GRE2014

Demonstration of Demand Response with Fuel Cell Units in a Condominium

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Ⅰ. Introduction

Background

After March 2011 Fukushima nuclear disaster, Japanese factories and offices and other buildings have been suffering from the shortage of electric power supply.

Demand-side management (demand response) has been the focus in recent years in Japan.

In demand response market of Japan, residential sector is expected to play an important role as well as industrial sector and commercial sector.

Demand response of residential sector

There are two types of demand response; one is by curtailment and the other is by generators.

Demand response of residential sector is mainly performed by curtailment of loads controlled by HEMS.

Inhabitants have to change the life pattern when performing demand response by curtailment, meanwhile they don’t have to change the life pattern when performing demand response by generators.

Demonstration of demand response by generators had never been performed in the residential sector.

Objective

To confirm generators in residential sector that is to say fuel cell units can be utilized for demand response.

To verify

- **Whenever or not fuel cell units can be utilized for demand response**
- **Reduction of electric demand by demand response**

Ⅱ． Facilities

What is a fuel cell unit？

A fuel cell unit is a micro-CHP system

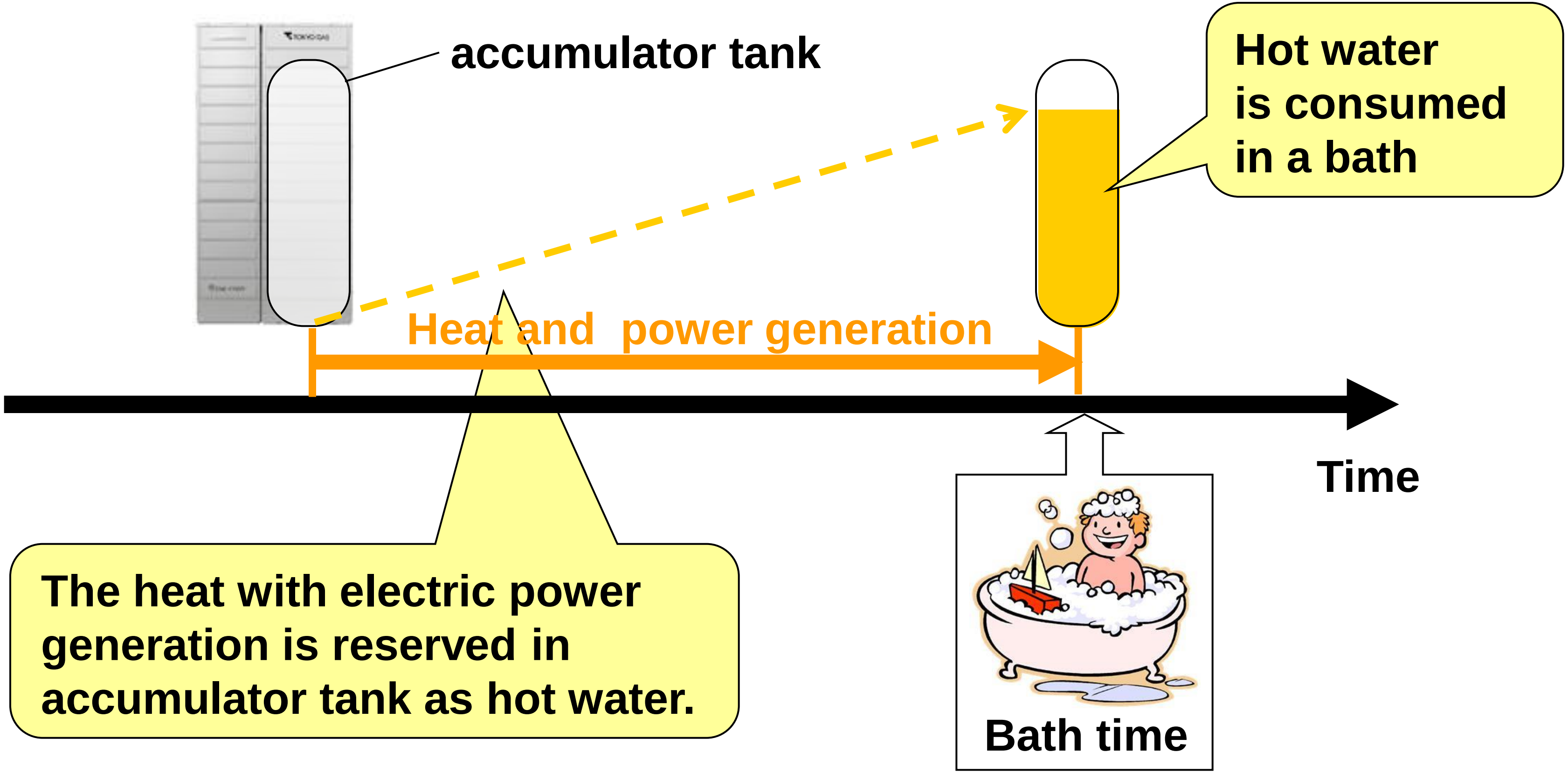
Electric output: 0.75 kW
Heat output: 0.94 kW

