An Overview of the Success Story of Jiangsu Electric's Residential Time of Use Program in China and Related Behavior Changes

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ABSTRACT:

China surpassed the United States in 2010 to become the world's largest energy consumer, and accounted for 71% of global energy consumption growth in 2011. China's energy mix is carbon intensive, using coal to supply 66% of the China's total energy consumption in 2012 (EIA 2015). One approach to reduce peak electricity consumption, which is often supplied by non-renewables, is through Time of Use (TOU) pricing, a demand response mechanism through which the electricity price is high during peak load demand period and low during off-peak load demand period.

Since 2003, Jiangsu Province in China implemented a TOU pricing scheme for residential customers. Throughout the years, over 95% of urban residents voluntarily enrolled in the TOU program shifting peak load by over 1,000 MW in its maximum, achieving on average 90.2% of grid utilization in 2007 (Jiangsu Electric Company 2008). Despite the effort, in summer 2014, peak demand in Jiangsu surged to historical high and threatened grid reliability.

This study investigated over 1,000 urban residential families in three representative cities in Jiangsu Province, namely Nanjing, Yangzhou, and Xuzhou, to develop a deep understanding of their load profile. Yangzhou's survey results are coupled with actual electricity consumption data to examine the effects of behavior on energy consumption as a basis for identifying effective strategies to reduce residential electricity consumption. The result indicated that the prevalence of room air conditioning played a pivotal role in residential consumers' electricity usage pattern. Other important behavior change to avoid the peak price rate is to shift showering and laundry to off-peak periods.

1. Introduction

Time of Use (TOU) pricing is an adaptive mechanism where the electricity price is high during the peak load demand period (during the day, and early evening) and low during the off-peak period (late at night). In the announcement by the Chinese National Development and Reform Commission in December 2013, all regions in China were required to develop and implement a TOU pricing mechanism for residential consumers by the end of 2015. According to the mandate, electricity companies shall develop mechanisms to encourage residential consumers to voluntarily enroll in the TOU programs (T. Li 2013).

Pilot TOU projects have been carried out in Chinese cities, with varying degree of success. In a pilot TOU program in Zhejiang province, about 20% of the electricity was shifted from on-peak to off-peak (B. Li 2012). Yet other pilot programs, such as the ones in Shijiazhuang, Hebei Province, were not well received by consumers. Even though TOU pricing has the demonstrated effectiveness in shifting its electricity use, after a half year of the pilot implementation in 2013, only 10% of the customers in Shijiazhuang were willing to continue with the program, a considerably low rate to achieve the benefits of TOU programs (Heibei Youth Daily 2014).

The varying results of the TOU pilot projects have puzzled Chinese decision makers. To date, no studies have been undertaken to explore the dilemma around lack of effectiveness of TOU rates in shifting electricity patterns and consumers' unwillingness to participle in the programs. The current approach is simply based on economic analysis. The US Department of Energy has recently started to fund consumer studies under the Smart Grid Initiatives to investigate consumers' behavior under time of use pricing (US Department of Energy 2016).

In China, this area of study has not been explored. From the pilot TOU project reports from China Southern Power Grid Company, the voluntary measure of the TOU pricing is the major concern for the electricity company. Difficult to anticipate consumer participation has created significant financial risks for electricity companies' investment in smart metering for TOU pricing. Only relying on the availability of pricing incentives and metering infrastructure to predict consumer behavior has demonstrated to be ineffective (B. Li 2012). Therefore, it is essential to consider consumers' perspectives and feedback in TOU program implementation to ultimately encourage more residential consumers to enroll in the program.

1.1 Background of Jiangsu's TOU Program

Jiangsu Province is the pioneer in China for residential TOU implementation. Since 2003, Jiangsu Province's TOU program has reached around 95% voluntary enrollment of urban residential customer (Yan 2014). The rate design for TOU pricing is:

Table 1 Jiangsu TOU Rate *(Jiangsu Electric Company 2008)*

	Peak Period 8am-9pm	Off-Peak Period 9pm – 8am
Rate	0.5583 RMB/kWh	0.3583 RMB/kWh

By 2007, the program shifted peak load over 1,000 MW, achieving 90.2% of grid utilization. Based on the calculation by Jiangsu Electric, the average investment for a new power plant as

4,500 RMB/kW, the reduction in investment is over 4.5 billion RMB. TOU pricing has greatly improved grid utilization rate. (Jiangsu Electric Company 2008).

