Yokohama Smart City Project: Large-scale Demonstration and Future Implementation

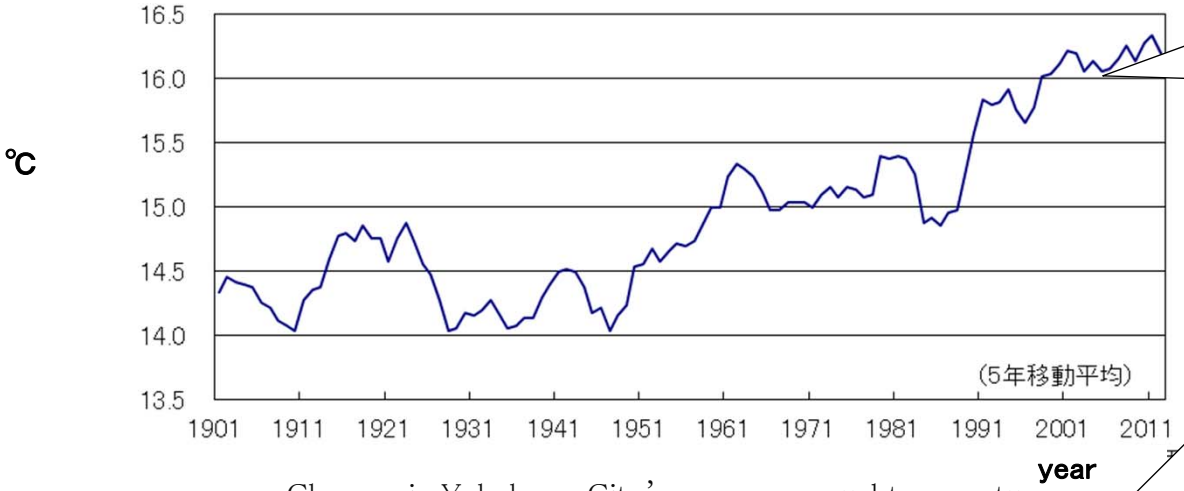
City of Yokohama

Climate Change Policy Headquarters

1 Challenges That Yokohama Faces

Challenges That Yokohama Faces

○Impacts of global warming



Changes in Yokohama City's average annual temperature

The temperature has risen approximately 2.7 degrees Celsius over 100 years.

Impacts of global warming such as localized heavy rain that is difficult to predict and other extreme weather events

Flood damage due to typhoons

Flood damage due to typhoons

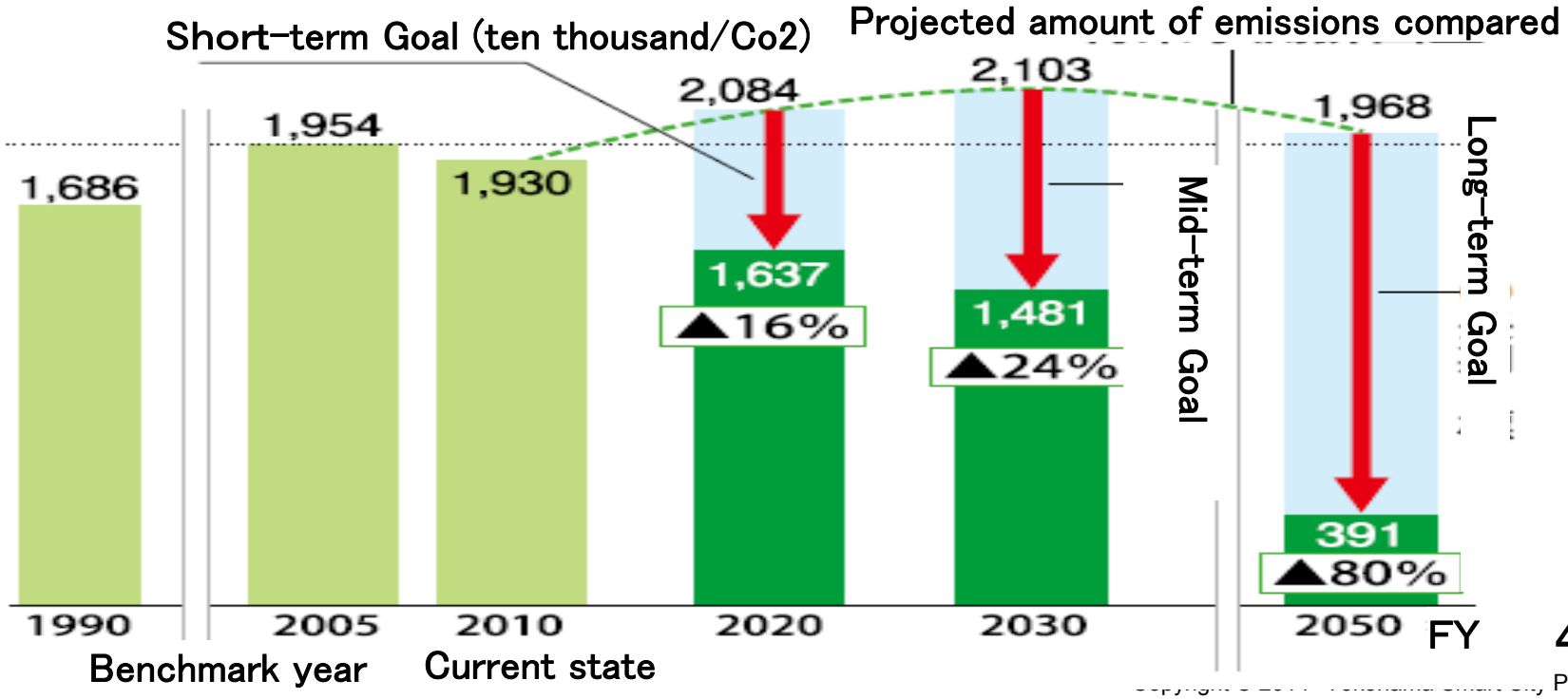
Ongoing targeted reduction for the amount of greenhouse gas emission

