





Reference: Balance between energy conservation and economic growth 1

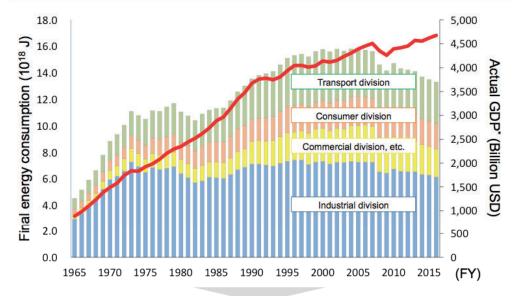
Japan has a track record of success in balancing energy conservation and economic growth.



Energy conservation is important, but if we don't use energy, won't economic growth slow down?

Case of Japan: It is possible to curb energy consumption while achieving GDP growth.

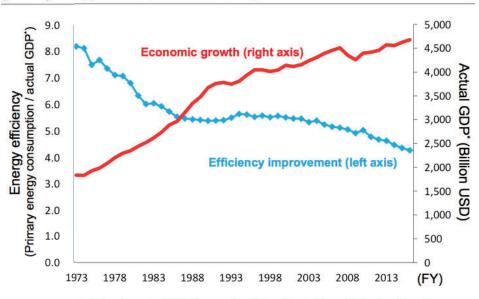
Trends in final energy consumption and actual GDP



Change in final energy consumption (FY1973-2016): 1.2 times

Actual GDP growth (FY1973-2016): 2.5 times

Trend in actual GDP and energy efficiency (primary energy consumption/actual GDP)



It should be noted that, for actual GDP figures, the data estimated from 2011 prices have been multiplied uniformly by the "2017 Average Rate (central market): 112.13 JPY/USD" reported by the Financial Markets Bureau of the Bank of Japan.

Source: Prepared based on Energy White Paper 2018 (Resources and Energy Agency)

Reference: Balance between energy conservation and economic growth 2

Energy conservation brings various benefits, such as cost savings, production stabilization, new product development, and improved quality of life of citizens, so has an element of strongly encouraging economic development.



Energy conservation is important, but won't it have a negative impact on economic growth?

Economic benefits of energy conservation









Reductions in energy required for production per unit production = cost reductions

Freedom from instability of energy procurement costs

Development of new energysaving products through improvements in energy conservation technologies

Avoidance of environmental degradation due to excessive use of energy

- Realization of highly efficient production
- Greater price competitiveness of products
- Realization of stable production volumes and prices
- Increases in manufacture and sale of energy-saving products (= increased sales revenue)
- Reduction in social costs (prevention of pollution, improvement of people's health, etc.)

Economic benefits

CONTENTS

Solution Ideas for Distributed Energy Management Systems

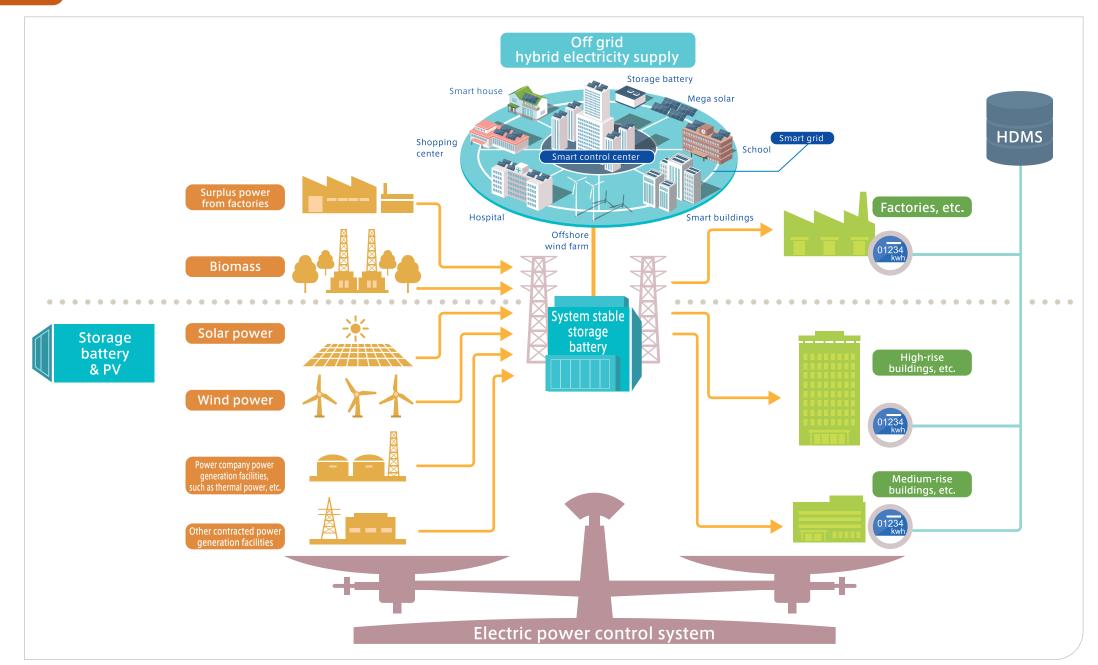
This document consists of the following three categories.

