A Study on Power Consumption of Household Appliances for Life Conduct Activity of Single Household in University Town

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Abstract

Objectives: Quantitative data are presented for the preparation of energy saving scenarios for university town single-households in South Korea estimated to be one million in number. **Methods/Statistical Analysis**: To extract the living activities of single-households around university towns and the periods of time spent by activity, a Time-use Survey was conducted with 31 subjects. Information on the home appliances retained by the subject households and the specifications were surveyed and the types of appliances used when the Time-use Diary was recorded and the amounts of time spent to use the appliances were recorded. **Findings:** The retention ratio and the specification of household appliances retained by the single households around universities were surveyed and presented. Even for the single households, although the basic household appliances necessary to conduct living activities tend to be retained in general, the specification aspect exhibited large differences compared to general households. In this study, the living activity characteristics of single households were classified by day of week as well as by period, the time required and energy consumption for each living activity were surveyed and analyzed, and quantitative data were presented for energy consumption. In the case of single households, the power consumption was shown to be higher for weekdays rather than for weekends, and during vacations rather than during semester. **Improvements/Applications**: The results of this study can be utilized when segmented energy consumption analyses are conducted utilizing national statistical data such as Time-Use Surveys.

Keywords: Household Appliances, Life Conduct Characteristics, Power Consumption, Single Household, University Town

1. Introduction

Although the relative weight of single households in Korea was only 3.7% of the total households in 1970, it was sharply increased in 90's, and has been sharply increased to 12.7% in 1995 and 27% in 2015. As factors for the increase in single households, women's entry in society, conversion to individualistic life, aging, pursuit of pleasantness, increase in leisure times, etc. may be considered. According to Statistics Korea, it is forecast to account for about7.63 million households or 35% of the total households by 2035¹. University towns have a high

demand for residential spaces for rent due to uniqueness in residence purpose, cost benefit, concentration of amenities, etc. In the case of Korea, the single households around universities are being predicted to be more than 1 million households². In the aspect that the single household around a university is a temporary residential form has a unique purpose of commuting to the university^{3.4}; it greatly differs from general residence households in retention and use behaviors of household appliances. many previous research indicated segmented energy consumption analyses could be help for maintain energy security and cities sustainability⁵⁻⁷.In particular, since basic home appliance and utilities to carry out life should be provided even in the case of single households, space utilization frequency and energy use density is high in comparison with residential buildings resided by several people. On the other hand, as study cases of analyzing energy use behavior of single households in university towns are very scarce, approaches from the energy-saving viewpoint and improvement attempts are needed.

The present study surveyed life conducts within a residential space and energy consumption behavior. First, retention ratio and specification for single households around universities were surveyed and presented. And indoor life conduct activity and power consumption of single households around universities during weekdays and weekends, during semester and vacation periods were comparatively analyzed.

2. Characteristics of Survey Object

Overview of the survey implemented to perform the present study is as shown in Table 1. Specification and retention status of life instruments were collected through recording of the number of retained units and power consumption or product name. To collect time use data within 24 hours, a questionnaire survey of Time-Diary form⁸ was conducted where life schedules of a college student in the single household were made to be prepared by handwriting in the unit of 10 minutes. For weekdays of Monday, Wednesday and weekends of Saturday, Sunday, the conducts performed, the life instruments used, the patter of using lighting, the cooking status were made to be recorded for analysis.

Table 1 Also shows the forms of residence contract of the surveyed objects. In terms of ownership form, the rent accounted for 100%. In terms of energy cost bearing, the case of being included in the rent cost as the flat rate scheme accounted for 63.33%, while the case of paying for as much as used by the measured rate system accounted for 36%.

3. Retention Form of Home Appliances

In the present study, data for specification and status of life instruments of single households was extracted from the result values of questionnaire survey to calculate the life instrument specification of single households. This was due to the fact that separate references were required for the life instrument specification of single households since the life instruments used by the single household were not only miniaturized so as to be more suited to life behavior of the single households in comparison with life instruments handled by general homes, but also expected to have a reduced energy efficiency.

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Category	Contents			
Target	Single household in university town (n:31)			
Method	Time-use Diary(10min Resolution), Questionnaire survey			
Duration	2014.Dec~2015.Feb(8weeks)			
Gender	Male:73.33% / Female:26.67%			
Contract Type	Rent:100%			
Energy cost bearing	Included in the rent cost(flat rate): 63.33% Paying for as much as used by the measured rate : 36%			

Table 1. Survey object and contents.

Table 2 shows retention ratios and the specification for single households around university town⁹. For a comparison of differences from general households, the retention ratio of life instruments for general residential households in Korea¹⁰ are shown. Even for single households, instruments to carry out minimum life conducts are shown to have been disseminated in general. As compared with general residential households, the retention ratio and the specification of major life instruments such as some TV, refrigerator, etc. showed a difference. Retention ratio of televisions was very low at 0.06 compared with general households. In the case of kimchi refrigerator with a high retention ratio for residential households in Korea, it was not retained by the single households around universities. On the other hand, laundry machines and general refrigerators were distributed among all households. In the case of refrigerators, sharp differences were observed in power consumption and specification.