○Increase of GHG emission

Rapid population growth (3.5 times that of 60 years ago)

→Population in Yokohama expected to increase until 2020

Estimated GHG emission in Yokohama



2. About YSCP
(Yokohama smart city project)

History of YOKOHAMA Project Selection

We were selected by the japanese government as a "Next-Generation Energy and social system demonstration area."

What is "Next-Generation Energy and Social System Verification"...?

It is a project designed to enable the building of smart grids and their promotion overseas, as part of the country's new growth strategy,
"Strategy to Achieve Global Leadership in the Environment and Energy Through Green Innovation."
Through this verification project, we aim to promote the international standardization of related industries, advance them to the next generation, and improve competitiveness in the area of energy and the environment.

Renewable energy should use existing power networks.

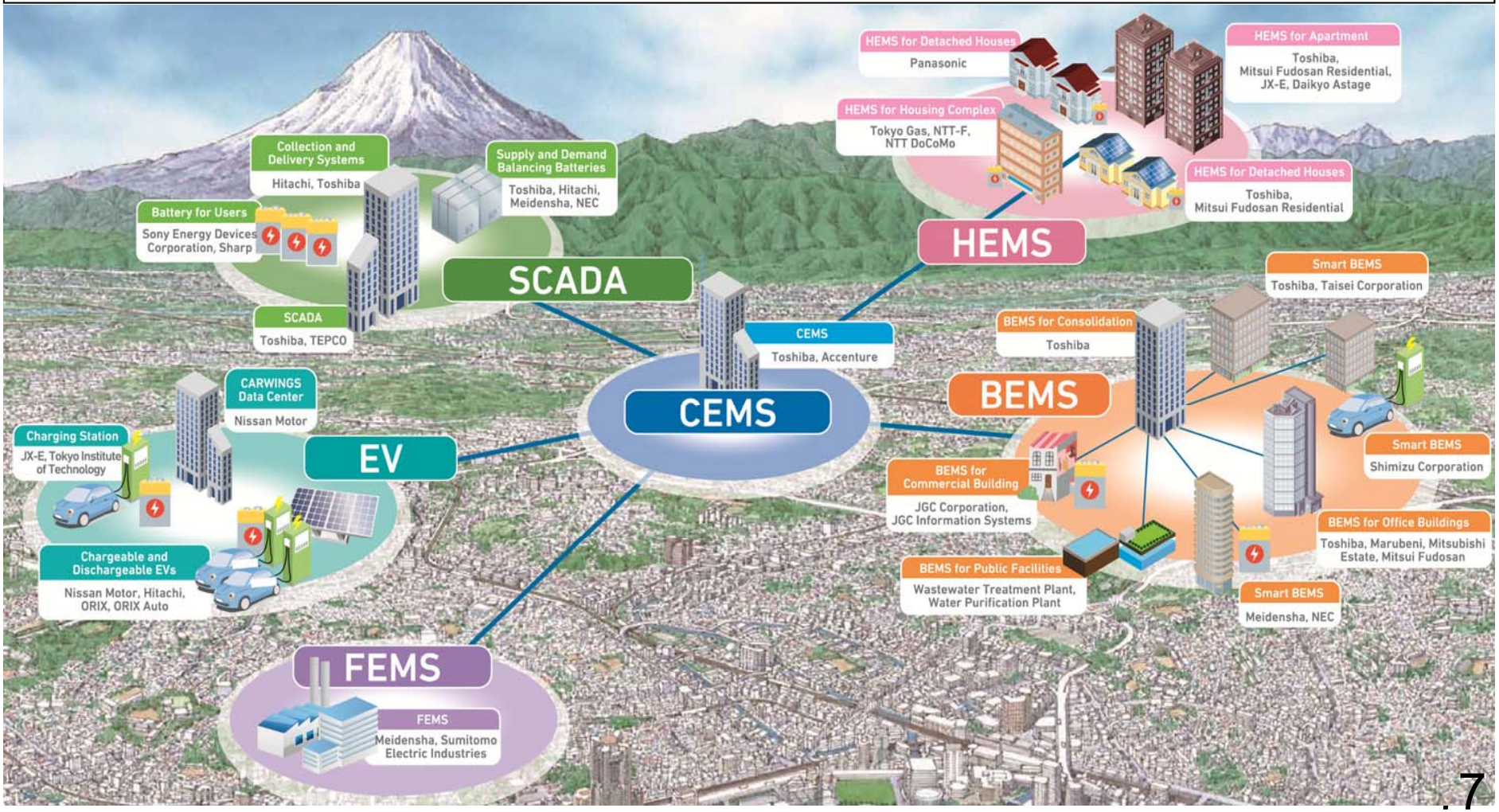
Advertising period: January 29th–February 28th, 2010
April: Of the 20 regions from around the country that submitted applications, four were selected.
August: The master plan was announced
(plan period: FY 2010–FY 2014).
March 11th, 2011: Great East Japan Earthquake Important points made:

Peak shifting and peak saving should also be part of the objective.

organizational diagram Overview and results of the verification project (coordination between Yokohama City, 34 businesses, and 15 projects)

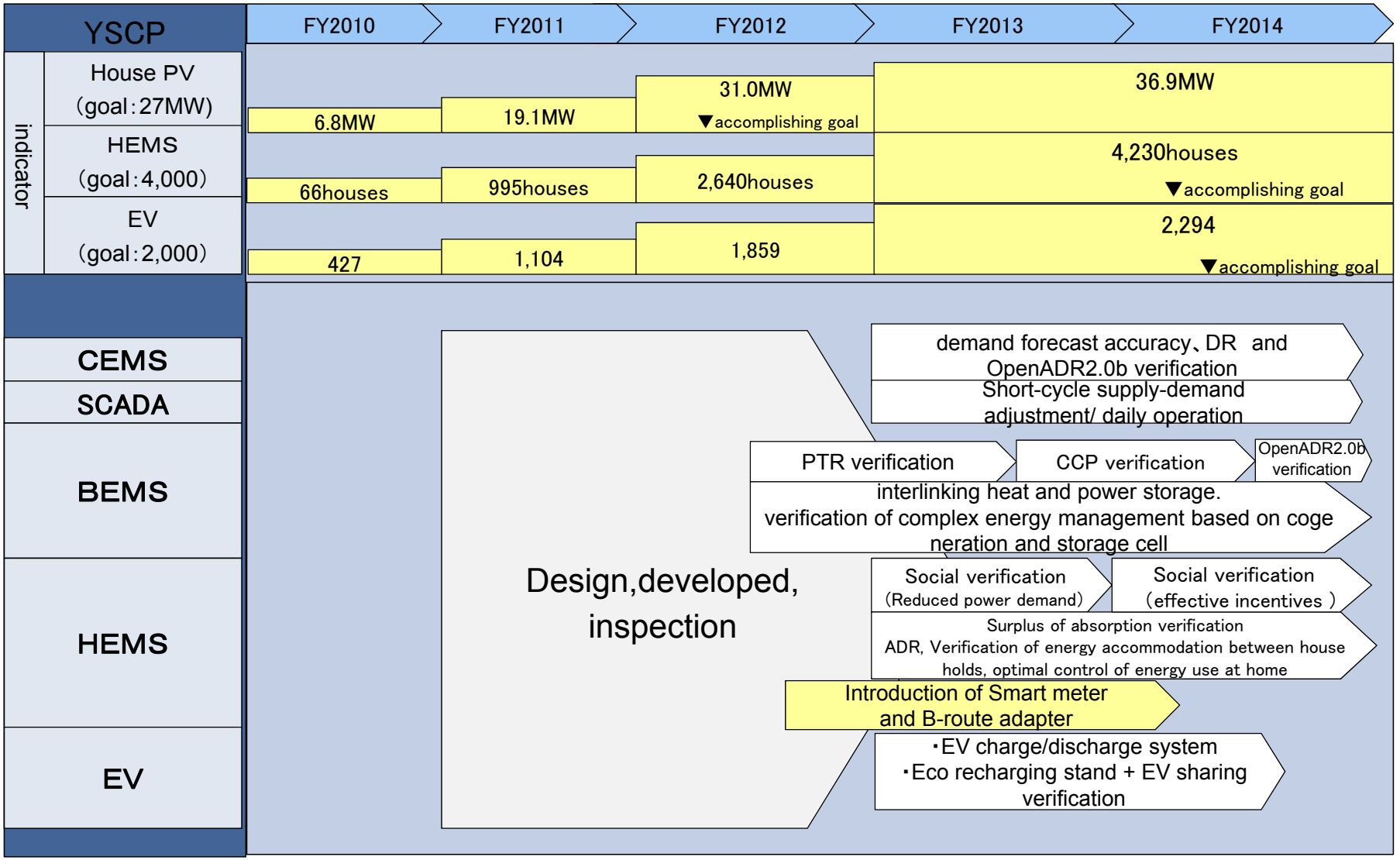
YOKOHAMA SMART CITY PROJECT

■ results (To FY2013)／goal(FY2010～FY2014)
HEMS(Home energy management system)(4,200/4,000) PV(37MW/27MW) EV(2,300/2,000)



current states for target and a schedule

Technically established a regional system centered by CEMS by the middle of FY2012 and also established operational models such as DR. Verification of various DRs was conducted to examine the effect in FY2013 and FY2014.