Potential solutions to "themes" envisaged in each category are presented.

Category	Energy Management Themes
Electrification and Stable Power Supply	a. Electrification of various regions b. Response to technical loss c. Improving efficiency of power companies
Energy Management in Buildings and Factories	a. Diagnosis in preparation for introduction of management systems b. Introduction of management systems
Energy Management in Cities and Communities	a. Introduction of management systems b. Optimal control of balance of supply/demand and energy mix



category 1 Electrification and Stable Power Supply





Electrification and Stable Power Supply

Theme a. Electrification of various regions

Solution

Hybrid Power Supply System for Off-Grid

Potential applications

Off-grid businesses (private-sector companies, local governments)

Need for this solution

To improve quality of life and to expand and create local businesses in off-grid areas, i.e., areas that are not yet connected to the power grid, the stable supply of renewable energy-derived power, which cuts back on the use of petroleum-derived fuel, is needed.

What this solution helps to achieve

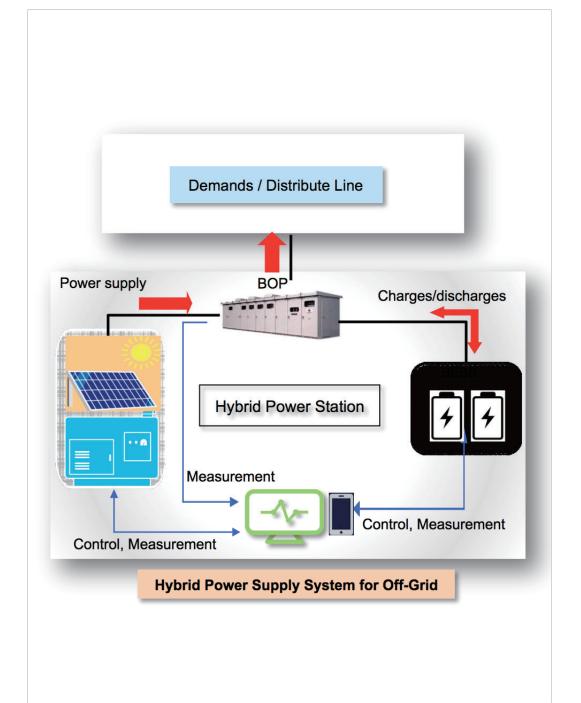
- •Stable provision of renewable energy-derived power
- •Operations control that maximizes power derived from renewable energies, reflecting the characteristics of utility equipment/load in commercial facilities (including load equipment control and power storage equipment control)

Features

- •Maximizes use of renewable energy-derived power (reductions in fuel use and CO2 emissions)
- Remote monitoring, remote control
- •Extendable in response to increased demand and load equipment control
- ●7 months for procurement, 2 months for installation

Where it is being used

Under development





Electrification and Stable Power Supply

Theme b. Response to technical loss

Solution

PV system with storage battery

Potential applications

Private-sector companies (factories, etc.), commercial facilities, etc. (e.g. Meidensha Numazu Plant)

Need for this solution

Responding to output fluctuations resulting from the expansion of renewable energies will play an important role in realizing a low-carbon society

What this solution helps to achieve

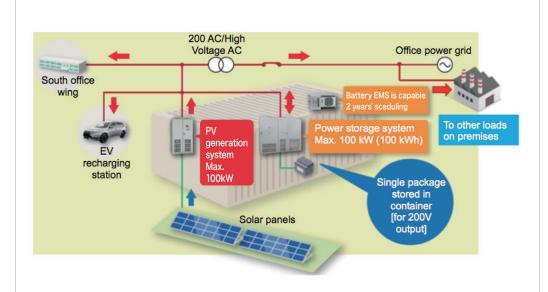
- Reduction of environmental burden (CO2 emission reductions)
- •Alleviation of renewable energy output fluctuations
- BCP response (contribution to local community)

Features

- •Various types of storage batteries can be connected to fit purpose
- •Scheduled charge/discharge operations, e.g. limiting maximum power consumption
- ●Load-following control, DR response
- Approx. 8 months from design to operation (ref.)

Where it is being used

Japan







Electrification and Stable Power Supply Theme b. Response to technical loss

Solution

Battery Energy Storage System that will contribute to stable operation of grid

Potential applications

Power transmission businesses, power generation businesses

Need for this solution

There is a need to reduce the fluctuations in power grid frequency and power flow caused by the introduction of unstable renewable energies, using safe and long-lasting storage battery systems.

