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The current approaches and issues on the smart community verification projects in Japan

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The current situation of the smart community verification projects in Japan

○ **Many projects were launched to establish smart community models since 2009 in Japan.**
(As of August 2015: More than 120 cases)

○ **Representative of the project:**
“Next generation energy and social demonstration system verification project “ by the Ministry of Economy, Trade and Industry in 4 areas (●).

③ Keihanna (Kyoto Area)

Housing estate model

- The followingness of the consumer side is inspected targeted for about 700 houses, the buildings and the EVs, etc..

(Mitsubishi Heavy Industries, Ltd.
Mitsubishi Electric Corporation
Kansai Electric Power Co., Inc. etc..)

④ Kitakyushu-city

Regional urban center model

- In a specific supply area, the cogeneration power plant is regarded as a base load power supply and the followingness is inspected targeted for the area and the houses, etc..

(Fuji Electric Co., Ltd.
NIPPON STEEL & SUMITOMO METAL CORPORATION etc..)

① Yokohama-city

Wide area metropolis model

- The large-scale project which targeted for about 4000 houses and 10 buildings, etc..
- The project which integrates the storage battery in the area, and is managed and controlled.

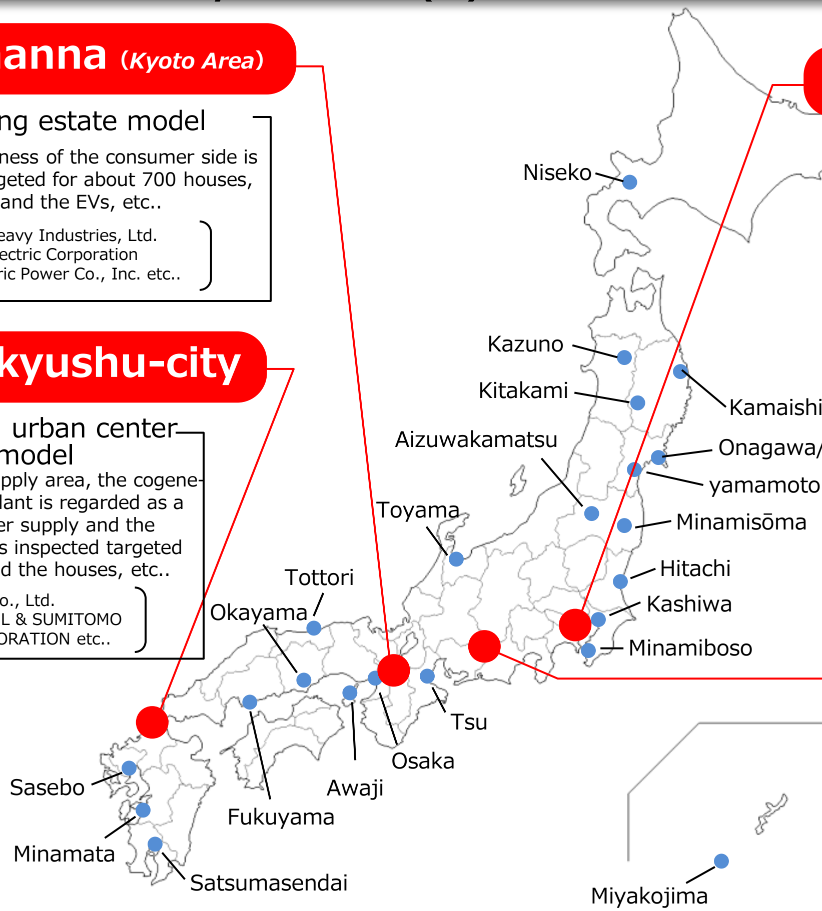
(TOSHIBA CORPORATION
Tokyo Electric Power Co., Inc. etc..)

② Toyota-City

Individual housing model

- The project of local production for local consumption at about 70 newly built houses where the equipment of energy creation and saving energy were established.
- The project of a next generation traffic system and car.

(Toyota Motor Corporation and
Chubu Electric Power Co., Ltd. etc..)

