

Evaluating a Behavioral DR Trial in Japan: Evidence from a One-year Experiment

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> IEPEC Long Beach August 11, 2015



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Funabashi trial – an overview

- Evaluating the *peak saving* impact of behavioral interventions.
- 4 interventions enabled by using "smart meter" data.
 - > Information-based: (1) IHD, (2) weekly reports, (3) email alert
 - > Price-based: (4) 30-minute rate uniformly designed with IHD
- RCT experiment for 16 months
 - August 2013 to November 2014
- Around 500 HHs in a condominium participated in the trial
 - From Aug 2013 ... 230 HHs (FIRSTs)
 - From Nov 2013 ... 230 + 270 HHs (SECONDs)

(the cond in Funabashi)



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Grouping: 3 treatment groups



(Note: Control group (group D) is under equivalent situation to the customers of standard TEPCO services.)

Price-based Intervention



The rate increases as a function of usage as measured every 30 min.

Information-based interventions



Real-time usage information (Assistive of the 30-min. tiered rate) A variety of information including comparison of peak time usage

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An Example of 'Story'



The example aimed to save usage during grid peak time by showing usage data from various aspects.

Personalized story selection

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Every week, an story for each household is automatically selected by monitoring their 30-minute interval data



- Select a story potentially more effective than others for each household.
- Provide messages/advices those fit to seasonal situation.
- > Avoid stories those have sent within a few weeks ago.



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Results

Column	(1)	(2)	(3)	(4)	(5)	(6)
- Evaluation period	S2013	S2014	S2014	W2013	W2013	Aug 2013 -
						Jul 2014
- Time slot	Grid peak	Grid peak	Grid peak	Cond peak	Cond peak	Whole day
	(1-4 pm)			(7-10 pm)		
Llougobald turges	FIDCT					
- Household types	FIRSTS	FIRSTS	SECONDS	FIRSIS	SECONDS	FIRSIS
- Group A	0.5	10.9	-5.1	5.1	10.4	3.4
30m rate + IHD	(5.4)	(5.9)*	(6.2)	(5.3)	(3.3)***	(2.6)
- Group B	11.6	8.8	7.6	10.9	13.0	4.7
30m rate + IHD + report	(5.3)**	(5.8)	(6.1)	(5.3)**	(3.3)***	(2.6)*
- Group C	4.0	7.4	7.8	12.7	11.3	4.0
Conv. rate + IHD + report	(5.2)	(5.7)	(6.0)	(5.2)**	(3.2)***	(2.5)
# households	224	224	267	224	267	224

Notes:

- Normalized consumption data is used as a dependent variable, so the estimates in this table are interpreted as average peak saving rates (columns 1–5) and electricity conservation rates (column 6) during the indicated time slots within each evaluation period.

- This table omits estimates of the following variables: post-treatment dummy, the average temperature of the peak times, the average humidity of the peak times, the average temperature of the previous three days, and a weekday dummy except for models for S13 and S14.

- Statistical significance: *** <0.01, ** <0.05, * <0.1.

- Standard errors are in parentheses. Standard errors are robust and clustered at the household level to control for serial correlation in the idiosyncratic error term.

Findings (1) – Group B

Column	(1)	(2)	(3)	(4)	(5)	(6)
- Evaluation period	S2013	S2014	S2014	W2013	W2013	Aug 2013 -
						Jul 2014
- Time slot	Grid peak	Grid peak	Grid peak	Cond peak	Cond peak	Whole day
	(1-4 pm)			(7-10 pm)		2
- Household types	FIRSTs	FIRSTs	SECONDs	FIRSTs	SECONDs	FIRSTs
	0.5	10.9	-5.1	5.1	10.4	3.4
	(5.4)	(5.9)*	(6.2)	(5.3)	(33)***	(2.6)
- Group B	11.6	8.8	7.6	10.9	13.0	4.7
30m rate + IHD + report	(5 3)**	(5.8)	(6 1)	(5 3)**	(3 3)***	(2.6)*
Group C	(3.5)	(3.0)		12.7	11.2	1.0
	(5.2)	Cridnos		Gond	nooless	4.0
Conv. rate + IHD + report	(5.2)	Ghu pea	K (6.0)	(SCOTU	реак	(2.5)
	(Su	mmer 1-4	4 pm)	(Winter ⁻		
# households	224	224	267	224	267	224

Saving in grid (summer 1-4 pm) & cond (7-10 pm winter) peak time
 Around 10%, some are statistically significant
 We do not observe obvious differences between effects in grid

& cond peak time

Findings (2) – Group B

	((-)	(-)	(-)	(-)	(-)
Column	(1)	(2)	(3)	(4)	(5)	(6)
- Evaluation period	S2013	S2014	S2014	W2013	W2013	Aug 2013 -
						Jul 2014
						JUI 2014
- Time slot	Grid peak	Grid peak	Grid peak	Cond peak	Cond peak	Whole day
	(1-4 pm)			(7-10 pm)		
 Household types 	FIRSTs	FIRSTs	SECONDs	FIRSTs	SECONDs	FIRSTs
- Group A	0.5	10.9	-5.1	5.1	10.4	3.4
	(5.4)	(5.9)*	(6.2)	(5.3)	(3 3)***	(2.6)
- Group B	11.6	8.8	7.6	10.9	13.0	4.7
Croup D						
30m rate + IHD + report	(5.3)**	(5.8)	(6.1)	(5.3)**	(3.3)***	(2.6)*
	4.0	<u>7</u> A	7.8	12.7	11.3	4.0
	$(\bigcirc . \frown)$	(J,T)		(J.Z)	(3.2)	
			KVV			куур
# households	224	224	267	224	267	224

Peak saving effects (kW) are higher than electricity conservation effects (kWh).