What this solution helps to achieve

- Frequency regulation
- Smoothing of renewable energy output
- Emergency power source back-up

Features

- Safety confirmed with nail penetration and crush tests
- •Extended service life, so can be used for a long time
- •Suitable for reducing fluctuation through rapid charge/discharge

Where it is being used

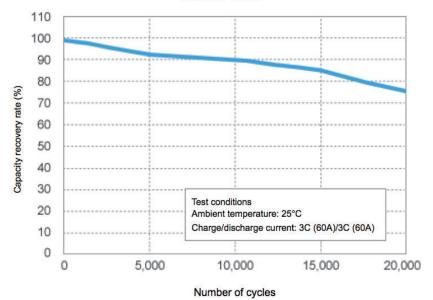
Japan, North America, Europe, Australia, Asia





Nail penetration No ignition in either test

Crush test



More than 75% capacity remaining after 20,000 cycles



Electrification and Stable Power Supply

Theme b. Response to technical loss

Solution

High-quality and secure power control system(Next Generation SCADA Solution)

Potential applications

Power companies (transmission and distribution)

Need for this solution

To achieve stable power supply, technologies for the design of SCADA that conforms to your own country's power system and cyber-security measures are essential. In addition to SCADA design, the enhancement of education and training (human resources development) in power system operation technologies will also be an important factor.

What this solution helps to achieve

- Improve power quality (duration and frequency of power outages) by designing and supplying the most optimal SCADA for your own country
- Even if the control center is expanded in line with increased power demand, there is no need to install additional SCADA, so major cost reductions can be achieved.
- Development of advanced technicians through education and training in power system operation technology.
- Provision of secure SCADA in line with your own country's guidelines.

Features

- Advanced power system operation training function for development of technicians in Japan.
- •Secure operations with introduction of biometric authentication
- Approximately 2 years from design to operation (depends on scale of power system and scope of design and works)
- ●Cost is approximately 1-20 billion JPY (depends on scale of power system and scope of design and works)

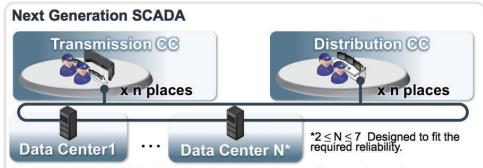
Where it is being used

Japan (scheduled for mid-2020)

Private & Public cloud design

General SCADA Distribution CC* Transmission CC* x n places x n places

Install the server in each CC* (*Control Center)



SCADA in cloud design significantly reduces the number of servers

High secure design

Advanced cyber security measures in two-factor authentication by "IC card" and "biometric authentication".



IC Card

- Operation area authentication
 Operation is possible at other CC

Biometric authentication (palm vein)

- Prevent spoofing Suppress remote operation from unauthorized intrusion.



Electrification and Stable Power Supply Theme c. Improving efficiency of power companies

Solution

Meter Data Management System for Smart Meters

Potential applications

Power companies (mainly distribution)

Need for this solution

Meter reading is done every month manually and when consumers moved in or out it also needed attendance of employee, and thus power distribution company needs to keep human resources for these operations. In retail company's perspective, monthly meter reading placed limitations on varieties of tariff plans they would like to provide. To solve these issue power distribution companies started to deploy smart meters and "Meter Data Management Systems" are required to handle large data collected from these smart meters.

What this solution helps to achieve

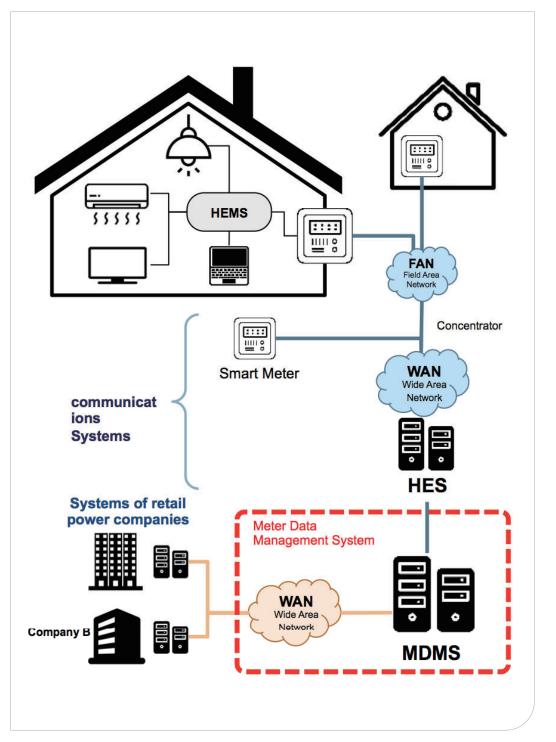
- ●Enable to collect forward and reverse power flow data every 30 minutes from more than 30 million low-voltage and high-voltage smart meters, 24/7
- •Real-time monitoring of all smart meter operational information and remote configuration

