For the Realization of

Energy System for Sustainable Society

CRIEPI
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Energy Transformation

Grid Innovation

Structured to drive innovation

by promoting the application of fundamental technologies across research areas

Each Research Laboratory consists of divisions organized according to the fundamental technologies they focus on, promoting the wide application of fundamental technologies across different research areas.In addition, the Strategy and Planning Division established in each Research Laboratory strategically facilitates cross-organizational research projects and cooperation with outside parties with the aims of bringing together the knowledge of different organizations and accelerating the delivery of outcomes.

Energy Transformation

Energy Transformation Research Laboratory
- Strategy and Planning Division
- Plant Systems Engineering Division
- Materials Science Division
  - Performance Demonstration (PD) Center
- Energy Chemistry Division

Mission

●Development of innovative energy conversion and storage technologies
- Development of hydrogen production and utilization technologies
- Assessment of potential of hydrogen energy carriers
- Development of rechargeable battery evaluation technologies
- Development of basic technology of poly-generation system

●Realization of zero-emission thermal power generation
- Development of CO_2 emission reduction technologies
- Development of combustion technologies suitable for hydrogen carriers
- Development of thermal power control and management technologies to accelerate introduction of renewable energy

●Lifetime extension of nuclear power plants and development of next-generation nuclear reactor
- Development of technologies for utilization and stable operation of existing light-water reactors
- Refinement of structural integrity evaluation methods for pressure vessels and core internals
- Establishment of nuclear fuel cycle technologies and support for nuclear facility decommissioning
- Development of fundamental technologies necessary for evaluation of require-ments for next-generation nuclear reactors

Grid Innovation

Grid Innovation Research Laborator
- Strategy and Planning Division
- ENIC Division
- Grid and Communication Technology Division
- Electric Facility Technology Division
  - High Power Testing Center
  - Shiobara Testing Yard

Mission

●Establishment of new nation-wide power system and advanced regional energy supply systems
- Keeping power system stability under the accelerated introduction of renewable energy
- Establishment of locally supply and demand balanced system by combining renewable energy, rechargeable batteries, and demand-side control
- Development of power distribution platforms to collect and share information on the power distribution system and link it to VPPs (virtual power plants)
- Establishment of communication technologies that combine real-time performance with interconnectivity and high degree of reliability including cybersecurity

●Support for asset management of electric power equipment
- Enhancement of resilience
- Optimal operation and maintenance of aging equipment

●Realization of all-electrified society
- Promotion of energy conservation and electrification in commercial, industrial, and transportation sectors
- Performance improvement and deployment of electric utilization technologies, such as heat pumps, electric vehicles, heating equipment, and electrification of agriculture

●Promotion of digital transformation in power and energy fields utilizing artificial intelligence, data science, human behavior research, etc.

Transforming power generation

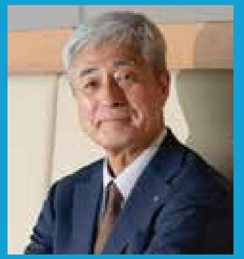
⋙ Energy Transformation (EX) Research Laboratory

Director
Masami Ashizawa

The electric power industry and the other energy industries are undergoing a historic turning point never experienced before, with the goal of achieving net-zero greenhouse gas emissions by the middle of this century. We will contribute to realization of SEEDS: Sustainable Energy Ecosystem makes Decarbonized Society, which a society that sustains a high quality of life, through transformation the energy systems and implementation them in society with our academic-based expertise and creativity to generate new value.There are the three keys to achieving Energy Transformation (EX) shown as follows.
i) "Build and maintain the best energy mix" to ensure energy security by avoiding geopolitical risks and improving energy independence.ii) "Decarbonize the power sector" to be enabled by maintaining and developing nuclear power, achieving zero emissions from thermal power with advanced circulation system of elements, and promoting renewable power.
iii) "Form an advanced energy network" incorporating hydrogen and synthetic gas production, transportation, and storage in the electric power system to improve flexibility and resilience.
To realize our future vision of SEEDS, three research divisions — Plant Systems, Materials Science, and Energy Chemistry — are united in our daily adventures. Why don' t you join us?

