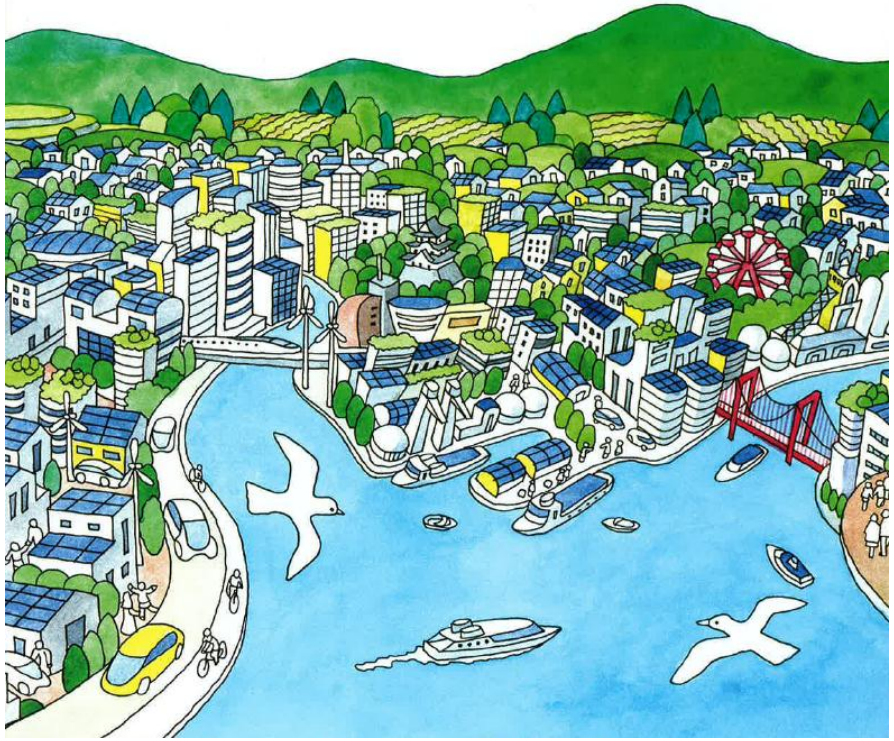
Smart Community Demonstration in Kitakyushu



Source: Brochure of Kitakyushu

Yosuke NAKANISHI

Corporate R&D Headquarters
Fuji Electric Co. Ltd

1. Introduction of Kitakyushu

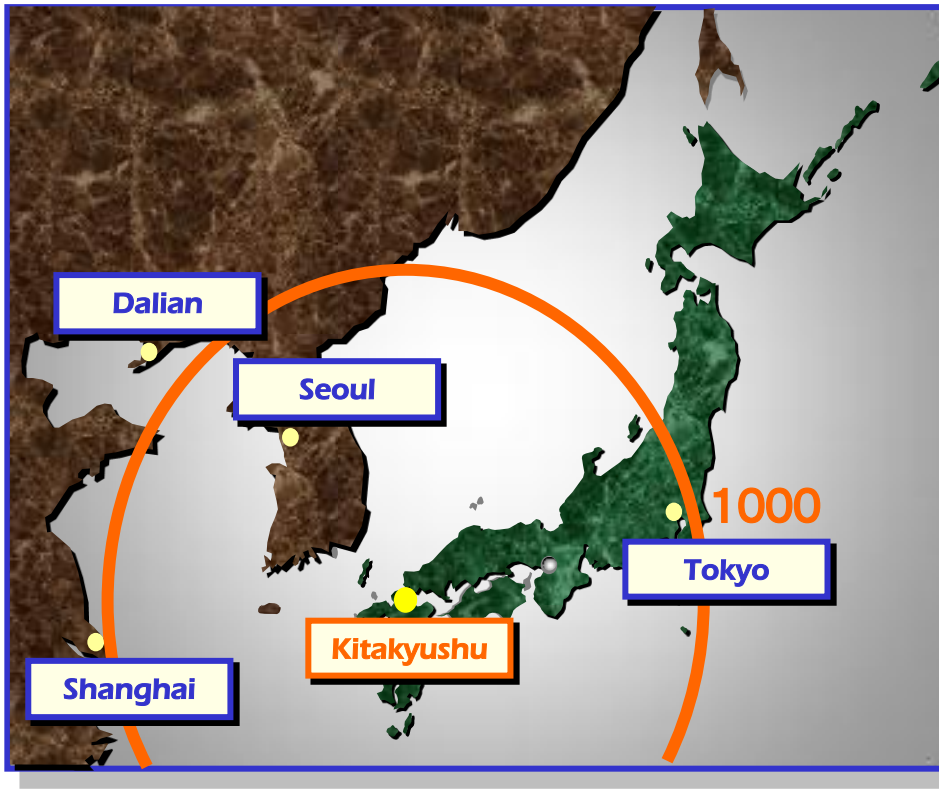
Introduction of Kitakyushu

Foundation for industrialization of Japan

-Yawata Steel Mill (currently Nippon Steel & Sumitomo metal Corp.) began operation in 1901-

Refer to "Showa History of 100 million people Vol.14" published by Mainichi Newspapers Company.