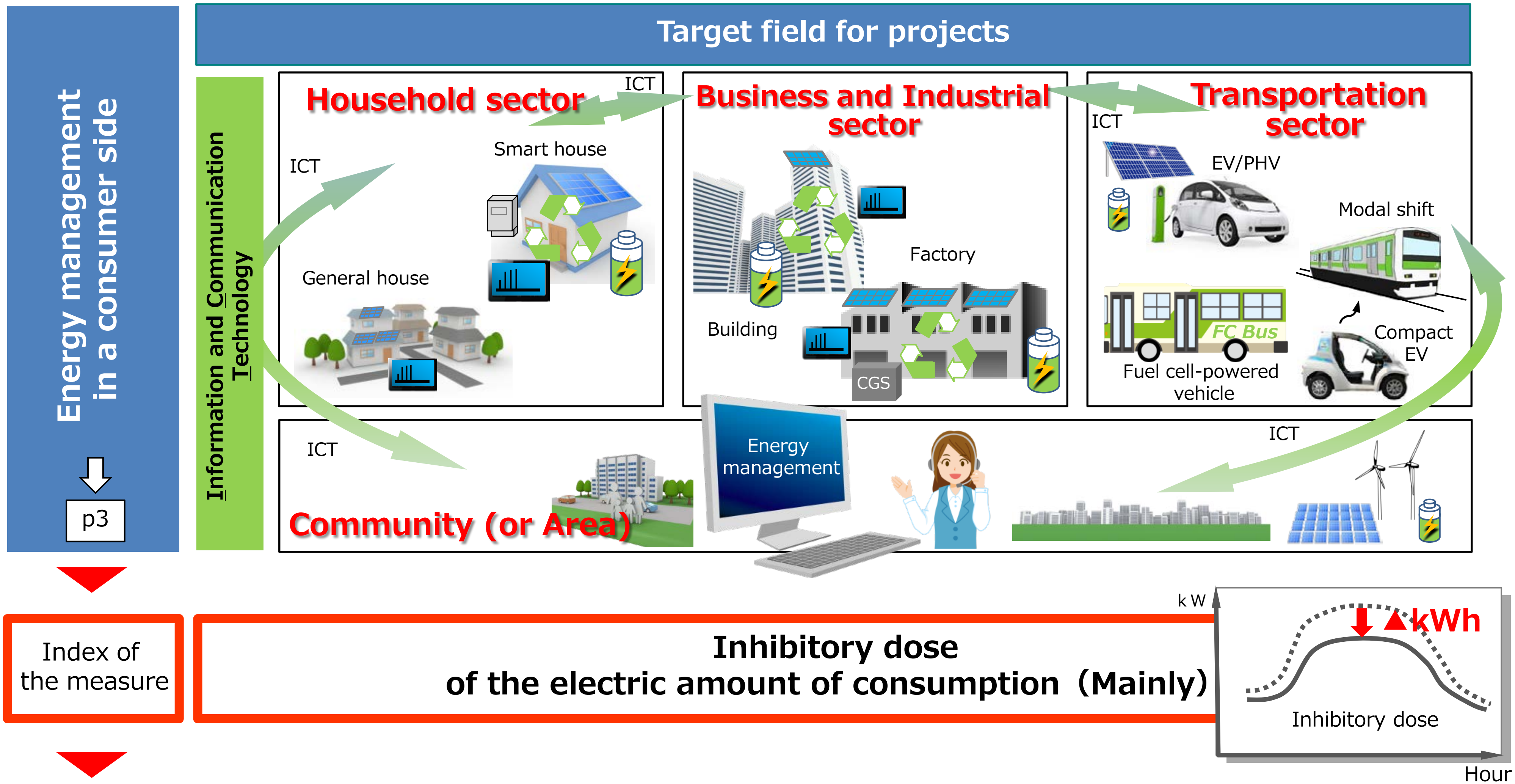


Example of project area	Form of the project
Niseko Town, Hokkaido	Local production for local consumption model using geothermal heat
Kazuno City, Akita	Local production for local consumption model using geothermal heat
Kamaishi City, Iwate	CEMS model
Kitakami City, Iwate	CEMS model
Miyako City, Iwate	EMS model for the fish processing industrial park
Onagawa Town, Miyagi	EMS model for the fish processing industrial park
Kesennuma City, Miyagi	EMS model for the fish processing industrial park
Ohira Village, Miyagi	EMS model for the industrial park
Ishinomaki City, Miyagi	CEMS model
Yamamoto Town, Miyagi	CEMS model
Minamisōma City, Fukushima	Large-scale HEMS model
Aizuwakamatsu City, Fukushima	CEMS model
Hitachi City, Ibaraki	EV bus model
Kashiwa City, Chiba	CEMS model
Minamiboso City, Chiba	CEMS model
Toyama City, Toyama	Compact city model
Tsu City, Mie	EMS model for campuses
Osaka City, Osaka	V2B model
Osaka City, Osaka	CEMS model using groundwater heat
Awaji City, Hyogo	Local production for local consumption model using electric storage facility
Tottori City, Tottori	CEMS model
Okayama City, Okayama	CEMS model using liquefied petroleum gas
Fukuyama City, Hiroshima	EMS model using a ship
Sasebo City, Nagasaki	EMS model for the theme Park
Minamata City, Kumamoto	EMS model for a fishing and agricultural village
Satsumasendai City, Kagoshima	EMS model for the industrial park
Miyakojima, Okinawa	Local production for local consumption model for islands

Key words of a smart community

✓ **Use of ICT.** ✓ **Efficient use of the area energy.**
✓ **Realization of comfortable living and business activity.**

The overview image of 4 area projects



Confirmation of the effect

① **The effect of Energy saving**

② **The effect of carbon dioxide emissions reduction**

③ **The effect of reduction in peak electric power**

\+ **Various questionnaire results**

The type of energy management

Type	Explanation of outline	Main inspection item		
		Energy saving	Carbon dioxide emissions reduction	Power peak-cut
Case Ⅰ **Dynamic pricing** (**The verification experiment of the DR which is led by electricity rate**) ⇨ p4 ～ p6	✓ Assume tightness of electric power supply and demand. ✓ Control electricity rates for targeted general households. ✓ Recommend the verification participant about an electricity rate of the peak time of the day beforehand on the previous day of the DR day. ✓ Monitor reaction of consumers for energy saving .	(▲)		●
Case Ⅱ **The verification experiment of the DR using EMS** ⇨ p7 ～ p12	✓ Control power demand by using EMS for each sector including residential, business, industrial, transportation, or a whole community. ✓ Monitor reaction of consumers for energy saving and adjustment of supply and demand by DR.	●	●	●

※DR ：Demand Response
※EMS ：Energy Management System

The basic specification for Dynamic Pricing

	Basic specification ※DR : Demand Response				Dynamic Pricing ※2	
	Smart meter	Visualization of the electric amount of consumption※1	Recommend of the DR: Home display	Recommend of the DR: PC or Smart phone, etc.	TOU (Time of Use)	CPP ※3 (Critical Peak Pricing)
Weekday (Usually)	▲	●	–	–	●	–
Day of the DR (Several times during the one season)	▲	●	●	●	–	● (Multi-step type)
Approaches for effective improvement	※1 Improvement of the visualization effect : **The visualization of the electric amount of consumption with an additional value.** (Ranking indication, etc.) ※2 Improvement of TOU and CPP effect : **The consulting for energy saving.** (Energy saving method or recommend replacing old appliances, etc.) ※3 Joining promotion of the CPP (opt-in type) : **"Bill Protection"** (Notify electricity rate of CPP service) **"Shadow Billing"** (Compare charges between CCP rate and usual rate)					

