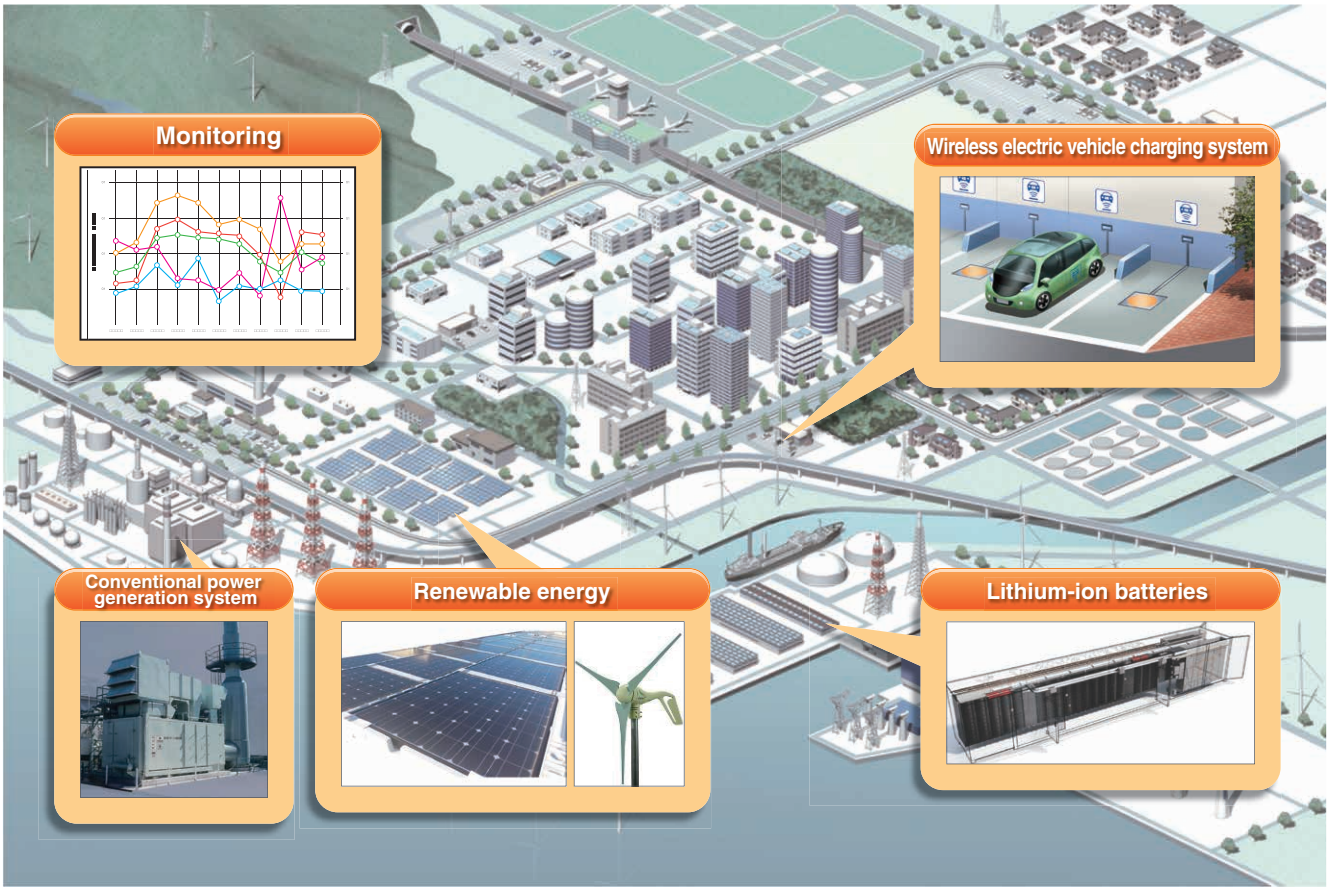
Using Electricity Intelligently

Smart energy network technology

Following the Great East Japan Earthquake and nuclear power plant safety issues that subsequently arose, the energy supply and demand balance in Japan is in a delicate state. Given this situation, in order to maintain comfortable lifestyles, stable plant and energy management is required that allows for balanced and optimal use of renewable energy and existing fossil fuels.