High total efficiency

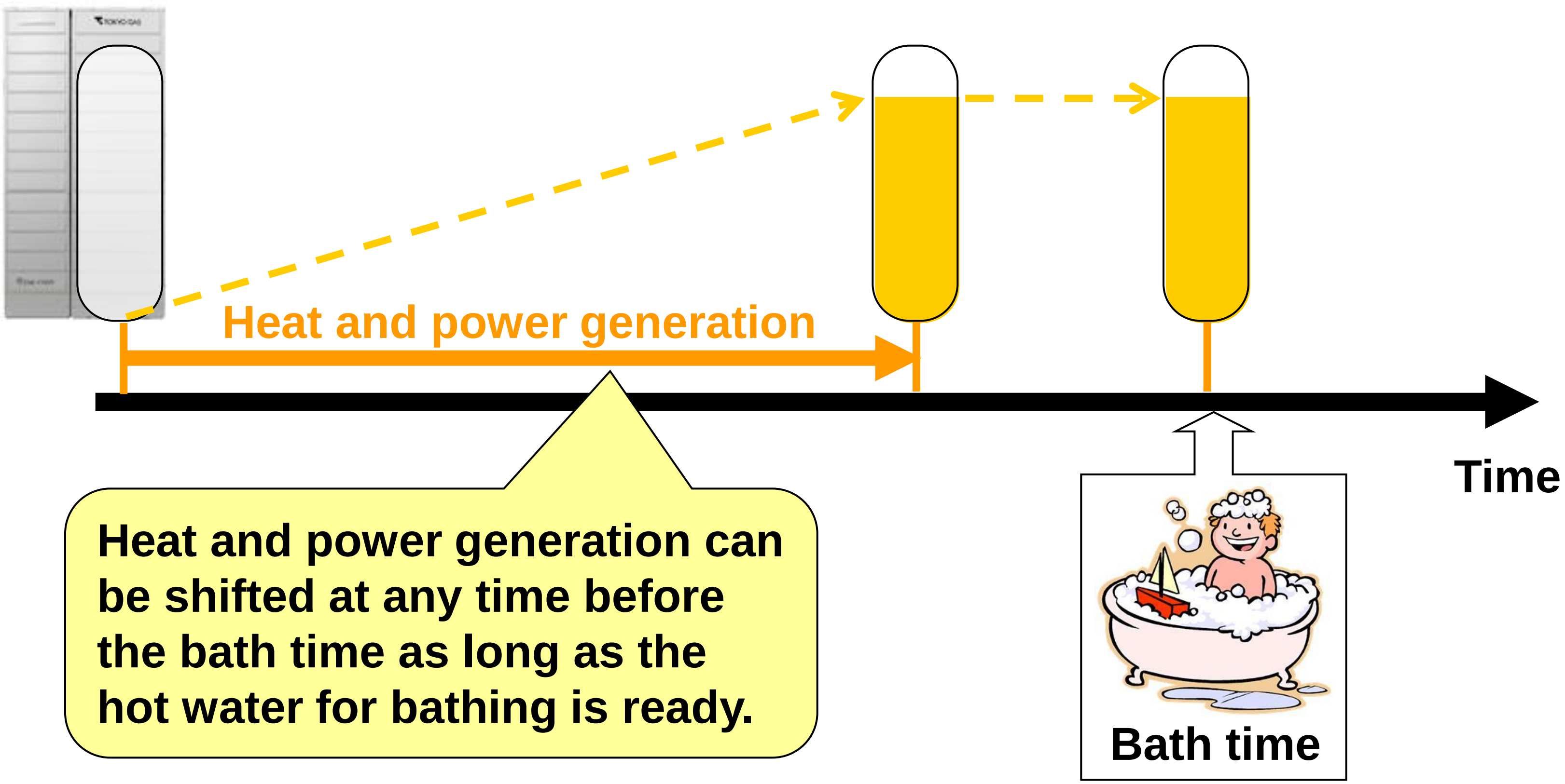
Electricity: 40% LHV
Heat recovery: 50% LHV