Image of TOU

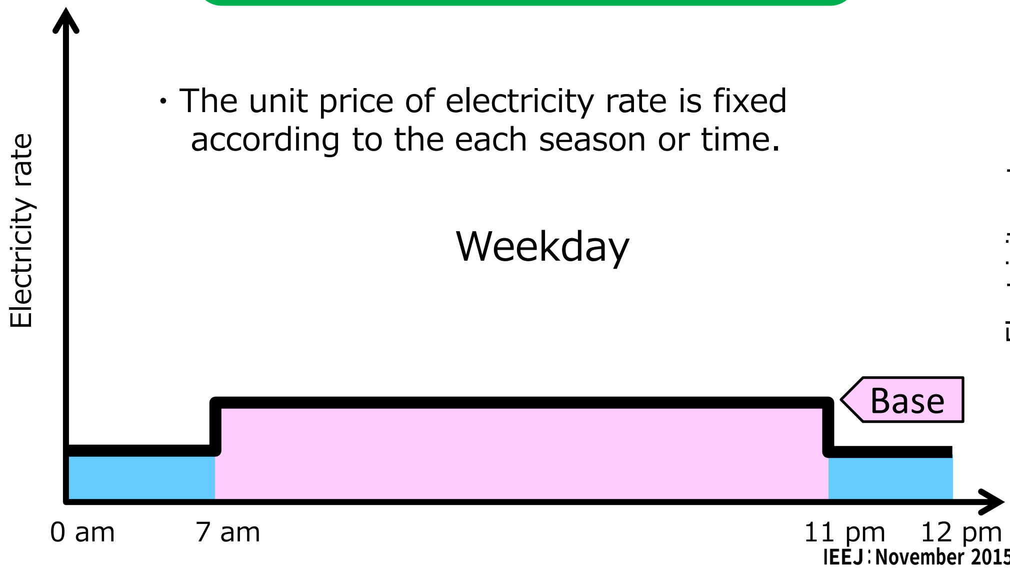
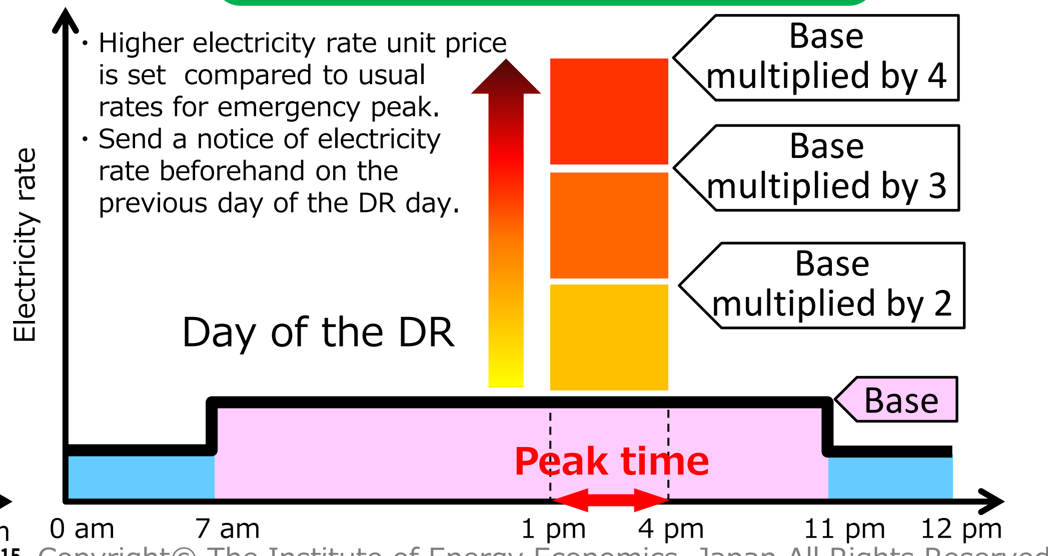
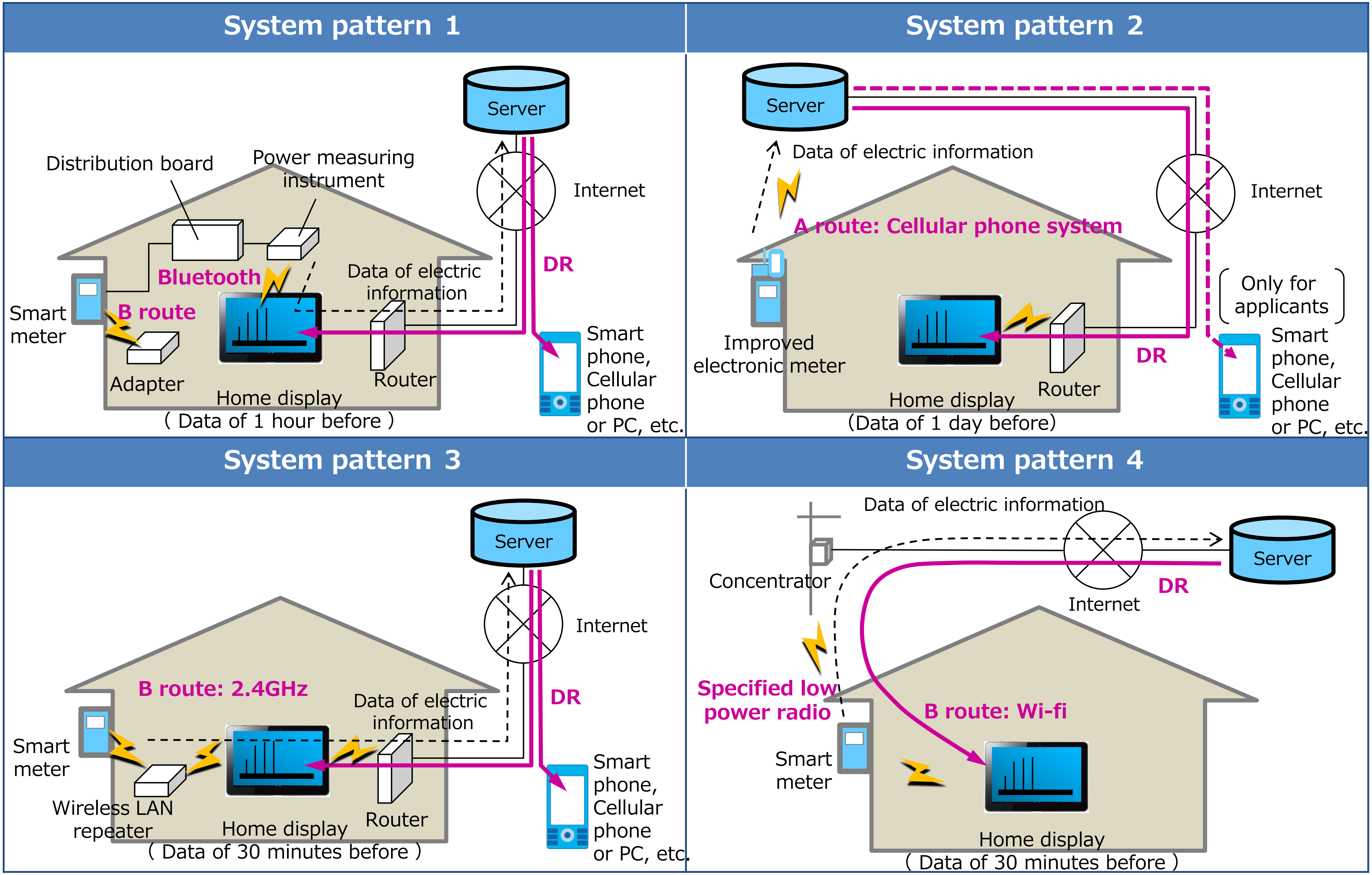


Image of CPP



The system configuration which achieves Dynamic Pricing



※DR : Demand Response

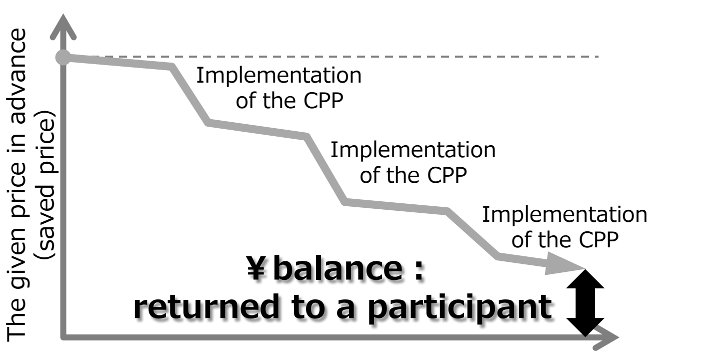
The consideration of a result of a dynamic pricing verification experiment

		Yokohama city	Toyota city	Keihanna (Kyoto area)	Kitakyushu city
Verification period		Apr. 2013 - Sep. 2014	Jan. 2013 - Feb. 2014	Jul. 2012 - Feb. 2014	Jul. 2012 - Feb. 2014
Participation enterprise		TOSHIBA ,Panasonic etc.	Chubu Electric Power	Mitsubishi Heavy Industries (MHI) Mitsubishi Electric (MELCO) Kansai Electric Power	Fuji Electric
Number of households (without Photovoltaics)		About 1,080 houses	About 90 houses	About 700 houses	About 180 houses (in a special supply area)
Electrification rate		40%	73%	30%	100%※1
Electric rate ※2	TOU	(Weekday) ¥45／kWh (Holiday) ¥21／kWh	Non-publication	(Weekday) ¥20／kWh	Non-publication
	CPP	**¥100／kWh (1 step)**	**¥50 , 80 , 100／kWh (3 Step)**	**¥40 , 60 , 80／kWh (3 Step)**	**¥50 , 75 , 100 , 150／kWh (4 Step)**
	Classification	Virtual price	Virtual price	Virtual price	Real price
Remarks		・Bill Protection ・Shadow Billing			

※2 ¥1 = $79（2012.7）～$107（2014.9）、€97（2012.7）～€138（2014.9）

		Yokohama city	Toyota city	Keihanna (Kyoto area)	Kitakyushu city
Effect of the energy saving	TOU	(included in the following)	(included in the following)	(Summer)▲9.1% (Winter) ▲11.7%	(The ▲9.1% in the Tokyo result in 2011 is included in the following, because ※1.)
	CPP	(Summer)**▲9.3%～▲14.9%** (Winter) Non-publication	(Summer)**▲11%** (Winter) **▲10%**	(Summer)**▲2.9～▲5.9%** (Winter) **▲2.0～▲4.0%**	(Summer)**▲18.8～▲20.2%** (Winter) **▲16.2～▲16.6%**

Image of the Virtual price



※It's subtracted according to the electric amount of consumption used at the DR time.