Features

- ●ICE61968-compliant interface (local fit)
- Large-scale data processing capacity (approx. 200,000 TPS)
- Provision of flexible service functions to suit business development

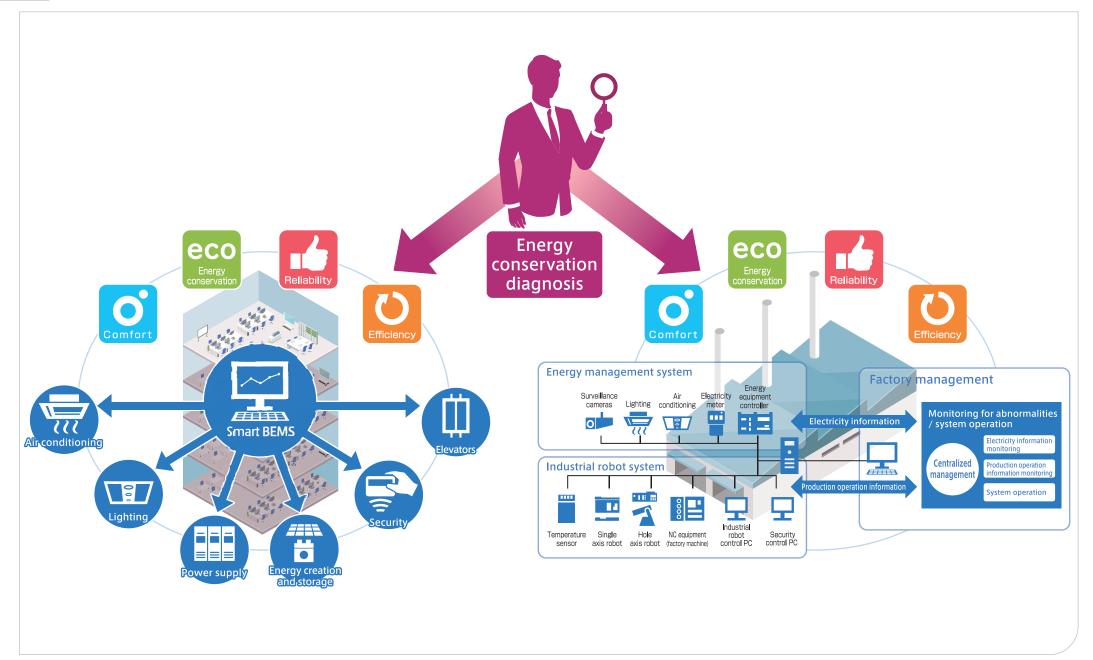
Where it is being used

Several power companies in Japan





category 2 Energy Management in Buildings and Factories





Energy Management in Buildings and Factories

Theme a. Diagnosis in preparation for introduction of management systems

Solution

Energy conservation diagnosis - equipment operational improvements and upgrades

Potential applications

Public facilities, universities, schools, hospitals, shops

Need for this solution

- •As the need for energy conservation increases, the need will arise to make operational improvements and upgrades to equipment installed in buildings, including existing ones, based on operational data.
- Going forward, there will be an expansion in needs corresponding to the expansion of energy conservation ratings of buildings, modeled on Singapore's Green Mark.

What this solution helps to achieve

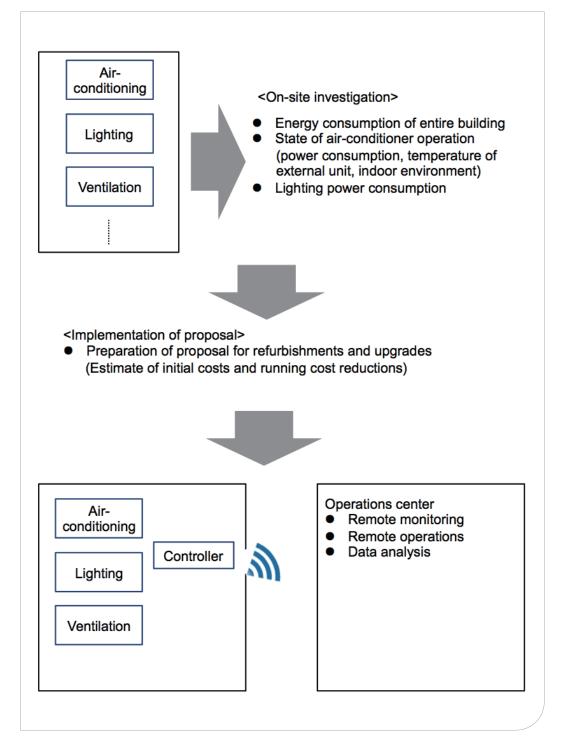
- Reduction of equipment operational costs (energy consumption, maintenance costs)
- Energy conservation and reduction of environmental burden
- Provision of comfortable environment for occupants

