

# Technology Innovation

## Power & Energy

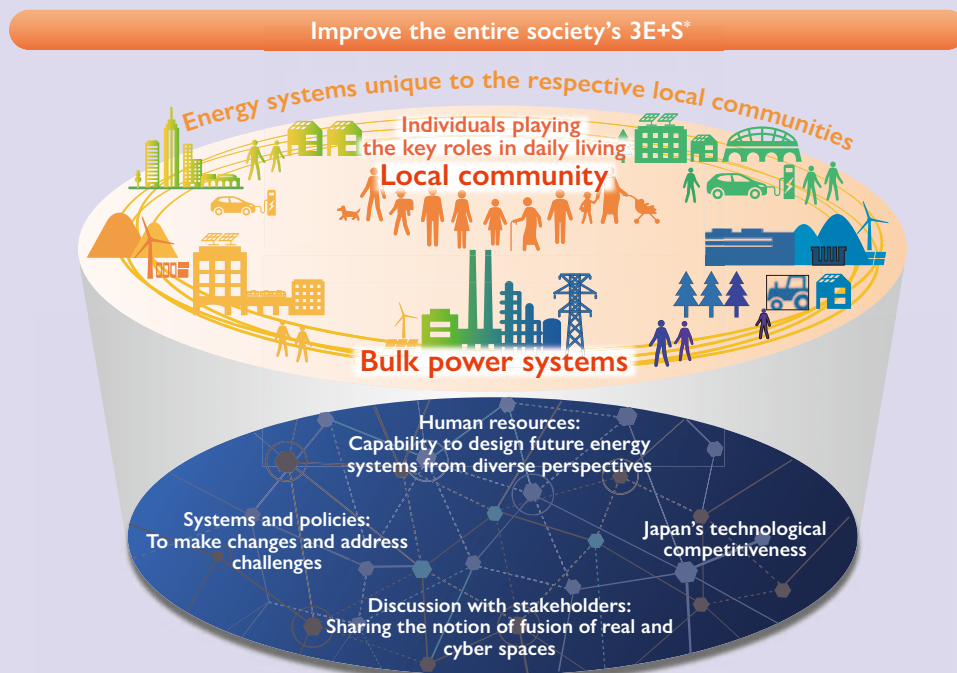
### 1 Work on Implementing Power System that Supports Society 5.0

Proposals are being put forward about the future energy system for Society 5.0. In June 2016, Hitachi established its Hitachi-UTokyo Laboratory as a new scheme for collaborative creation between industry and academia. Against a background in which an unstoppable shift is taking place toward a new system that includes wider use of renewable energy, greater use of distributed energy supplies, digitalization, and electrification, this laboratory is identifying the technical challenges as well as the policy and regulatory issues and developing common understandings of the problem with other stakeholders, while at the same time making this work public\*.

Amid rapid changes in the structure of the economy, society, and industry, there is a need for energy systems that suit their local communities, working in harmony with a variety of other infrastructure. Because of the regional variations and fluctuations over time that come with the adoption of renewable energy, it is difficult to limit the management of energy supply and demand and its pricing to single communities. Bulk power systems tie together a number of communities and act to coordinate the system as a whole. The division of roles between bulk power systems and community energy systems is no longer unchanging. Hitachi intends to rebuild those systems on the basis of their coexistence.

\* "Toward Realizing Electricity Systems to Support Society 5.0," Hitachi-UTokyo Laboratory.  
<http://www.ht-lab.ducr.u-tokyo.ac.jp/2018/04/18/20180418ht-lab-forum/> (April 18, 2018), in Japanese.

- Restructure local communities and bulk power systems which to coexist
- Establish a collaborative mechanism integrating rapidly increasing distributed resources



\* 3E+S: energy security (degree of self-sufficiency), economic efficiency (cost of electric power), environment (greenhouse gas emissions), and safety

