Research Subjects (FY 2017)

Nuclear power generation

● Advancements of the safety of light water reactors

■ Enhancement of systems and structures to secure safety

- Promotion of Risk Informed Decision Making Process at Nuclear Power Plants

■ Establishment of evaluation techniques for low-frequency phenomena

- Development of Evaluation Method of Fault Activity for Nuclear Facilities
- Development of Evaluation Method of Earthquake Motions for Nuclear Facilities
- Assessment for the risk and hazard of volcanic eruption on Nuclear Facilities
- Development of Extreme Weather Assessment and Countermeasure Technologies for Nuclear Power Plants
- Development of Tsunami Risk and Impact Assessment Technologies for Nuclear Facilities
- Development of advanced seismic safety assessment technologies for buildings, equipment and pipes of nuclear power plants
- Development of advanced seismic safety assessment technologies for grounds and structures of nuclear power plants

■ Advancement of core damage assessment methodology

- Development of safety evaluation techniques prior to core damage
- Technology Development for Performance Evaluation of Nuclear Fuel and Reactor Core during Severe Accidents
- Research on Evaluation Technology of Accident Progression and Related Phenomena after Core Damage

■ Evaluation of impact of major accidents

- Development of evaluation method of radioactive material in environment

■ Establishment of probabilistic risk assessment (PRA) technology

- Development of risk assessment methodology for nuclear facilities
- Development of internal fire and flooding prevent methodology introducing risk informed evaluation in nuclear facilities

■ Promotion and advancement of independent public safety activities

- Development of voluntary safety action programs for nuclear power stations in consideration of human factors

● Safe and stable operation of light water reactors

■ Improvement of maintenance techniques for light water reactors

- Development of evaluation techniques for pipe thinning at light water reactors
- Improvement of preventive maintenance technology for LWR components and piping
- Improvement of water chemistry for dose rate reduction
- Improvement of integrity evaluation method for reactor pressure vessels
- Improvement of integrity evaluation method for core internals, piping and other components
- Development of nondestructive inspection techniques for components and piping in nuclear power plants

■ Maintenance and expansion of radiation protection systems

- Quantitative evaluation of low-dose radiation risk and reflection to radiation protection systems

■ Greater advancements in light water reactor technology

- Technology improvement for performance evaluation of nuclear fuel and reactor core

● Establishment of nuclear fuel cycle technology

- Development of long-term storage management technologies for spent fuel
- Development of technology to improve safety and stable operations of nuclear fuel reprocessing plants
- Safety assessment for overseas return waste storage
- Securement of options for future nuclear fuel cycle

● Support for radioactive waste disposal operations

- Enhancement of reliability of long-term safety assessment technologies for radioactive waste disposal
- Development of streamlined approach for the implementation of radioactive waste disposal project

● Ongoing long-term use of nuclear reactors

- Technology development for metal fuel fast reactors and pyroprocess

● Decommissioning nuclear reactor facilities

- Fundamental technology development for decommissioning and dismantling of nuclear facility
- Development of decommissioning, defueling and remediation technologies for severe damaged nuclear site

Thermal power generation

● Ensuring reliability of existing thermal power plants

- Development of condition diagnostic and maintenance management technologies of thermal power plants
- Development of on-site diagnostic technique for boiler tube failure in thermal power plant
- Improvement of remaining life assessment, diagnosis and maintenance for boiler and steam turbine components in thermal power plant
- Development of preventing technology for corrosion and corrosion fatigue on feed water and steam system components in thermal power plant
- Development of the hard clinker countermeasure in pulverized coal fired boilers
- Development of preventing technology for sulfide corrosion on boiler tube in thermal power plant
- Development of life assessment technology for high temperature structural components made of high chromium steels in thermal power plants
- Development of maintenance and management technologies for gas turbines
- Development of countermeasures for biofouling and jellyfish invasion at cooling water intake structure of coastal power plant
- Development of performance degradation assessment and enhancement methods for thermal power civil engineering and building RC structures
- Development of technologies for increasing use of coal ash

● Thermal technology to mitigate environmental load

- Development of maintenance and improvement technology of environmental facilities for thermal power plants
- Investigation and Evaluation of the influence on trend of the environmental regulation for thermal power station
- Study on technologies to evaluate the structural integrity of components in next-generation fossil-fuel power generation
- Development of technologies to improve operation of IGCC plant and reduce environmental loading
- Feasibility study of triple combined cycle system based on pressure performance of SOFC bench-scale cell
- Development of technologies for expanded use of biomass in thermal power generation

● Diversification of fossil fuels

- Diversification Technologies of Fuel Types for Thermal Power Generation

● Response to large-scale introduction of renewable energy

- Development of technology to improve load following capability of thermal power systems
- Improvement of flexible operations of coal pulverized thermal power plant and estimation of the value of its flexibility

● Response to risk of disasters

- Natural disaster assessment and measures for thermal power plants

Hydropower generation

● Disaster prevention and maintenance and management for hydropower facilities

- Development of disaster prevention and maintenance technologies for hydropower facilities