Features

- •Reduction in on-site investigation costs through equipment packages and diagnosis proposals
- Reduction in operating costs through remote (cloud service) monitoring and operation
- ●3 months (design to operation) and 50 million JPY per building (case by case depending on size of property) for a standard case

Where it is being used

Japan, Europe, North America
Business to launch in Asia before end of FY2018





Energy Management in Buildings and Factories Theme b. Introduction of management systems

Solution

BEMS(Building Energy Management System)

Potential applications

Airports and other public facilities, large-scale commercial facilities, hotels, office buildings, government agencies, private-sector companies, etc. (e.g. Thailand's Amarin Plaza)

Need for this solution

- ●To achieve medium- to long-term energy conservation in the large-scale commercial facilities and office buildings, etc. that are being built in the construction boom in the large metropolitan centers, energy management systems need to be introduced in the planning and design stages.
- •For existing buildings that consume large volumes of energy as well, such systems need to be added to improve the efficiency of the building.

What this solution helps to achieve

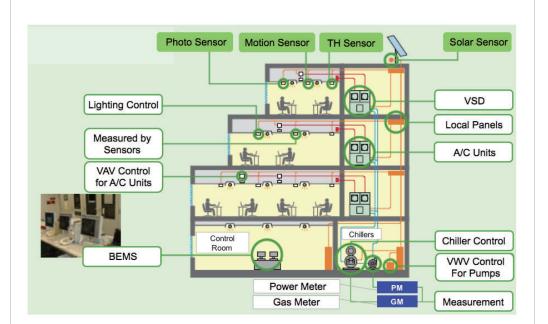
- Reduction in maintenance and operational costs of building itself
- Provision of comfortable environment for users
- Energy conservation and reduction of environmental burden

Features

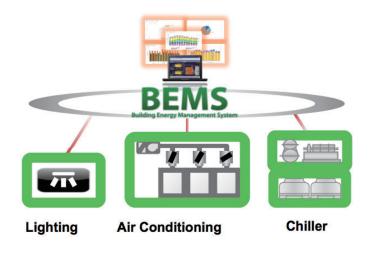
- Energy conservation applications with an accumulation of Japan's wealth of know-how and extensive track record
- •Real-time monitoring and optimal control possible
- Energy analysis and evaluation using detailed energy measurement and long-term data
- Supports ongoing energy-saving operations with cloud services
- ●Approx. 6 months and 30 100 million JPY from design to operation for a standard case

Where it is being used

Large-scale commercial facility in ASEAN



System Image





2 - 3 Energy Management in Buildings and Factories Theme b. Introduction of management systems

Solution

FEMS(Factory Energy Management System)

Potential applications

- Factories with power demand of 10MW or less (automotive manufacturing plant, food processing plant, etc.)
- •Industrial plants with large energy consuming processes (oil and gas, chemicals, iron and steel, etc.)

Need for this solution

In factories with complex energy operations, energy savings activities through the identification, visualization and analysis of detailed energy consumption trends are required.

What this solution helps to achieve

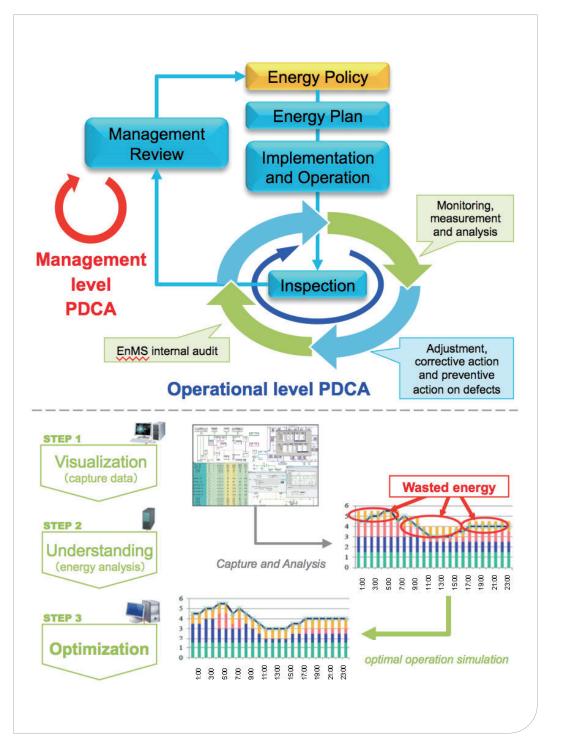
- •Budgetary control and visualization of energy consumption
- Reduction of energy consumption through operational improvements (3-50% savings)
- •BCP measures through combined introduction with gas co-generation system and integrated management of multiple energy means