A fuel cell unit has an accumulator tank reserving the heat co-generated electric power, and consume the hot water in accumulator tank at a time when bathing.

Example of operation of a fuel cell unit

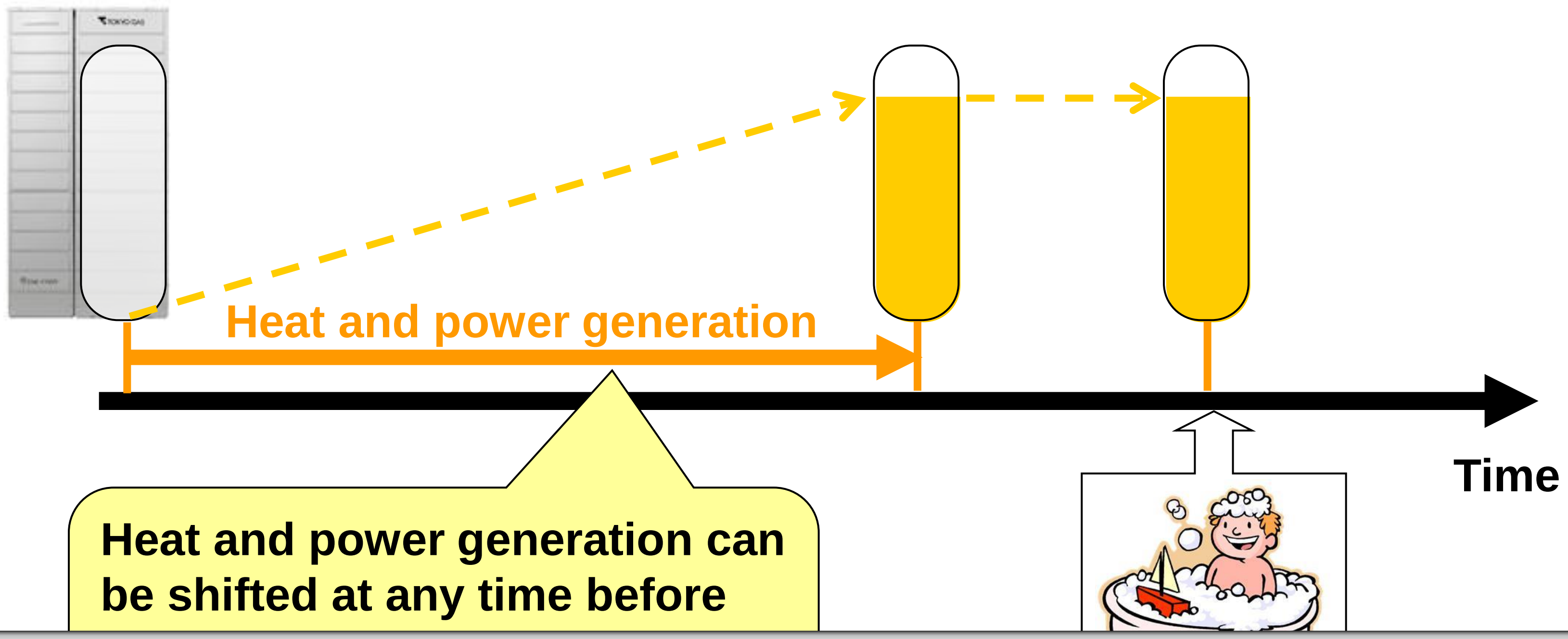


Time shift of the power generation



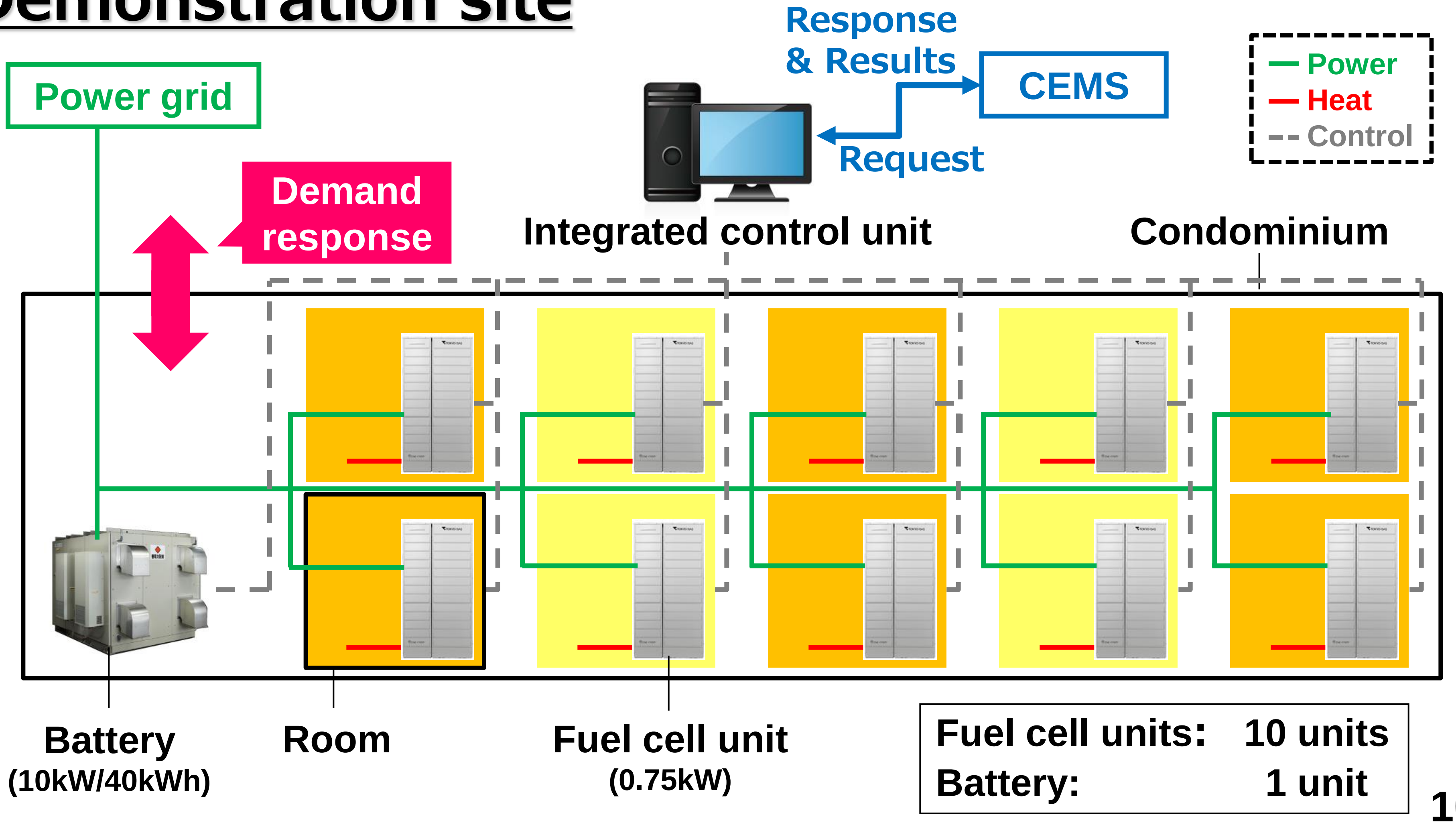
Heat and power generation can be shifted at any time before the bath time as long as the hot water for bathing is ready.