2. Purpose of the Study

Jiangsu's TOU pricing is not a typical TOU program design. The TOU pricing is the same all year without any seasonal variability or weekday/weekend difference. The extensive peak period from 8am to 9pm leaves very little flexibility for customers to shift their electricity price. This voluntary program however has received 95% voluntary enrollment rate for urban residential customers. Despite long peak hours which leave little choice for customers to shift their electricity usage behavior, Jiangsu Electric has reached significantly high voluntary enrollment of TOU, and successfully shifted peak load to off-peak periods. From the typical Jiangsu Province residential load curve, the implementation of TOU pricing has indeed changed residents' behavior.

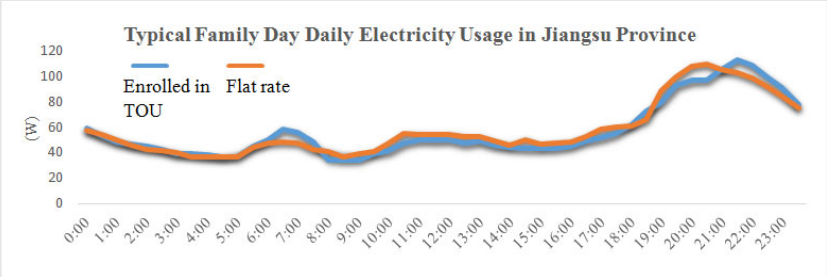

Figure 1 Typical family day daily electricity usage in Jiangsu Province (TOU vs. flat pricing) *(Jiangsu Electric Company 2014)*

As shown in Figure 1, a significant increase in electricity usage occurs right before 8am, and after 9pm for TOU pricing users. We can clearly see the original electricity peak from 8pm is successfully shifted to after 9pm.

This paper investigates how Jiangsu Electric achieved this accomplishment despite its traditionally considered ineffective example of TOU design, and what kind of behavior changes have actually engaged.

As Jiangsu Electric only has bulk data on the peak electricity shifted, there have been no studies that have investigated what certain behaviors the customers have actually engaged in to shift their electricity usage. This study investigates residents' actual electricity usage behavior to help Jiangsu Electric understand what actually contributed to residential customers' electricity usage pattern, how they shifted their electricity usage and what other factors influenced their electricity usage and behavior. With this information, Jiangsu Electric can utilize the results to design better TOU pricing and provide complementary services and enabling measures. The lessons learned from TOU pricing in Jiangsu province also provide valuable insights for other utility companies because Jiangsu Province received active participation of TOU programs despite a pricing structure that is traditionally perceived as "very inconvenient for behavioral change".

3. Methodology

This study has three major steps. The first step is to understand the background information of Jiangsu Electric's TOU program. The second step is to understand load shapes of residential energy usage to identify the major energy use drivers. The last step is to conduct a survey based on findings of the load curve to investigate how consumers responded to TOU pricing. Jiangsu Electric has fully participated in the study process, from background information collection to the survey collection process.

3.1 Interview and Background Information Collection

This process included interviews with Jiangsu Electric management and collected background information from Jiangsu Electric to gain insights on their process to promote Time of Use pricing, and how the rate was adopted throughout years.

3.2 Load Data Collection

Three cities in Jiangsu Province, Nanjing, Yangzhou and Xuzhou were chosen for the study. The three cities are different in terms of life style and climate.

Figure 2 City locations

Nanjing is the capital city of Jiangsu province with a well-developed economy. It is a relatively busy city mixed with many kinds of industries. Nanjing is in the hot summer, cold winter zone where no central heating system is provided during winter.

Yangzhou is a relatively small and relaxed city. Yangzhou is also a tourism city and people tend to come home early from work. Yangzhou is in the hot summer, cold winter zone where no central heating system is provided during winter. Both Yangzhou and Nanjing residents use electric heating (normally they install air-conditioning/heat pumps at home).

Figure 3 Lan Yuan, a neighborhood in Yangzhou where part of the survey was taken place

Xuzhou is an industrial city where 90% of the electrical load comes from industrial activities. Xuzhou is also a transportation center. Xuzhou is the only city among the three with central heating system.

