce revenue spending. One of the cost savings opportunities perceived by many university officials is to convert a typical 5-workday week into a 4-workday week (e.g., Monday to Thursday) with 10 working hours each day during the universities summer session. The potential savings come from the fact that the universities can be partially shut down during the prolonged weekends (Friday to Sunday). It is believed that the savings from partially shutting down an extra workday is much more significant than the marginal energy increase caused by the extended working hours during workdays.

This paper analyzes the potential energy cost savings of this approach for three real cases. The savings can be largely estimated by comparing whole-campus electricity consumptions between typical weekdays and weekends (or holidays). Energy overheads caused by the extended working hours (two more hours per working day) were also estimated. A limited shutdown scenario (similar to a typical weekend schedule) and a more aggressive shutdown scenario (similar to a typical holiday schedule) during the weekend periods are presented. The potential savings opportunities were from 0.32% to 1.53% of the annual electricity bills for different universities.

INTRODUCTION

Several universities within the Texas A&M University Systems were investigating the possibility of utility energy savings by switching from a typical 5-workday week to a 4-workday week during the university's summer session (June – August). The four working days are Monday through Thursday, 10 hours a day. By converting Friday from a typical weekday to a weekend day, the university will shut down most of the entire campus during the 3-day weekend, just like a long holiday (Christmas Break).

Potential savings were estimated for three universities – Texas A&M University at Corpus Christi, Prairie View A&M University and Texas A&M International University, to help university officials make decision as whether it is worthwhile to take this approach in an effort to cut utility expenditures.

CASE STUDY I – TEXAS A&M UNIVERSITY AT CORPUS CHRISTI

Texas A&M University – Corpus Christi (TAMUCC) has a total conditioned area of approximately 1 million square feet, with a total annual electricity bill of nearly $1.5 million in the year of 2002. The summer months applicable for 4-workday weeks are June, July and August.

The weighted average electricity price during this period is $0.0457/kWh from Monday to Friday, and $0.0359/kWh for Saturday and Sunday, based on the current electricity utility contract between the university and the utility company.