Innovating power grids

⋙ Grid Innovation (GI) Research Laboratory



Director
Koushitici Nemoto

With recent changes in international circumstances, energy security has become a global issue. As a result, renewed emphasis is being placed on S+3E. In particular, environmental compatibility, mainly in the form of carbon neutrality (CN), requires simultaneously advancing the electrification of energy demand and decarbonization of power sources. Additionally, the power systems that support these efforts need to be developed into a multi-layer and multi-functional industrial structure consisting of a grid infrastructure layer, which primarily consists of power equipment, and a cyber layer that utilizes digital data. The grid infrastructure layer includes the use of renewable energy as the main power source and the utilization of distributed energy resources (DER), while the cyber layer includes the use of big data obtained from power infrastructure and other sources. Furthermore, the prosumerization of the demand side will create the possibility of more flexible adjustment of the balance of electricity supply and demand, and various innovations are expected. In response to the needs and expectations of society, the electric power system is also entering an era of once-in-a-century transformation.
The mission of the Grid Innovation Research Laboratory (GI) is to support S+3E from the perspectives of grid technologies and power utilization technologies. In the words of Yasuzaemon Matsunaga, "Industrial research is the refinement of knowledge and virtue, and therefore should contribute to society," and we hope to be able to contribute to the stable and economical supply of electric power and the efficient utilization of energy.
Note: Japan' s energy policy sets S+3E as its basis, with safety as the major premise, and efforts are being made to simultaneously achieve energy security, economic efficiency, and environmental compatibility.

ENERGY TRANSFORMATION

EX

Development of energy conversion technologies for improving ability to adjust supply and demand

Thermal power generation has played a key role in the adjustment of supply and demand in the past, and its importance is increasing when renewable energy expands into power grids. On the other hand, CO_2 emissions from thermal power generation must be reduced. To achieve this, CRIEPI is investigating energy conversion technologies, including gasification, biomass application, and fuel cells/electrolysis, and evaluating their applicability (the time required for their realization and the scale and location of their application), efficiency, cost, etc. CRIEPI is also developing a polygeneration system with CO_2 capture (*), which is a promising technology.(*) Polygeneration system with CO_2 capture: A system that reduces the cost of CO_2 capture by making proper use of CO_2 at facilities where coal, carbon-based waste, and biomass are gasified, and the obtained syngas is used for power generation or the production of valuable chemicals according to the demand for electricity.

(*) Polygeneration system with CO_2 capture: A system that reduces the cost of CO_2 capture by making proper use of CO_2 at facilities where coal, carbon-based waste, and biomass are gasified, and the obtained syngas is used for power generation or the production of valuable chemicals according to the demand for electricity.

Development of technologies for production and utilization of hydrogen and ammonia

Hydrogen is increasingly expected to play a major role in the realization of a carbon-neutral society worldwide. CRIEPI is performing research and development on hydrogen production technologies, particularly technologies for evaluating alkaline water electrolysis and polymer electrolyte membrane water electrolysis, as well as next-generation electrolysis technologies such as solid oxide electrolysis. We are also studying and developing hydrogen use technologies, particularly those related to hydrogen and ammonia power generation, including ammonia co-firing in coal-fired power generation and the operation and maintenance of hydrogen gas turbines, with the aim of achieving zero-emission thermal power plants. In addition, we are carrying out research on assessing the economic efficiency and environmental performance of the entire hydrogen supply chain from production to transport, storage, and use.

Assessment of safety and performance of rechargeable batteries

Assessment of safety and performance of rechargeable batteriesAs renewable energy is increasingly becoming the main source of power, the use of rechargeable batteries is expected to expand for the absorption of surplus power of variable renewable energy and stabilization of power grids. To utilize rechargeable batteries as resources for energy storage stations and virtual power plants in various power markets such as the balancing energy market and the capacity market, maintaining performance and ensuring safety during long-term operation of rechargeable batteries is prerequisite.CRIEPI is developing performance evaluation technologies for lithium-ion batteries, which are rapidly increasing their use cases. Furthermore, we are conducting research and development of all-solid-state batteries, which are using non-flammable materials, for energy storage that can reduce the risk of accidents, as well as eliminate restrictions on where storage batteries can be installed.

