A social experiment for controlling electricity demand by visualization - A case of Nushima Island

Koji Shimada (Ritsumeikan Univ., Japan), Yuki Ochi (E-konzal, Japan)

1 Introduction

Distributed autonomous energy systems have received remarkable attention as a measure for climate change and natural hazards mitigation, especially in remote islands. Power demand management will be important in the systems. We are conducting a social experiment of visualizing real-time electricity consumptions thorough smart meters and tablet PCs with 51 households in Nushima Island, located in Hyogo Prefecture. The present study estimates an effect of visualization to manage power demand by panel data analysis.

2 Methodology

Contents of visualization are rotated monthly from pattern 1 to 3. Pattern 1 shows only own consumptions, pattern 2 addes average of 51 households, and pattern 3 adds a ranking moreover. In this study, factors that may have an influence on electricity consumptions are analyzed based on household panel data. Panel data analysis has the advantage that it is able to control difference among households. Eq. (1) describes the estimating equation to find an effect of the factors. Sample size is amounts to 7,543, which were collected from 51 households for 183 days from April 1 to September 30 except for missing value.

$$\begin{aligned} PCEC_{i,t} = C &+ \alpha_1 TA_{i,t} + \alpha_2 WS_{i,t} \\ &+ \alpha_3 RF_{i,t} + \alpha_4 CF_{i,t} \\ &+ \alpha_5 VC1_{i,t} + \alpha_6 VC2_{i,t} \\ &+ \alpha_7 VC3_{i,t} + \alpha_8 DUME_{i,t} \\ &+ \alpha_9 DUMT_{i,t} \\ &+ \alpha_{10} DUMV_{i,t} + \beta_i \end{aligned} \qquad \text{Eq. (1)}$$

$PCEC$	Per-capita daily electricity consumptions $[\mathrm{Wh/day}]$
C	Constant
TA	Daily mean temperature [℃]
WS	Daily mean wind speed $[\mathrm{m/s}]$
RF	Number of refrigerators
CF	Number of commercial freezers
$VC1,2,3$	Frequency of viewing consumptions in each pattern (1, 2 and 3) by a tablet PC in per day
$DUME$	Dummy variable for households where all energy is supplied with electricity
$DUMT$	Dummy variable for timber frame houses
$DUMV$	Dummy variable for summer vacation
α	Partial regression coefficient
β	Individual effect

Table 1 Estimation results

Variables	Coefficients		t values
C	1,565	***	16.14
TA	31.21	***	8.510
WS	31.45		1.350
RF	2,249	***	159.4
CF	3,298	***	306.2
$VC1$	-31.23	***	-4.151
$VC2$	-18.30	***	-4.495
$VC3$	77.82	***	5.227
$DUME$	215.4	***	10.57
$DUMT$	-752.4	***	-42.87
$DUMV$	2,347	***	16.85
Adjusted R-squared	0.9656		
Durbin-Watson stat	1.392		
Model	Cross-section SUR		

*** indicates statistical significance at the 1% level.

3 Results and discussion

Table 1 indicates that per-capita electricity demand decrease by 31.23 Wh/day as pattern 1 is viewed every time. It is interpreted that a family who checks their consumptions 5 times a day saves electricity by about 2.6 percent compared with a family who does not. The results clearly show that pattern 1 and 2 have an effect to reduce electricity demand, but on the other hand, consumptions tend to increase when pattern 3 is viewed. The impact of visualization is considered to be insufficient to reduce power demand substantially.

4 Conclusions

Although it can be noted from this analysis that visualization has some effect to reduce power demand, a more efficient methodology is needed. In this experimental project, dynamic pricing will be introduced in 2014. Economic incentive with visualization is assumed to be more effective to manage electricity demand.