#### 1 Overview of energy system that supports Society 5.0

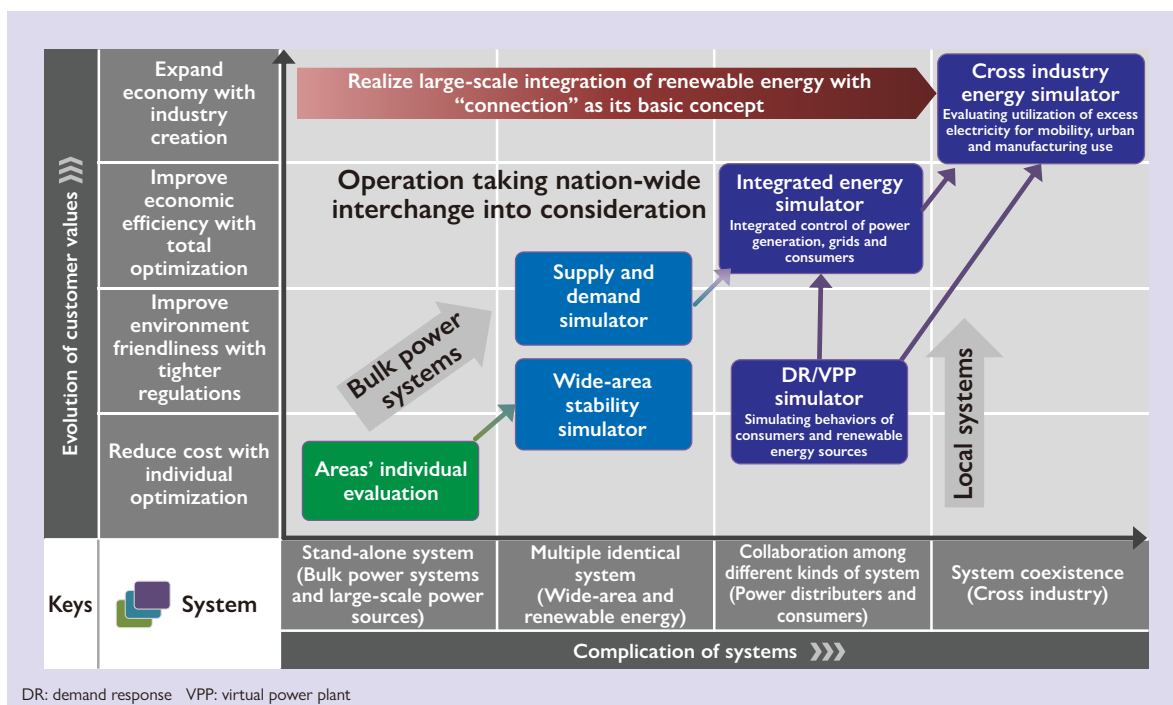
## 2 Energy System Evaluation Platform for Communities and Bulk Power Systems

Hitachi is working on putting together a platform for the analysis and evaluation of energy systems across all areas of society, especially electric power, in order to manifest the roles of local communities and bulk power systems.

Hitachi has previously developed a wide-area stability simulator for the purpose of evaluating policies for encouraging greater use of renewable energy in terms of their technology and benefits. Along with the balancing of supply and demand in the presence of large amounts of renewable energy, the simulator is also able to investigate how much renewable energy can be installed in practice and the extent of output suppression needed based on consideration of transient stability in the event of faults in different parts of the grid.

In the future, Hitachi intends to extend this into cross-industry applications beyond the energy sector, including things like integration with mobility systems as well as power distributors and consumers, and to build and make available evaluation environments in the form of cyber-physical systems (CPSs).

In this way, Hitachi intends to establish an environment in which the energy systems that support the world of Society 5.0 can be evaluated and use it as a platform for debating new worldviews with numerous stakeholders to come up with solutions.