Population: 975 thou. Area: 485k㎡



By courtesy of Kitakyushu

Overcoming Severe Environmental Pollution

In 1960s

Worst Air Pollution

"The Dokai Bay" Sea of Death

Present

Blue Sky & Sea
by the effort of
environmental
Restoration Activities

By courtesy of Kitakyushu

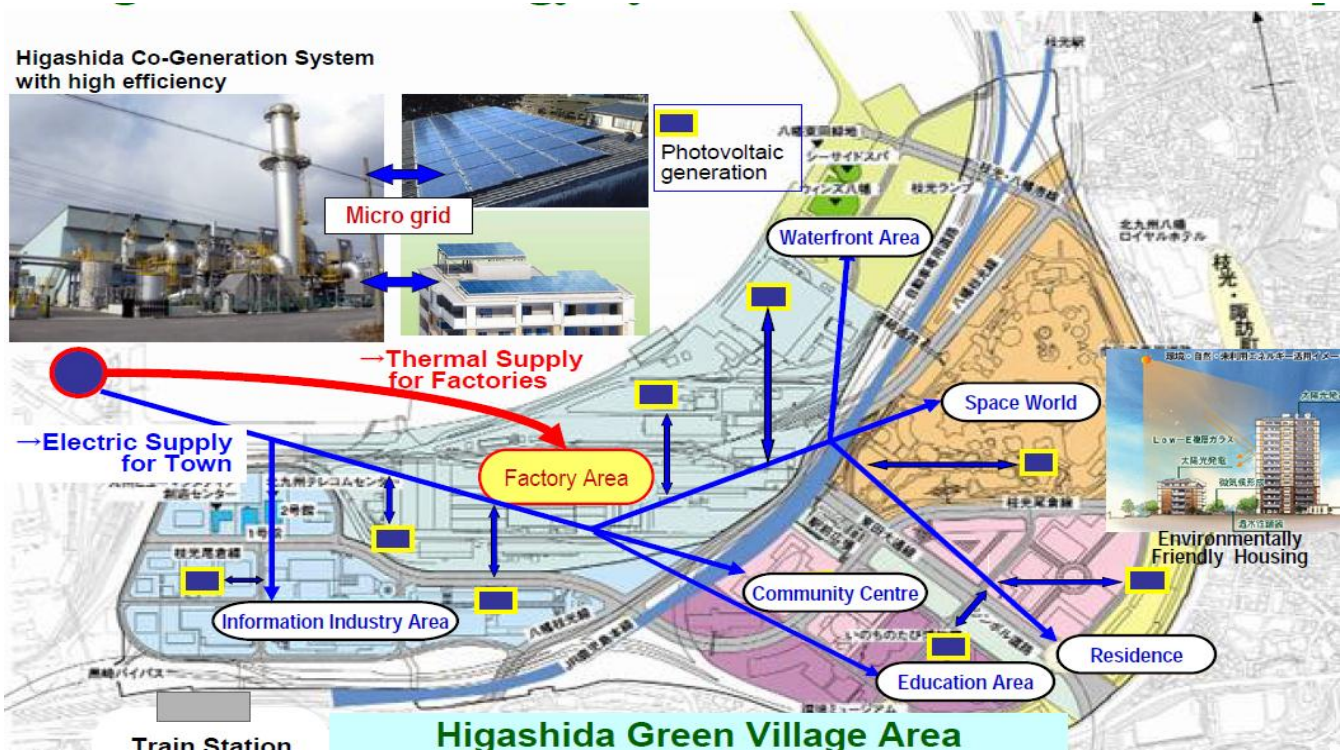
Sustainable Development

District information for energy resource

- 10 general electricity utilities have obligations and rights for the universal electricity service as the society's infrastructure in Japan.
- The experimental area in Kitakyushu is a special supply area where is permitted to supply the dedicated demand instead of those above elecricity utilities.
- Therefore one of the characteristics of this region is that it is possible to change the unit electricity price by changing the actual power contract in cooperation with Kitakyushu Higashida Maeda District Power Supply Union of the relevant region.

Local Production for local consumption

Mutual profit between steel mill area & village area for usage of thermal and electricity energy



2. The Kitakyushu Smart Community Creation Project

The Kitakyushu Smart Community Creation Project

1. Implementation body

Kitakyushu Smart Community Council
(67 companies/organizations)

2. Area of implementation

Higashida district, Yahata-Higashi ward
(Approximately 1.2 km^2)

3. Period of implementation

FY2010 – FY2014 (5 years)

4. Project scale

38 projects
16.3 billion yen
(planning budget)

The Kitakyushu Smart Community Creation Project

- Kitakyushu Smart Community Council (Kitakyushu City + 67 Companies /organizations)
- Management members: Kitakyushu city government (Social system), Fuji Electric (Energy), Nippon Steel & Sumitomo Metal Corporation(Energy), Japan IBM (Information infrastructure)

Community involvement type smart community → **Community for master of energy** → **CO_2 50% reduction**

Introduction of various renewable energy

- Town Mega Solar Generation

- Kitakyushu hydrogen town
- Power generation of industrial waste heat

Introduction of saving energy system over entire community

- Introduction of BEMS* and HEMS* corresponding demand response

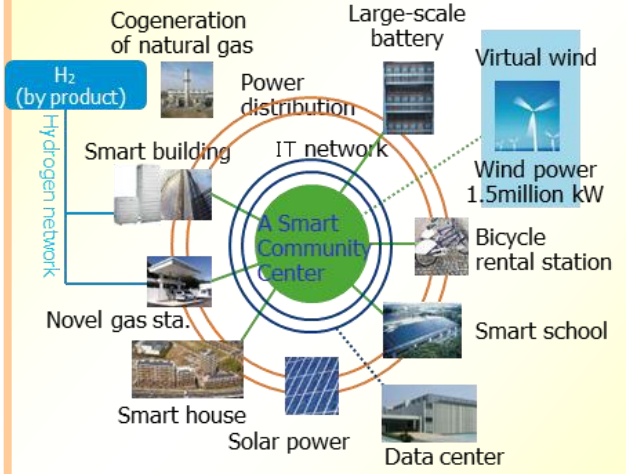
Smart office　Smart IDC　Smart factory

Next generation new transportation system

- Introduction of EV on a large scale
- Application of small vehicles providing fuel cell
- Cooperation of public transportation and community bus

CEMS for community (Citizens, business community participatory)