Image of the analysis of the effect

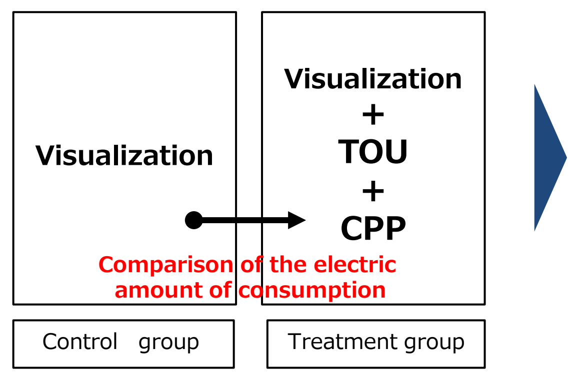


Image of the effect of an energy saving

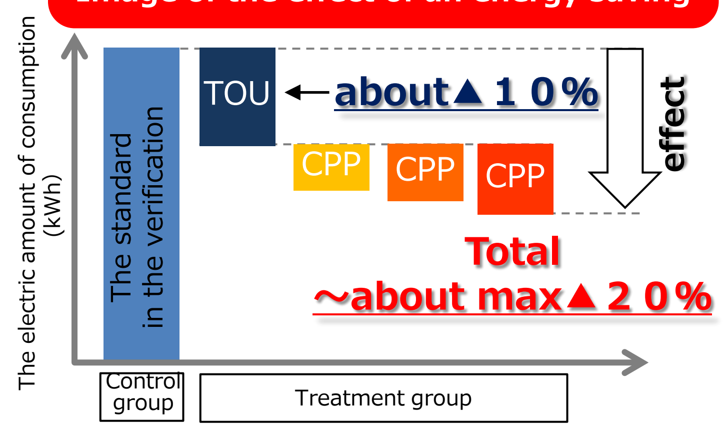
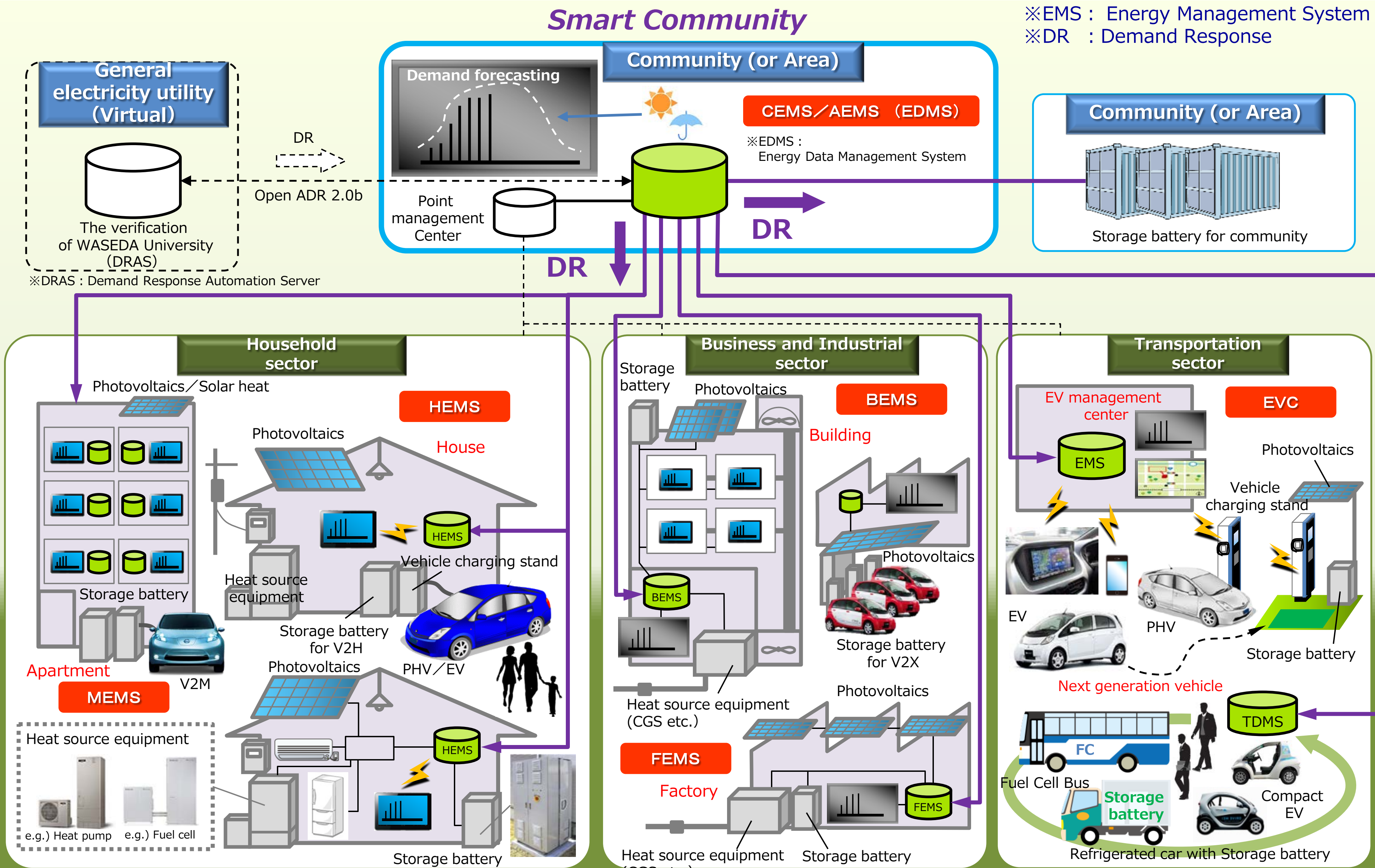


Image of the verification experiment of the DR using EMS

※EMS : Energy Management System
※DR : Demand Response



※TDMS : Traffic Data Management System

Yokohama : Case study of the Storage Battery SCADA system（TOSHIBA, etc.)

○ Characteristic of the storage battery SCADA system :