Concept of a smart energy network for a factory

Challenges of energy supply and demand

When we look at how much fossil fuel and resources are left in the world, we find that they are unevenly distributed in specific areas. Japan, which depends heavily on foreign energy and resources, is always under the threat of resource nationalism where some countries are trying to put their resources under the control of the state. In such a situation, in order to ensure stable energy and resource procurement, which is known as energy security, Japan has diversified

its suppliers of energy and resources, and is searching for alternative resources.

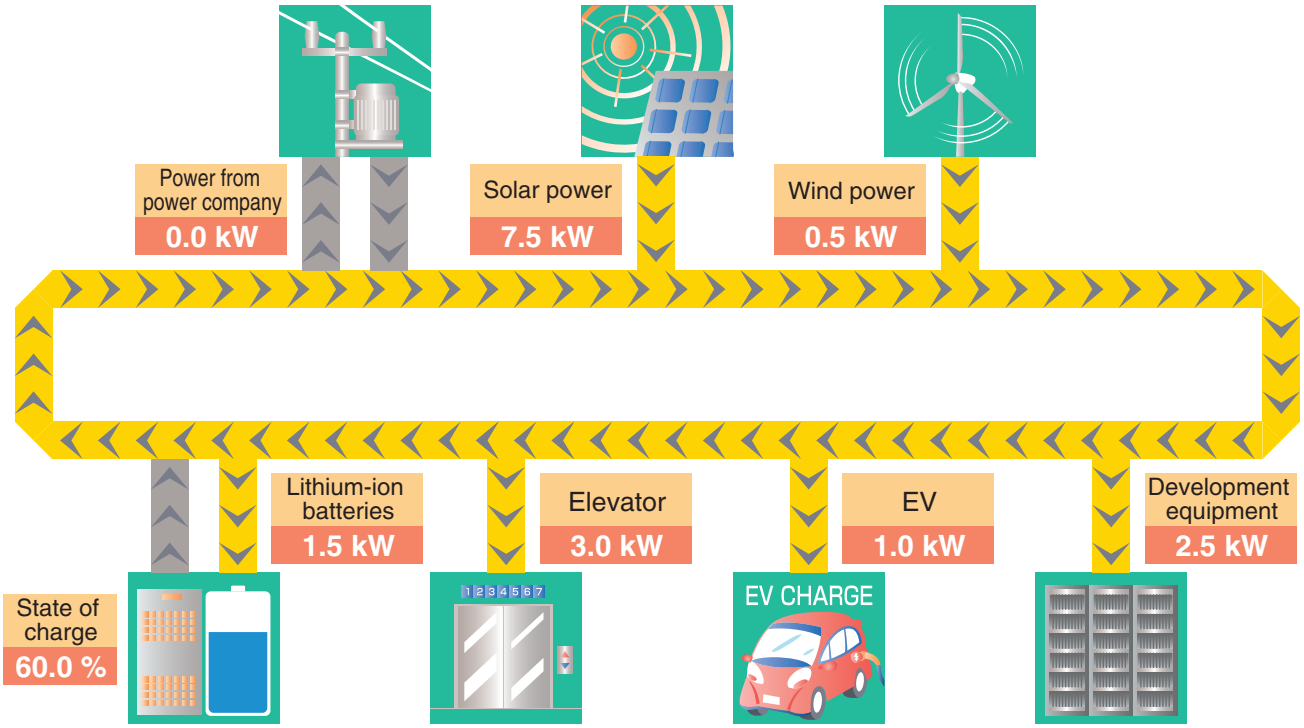
At the same time, Japan needs to tackle the issue of global warming. As a measure against global warming, renewable energy is attracting attention. However, the initial cost for renewable energy is relatively high, and therefore it will take some time for renewable energy to come into widespread use. For the time being, balanced use of fossil energy and renewable energy is required. For this reason, we think it important to develop a smart energy network that uses advanced information and communication technology to utilize the advantages of both renewable energy and fossil fuel.

Taking factory energy management as an example, distributed power supplies using fossil fuels, such as gas engine and gas turbine generators, are often installed to reduce dependence on external power supplies during the hours when power demand is highest and to secure an emergency power supply. In the future, in addition to this, we expect power generation facilities using renewable energy such as solar energy and wind energy to be provided, which would help ensure energy security at factories and promote measures against global warming.