- Regional Brownout System



- Smart Meter
- Eco-Point system for carbon offset

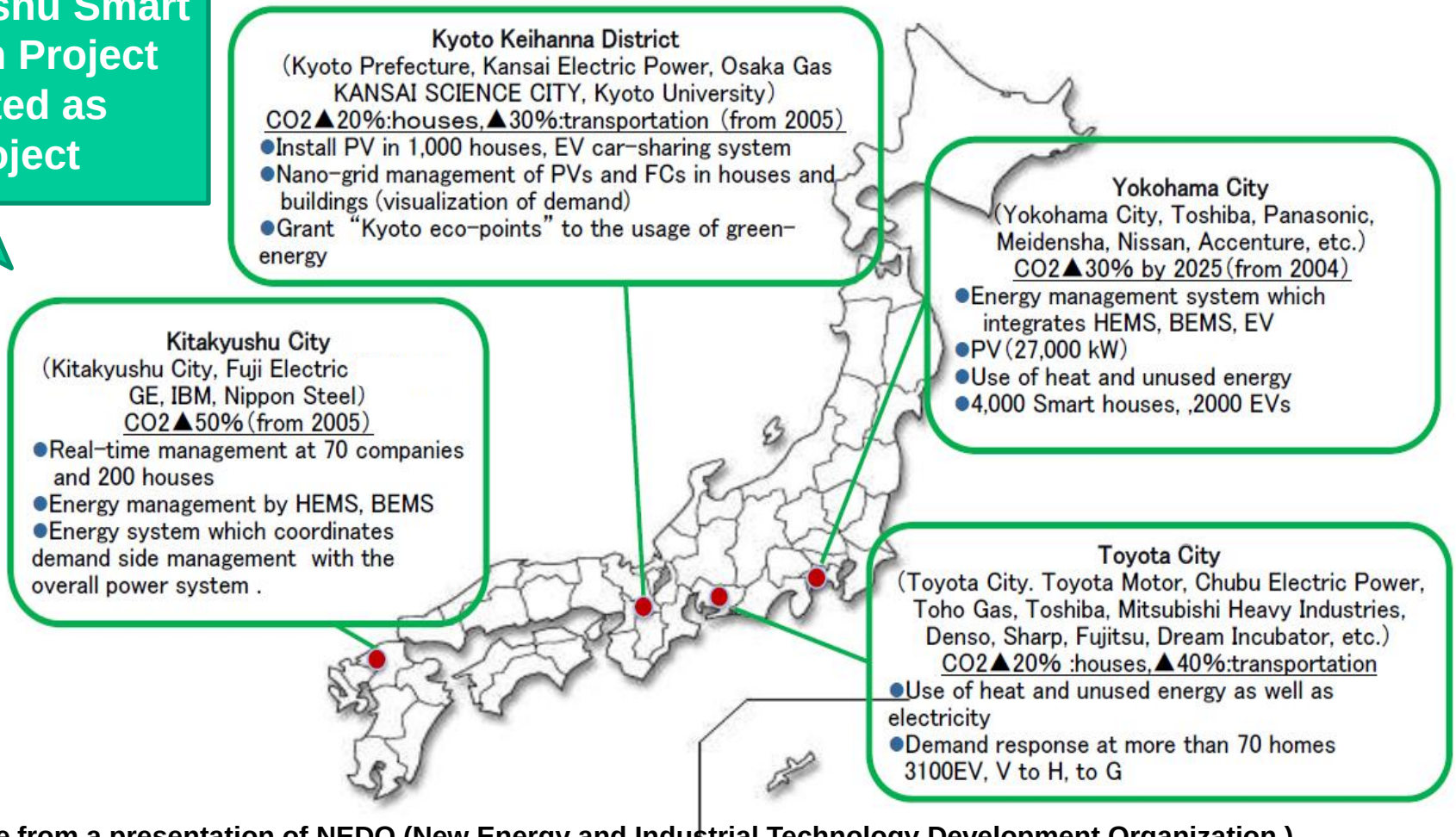
Project handled by Fuji Electric

*BEMS: Building Energy Management System　*HEMS: Home Energy Management System

Smart community pilot projects (FY2010 – FY2014 [5 years]) in Japan

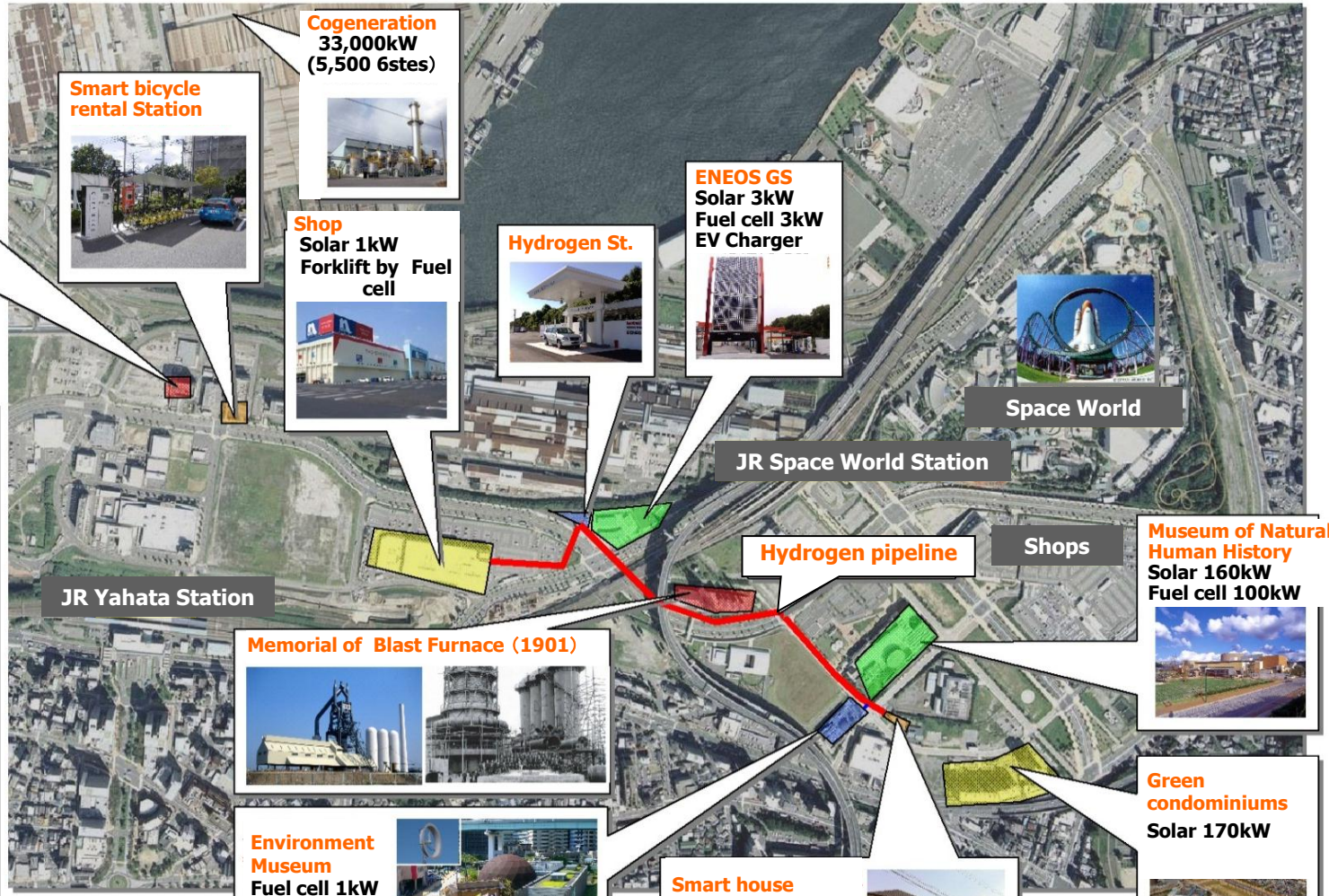
In Japan, the Ministry of Economy, Trade and Industry is promoting the four verification pilots to study the way of technologies and business in the smart community.

Kitakyushu Smart Creation Project is selected as Pilot Project

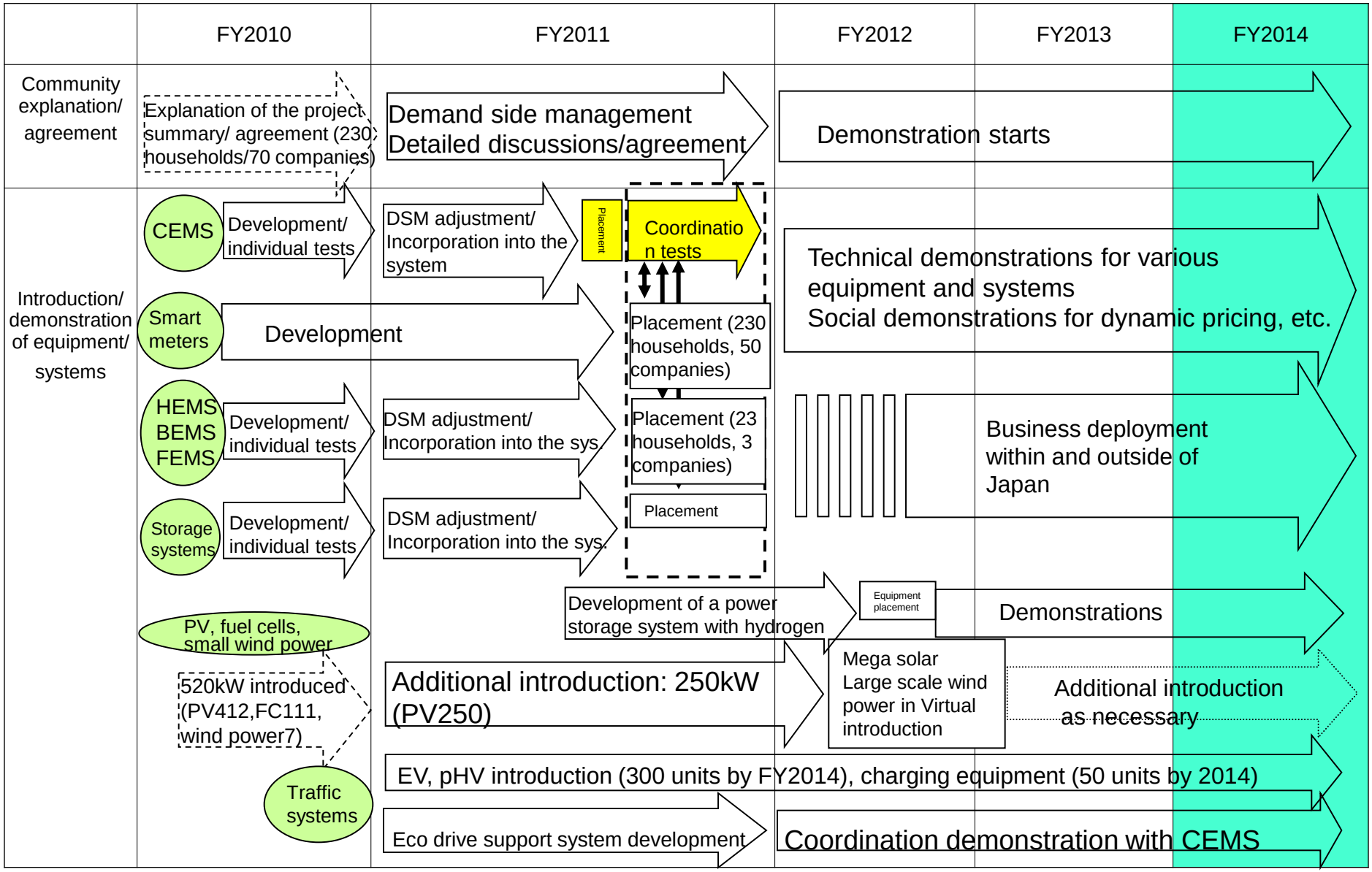


Reference from a presentation of NEDO (New Energy and Industrial Technology Development Organization)