Features

- •Able to identify flows energy needed for production processes, such as steam and cooling water not only of purchased
- •Achieve quantitative evaluation through budgetary control of energy consumption by division or process
- ●Through the combined introduction of FEMS and gas co-generation, and integrated management of multiple energy means, achieve BCP through energy savings by combined heat and power, or duplication of power sources

Where it is being used

Japan





Energy Management in Buildings and Factories Theme b. Introduction of management systems

Solution

Boiler-Turbine-Generator (BTG) controllability improvement

Potential applications

Process plants, etc. that consume large volumes of power, heat, gas, etc., such as thermal power stations

Need for this solution

●BTG equipment consumes massive amounts of energy. To operate them efficiently, the lowest-cost balance and distribution of steam and power needs to be decided and controlled under a variety of restrictive conditions, while following the demands for steam and power from the production plant.

What this solution helps to achieve

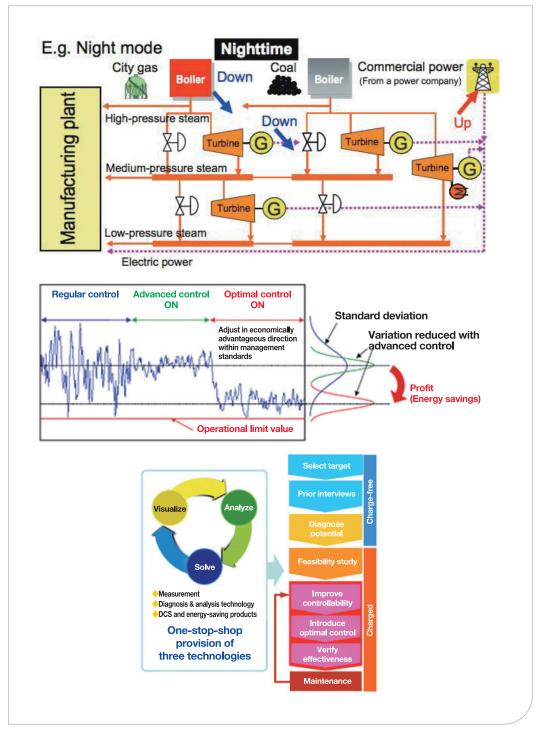
- •Reduce the burden on the operator through operational support and automation in order to operate in a stable manner in accordance with highly fluctuating demand.
- •Achieve minimization of total costs through control of power/steam balance.
- •Stabilize and reduce steam pressure through conduct optimal operation with advanced control, using multivariable-model predictive control.

Features

- As well as PID control through DCS, operation modes can be switched among multiple patterns by combining multivariable-model predictive control as advanced control
- Conduct simulations and calculate investment efficiency based on real data