3. About YSCP Verification

Verification Experiment Using HEMS (Verification for FY 2013)

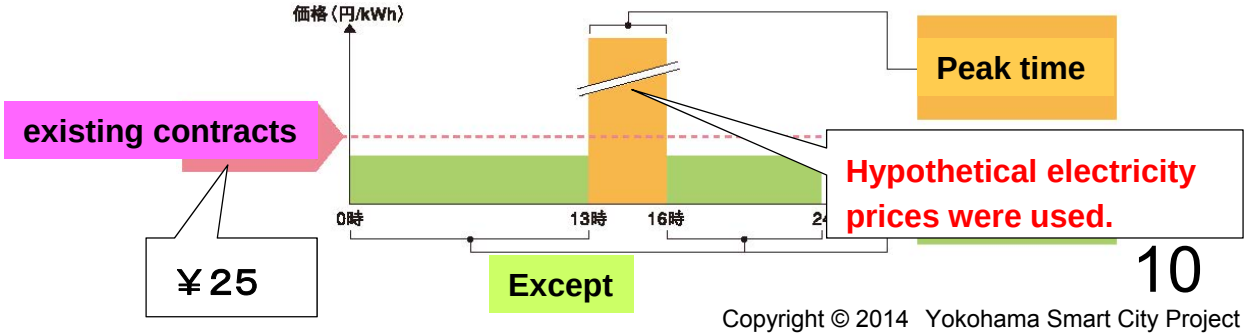
The HEMS records showed that as of the end of FY 2012, approximately 2,500 households had cumulatively installed HEMSs.
From FY 2013, of the above households, the approximately 1,900 households linked to a CEMS were divided into groups and participated in an energy conservation experiment.

<Composition of verification experiment groups>

Actual proof participant		Type	Menu
Total 1,900 Households	General group 1,700 Households	HEMS＋PV 1,200 Households	Visualization 400 Households
			CPP① 400 Households
			CPP② 400 Households
		HEMS 500 Households	Visualization 500 Households
	Specific group 200 Households	HEMS＋PV etc 200 Households	Visualization etc 200 Households

