

Information Feedback from In-Home
Displays and Salience Effects:
Evidence from Residential Electricity
Consumption

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Overview

- **Motivation**
- **Policy intervention**: providing households with in-home displays (**IHDs**)
- **Randomized field experiment**: IHD together with pecuniary incentives for electricity saving during peak hours
- **Results**: effects of IHDs

Motivation

- **Inattention to consumption information**: suboptimal consumption regardless of the individual's information-processing capacity (DellaVigna, 2009)
- **Limited capacity** to process information: mistakes in choosing optimal consumption even when fully informed (de Palma, Myers, and Papageorgiou, 1994)
- Under these circumstances, deviations from full consumption optimization reduce consumer welfare, making **policy interventions** necessary to increase attention and information-processing capacity

Electricity usage status as of Thursday July 25, 2013

Amount of electricity used on this day 761 kWh

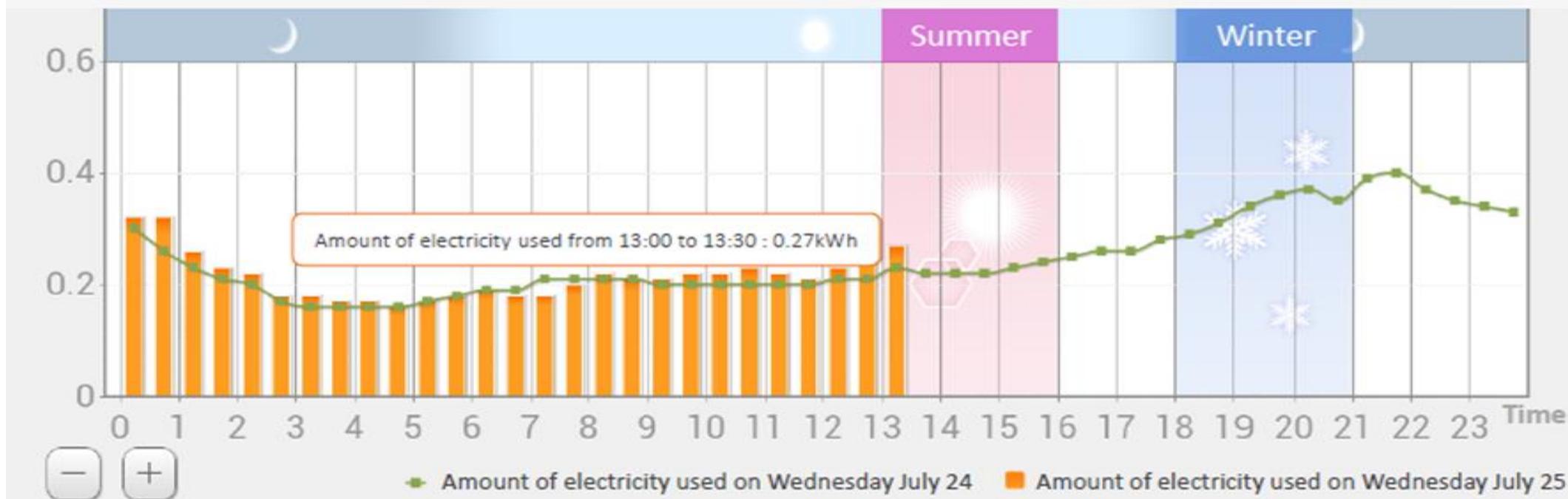
kWh

Thursday July 25, 2013

Electricity usage during the time period when the electricity charge rate is particularly high

(Summer) 13:00 to 16:00 1.36kWh

(Winter) 18:00 to 21:00 ._. kWh



Comparison with previous week

Comparison with previous day

< Date

Display/Hide comparison

Update

Research Questions

- **Q1.** Does the cumulative usage of IHDs affect residential electricity consumption?
- **Q2.** Is IHD provision energy-saving?
- **Q3.** Do pecuniary incentives affect electricity consumption and IHD usage?