The output of power generated by renewable energy such as solar energy and wind energy easily fluctuates because it is subject to weather and wind conditions which change constantly. Therefore, a system is needed to compensate for these output fluctuations and to supply stable power according to the power demand of the factory.

The amount of power supplied can be adjusted to the power demand of the factory, which is achieved by controlling the outputs of distributed power supplies such as gas engine and gas turbine generators. The response speed of distributed power supplies to output fluctuations is limited, and the power generation efficiency sometimes decreases because the distributed power supplies are not always operating under suitable conditions. These problems can be solved by using large batteries, which enable high-speed power input and output, and a large-capacity lithium-ion battery system is now available.

In addition, electric vehicles use lithium-ion batteries, and a large quantity of electric vehicles can be used for power flow control. For example, the amount of electricity generated by solar energy reaches its peak at noon, but the factory is not operating because the workers are on lunch break. In this case, not all the generated power is consumed and some of it goes to waste. Electric vehicles can be used to store the power generated by renewable energy, which generates power even when the demand is small.

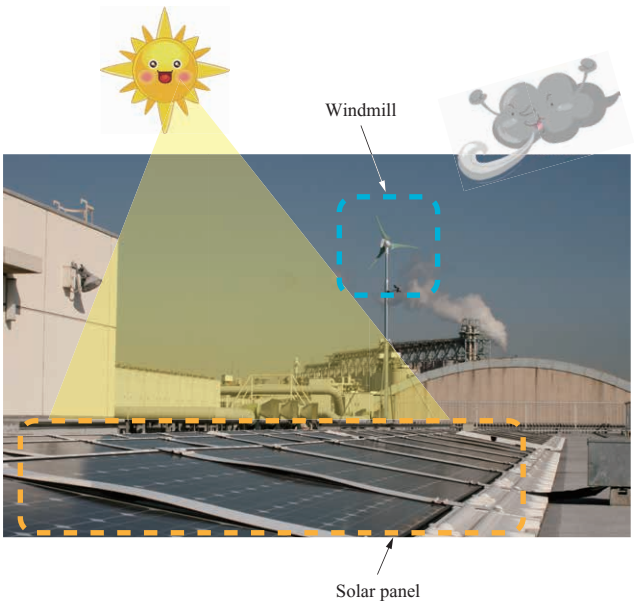


Small-scale experimental facility for a smart energy network

Data collection using small-scale experimental facilities

Before demonstrating an energy network using a factory, we constructed a small-scale test facility to verify the economic effectiveness of the network and the contribution to the reduction of environmental impacts and to accumulate data for studying how to implement the network.

This system consists of solar and wind power generation systems for generating power; lithium-ion batteries for storing it; electric vehicles, elevators, and various pieces of development equipment to consume the generated power; and remote monitoring and power management equipment for monitoring and controlling the equipment from a remote place. In addition, power units are provided to simulate distributed power supplies such as gas engine and gas turbine generators.



Solar panels and windmill

Solar panel	Single-crystal silicon
Maximum output	180 W per sheet × 56 sheets = Approx. 10 kW
Panel area	74 m^2

Solar power generation specifications

Rated output	1.1 kW (wind speed: 12.5 m/s)
Maximum output	4.0 kW (wind speed: 20.0 m/s)
Cut-in wind speed	2.5 m/s
Windmill diameter	1.8 m

Wind power generation specifications

Lithium-ion battery (left) and power management equipment (right)

Voltage range	DC 237 to 342 V
Battery capacity	80 A·h
Module construction	Prismatic cells