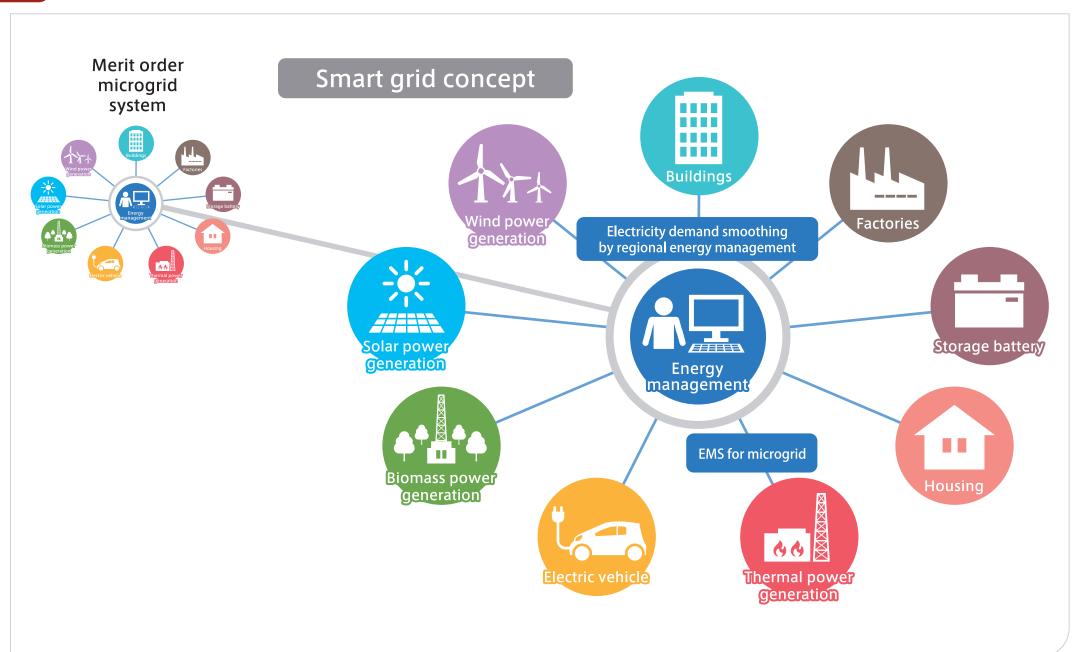
Where it is being used

Japan





category 3 Energy Management in Cities and Communities





Energy Management in Cities and Communities Theme a. Introduction of management systems

Solution

Leveling of power demand through local energy management

Potential applications

Local governments (particularly Smart Cities)

Need for this solution

To promote the introduction of renewable energies in developing countries, where power transmission networks are insufficient, the costs of investing in power transmission networks needs to be curbed.

What this solution helps to achieve

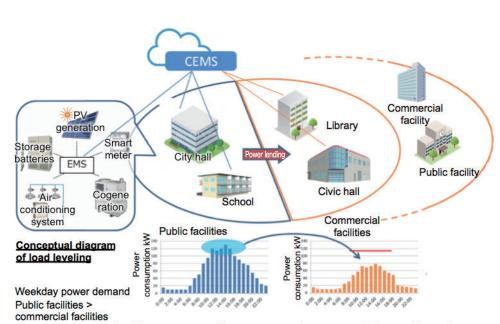
- Control of power demand by region
- Achieve the leveling off of power demand at low cost
- Maximize the effects of introducing renewable energies (PV, etc.)

Features

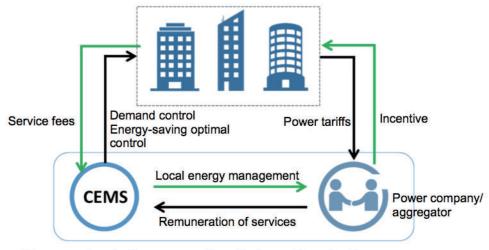
- •Because of the need to adjust demand from existing equipment (air-conditioning system) on the demand side, installation cost can be low.
- ●To make use of existing equipment, existing buildings are also targeted (Installed in around 6 months (building survey design operation) in standard cases)

Where it is being used

Japan, Europe
Considering starting a pilot project in Asia



Conceptual diagram of power demand leveling in combined regions



Conceptual diagram of collaboration between power companies and aggregators



Energy Management in Cities and Communities Theme a. Introduction of management systems

Solution

EMS for micro-grids

Potential applications

Power companies and power transmission/distribution companies especially in remote areas such as outlying islands, military bases, and excavation sites (e.g. mining sites)

Need for this solution

There is a need to achieve both the introduction of renewable energies and the grid stabilization in isolated power grids such as those of island countries.

What this solution helps to achieve

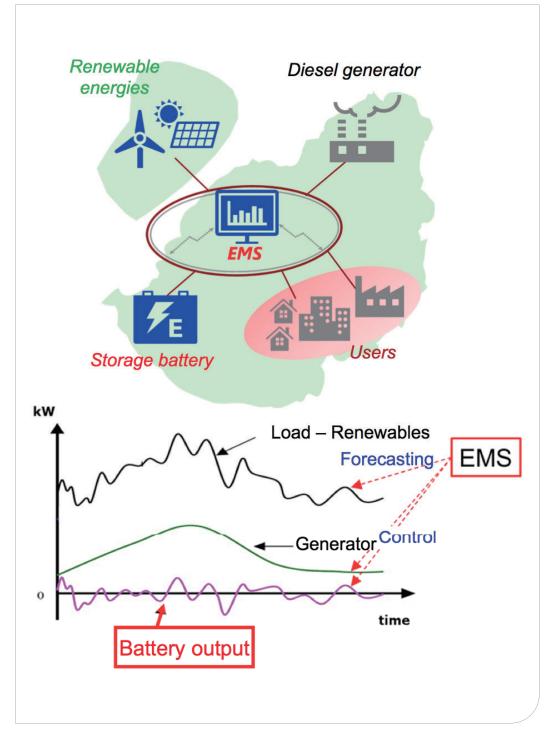
- •Smoothing of renewable energy output fluctuation
- •Stable operation of power grid (frequency and supply/demand balancing)
- Efficient operation of diesel generators combined with renewable energies (stable supply, reduction in fuel costs)

Features

- Expand introduction of renewable energies (around 1 year for installation of EMS)
- Propose generator and storage battery operational plan and support power grid operation
- Automate generator control as required

Where it is being used

Japan, North America, Europe, Asia





Energy Management in Cities and Communities Thomas Introduction of management systems

Theme a. Introduction of management systems

Solution

VPP(Virtual Power Plant)

Potential applications

Infrastructure service providers, real estate developers, etc.