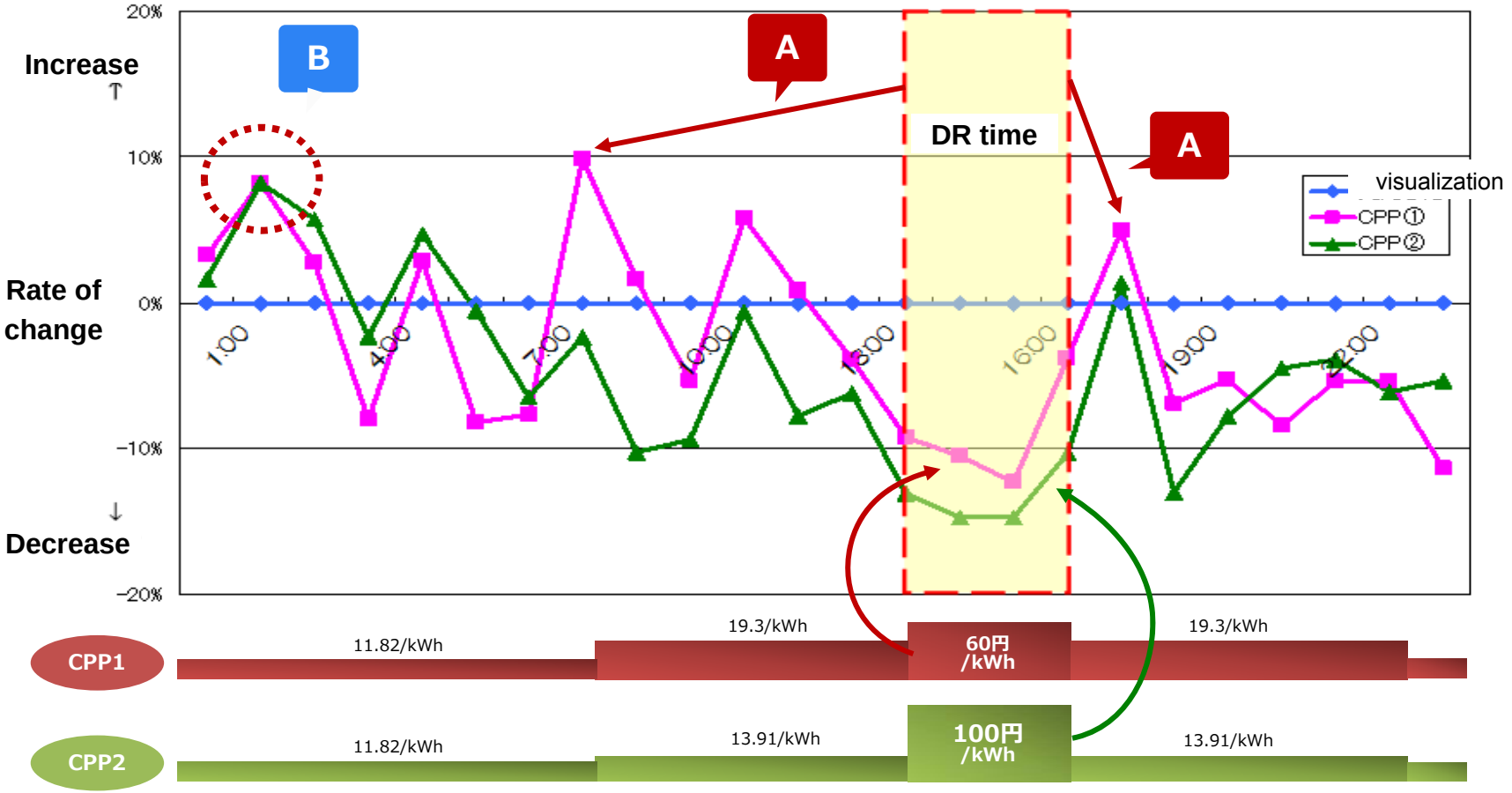
CPP（Critical Peak Pricing）

<The suggested way to participate in the energy conservation experiment: Engage in energy-saving acts while enjoying the time with your family.>



Results of Verification in Summer 2013

- A maximum peak shaving of 15.2% was confirmed with a demand response.
- Behavioral patterns that can be expected from the table below
  A: Reduced power demand during hours of demand response
  B: Usage of home appliances, water heater, etc. during late-night hours when the rates are lower



Verification Experiment Using HEMS (Verification for FY 2014)

The HEMS records show that by the end of FY 2013, approximately 4,200 households had cumulatively installed HEMS.
For the 2014 fiscal year, about 3,500 households will participate in one of the largest energy conservation experiments in the country.

<Composition of verification experiment groups>

Actual proof participant		Type	Menu
Total About3,500 Households	General group About 3,300Households	HEMS+PV About1,900 Households	①CPP ②TOU
		HEMS About1,400 Households	①CPP ②TOU ③PTR
	Specific group About 200Households	HEMS+PV etc About200 Households	①CPP ②TOU

<Rate plans to be used in the verification>

①CPP: In the event that the supply-demand balance is expected to be tight, an advance notice is given that a higher-than-usual rate will apply.

②TOU: A different rate applies depending on the time, but the same rate applies during the experiment period.

③PTR: In the event that the supply-demand balance is expected to be tight, an advance notice is given that a reward will be paid for reducing energy usage.

<For the verification in summer 2014, new verification items were added: >

- A demand response that is less burdensome for the consumer
- A mechanism that would attract prospective consumers
- Confirm intent to subscribe for the TOU and CPP rate plans and verify a way to predict the extent of the demand response effect

Results of Verification in Summer 2014

An examination of the effectiveness in energy reduction and effective incentives such as demonstrating the pros and cons of transitioning to a new rate.

Ways to encourage subscription	subscription	providing information	offering benefits	subscription rate
①	○	—	—	16.3%
②	○	○	—	30.7%
③	○	○	○	47.6%