4. Power Consumption Characteristics of Single-Household around University Town

For calculation of power consumption calculation, the specification of home appliances and probabilistic power

Appliance	Surveyed Single Household (University Student)		General Residential Households in Korea by KPX (2013)	
	Possession rate	Specification	Possession rate	Specification
Television	0.06	65W	1.23	130.6W
Refrigerator	1	43W	1.04	40.6
Kimchi Refrigerator	0	-	0.86	18W
Rice pot	0.70	463W	0.93	1036.2W
Coffee pot	0.25	1263W	0.49	(uninvestigated)
PC	0.45	143W	0.62	255.9
Laptop PC	0.61	61W	0.23	(uninvestigated)
Desk Lamp	0.32	20W	0.26	(uninvestigated)
Clothes Washer	1	208.5W	0.98	242.8W
Hair dryer	0.94	1244W	0.88	(uninvestigated)
Microwave	0.45	1612W	0.71	1040.3W
Air conditioning	0.87	1131W	0.78	1430.3W

 Table 2. Retention form of major home appliances for single household.

consumption by electricity units were adopted as shown in Tables 2 and 3. First, out of the Time use Survey Data obtained from 31 households, the data from 25 households were used excluding the data from six households with data deficits. Activity lists and the amounts of time consumed by Activity were extracted. Among the activities conducted indoor, those that used household appliances leading to energy consumption included TV watching, snack preparation, cloth washing, meal preparation, cooking, free time, grooming, web surfing, and study. Due to the diversity of the lives of single households, different types of appliances were used by different questionnaire survey respondents for the same activity. Based on the probability to use household appliances when activities are conducted and the specifications of household appliances of the single households surveyed as shown in Table 2, probabilistic consumption units according to activities conducted were derived as shown in Table 3.

Figure 1 shows major indoor life activities and the corresponding power consumption during weekdays and weekends. According to the result values from the present survey, the accumulated time for indoor conducts accompanied by energy consumption was shown to be much during weekdays as compared with weekends. Particularly, the times required by indoor leisure part and learning times using computer, smart instruments were

sharply longer for weekdays in comparison with weekends. The conduct consuming the most power within the single household was laundry, and was shown to consume energy of about 1188wh/day• household in weekdays, and 965wh/day• household in weekends. In the case of power required for 1 day as a result of using home appliances, it was 4095Wh for weekdays, which was higher than 3067Wh for weekends.



Figure 1. Daily power consumption during workday/ weekend.

Figure 2 shows major indoor life conduct times during semester/during vacation with a great effect on the life conduct of single households around universities together with the corresponding power consumption. According

Kind of Activities	Appliance	Use probability	Probabilistic Energy Consumption unit (w/10min)	
Watch TV	Television	1.00	10.83	
Snacks	Microwave	0.20	211.56	
	Coffee Pot	0.75		
Washing Cloth	Clothes Washer	1.00	133.66	
Prepare Meal	Rice Pot	0.68	69.72	
	Microwave	0.06		
Cooking	Microwave	0.10	25.59	
Free time	Laptop PC	0.49	16.90	
	PC	0.50		
	Desk Lamp	0.01		
Grooming	Hair iron	0.08	100.41	
	Hair Dryer	0.48		
Web	Laptop PC	0.25	20.40	
Surfing	PC	0.75		
Study	Laptop PC	0.37	13.90	
	PC	0.41		
	Desk Lamp	0.12		

Table 3. The probabilistic energy consumption unit ofindoor behavior.



Figure 2. Daily power consumption during semester/vacation.

to the result values of the present survey, the loner times and the higher energies were consumed during vacation periods rather during semesters in terms of overall use time of life instruments and power consumption. With the times spent indoors being increased as a difference in school class status, the use times of life instruments and the energy consumption resulting from life conducts appear to have been increased.. The largest consumption source of power among all periods from the aspect of power consumption was laundry, which consumed 902.21Wh/day• household during semester, and 1216.31Wh/day• household during vacation. In power consumption resulting from the use of home appliance, about 25% less energy was spent during semester (2745.69Wh/day• household) than during vacation (3678.49Wh/day• household).

5. Conclusion

In the present study, power consumption of household appliances was surveyed and analyzed as a function of life conduct activity for single households around universities. First, the retention ratio and the specification of household appliances retained by the single household around universities were surveyed and presented. Even for the single household, although the basic household appliances to carry out life conducts tend to be retained in general, the specification aspect was shown to exhibit a large difference as compared with general households. In particular, the retention ratios of TV and kimchi refrigerator having a very high retention ratio for general households of Korea were shown to be very low.

In this study, the life conduct characteristics of single households were classified per day of week as well as per period, time requires and energy consumption per life conduct were surveyed and analyzed, and quantitative data was presented for energy consumption. In the case of single households, the power consumption was shown to be higher for weekdays rather than for weekends, and during vacations rather than during semester

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