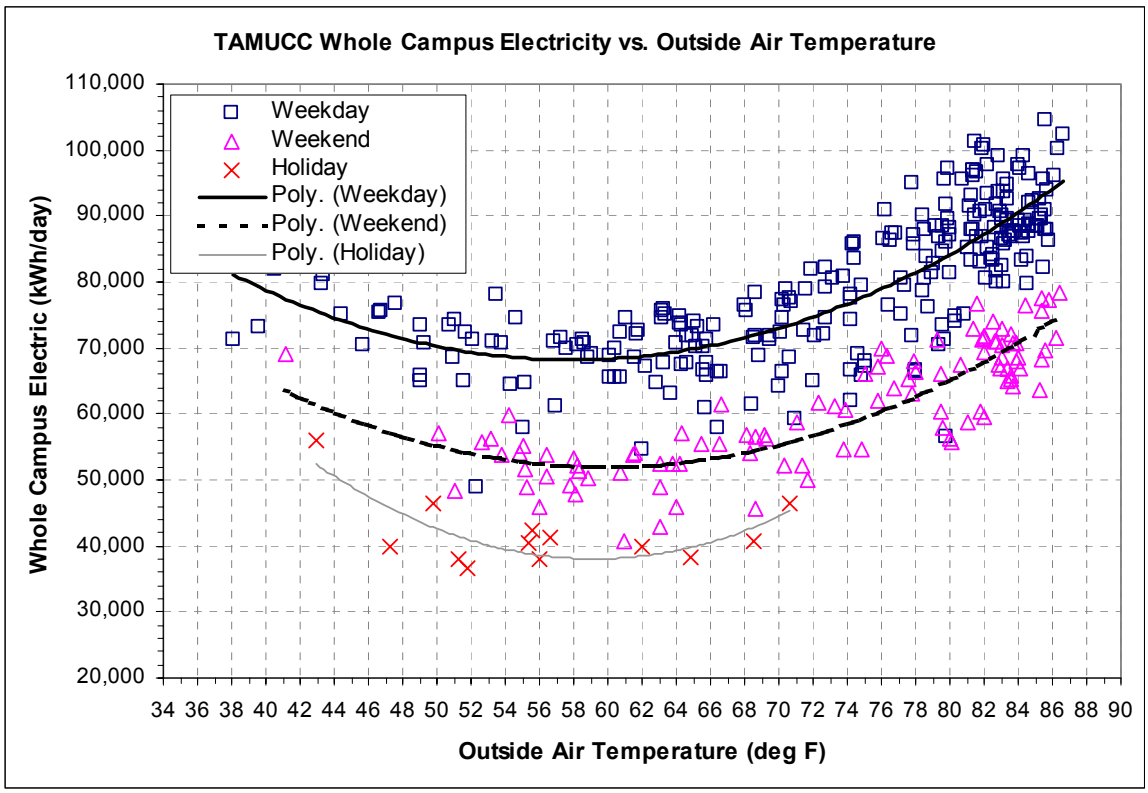

Figure 1. TAMUCC Daily campus electricity consumption for weekdays, weekends and holidays

Figure 1 shows the whole campus electricity (WCE) consumption (daily) profiles for weekdays, weekends and holidays. Daily WCE difference between a typical weekday and a typical weekend is around 20,000 kWh; Daily WCE difference between a typical weekend and a typical holiday is around 10,000 kWh; Daily WCE difference between a typical weekday and a typical holiday is around 30,000 kWh.

Interestingly, the prolongation of 2 hours during the working days (Monday through Thursday) probably will not increase the campus' HVAC load substantially. Most of the air-handing units had been operated from around 6:30 a.m. to 10:30 p.m. anyway though the working hours were from 8:00 a.m. to 5:00 p.m. Upon switching to the 4-working-day week schedule, operating schedules for most air-handling units schedules will remain unchanged for the 10-hour working days.

Activity related electricity consumption (lighting, computers, printers, and other plug loads) during the four working days (Monday to Thursday) would be slightly higher than the current level due to the prolongation of the working hours. Assume that 25% of the campus lighting and other plug loads (mainly offices) would need to run 2 more hours per working day, or 8 hours a week, and that the average campus office lighting and plug loads is 2 Watts per square foot. For a total campus area of approximately 1,000,000 square feet, this amounts to an increase in electricity consumption of around 4,000 kWh per week due to the extra 2 hours from Monday to Thursday.

Based on the above assumptions and analysis, the potential energy cost savings for a 4-workday week (instead of a 5-workday week) are calculated for the following two scenarios.

Scenario 1 – Limited Shutdown

Under this scenario, the campus will be partially shutdown on Fridays and Saturdays, just like the typical weekend operation. The campus will be shutdown more aggressively on Sundays, like the typical holiday operation.

Table 1. TAMUCC: Breakdown of 4-weekday week WCE savings for limited shutdown scenario

	Weekly Electricity Savings (kWh)	Total Weeks	Subtotal Savings (kWh)	Electricity Price ($/kWh)	Subtotal Savings ($)
Mon - Thu	(4,000)	12	(48,000)	0.0457	$ (2,193.60)
Friday	20,000	12	240,000	0.0457	$ 10,968.00
Saturday	-	12	-	0.03592	$ -
Sunday	10,000	12	120,000	0.03592	$ 4,310.40
		Total	312,000		$ 13,084.80

Table 2. TAMUCC: Breakdown of 4-weekday week WCE savings for extensive shutdown scenario