three times

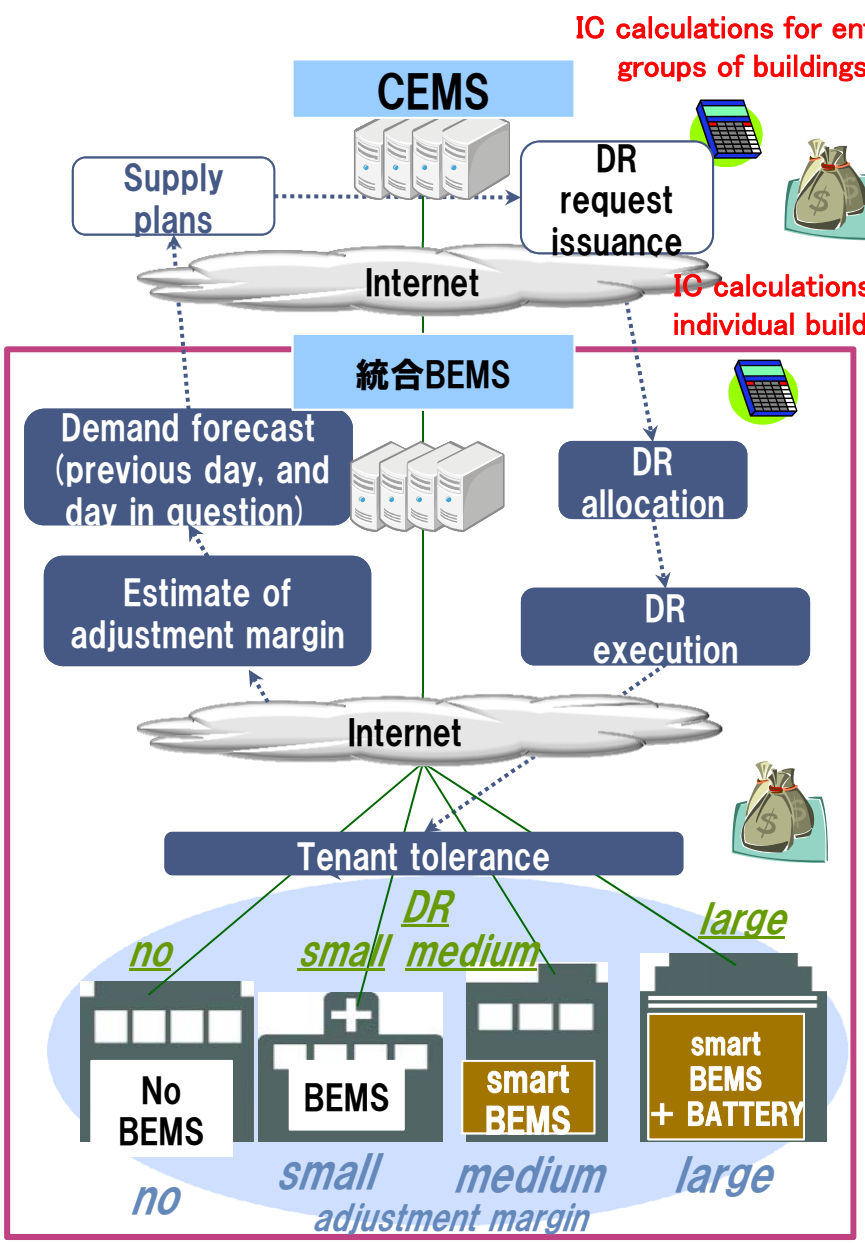
twice

Solicitation: Soliciting by introducing new electricity rate plans.
Providing information: Provide estimates based on records from the previous year or similar households; explain the pros and cons of subscribing to a new rate plan.
Offering benefits: Offer benefits to subscribing to a new rate plan.

● Participant Opinions

- About 90% of the participants said that their awareness of energy conservation rose and energy use dropped through the use of a HEMS.
- By installing a HEMS, immediate changes in behavior occurred, such as turning off the lights frequently and shortening the amount of time using a hairdryer.
- About 80% of the participants requested information on the best electricity rate plan based on the data collected from HEMSs.
- After the liberalization of the electricity retail market, the criteria for selecting a power company will largely be based on electricity rate plans.

The Workings of a BEMS - Integrated BEMS



Integrated BEMS

Buildings with diverse characteristics, ranging from large scale buildings (contract demand of 500kW or more) to medium to small scale buildings (50 to 500kW), are managed as a group. Optimal allocation of energy conservation amounts and maximization of demand response capacities are conducted.

Major facilities participating in the demonstration

Integrated BEMS Demand Response Verification (Winter and Summer 2013)

Objective: To achieve optimal use of energy at the local level, in the office and commercial building sector, through efforts such as maximizing peak shavings through demand response using integrated BEMSs

Content:

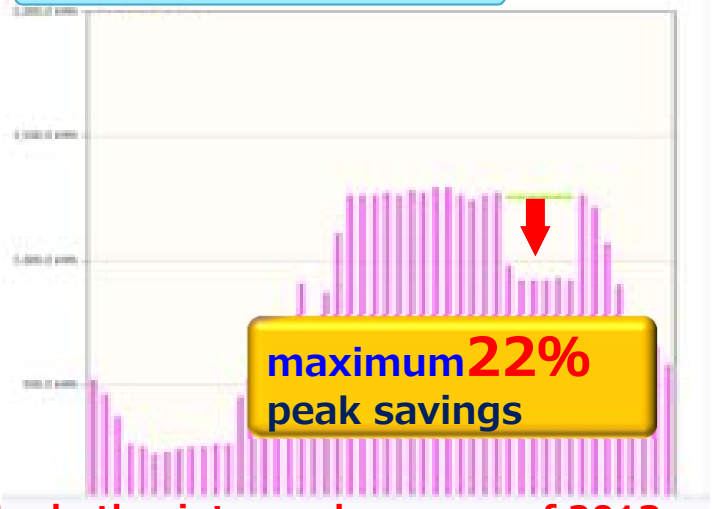
(1) The CEMS orders DR to an integrated BEMS.

(2) The integrated BEMS assigns a DR amount to each building according to the requested DR amount and taking into account the energy conservation and adjustment capacity of each building.

(3) Each building cooperates and carries out the energy conservation, reduction, etc. in accordance with the assigned amount.