Daily on-peak and off-peak electricity usage data from January 1, 2012 to August 31, 2014 were collected. 500 families' load data in Yangzhou,

500 families' load data in Nanjing, and 375 families' load data in Xuzhou were collected.

3.3 Survey

In order to understand actual behavior change under Time of Use pricing, a survey study was conducted.

The survey distribution method involved a paper survey to avoid self-selection issues that often happen in internet surveys (Hudson, et al. 2004). In addition, internet usage as well as emails is not as prevalent among Chinese residents while phone remains the most common form of communication. From interviews with the utility company employees, elderly customers seem to be the ones who pay more attention to electricity bills. An internet survey would likely overlook this population.

An 89 question survey was designed to evaluate potential factors influencing people's electricity usage behavior. For the purpose of this paper, only results related to appliance behavior usage are presented.

Jiangsu Electric was in charge of distributing and collecting the survey. Local utility companies affiliated with Jiangsu Electric were responsible for collecting survey results within the city. The surveys were printed and the employees of the local utility companies visited residents to have them completed. The data were collected from different income neighborhoods within the city. One high income, one medium income and a low income neighborhood were identified within each city for the utility companies to visit.

The employees of the utility companies used methodologies such as setting up booths for people to fill out the surveys, interviewing residents in their homes or simply asking people who stop by in targeted residential neighborhood to fill out the survey.

Parts of the surveys were filled out by residents, while the remainders of the surveys were completed by utility company employees while interviewing the customers. Participants' addresses were recorded to match up with their real electricity usage.

Each participant received a 20 RMB coupon or gifts from the utility company with equivalent monetary value.

429 valid surveys were collected from the city of Yangzhou with their actual electricity usage data. For this paper, only behavioral changes related to air conditioning usage are presented.

4. Findings

4.1 Financial Incentive for TOU Enrollment

From interviews with Jiangsu Electric's management and residents, it was found that Jiangsu Electric had used a very special way to promote TOU that is not usually seen in other utilities. The incentives that customers get from enrolling in TOU are in the form of bill savings. When rolling out TOU pricing in 2003, the TOU pricing was designed to save each family 15% of electricity bills under their previous usage patterns, with even greater savings if they engage in behavior change. Because of guaranteed bill saving for customers to enroll in TOU pricing, word of mouth was a very important channel to promote TOU pricing. By 2007, on average, electricity

bills decreased by 6 cents per kWh, around 11.5%. According to Jiangsu Electric, after the initial push of the TOU pricing, soon residents came to the utility company to request enrollment of TOU pricing. (Jiangsu Electric Company 2008).