Aerial photo image of the demonstration area (HIGASHIDA)



Schedule Smart Community Project(energy issues)



※DSM: Demand side management, DP: Dynamic pricing, IP: Incentive program

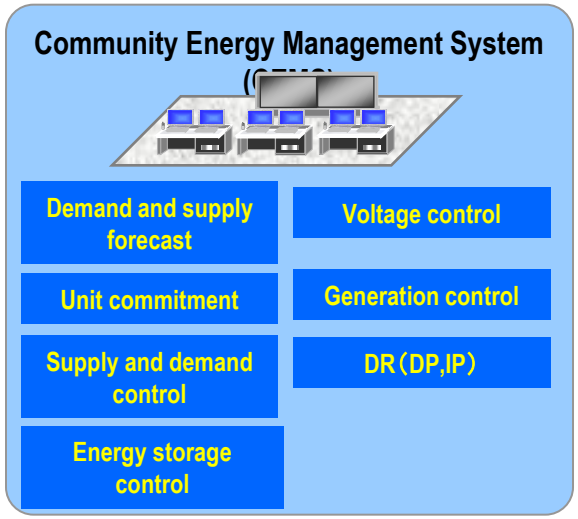
3. CEMS in Higashida Smart Community Project (Energy issues in community involvement)

How to accomplish subjects for Demonstration

Objective
Realization of low-carbon society
▼
Effective utilization of renewable energy

Challenge
Satisfy both system Stabilization & equipment cost containment

Demonstration
- supply and demand optimum operation
- maintain voltage and frequency control
- demand response (DP, IP)
- Optimal Operation of heat, electricity and hydrogen



CEMS makes the optimum plan for supply and demand of electric power, heat and gas (hydrogen) .
In case of supply-demand imbalance, supply-demand plan or demand response is changed via each x-EMS in interactive way.

⇒Cooperative X-EMS

X-EMS (Energy Management Sytsem)

- *Home Energy Management(HEMS)* for residential demand
- *Business Energy Management(BEMS)* for business demand
- *Factory Energy Management(FEMS)* for factory demand
- *Retail Energy Management(REMS)* for Retail (Shop /Store) demand

Cooperative Energy Management for community involvement

33MW; Cogeneration
-Thermal energy⇒Steelworks
- Electricity ⇒Stealworks, community

Special power supply zone

Community Energy Management System

Storage battery

Smart PCS

300kW × 2H

Control of recharging and discharging

Solar

Electric power gen. (Fuel Cell)

100kW

By-product hydrogen

Heat

Electric power generation control

Changing plan for supply and demand according to dynamic pricing (DP)

G

Plan for electric power generation

Load:approx.20MW

Price Info.(DP)

Concentrators

Buildings/Factory

BEMS

FEMS

Load control

Control of recharging and discharging

Loads

Air conditioning

Lighting

Product Line

Recharging and thermal storage

PCS

PV Generation

PCS

Home customers

HEMS

Load control

Control of recharging and discharging

Loads

Air conditioning

Lighting

Recharging and thermal storage

PCS

PV Roof Top

PCS

Home customers

Smart meter

Request for DP

Loads

Air conditioning

Lighting

PV Roof Top

PCS

Community Energy Management System (CEMS)

Role of CEMS

New energy systems (solar power and wind power) are not stable. Variations in electric power generated by the new energy systems cause the supply and demand imbalance. Because expectation to new energy is increasing significantly, a reverse power flow causes the voltage rise problem. CEMS plays a key role in solving these problems.

Advantageous functions

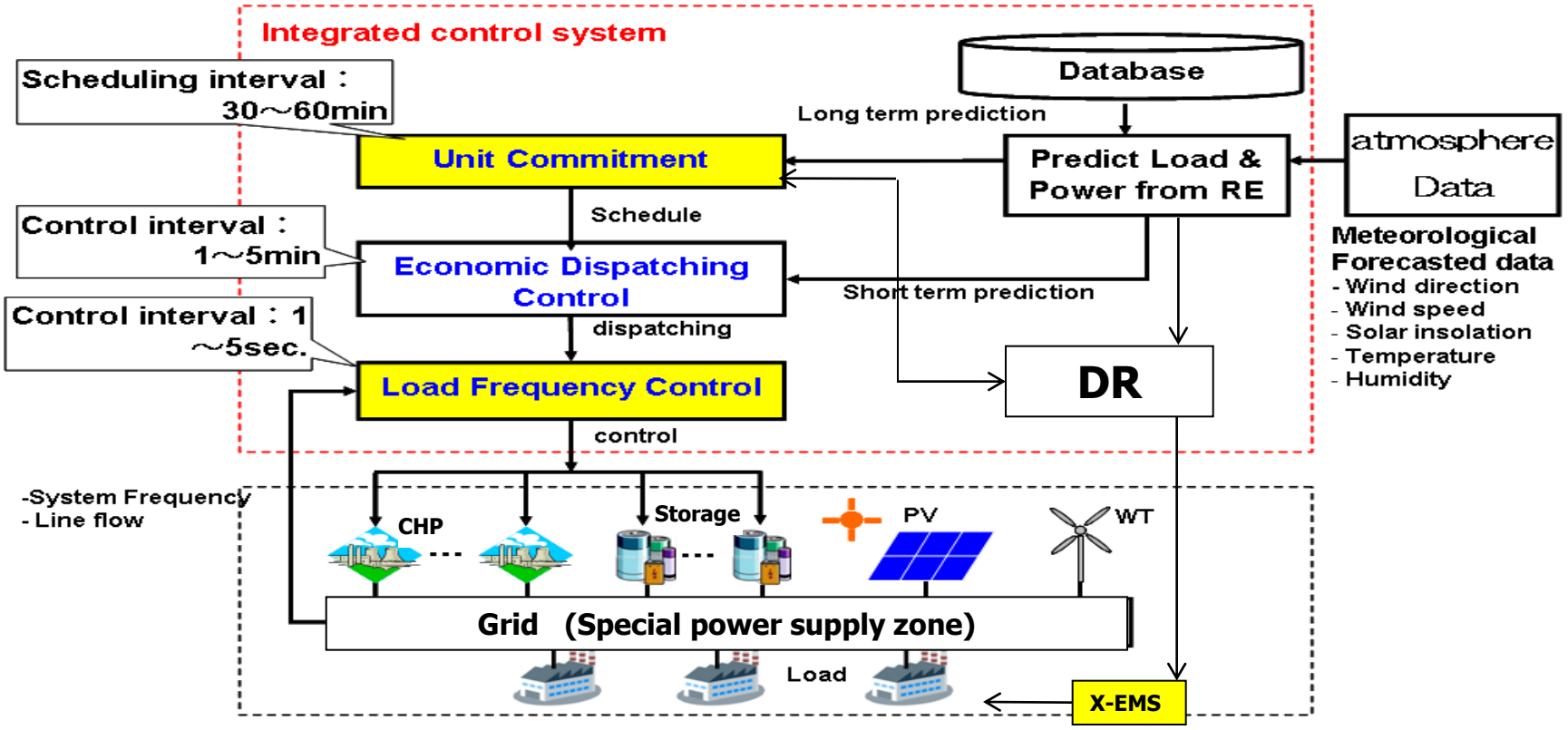
- Predicting electric power generated by the new energy systems (PV and wind turbine generator systems)
- Using rechargeable batteries to make an optimum plan for supply and demand; controlling supply and demand; and controlling frequency
- Stabilizing loads and providing demand response (DR) for balancing supply and demand (DR and DP of incentive type)
- Using smart meters so that home customers can see demand; and varying demand for electric power to amend the contract

Market expansion (including overseas market expansion)

- Intended to meet international electrotechnical commission (IEC) standards
- Packaging the system
- Supporting three languages (Japanese, English, Chinese)
- Enabling a single system to control two or more communities