Time shift of the power generation



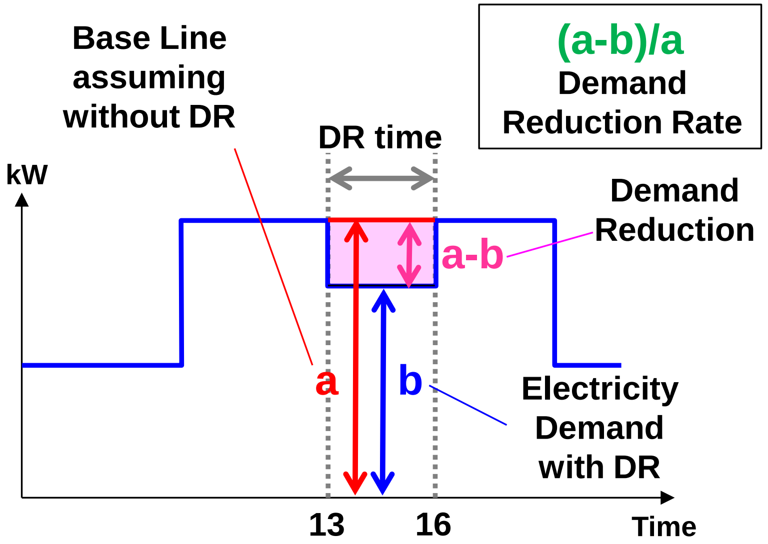
It is possible to perform demand response with fuel cell unit without lowering energy efficiency.

Demonstration site



Outline of demand response

DR time in summer : 13:00 to 16:00
DR time in winter : 17:00 to 20:00



The effect of demand response is evaluated by demand reduction rate.

Base line is electricity demand assuming the customer doesn’t participate in the demand response.