4.2 Electricity Load Curve Overview

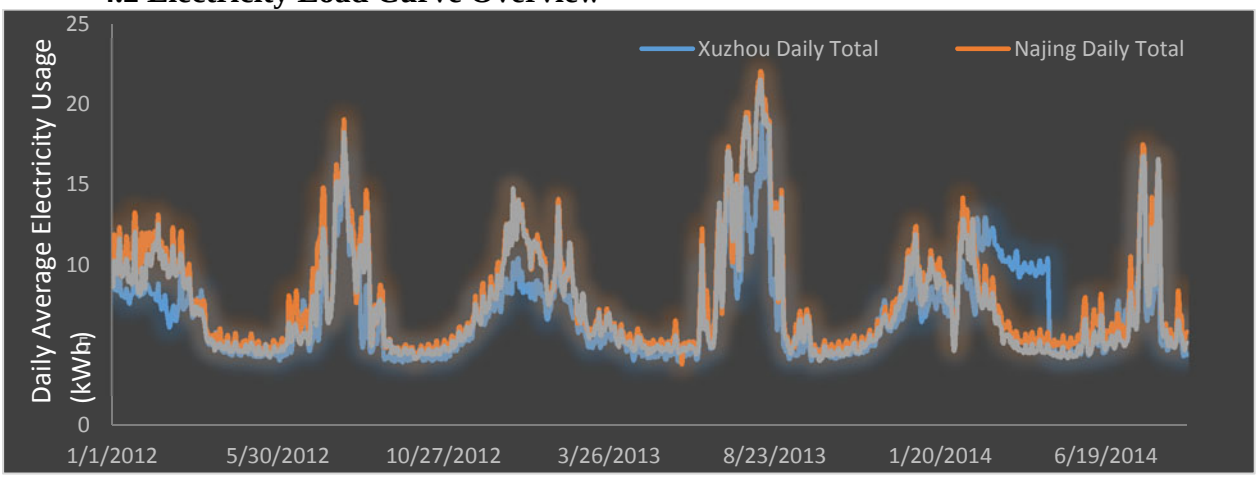

Figure 4 Electricity usage data generated load curve

The load curve is computed from averaging out the daily electricity usage over all collected families of that one particular city. From the load curve, it is clear that during the summer months the electricity usage at least triples compared to spring or fall. A similar pattern also happens during the winter months, though the increase in electricity usage is not as dramatic as in the summer months (200% increases during winter, 400% increases during summer). Yangzhou and Nanjing are geographically adjacent to each other. Therefore similar climate is implied. This is also reflected in the graph that the electricity usage load for both Nanjing and Yangzhou are very similar. Xuzhou's load curve is similar but different from Yangzhou and Nanjing's curve. Xuzhou is north of Nanjing and Yangzhou. Therefore, during winter it is colder and a centralized heating system is supplied to many neighborhoods. As seen here on the graph, Xuzhou's electricity usage during the winter is quite different from Yangzhou and Nanjing's electricity usage.

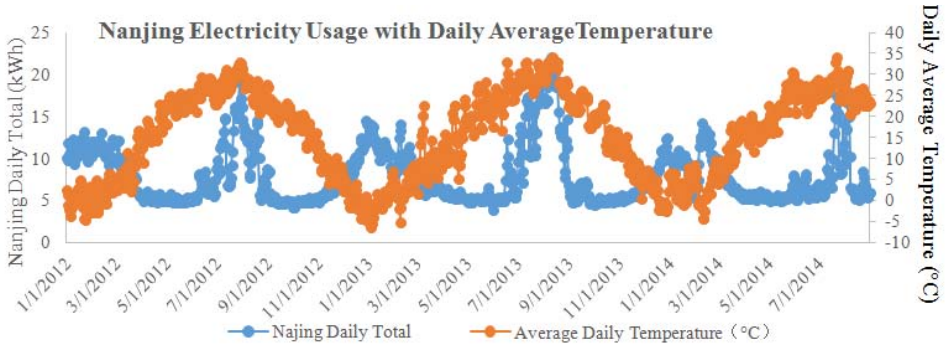

Figure 5 Nanjing daily temperature and electricity usage

As indicated by the graph, climate plays a major role in residential electricity usage which implies air-conditioning is the highest electricity load driver. The next highest electricity consumption source is space heating (often heat pump). Just to confirm the electricity usage is actually correlated with climate, a graph is plotted below for Nanjing. When temperature is high, electricity consumption surges. A similar trend also applies to winter months. As shown in the graph, air temperature during summer is quite high – goes to 35 °C or even higher. Winter, comparatively, is not as cold; it just slightly goes below freezing.

A quick linear regression analysis had been done in order to verify the relationship between electricity usage and temperature. Temperature was studied using heating degree days (HDD) and cooling degree days (CDD). Heating degree days are categorized as temperature below 18 degree C, and cooling degree days are categorized for temperature above 26 degree C. HDD and CDD are used to investigate a relationship between temperature and electricity usage in Nanjing.

```
. twoway (scatter NajingDailyTotal CDD26HDD18, sort)

. regress NajingDailyTotal CDD26HDD18
```

Source	SS	df	MS		
Model	155.080027	1	155.080027	Number of obs	= 974
Residual	11316.7424	972	11.6427391	F(1, 972)	= 13.32
				Prob > F	= 0.0003
Total	11471.8224	973	11.7901567	R-squared	= 0.0135
				Adj R-squared	= 0.0125
				Root MSE	= 3.4121

NajingDail~l	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
CDD26HDD18	-.0577605	.0158264	-3.65	0.000	-.0888183	-.0267028
_cons	7.740937	.1279527	60.50	0.000	7.489842	7.992032

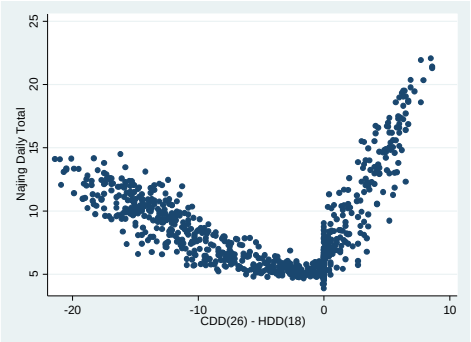

Figure 6 Relationship between temperature and electricity usage

It can be clearly seen from the above analysis that there is a very strong relationship between temperature and electricity usage. During summer, electricity usage goes up with temperature. During winter, electricity usage goes up when temperature gets colder.