	Weekly Electricity Savings (kWh)	Total Weeks	Subtotal Savings (kWh)	Electricity Price ($/kWh)	Subtotal Savings ($)
Mon - Thu	(4,000)	12	(48,000)	0.0457	$ (2,193.60)
Friday	30,000	12	360,000	0.0457	$ 16,452.00
Saturday	10,000	12	120,000	0.03592	$ 4,310.40
Sunday	10,000	12	120,000	0.03592	$ 4,310.40
		Total	552,000		$ 22,879.20

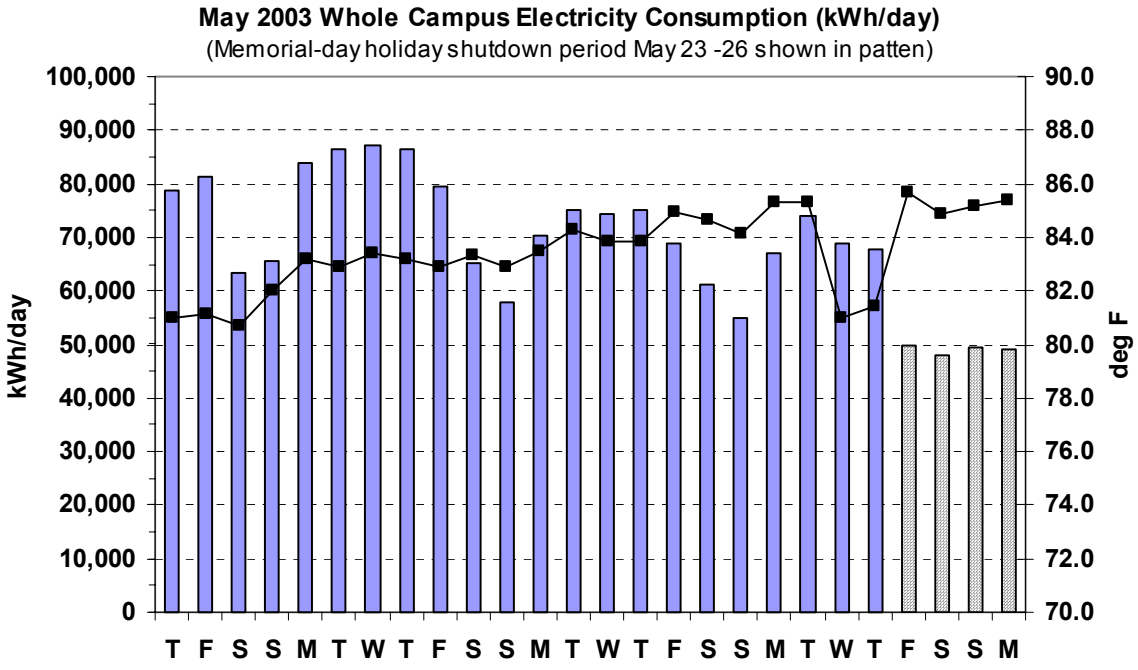

Figure 2. TAMUCC whole campus electricity daily consumption and outside air temperature

Table 3. TAMUCC: Electricity consumption of the 4-workday-week vs. the baseline week

	WCE	kWh Savings	Energy Costs	$ Savings	Average OAT
5-work-day week (May 12-May 18)	479,532 kWh		$ 18,868.63		84.16
4-work-day week (May 19-May 25)	424,495 kWh	55,037 kWh	$ 16,629.71	$ 2,238.92	84.11

This essentially converts the Fridays into weekends and Sundays into holidays, in terms of electricity energy consumption. The Saturdays remain the same. Total savings potential is estimated at $13,084 for this shutting down scenario, or approximately 0.87% of the year 2002 electricity bill. Table 1 shows the savings breakdown.

Scenario 2 – Extensive Shutdown

This essentially converts all three days into holidays. Total savings potential is estimated at $22,879 for this shutting down scenario, or approximately 1.53% of the year 2002 electricity bill. Table 2 shows the savings breakdown.