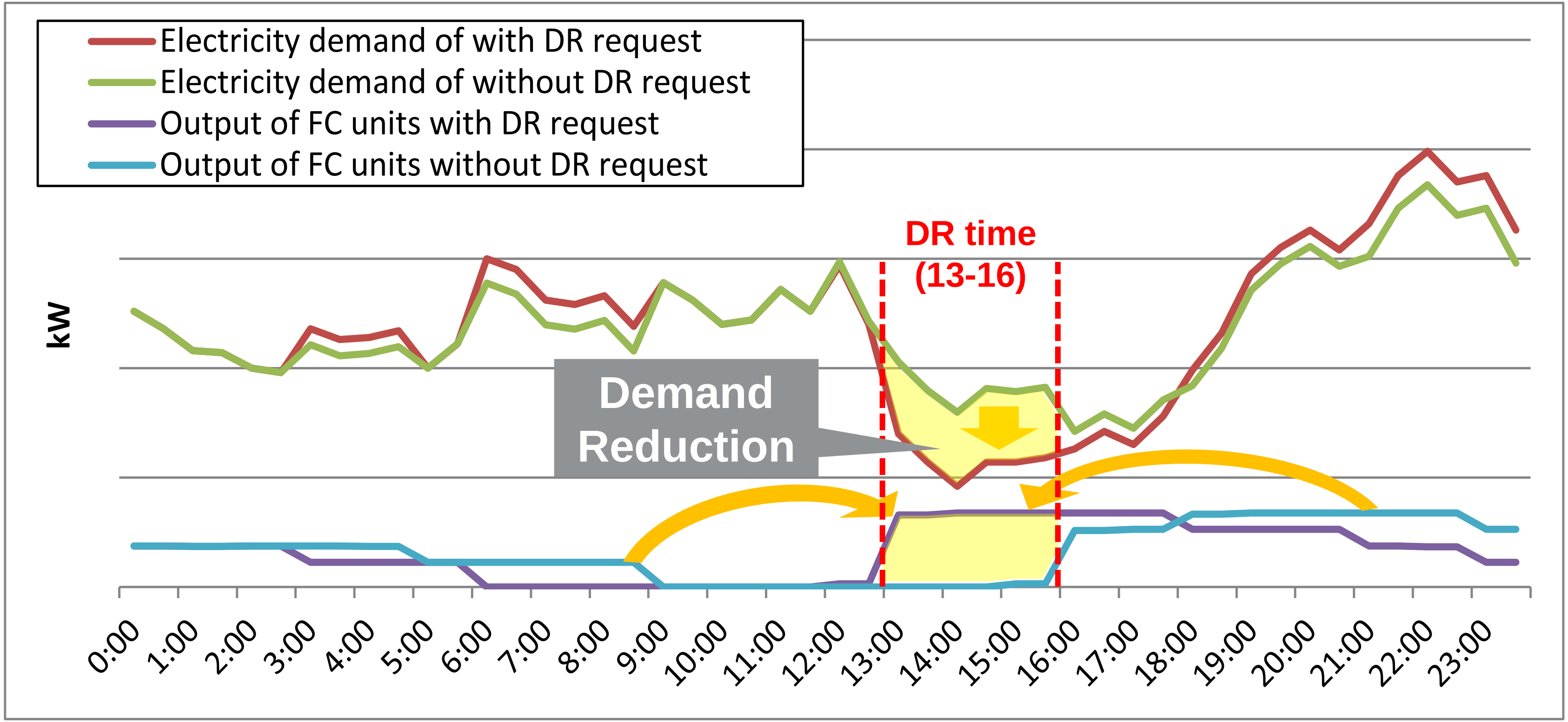
Calculation method of base line

Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.	Sun.	Mon.	Tues.	Wed.
	◎	◎	◎	◎			◎	DR request	DR

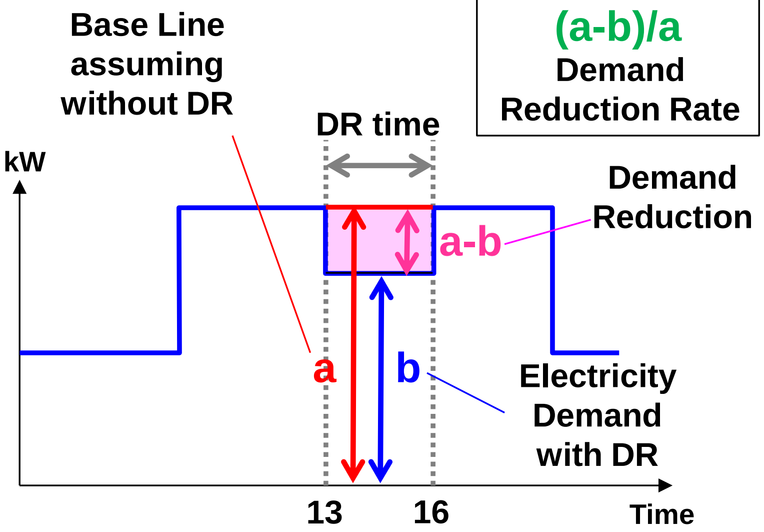
	Electric demand without DR[kW]						Average [kW]
	13:00 ～ 13:30	13:30 ～ 14:00	14:00 ～ 14:30	14:30 ～ 15:00	15:00 ～ 15:30	15:30 ～ 16:00	
Tues.	13.23	12.91	12.97	13.07	15.23	13.49	13.48
Wed.	15.37	14.91	14.90	15.33	17.81	15.40	15.62
Thurs.	13.43	13.08	12.65	13.25	15.63	13.71	13.62
Fri.	14.61	13.95	13.42	13.85	16.95	14.36	14.53
Mon.	16.76	16.80	14.90	14.03	16.68	14.52	15.61
Base line	15.58	15.22	14.40	14.40	17.15	14.76	15.25