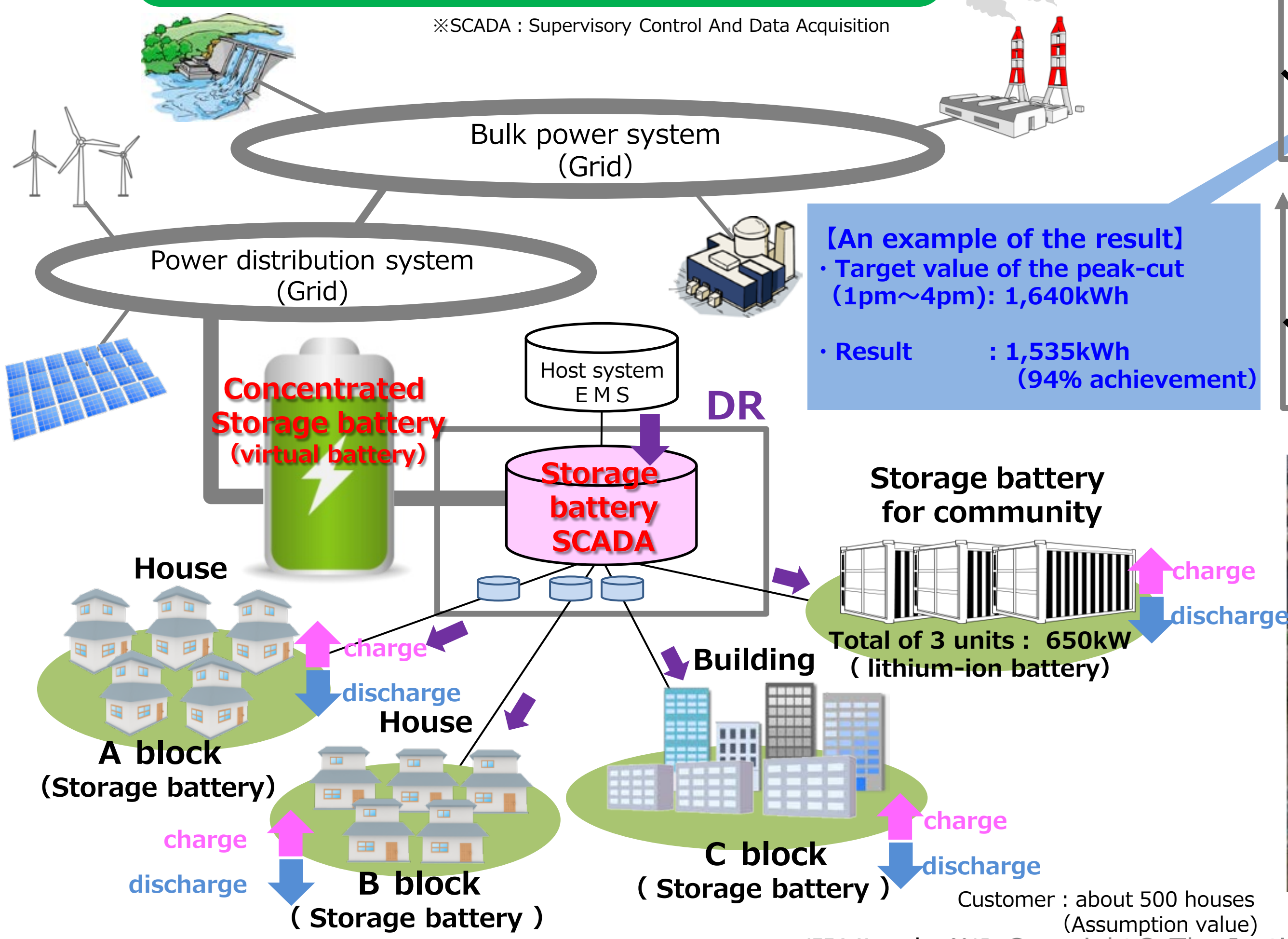
- The management system which controls multiple batteries installed in houses, buildings or the community **as one virtual battery**.

○ Advantage of the storage battery SCADA system :

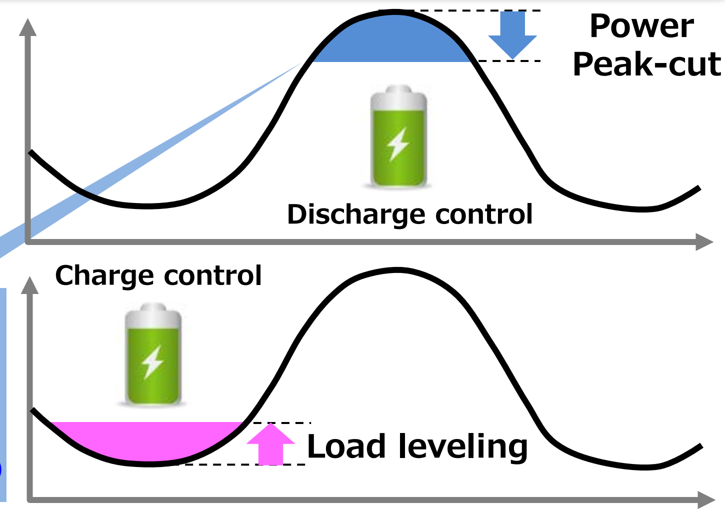
- **Reduction of the operative cost** of the storage battery.
- **Realization of "System stabilization"** and **"Large scale introduction of renewable energy"** by using the storage battery.

Image of the Storage battery SCADA

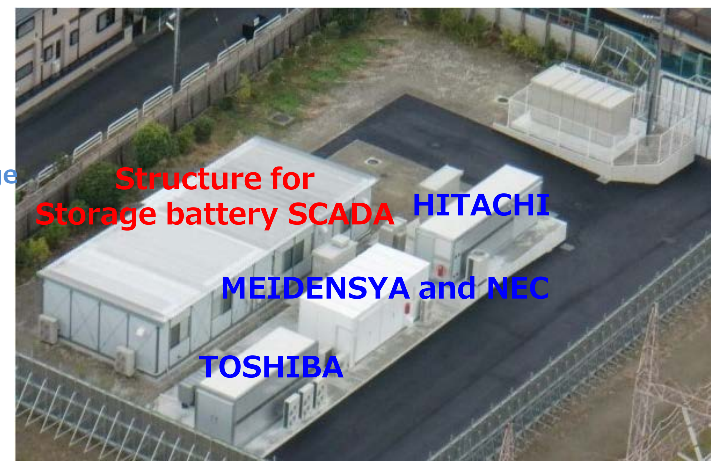
※SCADA : Supervisory Control And Data Acquisition



【An example of the result】
- Target value of the peak-cut (1pm～4pm): 1,640kWh
- Result : 1,535kWh (94% achievement)



Customer : about 500 houses
(Assumption value)



※Source of photo : "Smart City Portal of New Energy Promotion Council Japan." (add descriptions)

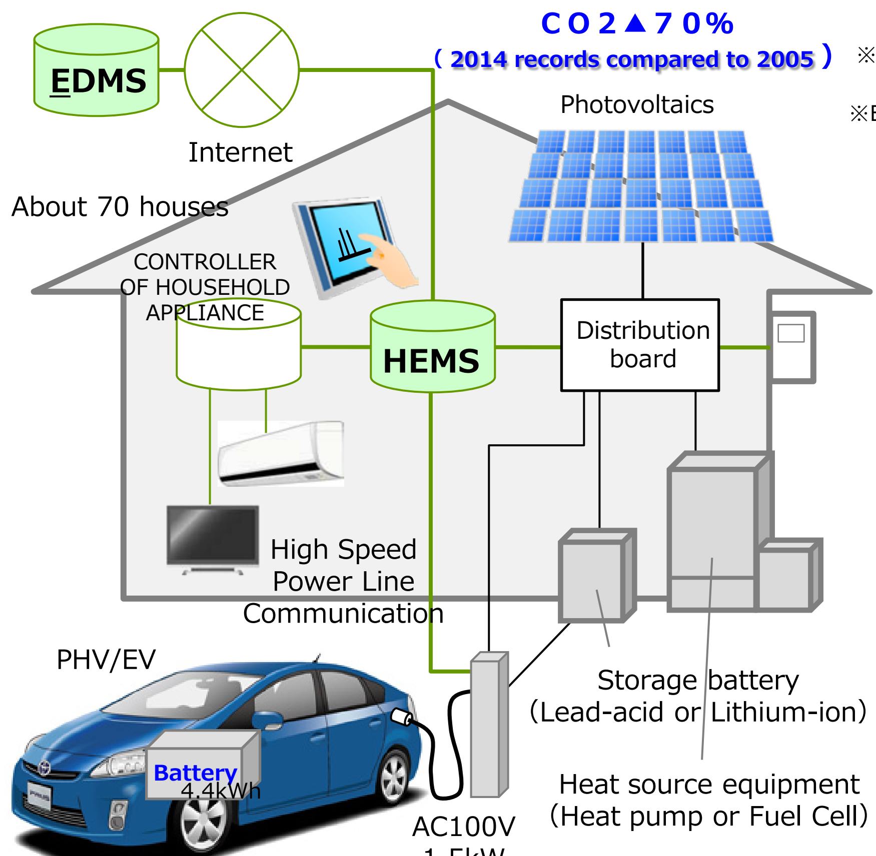
○ Approach of the household sector :

・The "V2H" verification experiment which regards a battery for PHV and an EV as one of charging equipment, and charges and discharges a battery.