Verification

The savings projection was verified with real data when the university practiced its first extensive shut down from May 23 to May 26, 2003 (the Memorial Day). Operating schedules for major HVAC equipment during this period was similar to those for holidays. Figure 2 shows the whole campus daily electricity consumption data for the period from May 01 to May 26, 2003. It is easy to notice the reduced electricity consumption during the long Memorial holiday weekend (Friday to Monday).

Compared with the week immediately prior to it, electricity consumption during the 4-workday week was reduced by 55,037 kWh, as shown in Table 3. The actual cost savings was around $2,239 per week, which is higher than the estimated savings of $1,906 per week.

CASE STUDY II – PRAIRIE VIEW A&M UNIVERSITY

Prairie View A&M University (PVAMU) is located in Prairie View, Texas. The weather is typical for south central Texas, hot and humid in summer and mild in the winter. The total conditioned area is approximately 1.3 million square feet. Similar energy consumption reduction measure (ECRM) was studied for the university due to state budget shortfall.

Daily electricity consumption and averaged ambient temperature data from May 22 to August 19, 2002 were used for the analysis. Two scenarios were considered. The first scenario uses the Saturday profile as the baseline and calls for a limited shut down for Friday operation. The second scenario uses the Sunday consumption profile as the baseline and calls for a similar operating schedule during Fridays and Saturdays. Estimated annual energy savings are $7,021 and $13,001 for the two scenarios, respectively. This represents 0.32% to 0.6% of the total annual electricity costs.

Whole Campus Electricity Consumption Patterns

Figure 3 is a time-series plot showing whole campus electricity consumption from May 22 to August 19, 2002. Also included is the ambient temperature for that period. Figure 4 is a scatter plot showing weekday energy consumption vs. weekend consumption. Also included is a holiday profile (Memorial Day, July 4, Christmas break) to show consumption data for a “complete” shutdown.

The potential energy savings were evaluated based on the following conditions and assumptions. The extra two hours of operation during the four workdays will not increase the HVAC load substantially since all air handling unit operating schedules remain the same during the work day. The new schedule will be implemented from May 19, 2003 to August 16, 2003, for a total of 13 weeks period. Current operation practice turns off heating when ambient temperature is over 70°F or so. Therefore, no gas energy savings are estimated. The avoided cost of electricity energy is $0.046/kWh. No demand savings are considered since the new operating schedule will not have significant impact on electric demand.