Design and evaluation of next-generation nuclear reactors

To utilize nuclear power, which is a carbon-free power source that enables a stable supply of electricity with enhanced safety, we are conducting research to clarify the technical requirements for next-generation reactors. We are also carrying out R&D studies on the feasibility of (1) offshore floating nuclear power plants considering their heaving in the sea and (2) passive safety systems that practically eliminate core melts by using seawater. In addition, we are developing a method for neutronic and thermal-hydraulic coupled analysis that is useful for achieving high economic efficiency. It will be achieved through the utilization of next-generation nuclear reactors, such as those with load-following operation, ensuring fuel integrity, and reducing the amount of spent fuel. Furthermore, we are identifying issues likely to be discussed in reviewing next-generation nuclear reactors and launching research projects that will contribute to resolving these issues.

CARBON NEUTRALITY

CRIEPI is where innovation is born

GI

Development of power system stabilization technologies for accelerating introduction of renewable energy

With the target of developing renewable energy into the major power source toward carbon neutrality, the capacity of wind power generation and photovoltaic generation will be greatly expanded. It is necessary to ensure the stability of power systems even if the System Non-Synchronous Penetration (SNSP) increases. CRIEPI is developing power system stabilization technologies including those for the control of inverter-based resources (IBR), such as renewable energy sources and battery energy storage systems, and the use of a motor–generator (M–G) set that is a composite device of a synchronous motor and a synchronous generator mechanically coupled through the common shaft and driven by renewable resources and energy storages. CRIEPI is also pursuing the development of the Real-time Smart Digital Twin (RSDT) that duplicates the characteristics of power systems on a computer and facilitates the advanced analysis of them. The RSDT will contribute to implementing appropriate stabilization measures by collecting information on power systems in real time and grasping their characteristics.

Development of technologies for formation and operation of next-generation regional grids

In line with the efforts to position renewable energy as the main power source, the stabilization of power systems, the independence and decentralization of regional grids, and the local production and consumption of electric power are required. Along with this, it is also necessary to enhance resilience and to cope flexibly with diverse forms of power supply and the use of renewable energy. To achieve carbon neutrality in Japan by 2050, our Research Laboratory is developing technologies for regional grid formation and tools to support the operation of regional grids. We are also conducting verification tests on protection schemes against reverse power flow into generator vehicles, the soundness assessment techniques for power systems affected by a disaster, and the blackout start systems, by carrying out analyses using the tools developed by our Research Laboratory. Our aim is to ensure a reliable power supply to areas experiencing a blackout due to a disaster through the use of generator vehicles and renewable energy power sources.

Development of asset management techniques for electric power equipment

Electric power transmission and distribution equipment is critical and essential infrastructure that supports modern society. It is necessary to estimate aging and functional failures of each piece of equipment, and to ensure the cost-effective operation and maintenance. For this purpose, our Research Laboratory is developing asset management support techniques based on the characteristics of each major equipment. The accuracy of failure rate estimation is improved by clarifying the deterioration mechanism by assessing the residual performance of aged equipment removed from actual fields, accelerated deterioration tests, etc., and development of diagnosis techniques. Such progress will lead to reliable risk assessment. Using these results, we are developing support techniques to optimize maintenance strategies of electric power transmission and distribution equipment by considering cost and risk.

Accelerating DX in Electric Power Industry

Digital transformation or DX is of significant importance to achieve efficient operations in the electric power industry. By integrating our optimization, prediction and numerical computation technologies with emerging artificial intelligence (AI), data science (DS), human ethology, web and cloud technologies, we create new methods and experiences. In addition, we are now developing the Web Simulation Framework (WSF) that makes possible to use all kinds of simulations on the web to change the simulation industry.

GRID INNOVATION