○ Approach of the transportation sector :

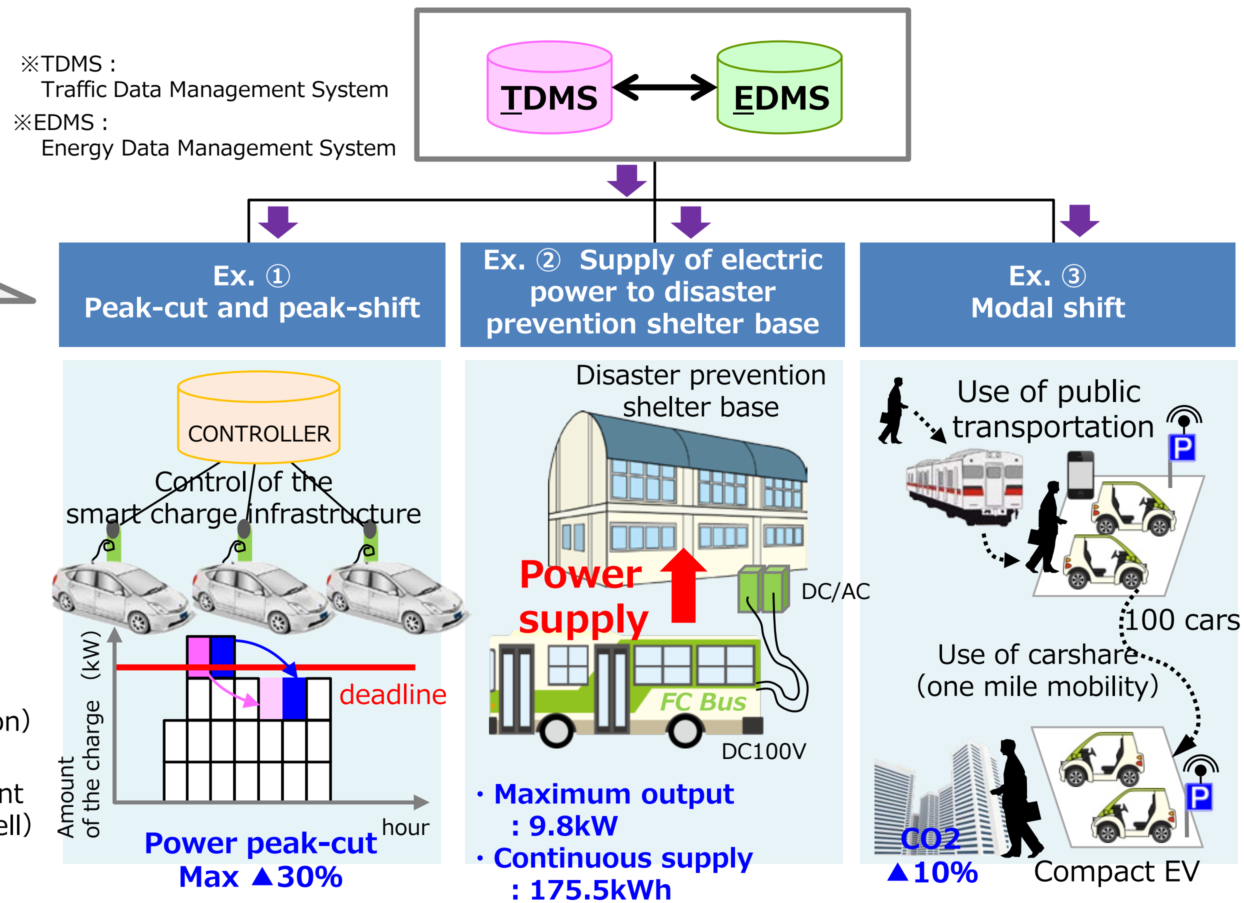
・Example① The verification experiment about the peak-cut and peak-shift of the electric power (Smart charge infrastructure).
・Example② The verification experiment about the supply of electric power to disaster protection shelter base (Fuel cell vehicle :FC Bus).
・Example③ The verification experiment about the Modal shift (One mile mobility: Ha-mo RIDE , etc.).

Image of the household sector



V2H（Vehicle to Home)

Image of the transportation sector



Keihanna： Case study of the CEMS and EV（MHI, MELCO, etc.）

○ Characteristic of the CEMS verification experiment :

- The verification experiment of **the adjustment type of supply and demand** which regards an entire community as a consumer including homes, buildings and EVs, and **controls the supply and demand for 24 hours** depending on a purpose.
- The realization of the energy saving and the carbon dioxide emissions reduction are controlled, and the supply of electric power is linked with a market price.

○ Characteristic of the EVC verification experiment :

- The verification experiment to **reduce a burden of the system electricity** by receiving DR request from CEMS, and controlling a charge timing of EV.