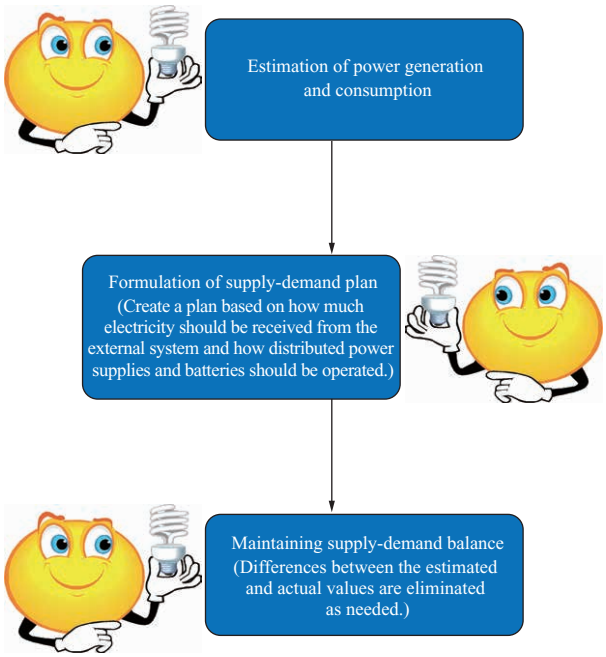
Lithium-ion battery specifications

The control method of this system changes according to the availability of the external power supply system.

When the external power supply system is operating normally, the internally generated power is used to cover the power consumption within the network, and the external power supply system is only used to compensate for any shortage.

With the currently developed control method, at normal times, the power generation and consumption are estimated on a daily basis to plan how much electricity will be supplied from the external system and how the distributed power supplies and batteries are operated. In reality, there are differences between the estimated and actual values, and the plan is modified as needed.

When a power failure occurs in the external power system, the network is automatically disconnected from it, and the network begins self-sustained operation, in which it is able to be sustained only by renewable energy and batteries.



Control method for normal operation

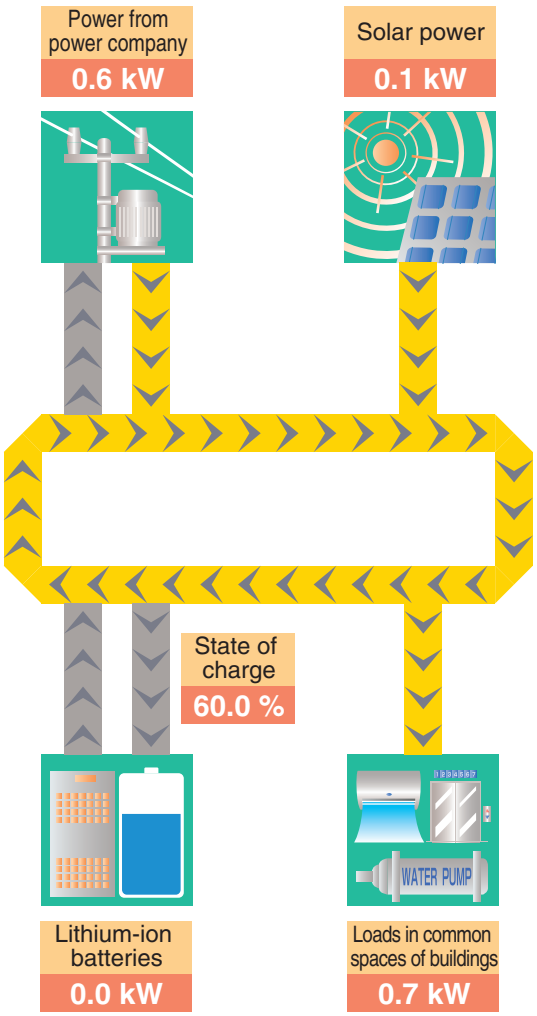
Smart energy network in apartments

We have introduced the technology developed by the IHI group using a smart energy network including solar power generation and electricity storage systems into an apartment being constructed in Tokyo. We have completed trial operation and just started full-scale operation.

The system we installed in the apartment consists mainly of a lithium-ion battery system, a solar power generation system, and power management equipment that controls the battery and generation systems. This system uses as much solar power as possible for the common spaces of the building and minimizes the amount of power supplied from the external power supply system.

Normally, this system is connected to elevators, air conditioning systems, and other loads whose power consumption fluctuates significantly for electric-load leveling and works to keep the amount of power purchased from the external power supply system from getting too high.

In case of emergency such as a power failure, this system is connected to the lights and outlets in the common spaces used in emergency situations and supplies power from solar power generation and batteries only.



Smart energy network in apartments

Thanks to support by the government, the spread of renewable energy and stationary lithium-ion batteries is expected to accelerate. We will establish the optimal method for energy use based on the operation data we have accumulated so far and offer a smart energy network system that our customers feel secure about using.

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