* DR: demand response DP: dynamic pricing

Control Procedure in CEMS

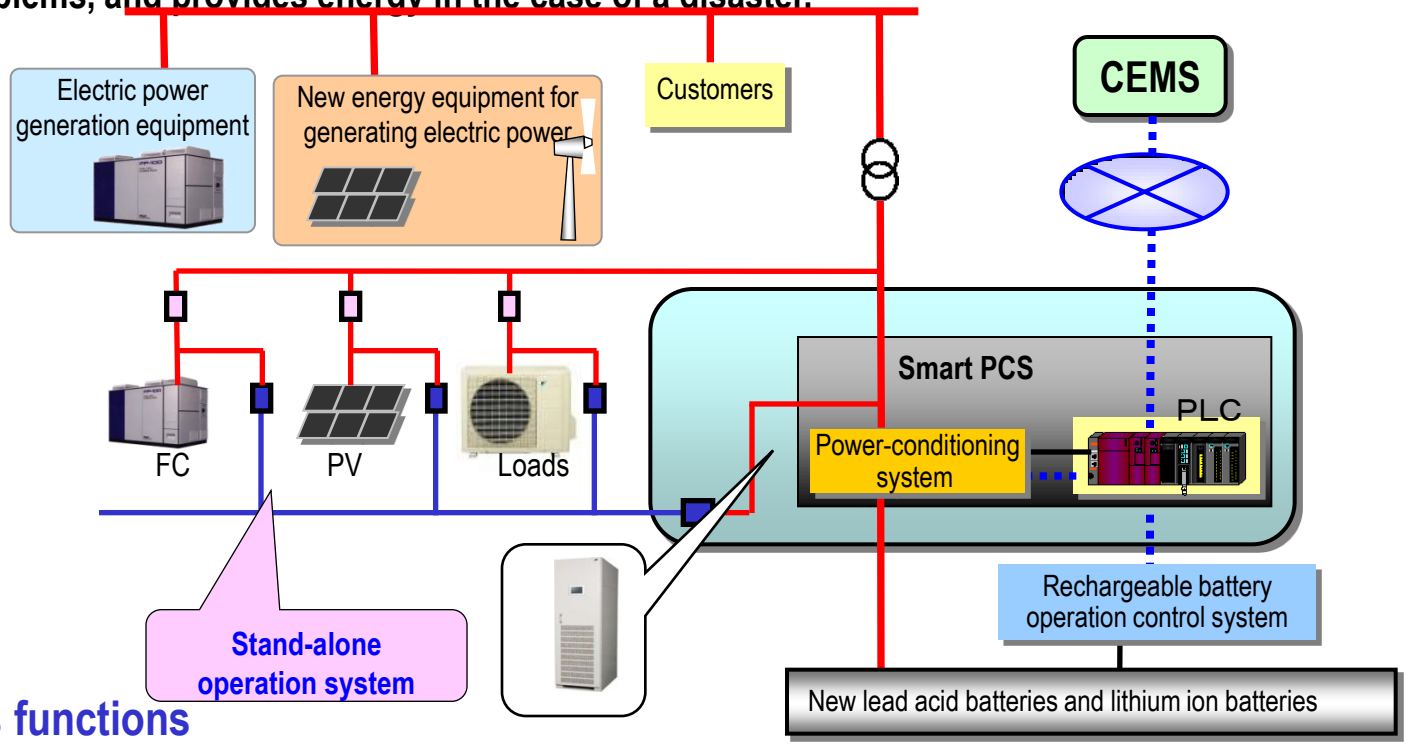


Function	Objects	Feature
Predict Load & power from RE	Load (Electricity, Heat, DP), PV, [WT]	Adjusting the prediction using error of recent data with the confidence intervals
Unit Commitment	Source (CHP, Fuel Cell)& storage for electric & heat, X-EMS	Planning start- stop in 30min. interval corresponding to fluctuation of demand & RE. with coordinated Demand response procedure (issued in twice of a day or every 30min.)
Economic Dispatching	[Generator]	Considering of Changing rate of generation
Load freq. Control	[Generator], Storage	Control of freq. or tie-line power with coordinated storage

Smart Power Conversion System for batteries

Role of smart PCS for batteries

When Inverters without inertia energy increase to be used for renewable energy, the main electric power transmission system lacks reserve capacity and has low quality (in frequency). The smart PCS plays a key role in solving these problems, and provides energy in the case of a disaster.



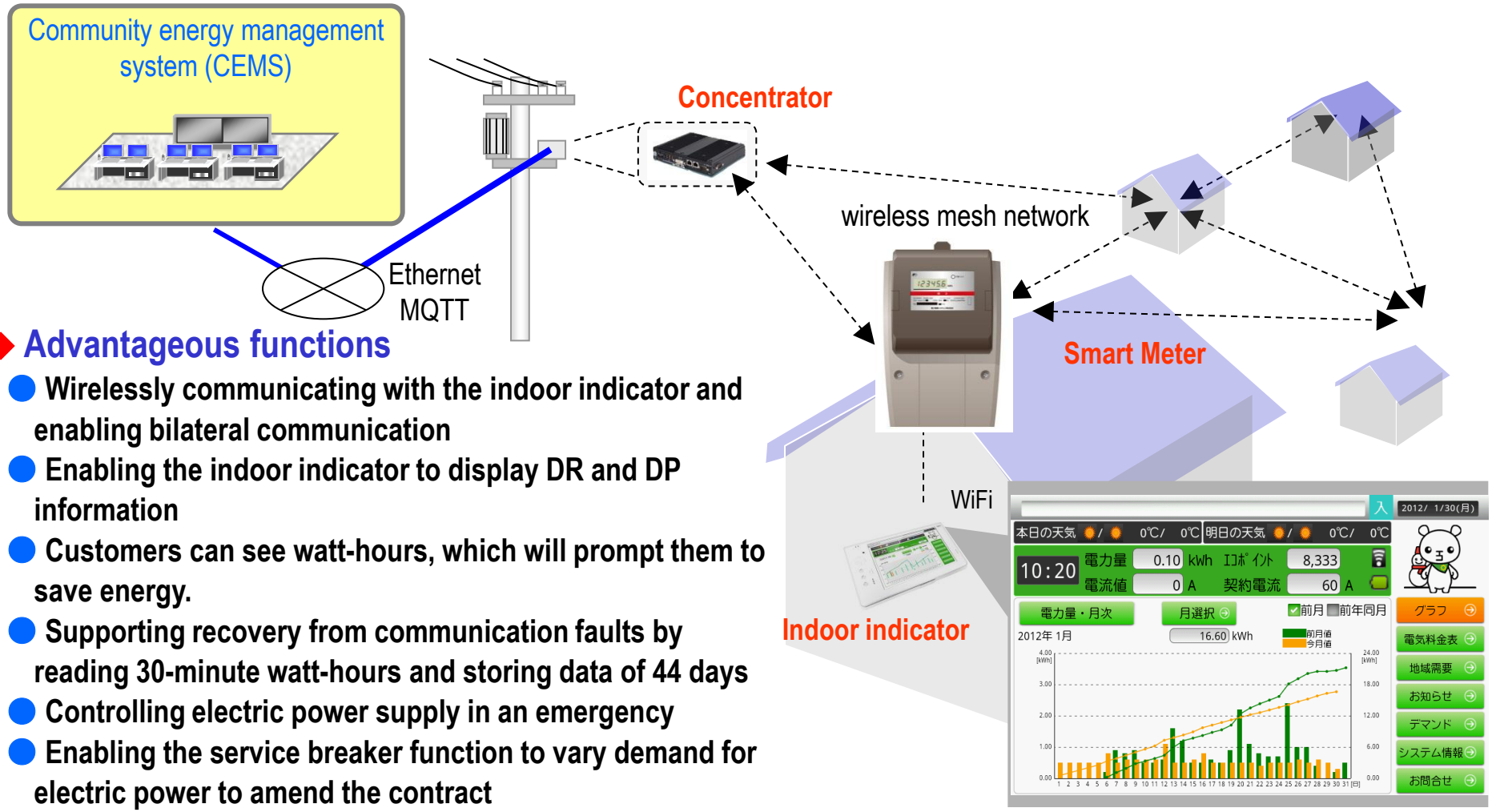
Advantageous functions

- Communicating with EMS, stabilizing loads by two-way communication and providing reserved capacity in an emergency
- Reducing instantaneous frequency variations by high-speed frequency control
- Governor-free function
- Controlling voltage by reactive power
- Stand-alone operation with variable frequency control

Smart Meters for Demand Response

Role of smart meter

With the smart meter, CEMS performs automated meter reading. In order to stabilize loads and balance supply and demand, the smart meter provides CEMS's request for demand response, and operates so that the customer can see watt-hours.