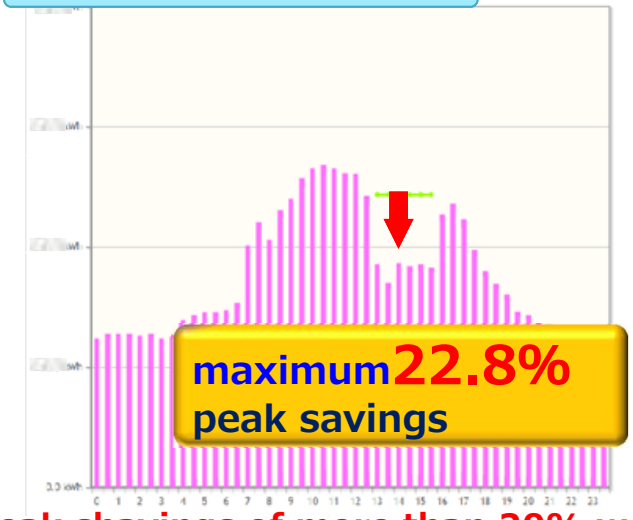
Winter season (January 2013-)
peak hours: 5pm-8pm

Number of office buildings and commercial buildings: 6



Summer season (July 2013-)
peak hours: 1pm-4pm

Number of office buildings and commercial buildings: 14



For both winter and summer of 2013, maximum peak shavings of more than 20% were achieved. An incentive of ¥15/kWh or more was confirmed to produce an effective demand response.

Integrated BEMS Demand Response Verification (Summer 2014)

1) Demand response (DR) implementation format: A DR was implemented on seven occasions between July 1st, 2014 and September 30th, 2014.
2) Scale of implementation: The total contract demand of sites participating in the verification was approximately 70,000kW.
※This is equivalent to about 23,000 average households (at 3kW per household).
3) Verification items:
-Improve the certainty in reduction amount (verified by a bid-based negawatt power trading system)
-Shorten the response time after a DR is implemented (verification of "Fast DR")
4) Participating companies: 29 in total, after 15 city-owned facilities etc. were added to the 14 sites

Item #1: Improving the certainty in reduction amount (via negawatt power trading) (preliminary report)
- On average, a reduction of more than 90% of the reduction target was accomplished across all sites.
- It was confirmed that the guideline price in order to achieve reduction targets is about ¥30/kWh.

[Project results] promotion of an energy-saving & low-carbon system through application of advanced EMS and energy creation, storage, and renewable energy technology, plus power peak shaving through demand response based on interlinkage with EMS at each site

YOKOHAMA SMART CITY PROJECT

Storage Battery SCADA

Integrated control of storage batteries
- Interface enabling consolidation
- System for virtual consolidation of plural batteries
- Promotion of interface standardization
- Short-cycle supply-demand adjustment/ daily operation

Shinjuku Demonstration Utility DRAS

CEMS

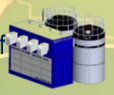
Major metropolitan area type: total control of plural divisions
- Attainment of 5% demand forecast accuracy
- Accommodation of OpenADR2 (instantaneous end-to-end confirmation from DRAS to each site)

HEMS

Energy-saving manual and automatic control/optimal control of storage batteries/ Power and heat interchange among housing units
- Peak-shaving effect: 15.2% maximum
- Effects of measures for inducing a switch to floating power tariffs
  Double with information provision
  Triple with information provision & privileges
- ADR power-saving effect: 16.6% at maximum
- Harmonized control of solar batteries and storage batteries
- Establishment of a fuel battery sharing model for collective housing

FEMS

Extensive use of large-scale storage batteries and renewable energy
- Integrated optimal control of CGS and RF storage batteries
- Accommodation of OpenADR2.0b



Proving test results

Achievement of energy-circulating cities by making the most of proving test results

BEMS

Large-scale building cluster management/extensive use of heat storage
- PTR-type DR: attainment of 22% peak shaving at maximum
- CCP-type DR: average target attainment rate of over 90% at all sites
- Optimal operation of heat and power source systems
- Stationary, large-scale lithium-power storage system
- Hybrid power storage system

YSCP implementation

Yokohama Smart Business Council

-Partner companies-
Energy suppliers, construction companies, manufacturers of electrical machinery etc.

- **Promotion of energy reduction and creation**
- **Higher resilience to disasters**
- **Economic stimulation**
- **Further heightening of citizen recognition**