4.3 Behavioral Change Overview

From survey results, the top three behavior changes under TOU pricing include air-conditioning usage (213 respondents), when they shower (210 respondents), and time of use of washing machines (186 respondents). Interviews with residents have also confirmed that people are aware that air-conditioning uses the most electricity, so they engage in behaviors to reduce AC usage. Also, during the interview, some residents confirmed they would get up earlier in the morning to take showers to avoid peak pricing, and some residents confirmed they wash clothes during off-peak hours.

ANOVA test with Tukey correction shows that for families who made behavior changes, their electricity usage is significantly different. Given air-conditioning (heat pump) as the highest portion of electricity usage, for customers who claimed they changed their air-conditioning usage, their electricity usage is significantly higher in almost all seasons, including summer, winter as well as April-May.

4.4 Air Conditioning Usage Survey

Load curves in figure 4 and 5 suggested air-conditioning is the major load driver. Therefore, this paper dedicates a section to report AC usage in the home. Descriptive statistics related to air-conditioning usage are described below in Table 2.

Table 2 Descriptive statistics related to air-conditioning in the survey

	Number of responses	Percentages
5. Does your family use air-conditioning?		
Yes	401	97%
No	14	3%
6. What is the type of air-conditioning at home?		
Central	12	3%
Room	419	97%
7. Number of room air-conditioning units		
1	102	24%
2	149	36%
3	114	27%
4	43	10%
5	6	1%
6	3	1%
7	2	0%
9. What is the normal temperature setting of your air-conditioner during summer? ___ ° C		
Average: 26.4°C, Standard Dev: 1.44°C		
10. How does your family normally use their air conditioning		
Keep all air-conditioners on at home	57	14%
Turn on air-conditioners in rooms that are occupied	338	85%
Other	1	0%
11. Do you turn off air-conditioners when going out?		
Always	246	61%
Sometimes	131	32%
Occasionally	26	6%
Never	3	1%
12. When using air conditioning, your family: (Ventilation)		
Always shut doors and windows	293	72%
Sometimes shut doors and windows	84	21%
Occasionally shuts doors and windows	28	7%
Never shuts doors and windows	1	0%
13.Will you turn off AC or set a timer for AC before going to sleep		
Always	193	47%
Sometimes	164	40%
Occasionally	38	9%
Never	12	3%
14. What is the reason you turn air-conditioners off or set a timer when going to sleep (Check all that apply)		
Health	283	46%
Energy Saving	315	51%
Other	15	2%
15. Have you ever used less air conditioning to save on electricity?		
Always	157	39%
Sometimes	189	46%
Occasionally	48	12%
Never	13	3%
16. Did you ever raise air-conditioner set temperature to save on electricity?		
Always	123	30%
Sometimes	182	45%
Occasionally	84	21%
Never	15	4%
I did not know raising air-conditioner set temperature can reduce electricity use	2	0%
17. Did you ever reduce air-conditioner use during peak period (high electricity price period)?		
Always	158	39%
Sometimes	184	45%
Occasionally	48	12%
Never	16	4%

By conducting ANOVA Tukey Test, strong statistical significance was detected for the number of air conditioners one family owns in relation to energy usage at homes in all seasons. It can be clearly shown in the result that families with more room air conditioners use more electricity compared to families with less air conditioners at home. Statistical significance has been detected for the number of air conditioners at home. “More than 4” means more than 4 air conditioners at home.