Advantageous functions

- Wirelessly communicating with the indoor indicator and enabling bilateral communication
- Enabling the indoor indicator to display DR and DP information
- Customers can see watt-hours, which will prompt them to save energy.
- Supporting recovery from communication faults by reading 30-minute watt-hours and storing data of 44 days
- Controlling electric power supply in an emergency
- Enabling the service breaker function to vary demand for electric power to amend the contract

4. Demand Side self Management

- Preliminary results of Demand Response -

Kitakyushu think about Demand Side Management

30 years ago

"Demand side management" – Unilateral approach by the supplier

Change

Consumer+ producer = prosumer

Community Involvement

"Demand side self management" - Own solution by the consumer

DP (Dynamic Pricing)

By changing the unit electricity price (Static / Dynamic) by season and by time, change the behavior of consumers.

"Personal competition"
By individual participants

+

IP (Incentive Programs)

By granting the points which make the consumers to go out from the individual wasted consumption to central effective consumption, encourage the behavior change in consumers.

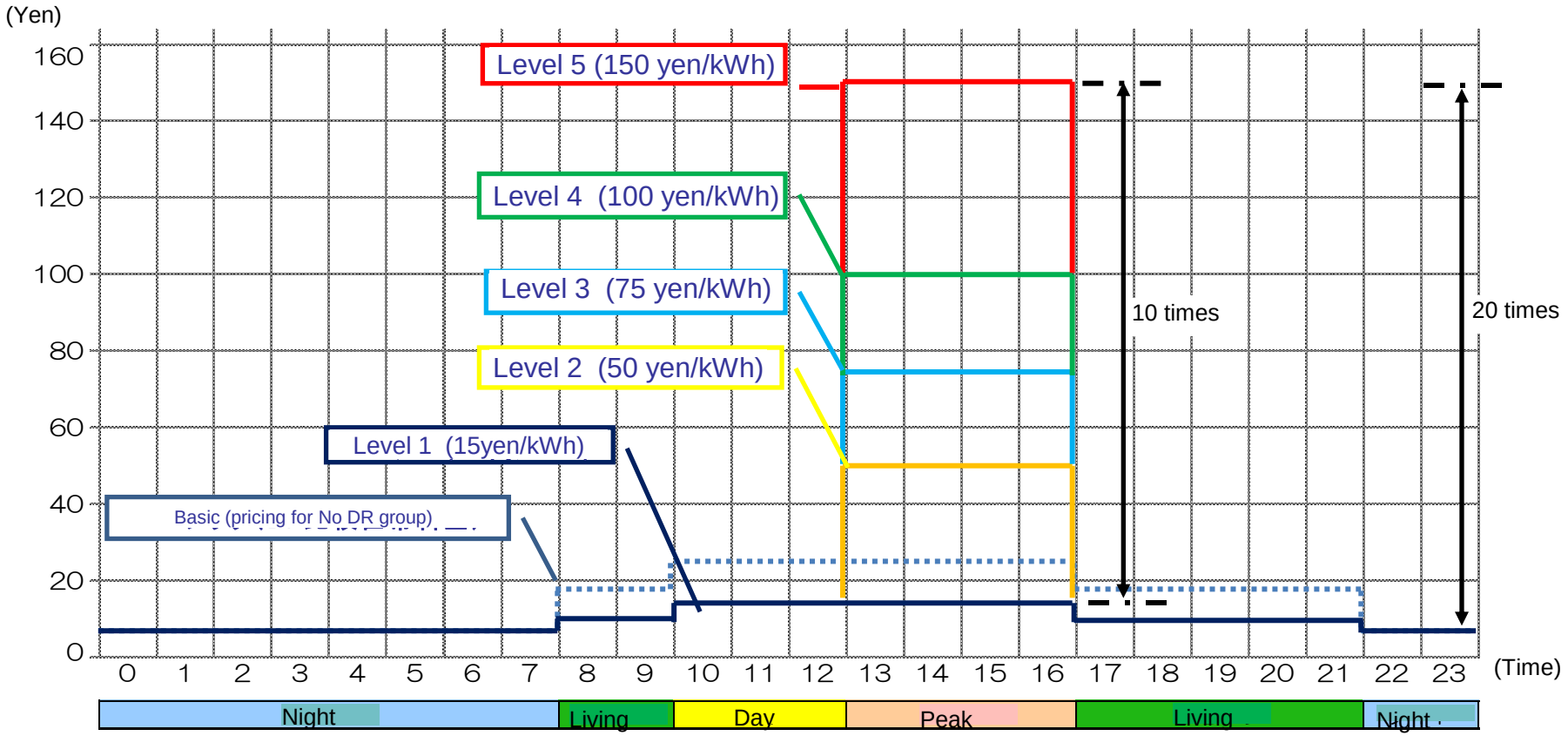
" Team competition"
By communities

Features

- Surplus of renewable energy will be covered by demand creation.
- Combination of IP and DP to build effective mechanisms to ensure sustainability.
- Building the mechanism to lead the change in behaviors of consumers to be linked to the change in lifestyle and vitalization of the community.

Example of the Pricing Table (Summer)

<June – September>



Initiation condition * Apply prices between level 2 and 5 when the maximum estimated temperature is over 30 degrees Celsius in summer.

*Apply level 1 on weekends and holidays

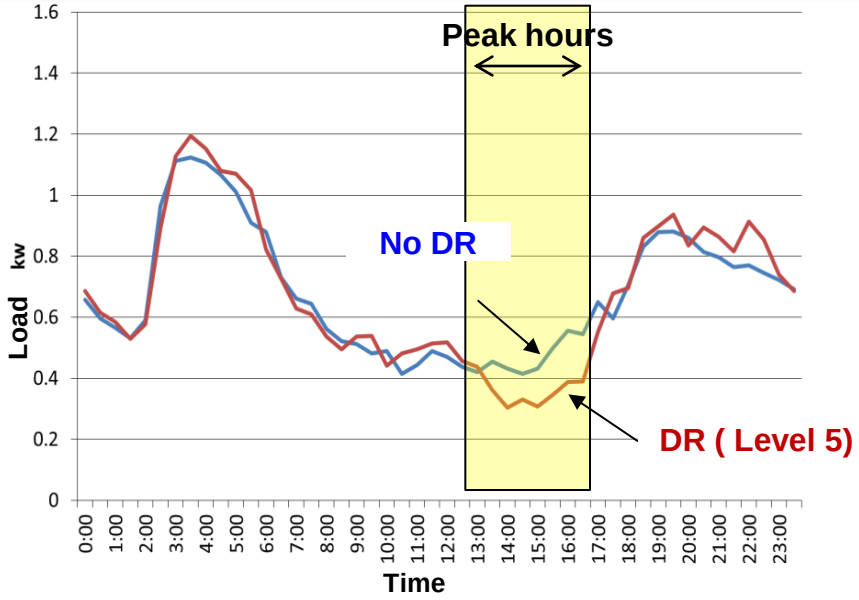
Notification timing * Notify consumers of the pricing “around 3pm on the previous day” and “morning of the day” through smart meters.