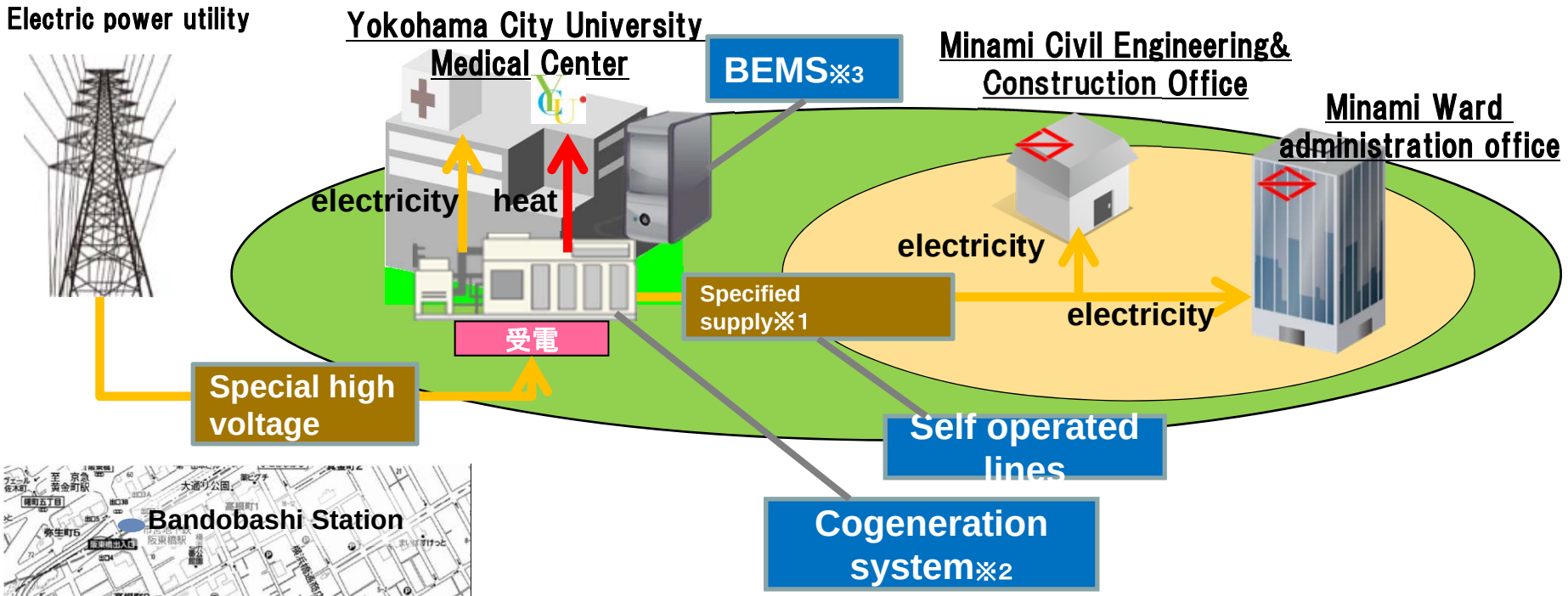
EV-EMS

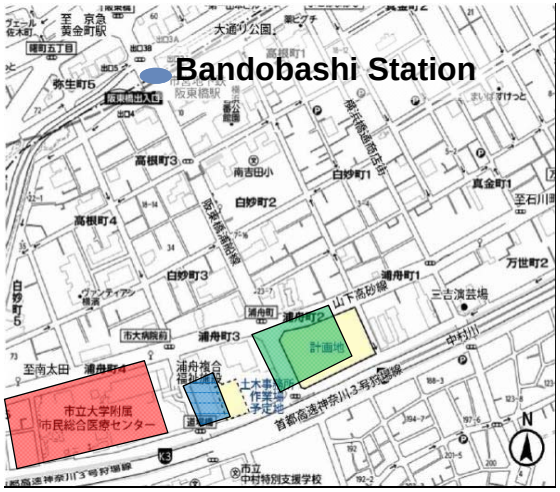
Shaving of peak demand associated with EV recharging through storage battery control
- EV charge/discharge system
  PV consumption on-premise rate improvement of 25%, CO2 emission reduction of 25%
- Eco recharging stand + EV sharing
  PV on-premise consumption rate: about 30%, CO2 emission reduction of 15%

4. From Verification of YSCP to Implementation

Achievement of community energy management based on specified supply

- Disaster preparedness will be improved through energy cooperation between hospitals and the ward hall.
- By implementing the cogeneration of energy, not only will operations become more efficient but waste heat will be effectively used, thereby reducing CO2 emissions as well as cost.
- Old heat source equipment will be renewed, and optimal energy control will be conducted by a BEMS.





※1 Generated electricity will be supplied to specified partners with close ties.
※2 While electricity will be generated via gas engines etc., the accompanying waste heat will be used to meet the demands for heat such as air conditioning.
※3 Effective utilization of waste heat and optimal control of local energy will be conducted via a BEMS.

Achievement of an Energy – recycling City

「City of YOKOHAMA Energy Action Plan」（March 2015）

○ Try to achieve a secure, safe, and eco-friendly city by realizing low carbon society, contributing to regional stable supply of electricity, and reducing impacts caused by disasters based on introduction of autonomous distribution type power source as well as efficient use of heat by using renewable energy.

○ As a Future City, try to set such a life style in place that allows for promotion of energy policy enforcement, introduction of new technologies and environment while sharing a plan with 3,700,000 citizens and 110,000 business operators

Approaches for transition from proving tests to actual implementation based on public-private partnership

- Institution of the Yokohama Smart Business Council, a new organization resting on public-private partnership (slated for April 2015), in order to bring energy-circulating cities* into reality by making full use of the results of proving tests in the Yokohama Smart City Project (YSCP).
  * Cities that have an increased supply of energy from their vicinity and make waste-free, efficient use of it.
- Promotion of new approaches to operation of energy management systems and energy coordination, and deployment of the technologies and systems developed to date both inside and outside Japan