Table 3 ANOVA test with Tukey correction on the relationship between number of air conditioners at home and electricity consumption

Question: How many room air conditioners at home?	“More than 4” - 1	“More than 4”- 2	3 - 1
Summer Average	(2.3,7.7)	(1.0,6.0)	(0.8, 5.1)
Summer Peak	(1.2,4.1)	(0.4,3.2)	(0.4,2.8)
Summer Off-Peak	(0.9,3.7)	(0.4,3.0)	(0.1,2.4)
Winter Average	(2.7,10.1)	(1.4,9.4)	(1.2,7.2)
Winter Peak	(1.1,4.9)	(0.4,4.0)	(0.5,3.6)
Winter Off-Peak	(1.3,5.4)	(0.6,4.60)	(0.4,3.8)
April-May Average	(0.3,1.8)	(0.10,1.5)	
April-May Peak	(0.7,3.3)	(0.4,2.8)	
April-May Off-Peak	(0.3,1.6)	(0.2,1.5)	

5. Discussion

5.1 Program Overview

The analysis of load curves and the preliminary survey results shows that behavior related to the usage of air conditioners has the greatest impact on residential family electricity usage in Jiangsu Province. Appliance usage behavior other than behavior associated with air-conditioning also plays a role in non-summer seasons.

In this study, customers actually took significant action to save on electricity, especially for reducing air conditioner usage. However, unlike other Time of Use pricing schemes in other jurisdictions, Jiangsu used cost savings as a motivation to successfully attract the majority of their customers to participate in Time of Use pricing. After people are enrolled in the TOU program, people came to an understanding of different pricing at different times of the day, which encouraged them to shift their electricity to off-peak periods and/or use less electricity during on-peak periods. Because of the prevalence of room air conditioners, it gave residential customers more ability and control to actually adjust their electricity usage behavior to save on electricity usage during certain periods of the day. Survey results showed that people actually decide to act according to the most optimal way to use air conditioners.

5.2 Air Conditioners

Air-conditioning plays a key role in summer electricity usage in Jiangsu. One outcome that has been observed is the special role that room air conditioners play in Chinese residential energy usage. In residential units in North America, it is common to have central HVAC system for the entire family, while each individual room may or may not have an individualized thermostat.

5.2.1 Control of Room Air Conditioner

Room air conditioners come with a controller that homeowners use to turn them on and off, control temperature, control wind speed and direction, schedule a timer etc. A typical room air-conditioning controller is shown below.

Figure 7 Typical room air-conditioning at home and controller

According to the survey, a majority of participants actually practiced the most energy-efficient approach when using room air-conditioning. Referring to findings above, 85% of survey respondents reported turning on air-conditioning only in rooms that are occupied and only 15% of survey respondent keep all air-conditioning on at home. In terms of the behavior of turning off air conditioners, the majority of the respondents turn off air conditioners when the rooms are no longer occupied: 61% of respondent always turn off air conditioners when going out with 32% respondents sometimes turning off air-conditioning when going out. In addition, residents in general practice effective ventilation habits – people keep windows and doors shut when turning on air-conditioning: 72% of respondent always shut doors and windows when air conditioners are on, with 21% of respondent sometimes shut windows and doors when air-conditionings are on. It could also attribute to people wanting rooms to quickly cool down. This habit is effective in reducing energy wasted to cool rooms. Shutting doors and windows directly contribute to the temperature of the room. While in homes with central air conditioner, it would be more difficult for people to monitor if windows are all well shut in all rooms. The survey also shows residents adjust the temperature set point to further reduce electricity usage.

The number of room air conditioners installed at home has a statistically significant effect on home electricity consumption. Families with more than 3 air-conditioning units at home use significantly more electricity all year. The reason that the effect is not only on summer energy consumption is because the city where the survey was administered does not have a centralized heating system. The “air-conditioners” also serve as electric space heaters during winter so they are used to control temperature at homes all year around (70% of the survey participant choose to heating method as air-conditioning/heat pump).

5.2.2 Effort for Using Air Conditioner to Save on Electricity

Survey results showed that residents understand that air-conditioners are the largest contributor to home electricity usage. In question 61 where it asks residents to rate the top three electricity consumption appliances, air-conditioners received the most votes (264 out of 420 votes). Therefore, if they have the willingness to save electricity, air conditioners would be the first

appliance to consider. As a result, findings show a significant portion of the population has attempted to change its air conditioning usage behavior to save electricity usage.

5.2.3 Temperature Setting

The survey has suggested residents in Jiangsu have an average temperature setting around 26.4°C during summer, which is even higher than summer home temperature set point suggested by US Department of Energy.