Image of the adjustment of supply and demand

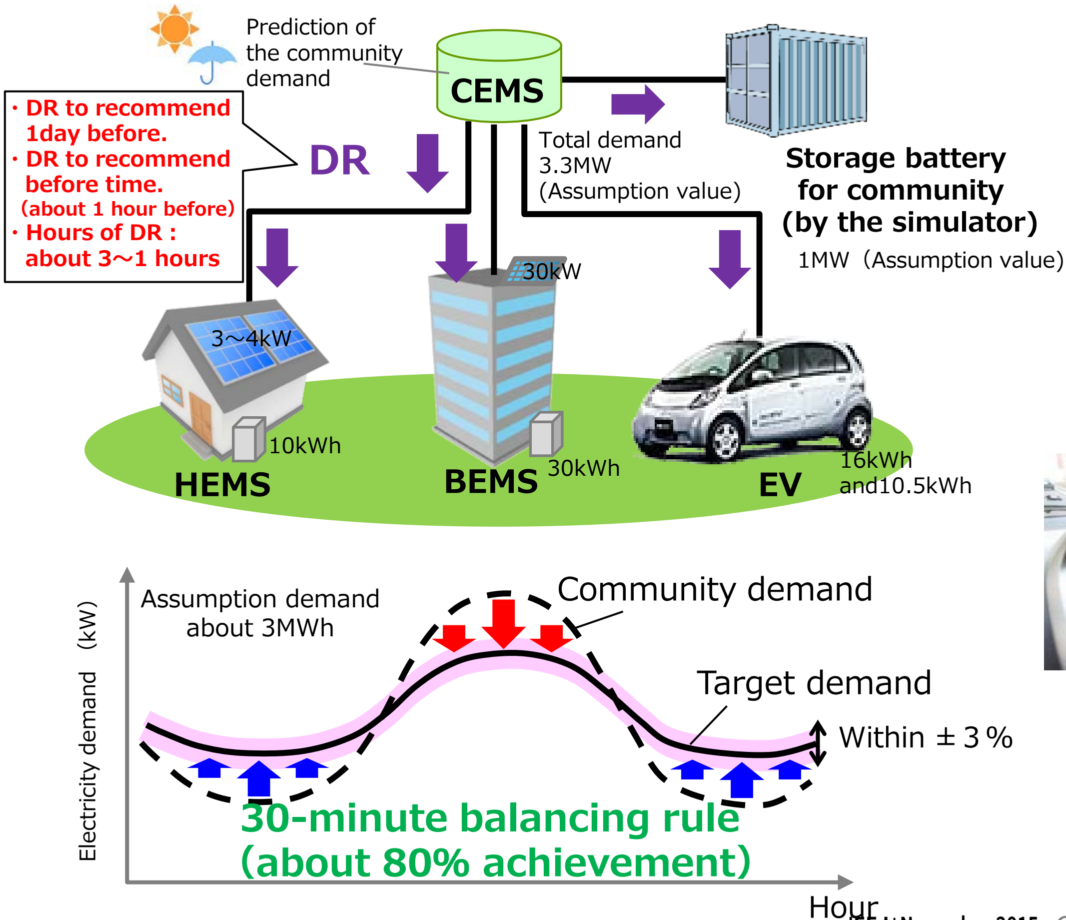
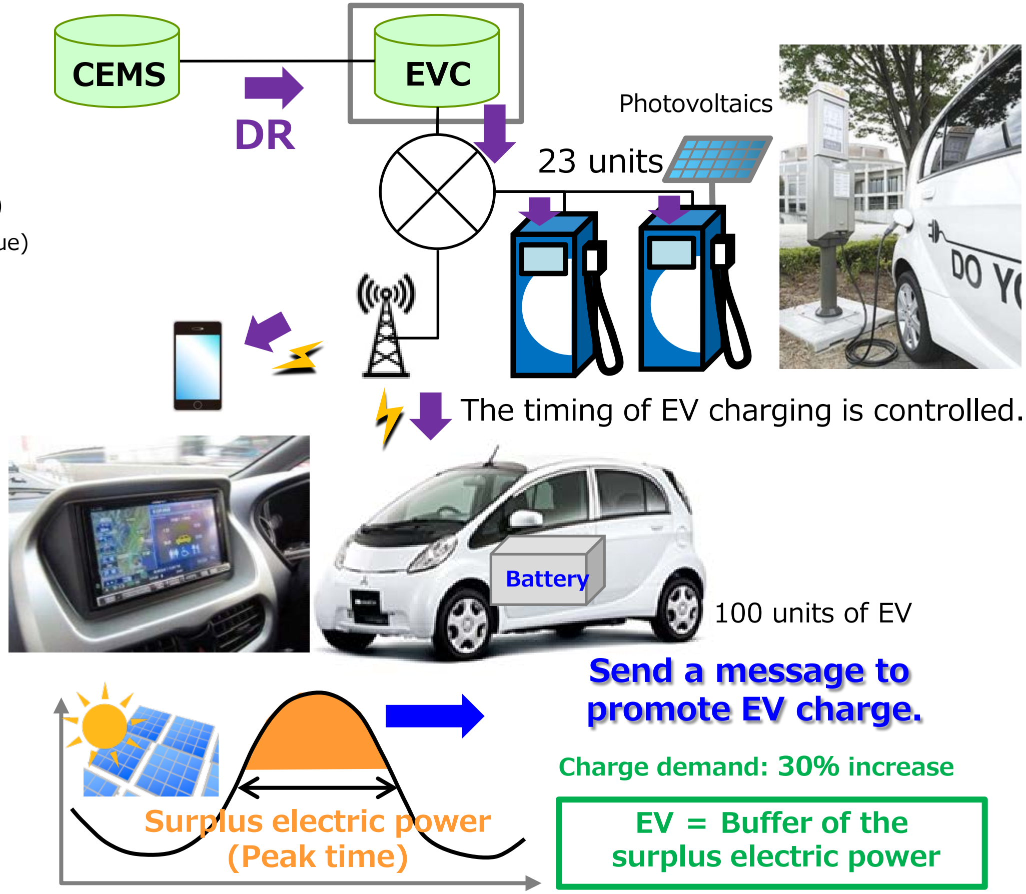


Image of the EVC verification experiment



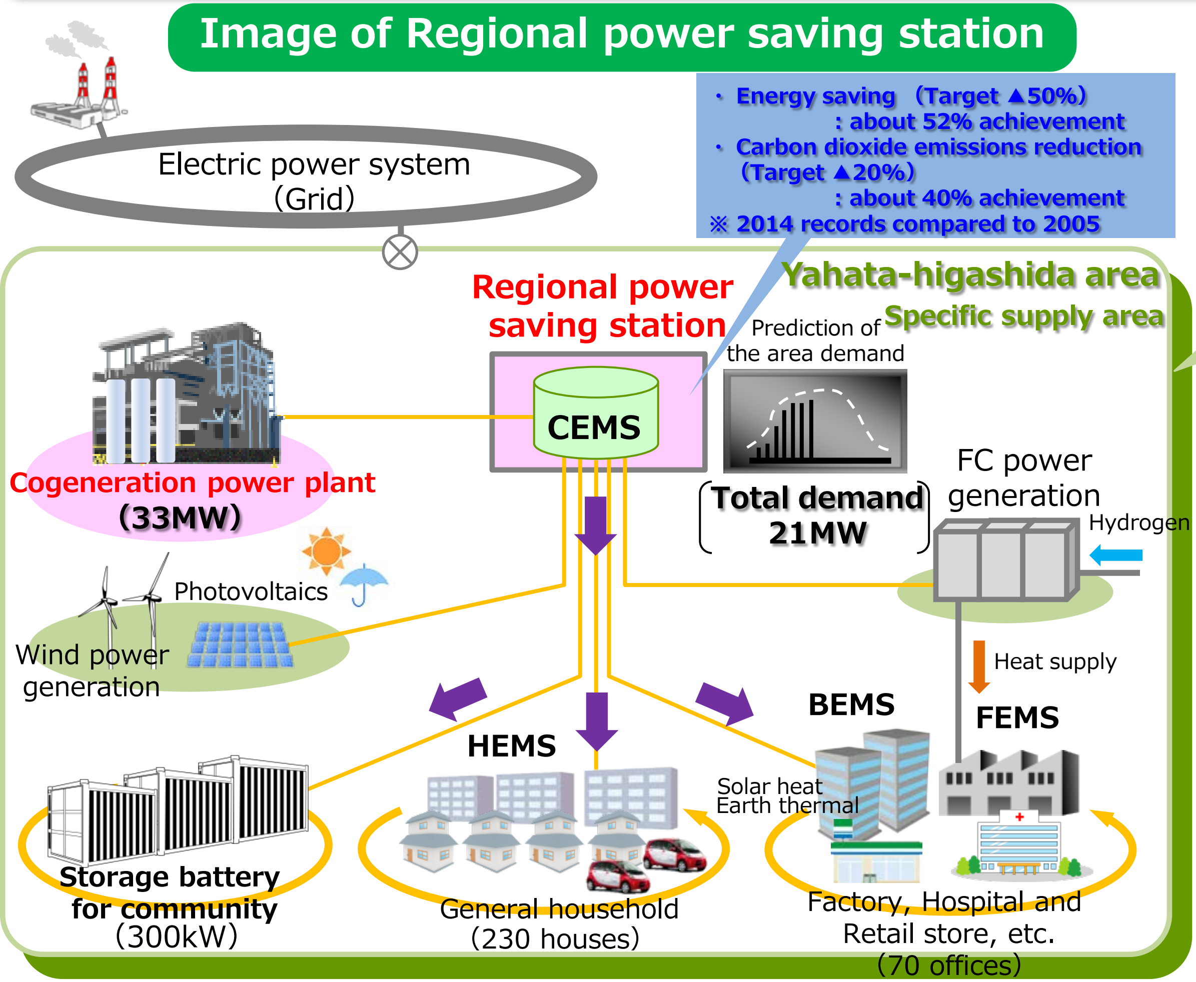
Kitakyushu : Case study of the CEMS （Fuji Electricetc Co., LTD.）