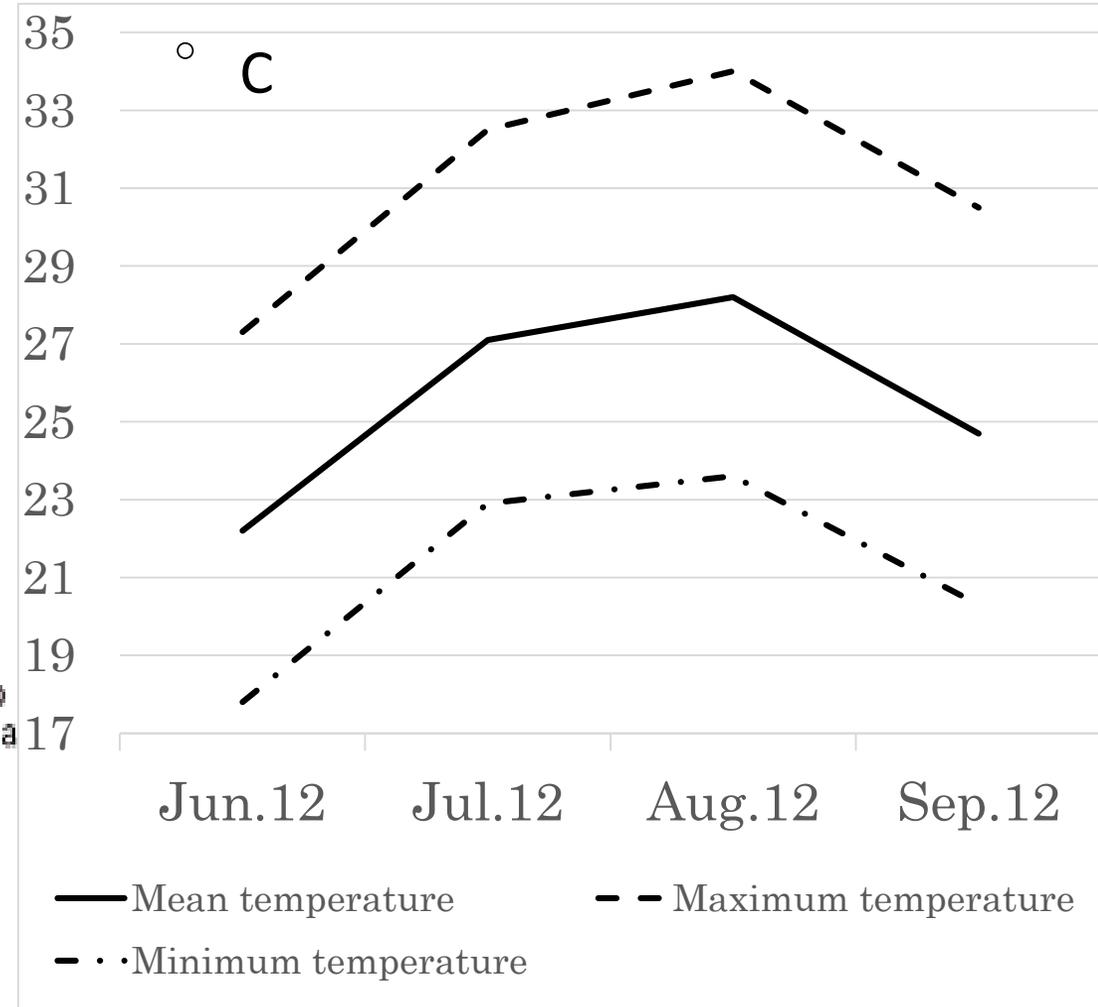
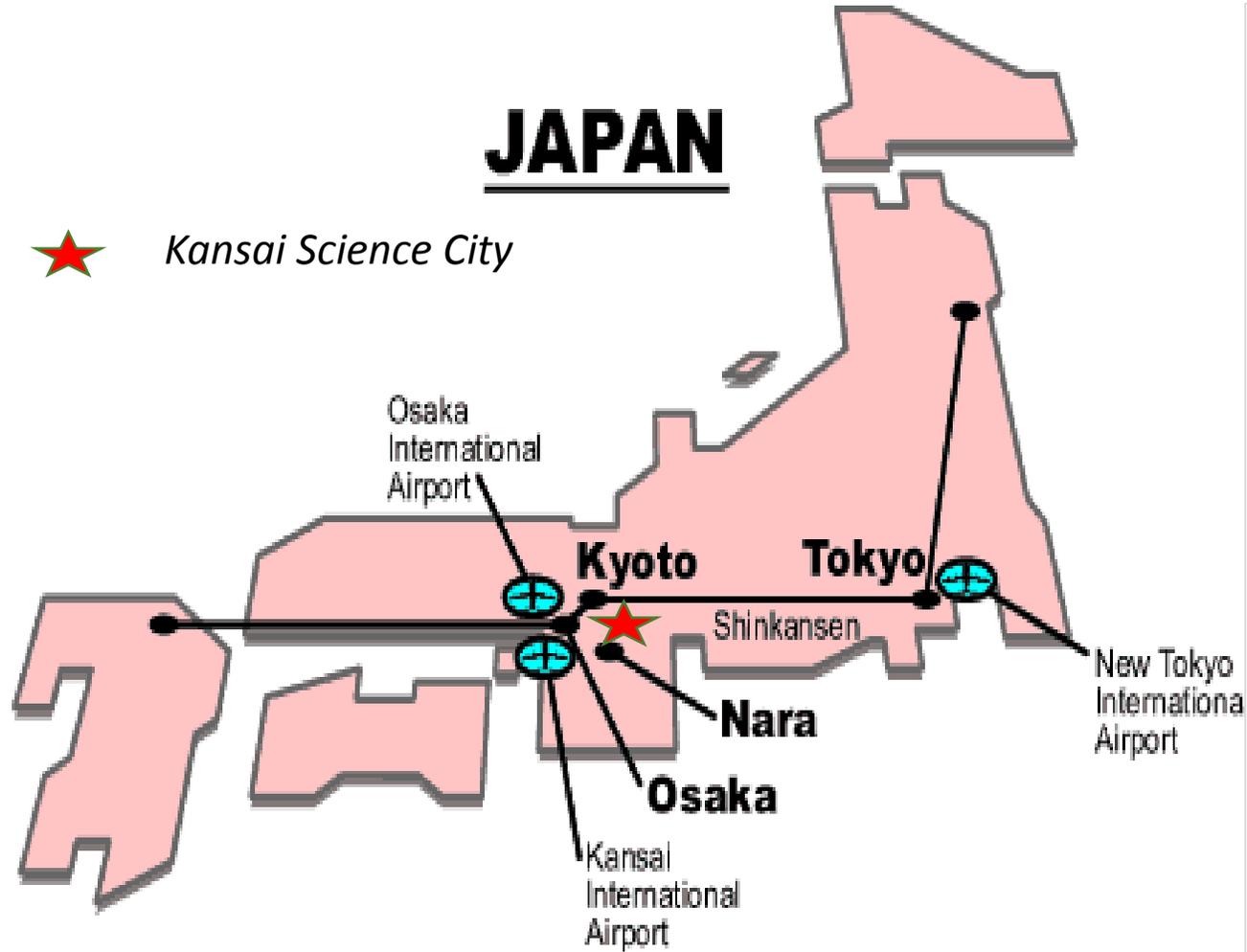
Randomized Field Experiment