2 Evolution of energy system evaluation platform

## 3 Next-generation Nuclear Power Generation System

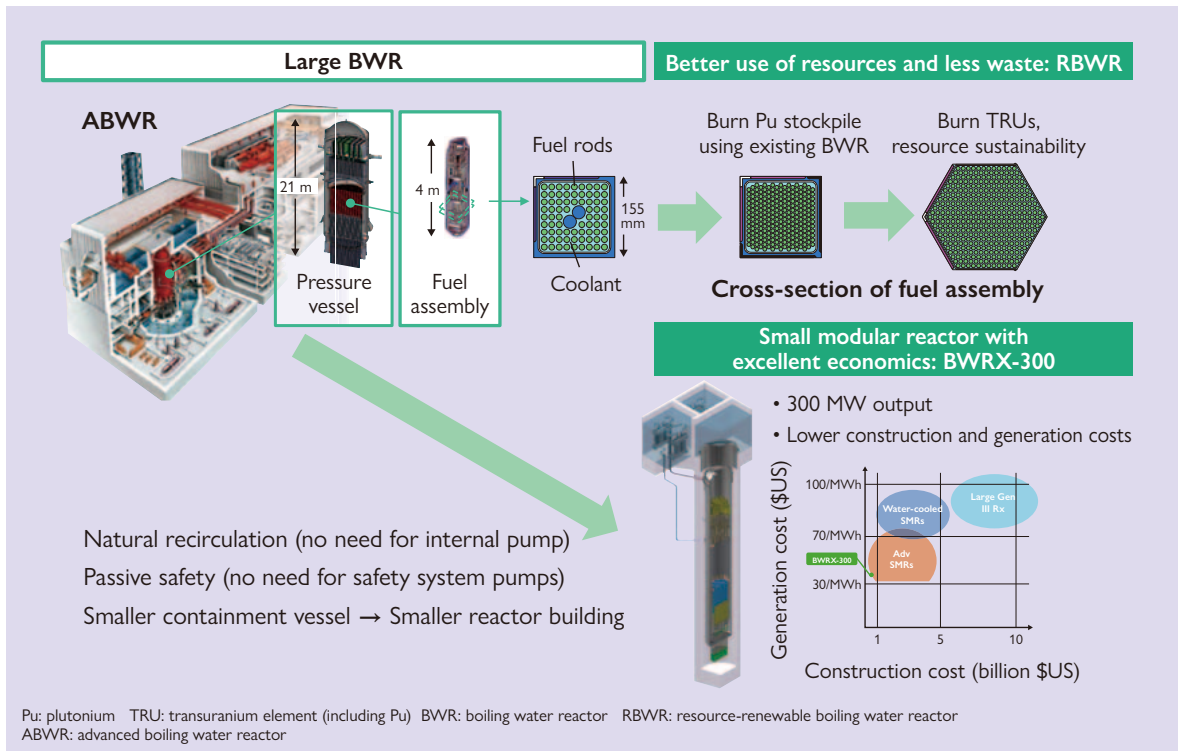
Using the widely used boiling water reactor (BWR) as a base, Hitachi is proceeding with the development of a nuclear reactor that satisfies society's need for better economics and reducing the environmental impact of spent fuel.

The resource-renewable boiling water reactor (RBWR) is intended to make more effective use of resources and to reduce the environmental impact of spent fuel. The RBWR features tightly packed fuel rods and utilizes the boiling of the coolant inside the reactor (the feature that gives the BWR its name), to minimize the deceleration of neutrons due to collisions with cooling water and thereby to increase the neutron energy over that of a conventional BWR. This enables the reactor to reuse the transuranium elements such as

plutonium and minor actinide that are contained in spent fuel and are responsible for it remaining radioactive for such a long time.

The BWRX-300 is a small modular reactor with an output of 300 MW that is being jointly developed by the US company GE Hitachi Nuclear Energy and Hitachi-GE Nuclear Energy, Ltd. Whereas past practice with BWRs has been to take advantage of economies of scale by building larger reactors such as the advanced boiling water reactor (ABWR), there has also been a rising demand in recent years for small reactors due to grid constraints and a desire to minimize the upfront investment risk. By utilizing the same configuration as the BWR, whereby steam from the reactor is fed directly into the turbine generator, to simplify the reactor design and reduce power plant construction, operating, and maintenance costs, the objective for the BWRX-300 is to combine smaller size with a lower cost of generation per unit of output.

Hitachi is contributing to lower construction costs mainly by drawing on its past experience with small reactor development to optimize the modular construction and use system analysis techniques to make the plant smaller.



3 Development of BWR that meets needs of society

## 4 Improved Energy Production of Wind Farm by Wind Turbine Control Technology Considering Wake Effects

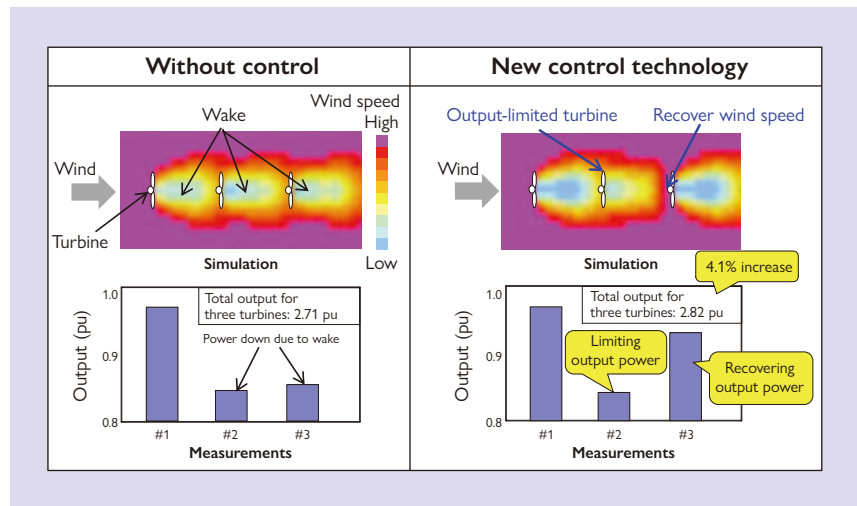
Customer demand for improved energy production from wind farms is increasing because of changes in feed-in tariff rates and the number of suitable sites for wind turbine construction is decreasing.