(Currently being used in EV recharging demonstration trial service businesses in Japan and US)

Need for this solution

For the promotion of energy savings and renewable energies on the regional level, integrated management and effective use of the distributed energy resources throughout the region are required, through advanced energy management technology.

What this solution helps to achieve

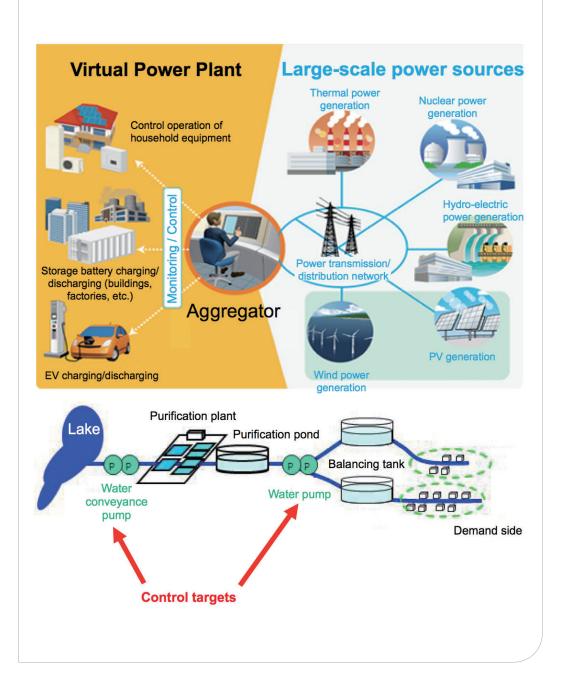
- <Value for grid operators>
- Remote control and integrated management of energy resources
- Acquisition of low-cost regulating ability
- •Creation and utilization of resources by Distributed Control System(DCS)
- <Value for users>
- •Acquisition of compensation by provision of grid regulating ability
- Reduction of capacity payment of electricity by introduction of EMS

Features

- DCS to bring resource creations of new resources and use of existing resources on the demand side
- •Control of water supply pumps to ensure stable output
- •Combination of high-speed optimally-planned engine and real-time control to achieve high-precision control of electric power
- ●EMS function to enable sector coupling and external device I/F

Where it is being used

United States, Japan





Energy Management in Cities and Communities

Theme b. Optimal control of balance of supply/demand and energy mix

Solution

Merit-order micro-grid system

Potential applications

Medium to large outlying islands (e.g. Singapore's Agency for Science, Technology and Research)

Need for this solution

- •Because small-scale power grids that supply electricity from distributed power sources are susceptible to the effects of environmental changes and demand trends, maintenance of power quality, reductions in operating and fuel costs, and reduction of environmental burden are needed.
- •In addition, islanding operation function is necessary to ensure energy supply reliability.

What this solution helps to achieve

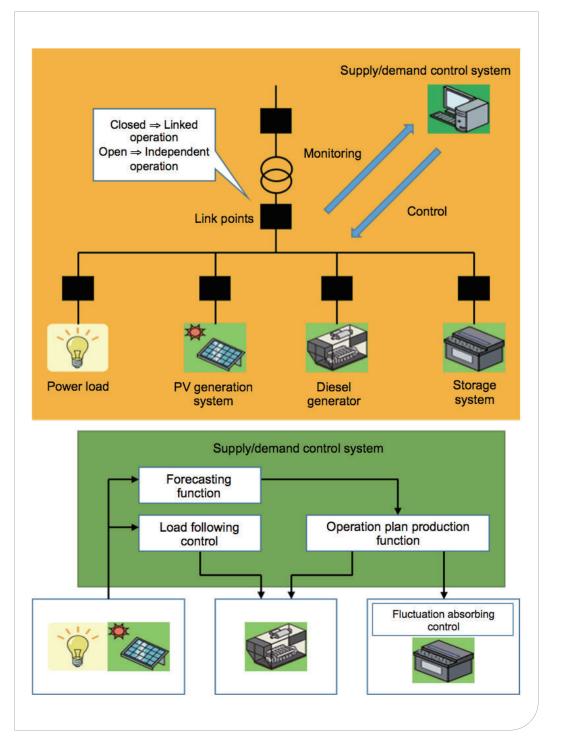
- Constant maintenance and optimization of supply/demand balance
- Responses to frequency fluctuations
- Economical power operations

Features

- Grid operation and independent operation both possible
- Merit-order operation based on mathematical programming

Where it is being used

ASEAN



Solution Ideas for Distributed Energy Management Systems

This document is developed with support from these Japanese companies.

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