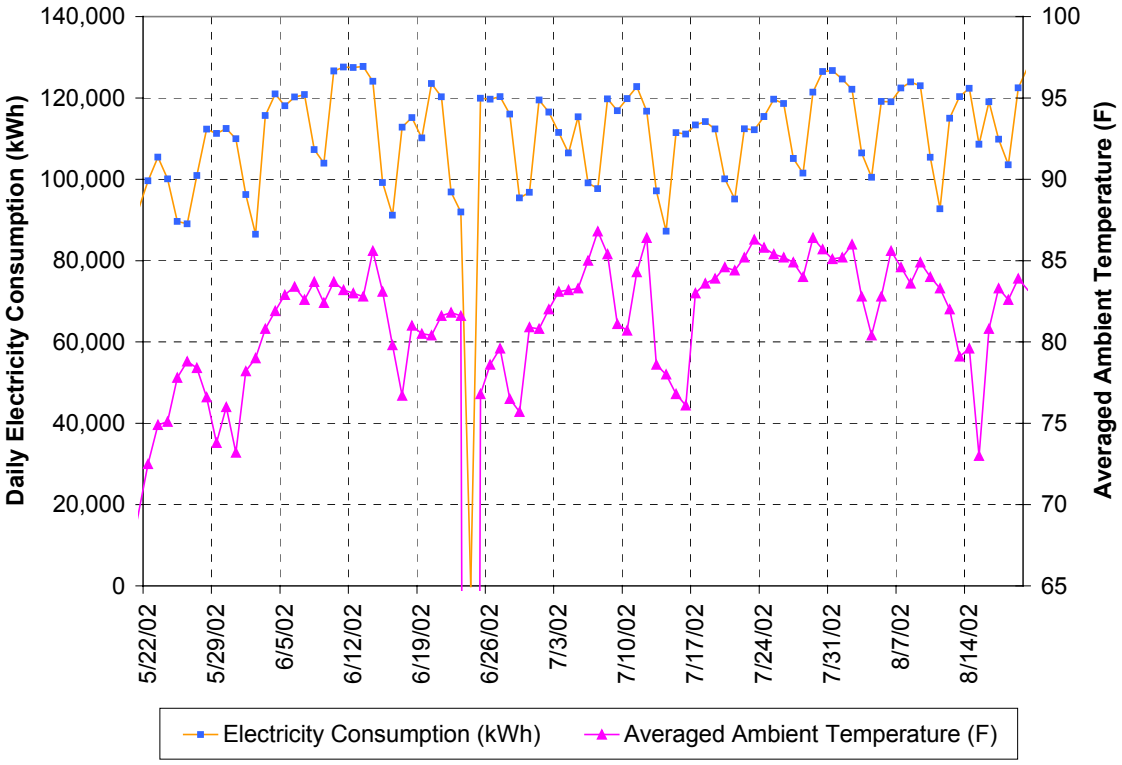

Figure 3. PVAMU whole campus electricity consumption for summer of 2002

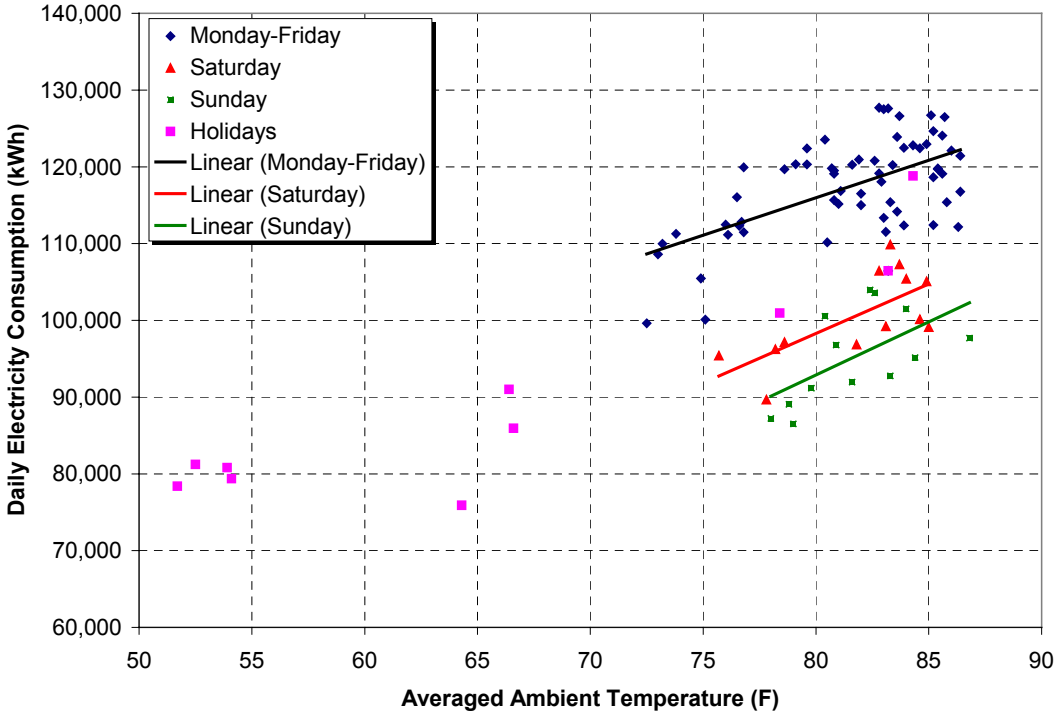

Figure 4. PVAMU: Scatter plot of the consumption vs. averaged ambient temperature

Table 4. PVAMU: Breakdowns of potential savings for a limited shut down.