Ⅲ． Results

Example of electricity demand with/without demand response request

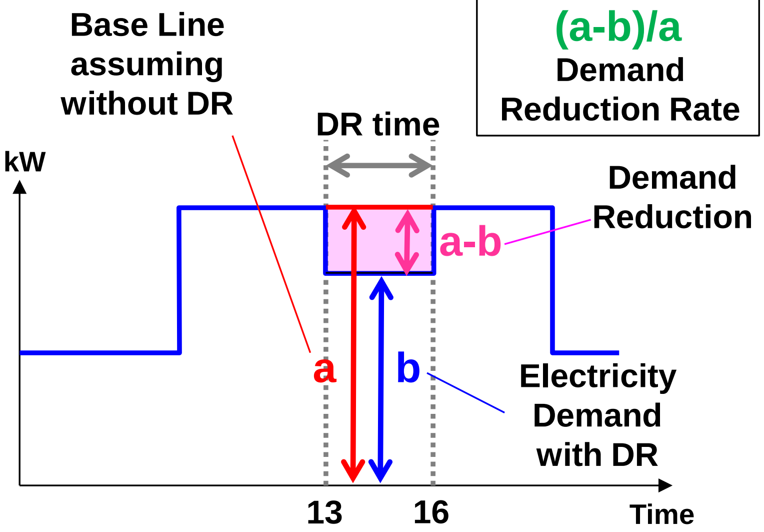


Results of demand response in Summer



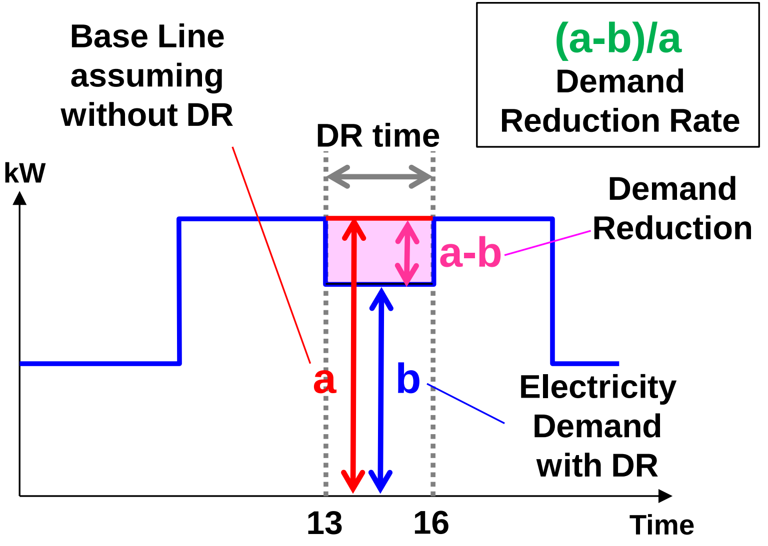
Date	Time	Base Line a	Electricity Demand b	Demand Reduction a-b	Demand Reduction Rate (a-b)/a
7/19	13:00-16:00	17.1kW	6.3kW	10.8kW	63%
7/25	13:00-16:00	14.7kW	2.4kW	12.3kW	84%
7/30	13:00-16:00	14.9kW	5.8kW	9.1kW	61%
8/8	13:00-16:00	17.0kW	4.3kW	12.7kW	75%
8/9	13:00-16:00	16.3kW	7.4kW	8.9kW	55%
8/30	13:00-16:00	16.6kW	12.7kW	4.0kW	24%
9/3	13:00-16:00	15.7kW	9.2kW	6.6kW	42%
9/5	13:00-16:00	16.8kW	7.1kW	9.8kW	58%
				Average	58%

Results of demand response in Winter



Date	Time	Base Line a	Electricity Demand b	Demand Reduction a-b	Demand Reduction Rate (a-b)/a
1/15	17:00-17:30	19.4kW	8.9kW	10.5kW	54%
	17:30-18:00	19.6kW	8.7kW	10.9kW	56%
	18:00-18:30	20.2kW	10.5kW	9.7kW	48%
	18:30-19:00	20.4kW	10.5kW	9.8kW	48%
	19:00-19:30	19.7kW	11.4kW	8.3kW	42%
	19:30-20:00	19.1kW	11.7kW	7.4kW	39%
1/16	17:00-17:30	19.4kW	7.4kW	12.0kW	62%
	17:30-18:00	19.6kW	7.5kW	12.1kW	62%
	18:00-18:30	20.2kW	10.0kW	10.2kW	51%
1/29	17:00-17:30	16.8kW	6.1kW	10.7kW	64%
	17:30-18:00	18.0kW	7.4kW	10.6kW	59%
	18:00-18:30	17.5kW	8.1kW	9.4kW	54%
	18:30-19:00	16.3kW	9.6kW	6.7kW	41%
	19:00-19:30	14.9kW	10.5kW	4.4kW	29%
	19:30-20:00	15.3kW	10.3kW	4.9kW	32%
				Average	**49%**