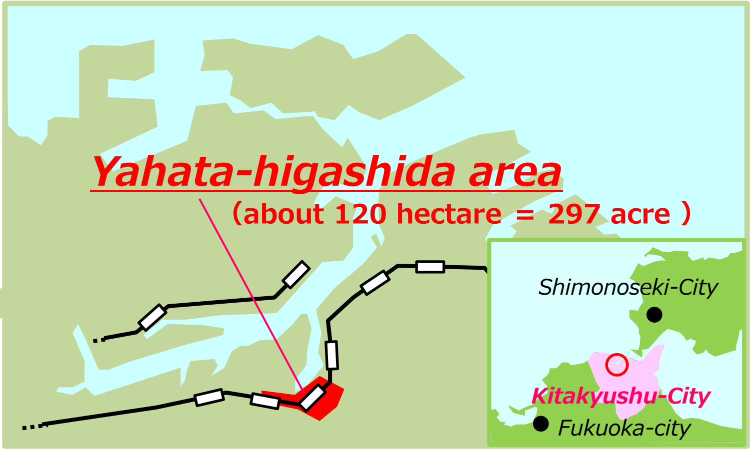
○ "Cogeneration power plant" and "Regional power saving station" are established in a specific supply area, and a verification experiment with an actual charge base is developed.

○ The role of Regional power saving station :

- To manage the overall energy services in the area, such as electricity, heat, and water.
- To provide the low electric charges by controlling the storage battery of the houses or community according to the supply demand situation in the area.

Image of Regional power saving station





○ Regional power saving station

※Source of photo: "Smart City Portal of New Energy Promotion Council Japan."

The basic specification of the verification experiment of the DR using EMS

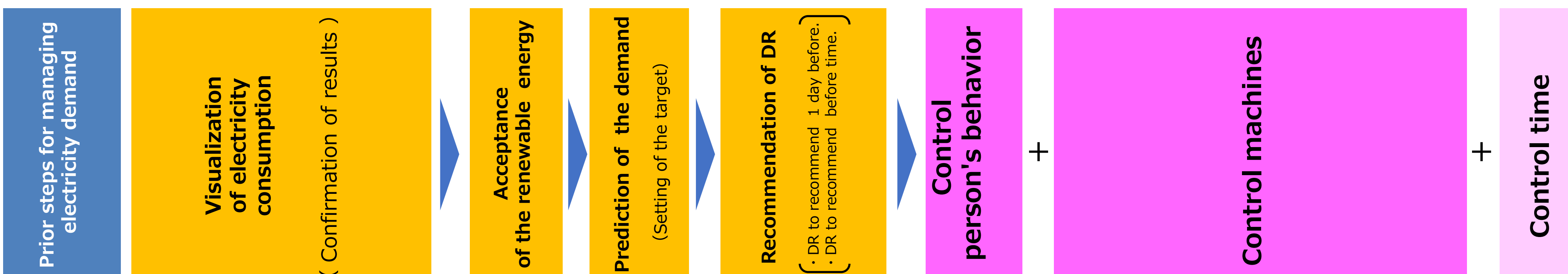
※DR : Demand Response

○ **The type of energy management ：**

After visualizing the electric amount of consumption, mainly, it's classified into 2 types, "the indirect control system which controls person's behavior" and "the direct mechanical control system by which a machine controls itself".

○ **The storage charge is a common indispensable item of each sector as a coordinating role of target achievement and demand fluctuation by PV.**

Sector	Basic specification							Type of energy management					
	Smart meter	Visualization of electricity consumption		Renewable Energy (PV, etc.)	Prediction of the demand (EMS)	Recommend of the DR		Indirect control	Direct control				Other
		For manager	For consumers			Home display	PC or Smart phone, etc..	Incentive pay	Storage battery	Heat source equipment	Load control	Charge infra-structure	Shortening of the DR time
CEMS	–	○	–	△	○	○	–	○	○	–	–	–	△
HEMS	△	–	○	○	○	○	△	○	○	△	△	–	–
BEMS FEMS	△	○	○	○	○	○	–	○	○	○	○	–	–
EVC	△	○	○	○	○	○	△	○	○	–	–	○	△
Remarks	・There are measurement methods with CT and the tap.							・The effect is limited.		・Introduce energy saving equipment and gas equipment. ・Expansion of the heat supply. etc..			



The consideration of issues based on 4 area verification projects

Sector	Issues	Expected domains in future
Community (or Area)	○ How to secure funds for the DR incentive payment. ○ Development of the capacity market and PPS market. ○ Expansion of the equipment and sector for the DR service.	○ Energy aggregator business. ○ Application of CEMS as a method to reinvigorate local economy. e.g. Service to promote purchasing will of consumers and change their actions.
Household	○ How to secure funds for the DR incentive payment. ○ Expansion of the household appliance and equipment for the DR service. ○ Durability of energy saving behavior and visualization effect .	○ Develop mechanism for surplus electric power generated from PV within a home. e.g. Dissemination of HEMS, PV, Storage battery as a set. ○ Harmonize between energy and services and closely link with daily life. e.g. Management of health and medical care, crime prevention, and the distribution network.
Business and Industrial	○ How to secure funds for the DR incentive payment. ○ Improvement of the precision of the demand prediction technology (Avoid imbalance). ○ Introduction of EMS based on cost-effectiveness (Development of the local implementation type and the cloud type depending on a building scale).	○ Business of the negative watt in the electric market. e.g. Spread of Cloud based BEMS. ○ Energy saving as the whole energy system. e.g. ・Adaptation of the electricity and heat supply as a set in wider area. ・Expansion of the visualization of the gas demand and the DR service.
Transpor-tation	○ How to secure funds for the DR incentive payment. ○ Expansion of the equipment for the DR service. ・The spread of next-generation cars. ・The spread of energy filling stations. ・The spread of traffic management systems (TMS).	○ Promotion business of EV charging using surplus electricity generated by PV. ○ Preparation for the dissemination of TMS. e.g. Establish a dissemination framework including the cooperation with the traffic authorities.

※PPS : Power Producer and Supplier

○ It is a common issue to secure **funds for the DR incentive pay**.
○ It's the biggest issue to seek a method **of incorporating such a mechanism in the society.**
This is a more significant issue than a technical issue.

Challenge for the spread of a smart community

Needs for a smart community

- Flexible energy usage within an area
- Measures for disaster prevention
  - Resilience
- Affordable electricity rate
  - Local production for local consumption of energy
  - Improvement of the local value
- Measures for environment
- City planning
  - Compact city
- Value-added service
  - Internet of Things (IOT)
- Regional economy revitalization
  - Improvement of administrative service
- etc.

Judgment

Cost

Benefit

- 3 E + S
- Ripple effect in the area
- Satisfaction
- Regional attractiveness
- Comfort
- Quality of life (QOL)
- etc.

It's necessary to judge overall based on the cost benefit and an additional value.

※3E+S : Energy Security , Economic Efficiency , Environment and Safety

Thank you for your attention.

URL : http://eneken.ieej.or.jp