Account distribution * Accounts (9,000 yen) have been distributed (deducted when the price goes higher than the existing price) so that the citizens participating in the demonstrations can participate with security.

Comparison of “DR” and “No DR” at Level5

- Electricity price at level 5 is ¥150/kWh.
- Load of “DR” is lower than that of “No DR” during peak time.
- At the mid night, that relation is opposite.

DR shifts the load from expensive time to cheap time.

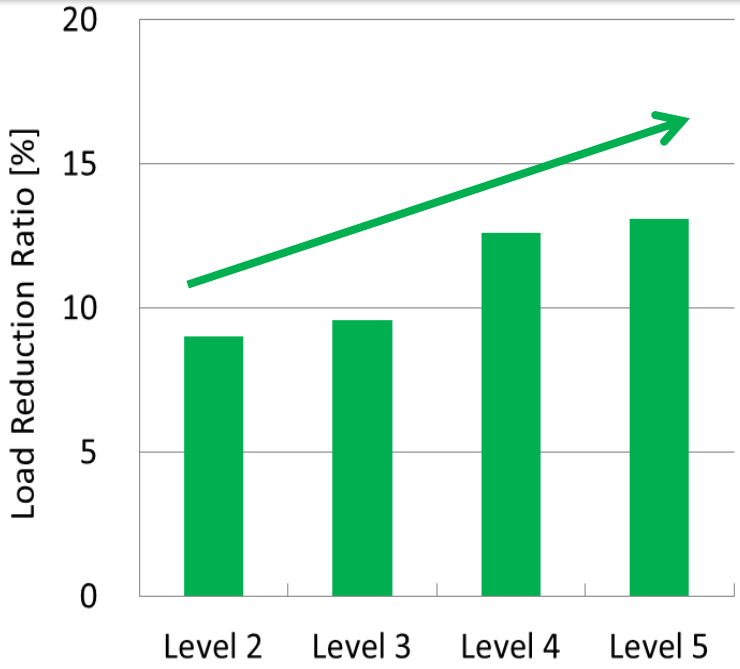


Comparison of averaged road curves between “DR” and “No DR” on August 20th in 2012

Reduction ratio of DR group

- Reduction ratio was analyzed by Prof. Ida in Kyoto univ.
- Load of over level 2 is lower than that one of level 1.

The higher DR level (Electricity price),
The larger reduction ratio



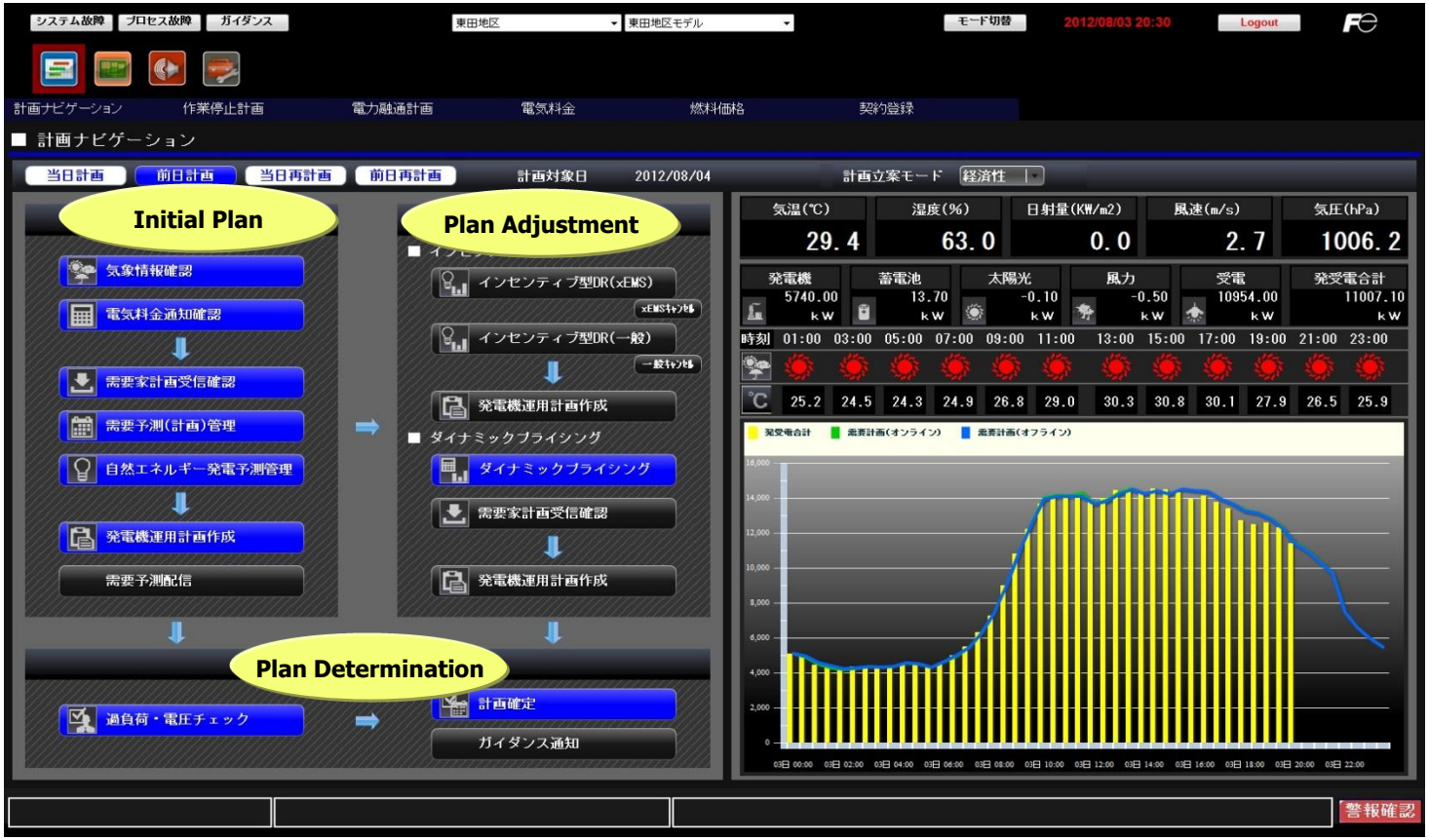
Load Reduction Ratio at each level of demand response in summer of FY2012

5. Demonstration of CEMS Display

Example of CEMS Screen

- Receive of weather data
- Receive of BEMS/HEMS operation plan
- Forecast of demand and supply and renewable power
- Generation planning
- Calculation of Dynamic pricing Incentive Program
- Operation plan adjustment
- Re-Forecast based on operation plan
- Generation planning
- Prior Check
- Online registration

Navigation screen



The screen of making operation plan

You can grasp the whole status of making operation plan and jump to screens of detail status from this screen by click on .