Results of demand response in Winter



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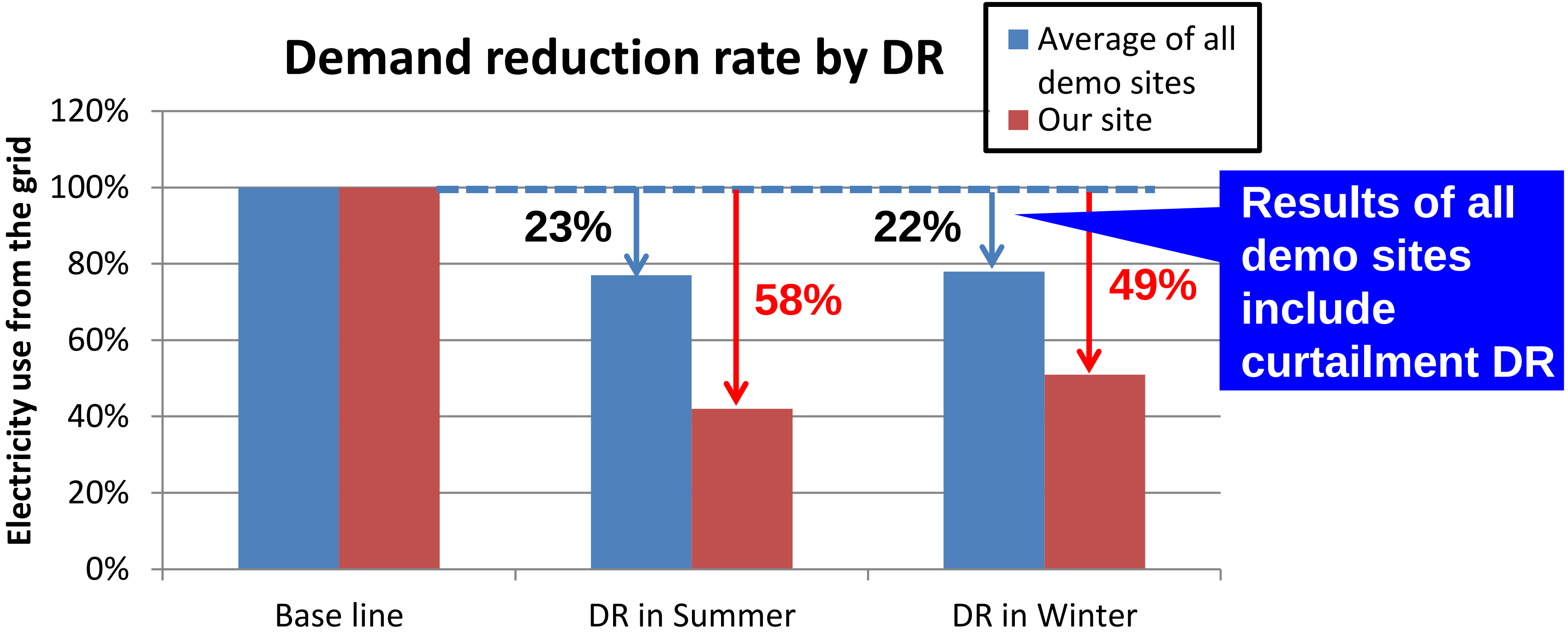
	18:30-19:00	20.4kW	10.5kW	9.8kW	48%
	19:00-19:30	19.7kW	11.4kW	8.3kW	42%
	19:30-20:00	19.1kW	11.7kW	7.4kW	39%
1/16	17:00-17:30	19.4kW	7.4kW	12.0kW	62%
	17:30-18:00	19.6kW	7.5kW	12.1kW	62%
	18:00-18:30	20.2kW	10.0kW	10.2kW	51%
1/29	17:00-17:30	16.8kW	6.1kW	10.7kW	64%
	17:30-18:00	18.0kW	7.4kW	10.6kW	59%
	18:00-18:30	17.5kW	8.1kW	9.4kW	54%
	18:30-19:00	16.3kW	9.6kW	6.7kW	41%
					29%
					32%
					49%

Fuel cell units can be utilized for demand response in residential sector.

Demand reduction rate



Demand response by generators can reduce more electricity demand than demand response by curtailment.

Ⅳ. Conclusion

Conclusion

- Generators in residential sector that is to say fuel cell units can be utilized for demand response.

- Demand response by generators can reduce more electricity demand than demand response by curtailment.

- Demand response with generators can reduce electricity demand without changing the life pattern of inhabitants.

Outlook

The sales targets of fuel cell units in residential sector

In Japan
2020: 1,400,000 units (Total 1.0 GW)
2030: 5,300,000 units (Total 4.0 GW)

Fuel cell units in residential sector have potential to reduce significant electricity demand when participating demand response.