	Weekly Electricity Savings (kWh)	Total Weeks	Energy Savings (kWh)	Cost Savings*
Monday - Thursday	(5,260)	13	(68,380)	$ (3,145)
Friday	17,000	13	221,000	$ 10,166
Saturday	-	13	-	$ -
Sunday	-	13	-	$ -
Total			152,620	$ 7,021

* The number in parenthesis is negative cost savings, or cost penalties

Table 5. PVAMU: Breakdowns of potential savings for a complete shut down.

	Weekly Electricity Savings (kWh)	Total Weeks	Energy Savings (kWh)	Cost Savings
Monday - Thursday	(5,260)	13	(68,380)	$ (3,145)
Friday	22,000	13	286,000	$ 13,156
Saturday	5,000	13	65,000	$ 2,990
Sunday	-	13	-	$ -
Total			282,620	$ 13,001

In Figure 4, the linear trend lines represent the statistical average value for each data group. Daily electricity consumption difference between Saturday and Sunday is approximately 5,000 kWh; Daily electricity consumption difference between weekday and Sunday is about 22,000 kWh.

Electricity consumption profile during the workdays will be similar to current usage. However, activity related electricity consumption in offices during the four workdays would be slightly higher than the current level due to the prolongation of the working hours (lights, computers, printers, copy machines and other plug loads will stay on longer if they are currently being turned off at 5:00pm or 6:00 pm). Assuming that 25% of the campus lighting and other plug loads (mainly offices) would need to run 2 more hours per working day, or 8 hours a week, and that the average campus office lighting and plug loads is 2 Watts per square foot. For an area of approximately 1,300,000 square feet for major buildings, this amounts to an increase in electricity consumption of around 5,200 kWh per week.

Results

Based on the above assumptions and analysis, the potential energy cost savings for a 4-workday/week operation (instead of a 5-workday/week operation) is calculated for the following two scenarios.

Scenario 1 - Limited shutdown on Fridays, i.e., Friday operation will be similar to current Saturday operation. Sunday's operation remains the same. Total savings potential is estimated at $7,021, or approximately 0.32% of the total annual electricity costs, as shown in Table 3.

Scenario 2 - Complete shutdown on Fridays and Saturdays, i.e., Friday and Saturday's operation will be similar to current Sunday operation. Sunday's operation remains the same. Total savings potential is estimated at $13,001, or approximately 0.60% of the total annual electricity costs, as shown in Table 4.

CASE STUDY III – TEXAS A&M INTERNATIONAL UNIVERSITY

Texas A&M International University (TAMIU) is located in Laredo, Texas. The weather is very hot in the summer and moderate in the winter. The hot weather typically lasts more than half of the year. The total conditioned area is approximately 565,000 square feet.