5.3 Peak Shifting and Energy Conversation Implications

The implementation of TOU pricing has resulted in two kinds of consumer behaviors:

1. Peak electricity usage reduction/energy conservation
2. Peak electricity usage shifting

5.3.1 Peak Electricity Reduction and Energy Conservation

Air-conditioning again plays a significant role for those two kinds of behaviors. Since Yangzhou gets very hot during summer (Specific Yangzhou's historical weather data could not be found. Please reference Nanjing's temperature curve since those two cities are very close geographically), especially during the day, it is difficult for people to not use air-conditioners. Also they could not potentially "shift" their air-conditioning usage because they have to turn it on when it is hot. However, people can definitely choose to use less air-conditioning during the day by raising the temperature set point, use air-conditioning for shorter periods of time or engage in energy efficient way of using air-conditioner, such as keeping windows and doors shut. Therefore, air conditioners play a key role for peak electricity usage reduction/energy conservation.

5.3.2 Peak Electricity Usage Shifting

For appliances or electricity usage behaviors that have some flexibility in usage, people have the ability to shift their usage to off-peak periods.

From the results and discussion above, changing shower time and washing machine time to off-peak periods are the most common electricity usage shifting behavior.

6. Conclusion

The study investigated how Jiangsu residential consumers have responded to the Time of Use pricing for the past 10 years since its implementation. As no studies have ever been conducted to understand real behaviors behind the load shifting, this study provides insights to those behaviors and provides insights for future TOU program design, not only for Jiangsu Electric but also for utilities across the world. Financial incentives to draw residents into the program are clearly shown to be effective, and are able to encourage future behavior shift under Time of Use pricing. Hot summer days require air conditioners to stay on, which has contributed to the surge in electricity usage in residential homes.

It is noted that Jiangsu's urban residential customers have in general adopted good electricity usage behavior which contributes to energy conservation and peak shifting. Room air conditioners played a key role because residents have to manually turn air conditioner on and off.

Residents are well aware that air conditioning is the largest contributor to their electricity usage, so they aim to minimize air conditioner usage. Room air conditioners are only used when rooms are occupied, with doors and windows well shut. The number of air conditioners (heat pump) at home directly brings up families' electricity bills both during summer and winter. While changing air conditioner usage behavior is most commonly adopted by residents to save on electricity bills, other top behavior changes to avoid peak price rates are to shower or wash clothes during off-peak periods.

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Reference

Cappers, Peter, interview by Jing Ge. 2015. Apr 20, 2014. *Information regarding to industry norm for residential TOU pricing design*.

Energy Information Agency. 2015. May 14, 2015. *China.* *http://www.eia.gov/beta/international/analysis.cfm?iso=CHN*

Faruqui, A., Ryan H., and Jennifer P. n.d. *Time-varying and dynamic rate design.* The Brattle Group.

Faruqui, A., Sergici S., and Eric S. 2013. *Consistency of Results in Dynamic Pricing Experiments - Toward a Meta Analysis.* San Fiego: The Brattle Group.

Heibei Youth Daily. 2014. *Shijiazhuang pilot TOU study, only 10% continued the program after pilot* . Jan 8, 2014, http://www.hbqnb.com/html/2014/bendi_0108/9396.html.

Hudson, D., Lee-Hong S., Diane H., and Tim H. 2004. "Telephone presurveys, self-selection, and non-response bias to mail and Internet surveys in economic research." *Applied Economics Letters* 237-240.

Jiangsu Electric Company. 2008. *Jiangsu Electric Residential TOU Implementation Result - 0828.* Nanjing: Jiangsu Electric Company.

Jiangsu Electric Company. 2014. "Information provided by Jiangsu Electric."

Li, B. 2012. *Residential Time of Use study in China Southern Power Company.* China Southern Power Company.

Li, T. 2013. *Chinese National Development and Reform Commission.* Dec 26, 2013. http://finance.people.com.cn/n/2013/1226/c364101-23949122.html.

US Department of Energy. 2016. *Demand Response.* http://energy.gov/oe/technology-development/smart-grid/demand-response.

Valeria, D., Lyons S., and Nolan A. 2012. *Estimating the impact of time-of-use pricing on Irish electricity demand.* MPRA.

Yan, Q., interview by Jing Ge. 2014. *Residential Consumer TOU Jiangsu* (4 27).