Findings (3) – Group A

(1)	(2)	(3)	(4)	(5)	(6)
S2013	S2014	S2014	W2013	W2013	Aug 2013 -
					Jul 2014
Grid peak	Grid peak	Grid peak	Cond peak	Cond peak	Whole day
(1-4 pm)			(7-10 pm)		
FIRSTs	FIRSTs	SECONDs	FIRSTs	SECONDs	FIRSTs
0.5	10.9	-5.1	5.1	10.4	3.4
(5.4)	(5.9)*	(6.2)	(5.3)	(3.3)***	(2.6)
11.6	8.8	7.6	10.9	13.0	4.7
(5.3)**	irid neak	(6.1)	(5 Cond	neak	(2.6)*
4.0	7.4	7.8	12.7	11.3	4.0
(<u>(S</u> um	mer 1-4	om() 5.0)	(Winter)	7-10 pm)	(2.5)
224	224	267	224	267	224
	(1) S2013 Grid peak (1-4 pm) FIRSTs 0.5 (5.4) 11.6 (5.3)** G 4.0 (Sum 224	(1) (2) S2013 S2014 Grid peak (1-4 pm) Grid peak FIRSTs FIRSTs 0.5 10.9 (5.4) (5.9)* Grid peak (Summer 1-4) 224 224	(1) (2) (3) S2013 S2014 S2014 Grid peak (1-4 pm) Grid peak Grid peak FIRSTs FIRSTs SECONDs 0.5 10.9 -5.1 (5.4) (5.9)* (6.2) Grid peak (Summer 1-4 pm) 78 224 224 267	(1) (2) (3) (4) S2013 S2014 S2014 W2013 Grid peak (1-4 pm) Grid peak Grid peak (7-10 pm) Cond peak (7-10 pm) FIRSTs FIRSTs SECONDs FIRSTs 0.5 10.9 -5.1 5.1 (5.4) (5.9)* (6.2) (5.3) Grid peak (Summer 1-4 pm) Cond 224 224 267	(1) (2) (3) (4) (5) S2013 S2014 S2014 W2013 W2013 Grid peak (1-4 pm) Grid peak Grid peak Grid peak Cond peak (7-10 pm) Cond peak (7-10 pm) FIRSTs FIRSTs SECONDs FIRSTs SECONDs 0.5 10.9 -5.1 5.1 10.4 (5.4) (5.9)* (6.2) 5.3 (3.3)*** Grid peak (Summer 1-4 pm) Cond peak (Winter 7-10 pm) Cond peak (Winter 7-10 pm)

With 30-min rate and IHD, peak saving effects in 7-10 pm is likely more stable than in 1-4 pm.

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Findings (4) – Comparing A & B

Column	(1)	(2)	(3)	(4)	(5)	(6)
- Evaluation period	S2013	S2014	S2014	W2013	W2013	Aug 2013 -
						Jul 2014
- Time slot	Grid peak (1-4 pm)	Grid peak	Grid peak	Cond peak (7-10 pm)	Cond peak	Whole day
- Household types	FIRSTs	FIRSTs	SECONDs	FIRSTs	SECONDs	FIRSTs
- Group A	0.5	10.9	-5.1	5.1	10.4	3.4
30m rate + IHD	(5.4)	(5.9)*	(6.2)	(5.3)	(3.3)***	adding
- Group B	11.6	8.8	7.6	10.9	13.0	weekly
30m rate + IHD + report	(5.3)**	(5.8)	(6.1)	(5.3)**	(3.3)***	(2reports
	4.0	7.4	7.8	12.7	11.3	4.0
Conv. rate + IHD + report	(5.2)	(5.7)	(6.0)	(5.2)**	(3.2)***	(2.5)
# households	224	224	267	224	267	224

Adding weekly reports to 30-min. rate and IHD stabilize the peak saving effects in 1-4 pm.

the lalosynciatic error term.

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Survey data: How frequently check IHD?



Around half of all households check IHD everyday even in summer 2014

Survey data: How frequently check reports?

Note: Summary of valid responses in summer 2013 from group B and C to the question, "Check each week in which you opened reports."



99% reports were opened in summer 2013 (paper-based reports sent via postal mail)

Survey data: How frequently check reports?

Note: Summary of valid responses in summer 2014 from group B and C to the question, "Check each week in which you opened reports."



Only 50% reports were opened in summer 2014 (pdf-file reports sent via email)

Variation of peak saving effects by consumption level

Note: Estimation results of the impact on the five sub-groups of group B, based on 20th, 40th, 60th, and 80th percentiles of posttreatment peak time average consumption. "+++", "++", "+", "-" and "--" in this figure denote "more than 80th percentile", "60th-80th percentile", "40th-60th percentile", "20th-40th percentile" and "less than 20th percentile", respectively. The results use normalized consumption data of group B and D for FIRST and SECOND pre-treatments and each post-treatment period.



Conclusion

- Behavioral intervention was effective for peak saving.
 - Around 10% saving with (1) 30m rate, (2) IHD and (3) report
- Well-designed information (IHD, weekly reports) are well accepted by participant households.
 - > 99% of paper-based reports are opened in 2013
 - Around half of all households check IHD everyday even in summer 2014
 This point could be an advantage compared to price-based DR (e.g., CPP)
- There are variation in peak saving effects, thus targeting may be an option.
- Investigating well-designed behavioral intervention for peak saving using smart meter data may have potential for more effective demand management.

Thank you very much for your attention.

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