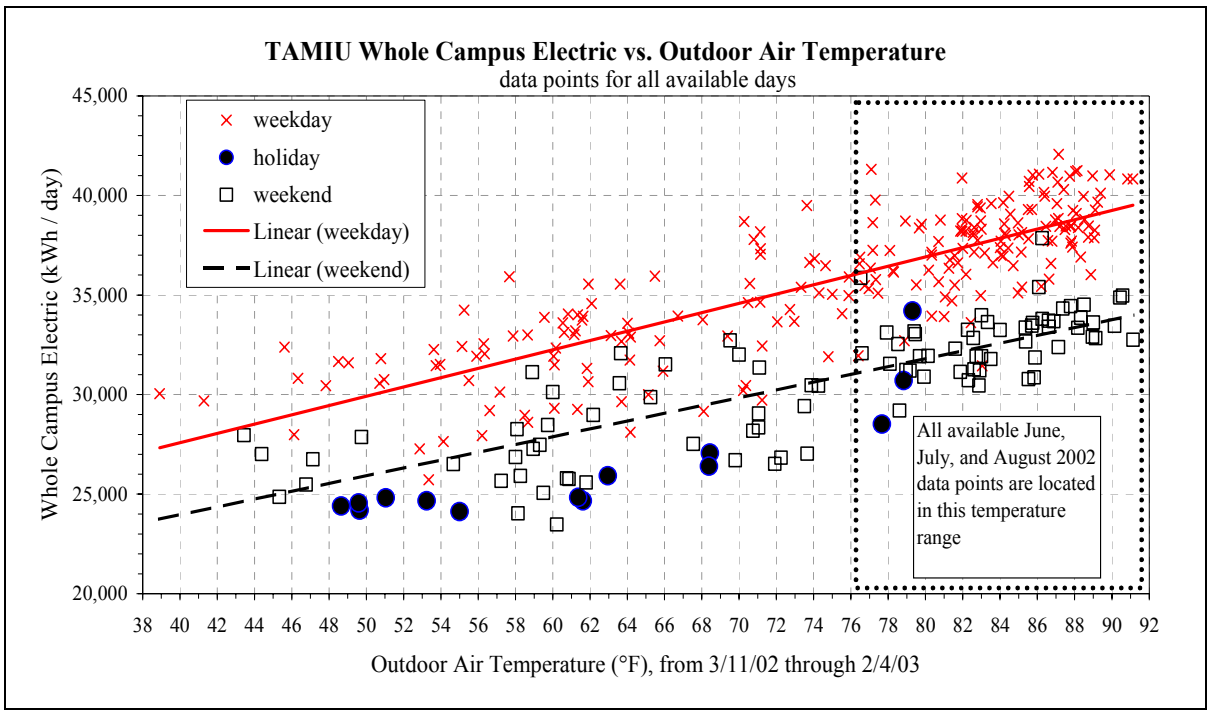

Figure 5. TAMIU whole campus electricity for weekdays, weekends and holidays

Whole campus 15-minute electric data was readily available because of metering installed at the central plant. The campus electric data was examined from March 10, 2002 through February 4, 2003. Data were analyzed for the Monday through Friday workweek, weekends, and holidays time periods. The holidays taken into account were Spring Break (3/14 and 3/15), July 4th, Thanksgiving Break (11/28 and 11/29), Christmas Break (12/23/02 – 1/1/03), and Martin Luther King Jr. Day (1/20/03). The National Weather Service (NWS) outdoor temperature data for the Laredo airport were averaged on a daily basis for examination of the temperature dependency of the campus electricity consumption.

The weekend electrical profile on average is 5,000 to 6,000 kWh per day lower than the Monday through Friday average during the warm weather. Examination of the data showed a maximum of 10,000 kWh / day difference. The present energy charge is $0.047 / kWh. The savings per week would be approximately $330 if the TAMIU operated all three days like the current Sunday profile. If Friday was operated like the current Saturday, i.e. a partial shutdown for both Friday and Saturday and then a complete shutdown on Sunday, the savings would be about $235 per week. Therefore, expected savings from a 4-day workweek, for 13 weeks, would vary from $3,000 to $4,300 (or 0.62% to 0.89% of the annual electricity bill), depending on whether there was complete or partial campus shutdown.

CONCLUSIONS

Energy savings by turning a typical 5-workday-8-hour week to a 4-workday-10-hour week during summer months were investigated for three independent universities within the Texas A&M University Systems. The estimated cost savings range from 0.32% to 1.5% of the annual electricity bills for different shutdown scenarios. Potential energy savings are mainly dependent on the activity level of weekends and holidays as compared to normal working days. The bigger the difference is, the bigger the energy savings are. It is worth mentioning that universities may enforce activity-related plug loads to the lowest level during the prolonged weekend (Friday to Sunday) to maximize the energy savings. The energy consumption during these weekends may be reduced to a level even

lower than typical holidays for similar weather conditions.

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