- **Summer**: July 23, 2012, to September 13, 2012 (36 days)
- **Subjects**: **501** households living in the south of Kyoto, Japan
- **Control** : **126** households
- **Treatment** : **375** households could use IHDs at any time during the experiment

Pecuniary Incentives for Peak Reduction

- Money-convertible **electronic points worth 70 US dollars** (1 US dollar = 100 yen): 70% of the monthly average electricity expenditure
- Treatment lost points which were computed as the product of the unit electricity price (**40, 60, or 80 cents per kWh**) and electricity consumption during peak hours on “**critical peak days**”
- Households that saved more electricity during peak hours could receive more money by converting electronic points in the end
- **Five critical peak days** for each price of electricity were called on a day-ahead basis
- **20 cents** during peak hours of non-critical peak days on weekdays

Location and Climate of the Experimental Site



Source: Kansai Science City, <http://www.keihanna-plaza.co.jp>

Source: Japan Meteorological Agency. <http://www.jma.go.jp>.

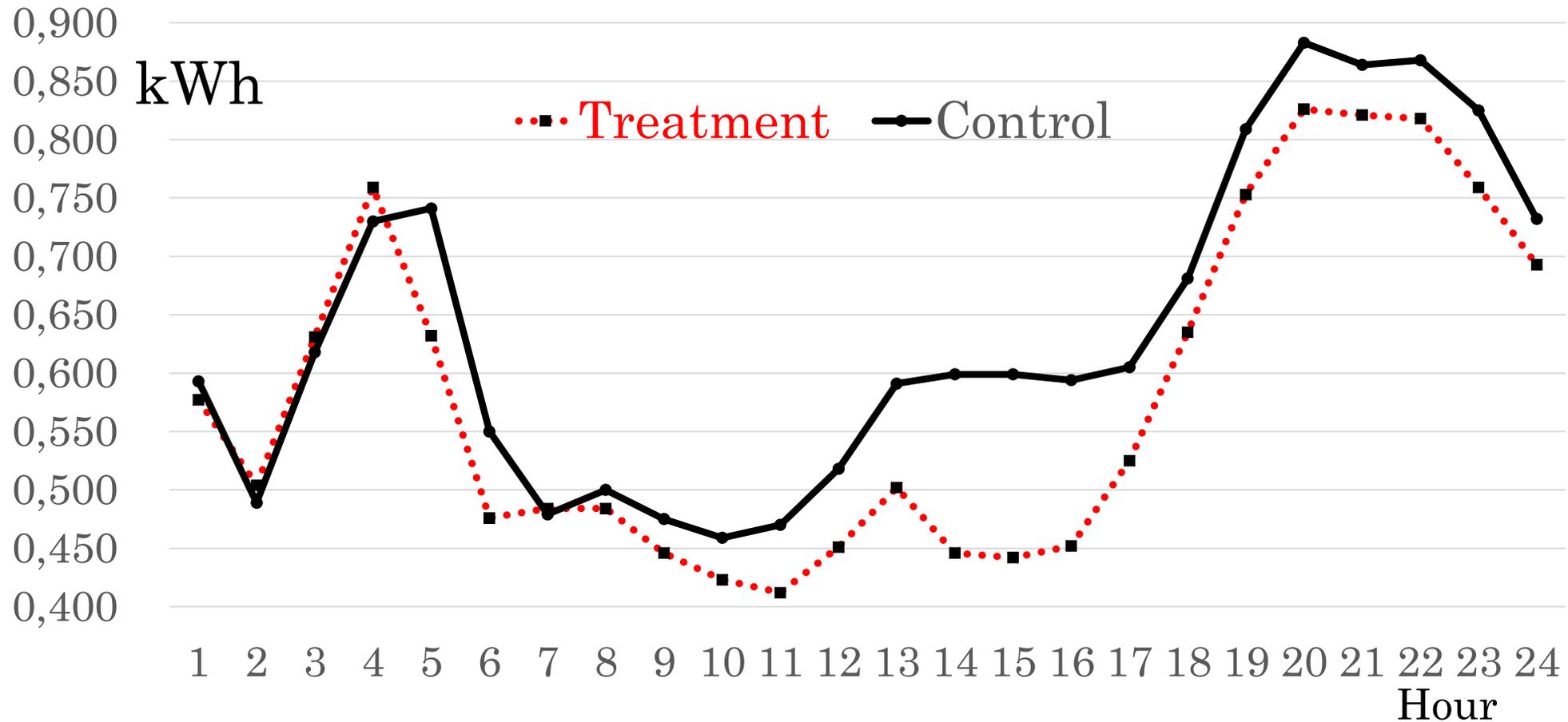
Comparison between the Control and Treatment Groups before the Experiment

	Control	Treatment	
	Mean	Mean	Difference
Daily-average electricity usage in June 2012 (kWh/day)	12.36 (7.35)	11.89 (6.20)	-0.47 (-0.63)
All electric = 1	0.36 (0.48)	0.28 (0.45)	-0.08 (-1.57)

Notes: The column “Difference” indicates the difference in each variable for the treatment group with respect to the control group. In the column “Mean,” standard deviations are in parentheses. In the column “Difference,” *t*-statistics are in parentheses.

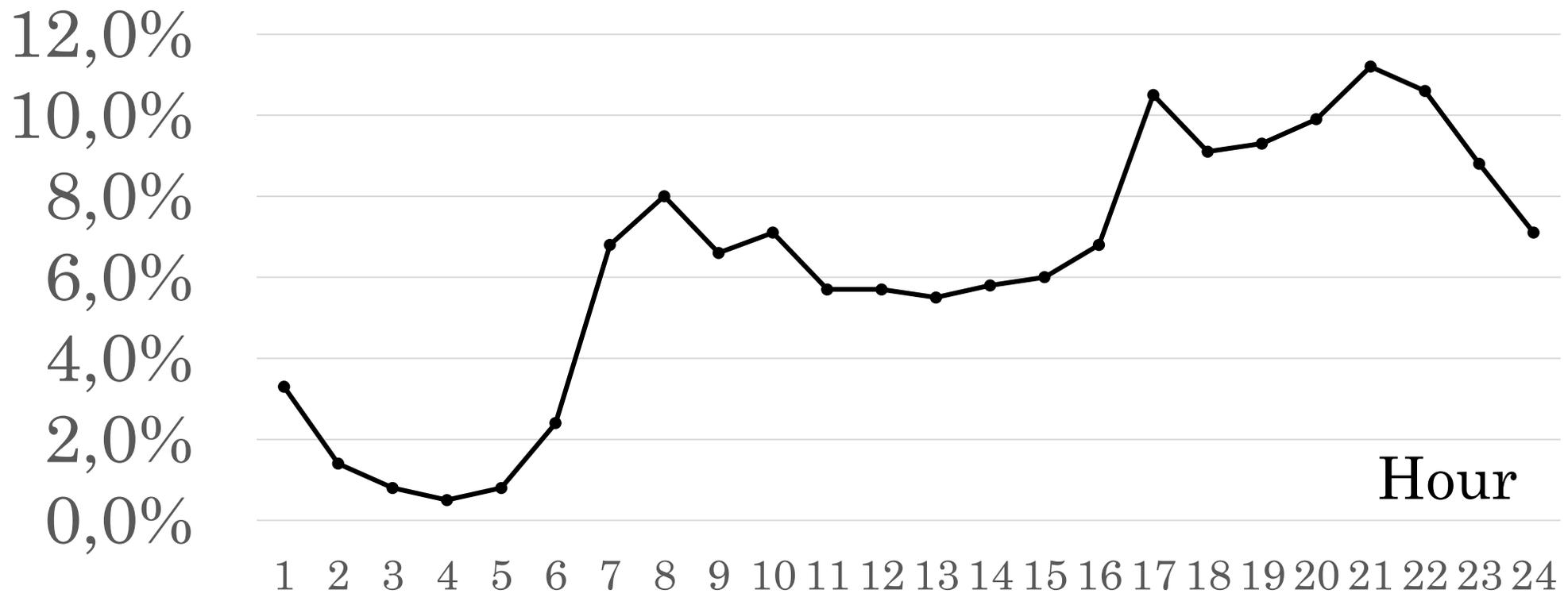
Source: The Keihanna Eco-City Next-Generation Energy and Social Systems Demonstration Project Promotion Council