Example of CEMS Screen

- Receive of weather data
- Receive of BEMS/HEMS operation plan
- **Forecast of demand/supply and renewable power**
- Generation planning
- Calculation of Dynamic pricing Incentive Program
- Operation plan adjustment
- Re-Forecast based on operation plan
- Generation planning
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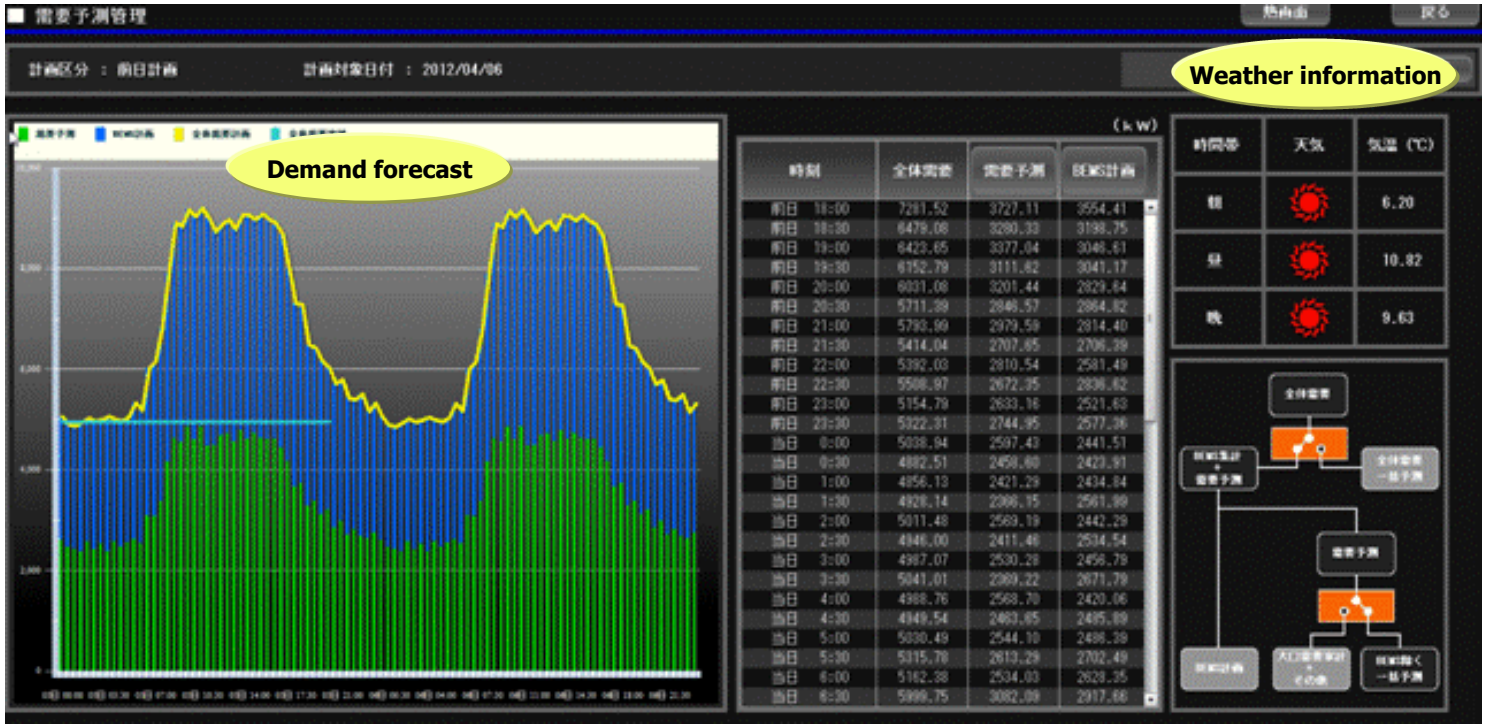
- Online registration

Forecast of demand/supply and renewable power generation



The screen of demand forecast results

You can switch results of Demand forecast of whole community or each consumer.
Forecast results of several alternative methods are displayed, and operators can select the best method.

Example of CEMS Screen

- Receive of weather data
- Receive of BEMS/HEMS operation plan
- Forecast of demand/supply and renewable power
- **Generation planning**
- Calculation of Dynamic pricing Incentive Program
- Operation plan adjustment
- Re-Forecast based on operation plan
- Generation planning
- Prior Check
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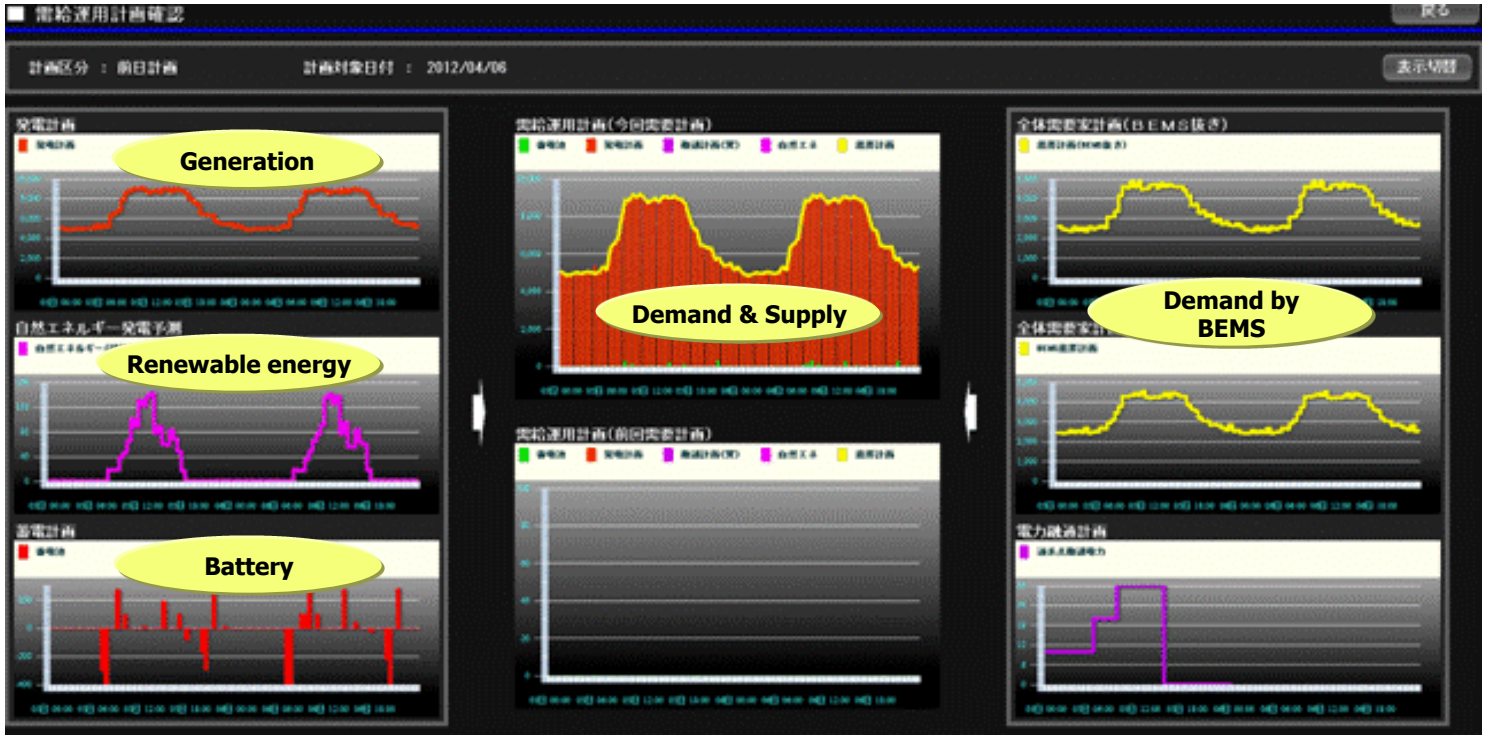
Generation planning



The screen for calculation results of power generation plan
Graphs of demand forecast, renewable energy generation prediction, and operation plan of generators and batteries are displayed.

6. Summary

Summary

The Kitakyushu Smart Community Creation Project (council) was selected by the Ministry of Economy, Trade and Industry of Japan in April 2010 as a smart community demonstration pilot project.

We have been developing Community Energy Management System (CEMS) with cooperative x-EMS such as HEMS, BEMS, FEMS and so on, to realize the concept "Local production for local consumption" using renewable energy and both demand and supply control.

Based on the community involvement, social demonstration of demand response is conducted and reviewed by way of both dynamic pricing and incentive (recommend) program.

We desire to make proposals of smart grid systems to the reconstruction assistance in Tohoku area, where experience of the huge Earthquake (Blackout, electrical power shortage, …) remind us the importance of stable electric supply.