This has resulted in the construction of wind farms that are crowded with wind turbines, creating a problem with decreasing energy production due to decreased leeward wind velocity caused by wake effects. Hitachi developed a wind turbine control technology which increases the total amount of electric power produced by a wind farm. This control technology is using power limit control which takes wake effects into consideration. Control is applied to the windward wind turbines as the leeward wind turbines recover wind speed and power.

A demonstration of the technology was begun in April 2018 using three 2-MW downwind turbines at a wind farm belonging to Chubu Electric Power Co., Inc. According to the

results obtained between April and July, Hitachi confirmed the reduction of the influence of wake effects using this control. And, a 4.1% increase in the amount of power generated during times when wake effects were present (relative to past data). The meaning of this result is a 1% increase in annual energy production.

This demonstration will continue to verify the influence of control parameters to increase energy production.



4 Results of simulation and actual measurements of control technology for improved energy production

## 5 Operation and Management System for Smart Meters Using HAF/EDC for High-speed Calculation and Updating of Power Metering

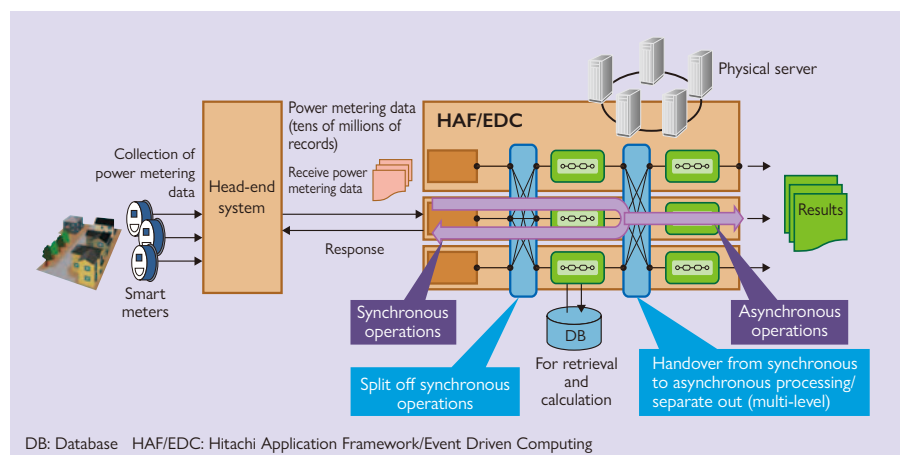
The electricity industry is seeing accelerating moves toward the real-time collection and analysis of data from smart meters and sensors and its use in applications such as demand prediction and maintenance services. Against this background, Hitachi has developed an operation and management system that uses the Hitachi Application Framework/Event Driven Computing (HAF/EDC) distributed execution platform\* for the high-speed collection, calculation, and storage of power metering data from smart meters.

This application receives tens of millions of power metering data records at 30-minute intervals from a network of smart meters via a head-end system. These need to be collated against past data and the differences calculated within a short timeframe, with the retrieval and saving of data in a data lake having the potential to become a bottleneck. The head-end system also requires a rapid response and measures to prevent loss of data.

To achieve this, Hitachi developed a multi-level execution technique for synchronous and asynchronous processing that, along with the distributed execution of data retrieval and storage on HAF/EDC, splits operations into those that require synchronous execution during the time between receiving metering data and sending a response and those operations for which this is not required, and is able to tie these two different types of processing together in a flexible manner. Using this technique, the required performance can be achieved using only five physical servers with typical specifications, achieving the requirement of a fast response with no loss of data.

In the future, Hitachi intends to contribute to measures for the use and evaluation of data in various different industries by using HAF/EDC as a base for further enhancing techniques for processing large amounts of Internet of Things (IoT) data with high speed and availability.

\* A development platform and application runtime platform for event-driven systems



5 Updating and calculation of power metering data from smart meters