Average Hourly Electricity Consumption



Source: The Keihanna Eco-City Next-Generation Energy and Social Systems Demonstration Project Promotion Council

Proportion of Households Using IHDs by Hour of the Day



Source: The Keihanna Eco-City Next-Generation Energy and Social Systems Demonstration Project Promotion Council

Model for Electricity Consumption & IHD Use

- $\log(KWH_{i,t}) = a_i + [b_0 + b_1 \log(KWH_6_i)] \log(1 + S_{i,t-1} + \delta_{i,t})$
 $+ \sum_k c_k D_{k,i,t} - \omega_{1,2} M_{i,t} + \sum_k h_k H_{k,t} + \varepsilon_{1,i,t}$
- $L_{i,t} = \alpha_i + \sum_k \tau_k D_{k,i,t} + \sum_k \mu_k H_{k,t} + \varepsilon_{2,i,t}$
- $KWH_{i,t}$: electricity consumption of household i at time t
- $\delta_{i,t}$: dummy for IHD use, $S_{i,t} = \sum_{k=1}^t \delta_{i,k}$
- $L_{i,t}$: latent variable for IHD use, $\delta_{i,t} = 1$ if $L_{i,t} \geq 0$, and $\delta_{i,t} = 0$ if $L_{i,t} < 0$
- $D_{k,i,t}$: dummy for price k ($k = 20, 40, 60, 80$ cents/kWh)
- $H_{k,t}$: dummy for hour or date
- KWH_6_i : household i 's daily-average electricity consumption in June 2012
- $\varepsilon_{1,i,t}, \varepsilon_{2,i,t}$: error terms whose covariance is $\omega_{1,2}$
- $M_{i,t}$: inverse Mills ratio

Q1. Does the cumulative usage of IHDs affect residential electricity consumption?

- **YES**, 1% significance of the coefficients of the term $\log(1 + S_{i,t-1} + \delta_{i,t})$ and the interaction term $\log(1 + S_{i,t-1} + \delta_{i,t}) \times \log(KWH_6_i)$ in the fixed effects model

Q2. Is IHD provision energy-saving?

- **YES**, for households that consumed more than 15.55 kWh per day in June 2012 (approximately 20% of all households).
- **NO**, for households that consumed less than 15.55 kWh per day in June 2012 (approximately 80% of all households)
- Contrast with the previous literature that indicates energy-conservation effects of the presence of an IHD
- Reason (1): analysis of information acquisition
- Reason (2): “boomerang effect” of IHD use against excessive energy-saving after Fukushima

Q3. Do pecuniary incentives affect electricity consumption and IHD usage?

- **YES** for both electricity consumption and IHD usage
- Energy-saving effects of pecuniary incentives on peak-time consumption range from 13% to 24%
- Pecuniary incentives encourage households to use IHDs

Conclusion

- IHD use is expected to reduce deviations from the optimal consumption by salience and learning through attention
- While the cumulative usage of IHDs reduced the electricity consumption of “energy-using” households, it raised that of “energy-saving” households whose electricity consumption had been relatively modest before the experiment