Renewable energy

● System resilience with high integration of renewable energy sources

▽Development of next generation power distribution network system
▽Development of power system technology contributing to transmission system resilience with high integration of renewable energy sources
▽Development of supply-demand operation and control technology using energy storage system
▽Development of accurate power output estimation and forecast techniques of photovoltaic and wind power generation
▽Performance evaluation of stationary energy storage battery systems for stabilizing power grid connected with renewable energy generation
▽Analysis and evaluation for policy design to the issues arising with large scale introduction of renewable energy

● Expanded introduction of biomass and geothermal power generation

- Development of innovative technologies for promoting the introduction of geothermal power

▽Development of technologies for expanded use of biomass in thermal power generation

Electric power transmission and distribution

● Response to reforms in electric power system

- Greater advances in systems to analyze surveys and forecast economic and electric power markets to project demand
- Development of support technology for widening system operation and reinforcing system interconnection
- Development of techniques to maintain supply reliability of power system under Japanese Electricity System Reform
- Development of technologies related to electromagnetic transient simulations of power systems
- Development of technologies to construct power utilities' communication infrastructure utilizing general-purpose communications technology

● Formation, maintenance and upgrades of substations and transmission lines

■ Advancing preservation technology for aged facilities

- Diagnostic technology for overhead transmission facilities
- Diagnostic technology for underground transmission cable system
- Diagnostic technology for substation equipment

■ Support to streamline facility design and operate facilities

- A study on rationalization of insulation design of the power apparatus and systems based on the lightning risk management
- Solutions for electromagnetic compatibility and electromagnetic interference (EMC/EMI) caused by HV substations and transmission lines
- Development and estimation of countermeasure technology for fault currents to secure public safety
- Verification of washing mechanism and development of practical washing technologies for PCB removal from PCB contaminated transformer
- Development of countermeasures against wildlife causing trouble in electric transmission facilities
- Development of maintenance and replacement technologies of communication systems used for power system monitoring, protection and control

■ Next-generation equipment technology anticipating future facility upgrades

- Evaluation techniques for power semiconductors
- Development of high efficient electric power distribution facilities for next generation

● Response to changes in supply form and demand-side changes

■ System resilience with high integration of renewable energy sources

- Development of next generation power distribution network system
- Development of power system technology contributing to transmission system resilience with high integration of renewable energy sources
- Development of supply-demand operation and control technology using energy storage system
- Development of accurate power output estimation and forecast techniques of photovoltaic and wind power generation
- Performance evaluation of stationary energy storage battery systems for stabilizing power grid connected with renewable energy generation

■ Next-generation power distribution system technology compatible with greater activity in demand region

- Power quality preservation and enhancement for distribution systems with advanced customer devices

● Forming, maintaining and update power distribution facilities

- Development of evaluation technology on lightning risk management and fault current countermeasures for distribution systems
- Diagnostic technology for power distribution equipment

● Response to disaster and human risks

- Evaluation of and countermeasures against earthquake damage to distribution facilities
- Development of extreme weather forecasting and hazard evaluation methods for distribution facilities
- Evaluation of and countermeasures against damages meteorologically caused to distribution facilities
- Application of disaster mitigation and restoration support technologies for electric power distribution equipments
- Development of cyber attack corresponding technology for power equipment monitoring and control system

Customers services

● Promotion of energy conservation and electrification and enhanced customer satisfaction

- Development and evaluation of advanced heat pumps
- Development of energy-saving and electrification technology in consumer and industrial sectors
- Research and development for electrification promotion of the transportation sector
- Development of Customer Satisfaction Measures utilizing Energy Related Information
- Assessment of the value of next-generation electricity demand management
- Power Retail Business Strategies and Issues in the Post FIT Era

Environment

● Response to environmental policy and regulations

- Research on domestic and international climate change policies
- Scientifically and economically rational scenarios to reduce CO_2 emissions
- Health Risk Analysis of Electromagnetic Fields and Other Environmental Factors
- Analysis of environmental expenditures and source apportionment of pollutants associated with air quality regulations

● Efficient environmental assessment

- Development of advanced and efficient impact assessment methods for atmospheric environment
- Development of advanced and efficient impact assessment methods for coastal environment
- Improved efficiency of assessment of impact on plants, animals and ecosystems and development of new evaluation methods

Utility management

● Ensuring consistency of power system reforms and energy measures

- Issues in institutional design of the electricity system reform
- Analysis for economic impact and political, regulatory and legal risk of nuclear power in Japan
- Analysis and evaluation for policy design to the issues arising with large scale introduction of renewable energy
- Structural analysis of energy and electricity demand

Common cross-cutting field

● Overall optimization through supply/demand coordination

- Optimization of advanced power supply and demand management

● Trend of develop technology in an overall electric power industry

- Analysis of global trends of technology development under changing business environment in electric power industry

● Common technology for application in diverse fields

- Development of advanced sensing technology for power plant components
- Development of high precision and high reliability analysis evaluation technique
- Trend survey of technology utilizing hydrogen
- R&D of Next Generation Electric Energy Storage Technologies
- Development of IoT solutions for Value Added Energy
- Development of elemental techniques for material strength evaluation methods utilizing miniature specimens

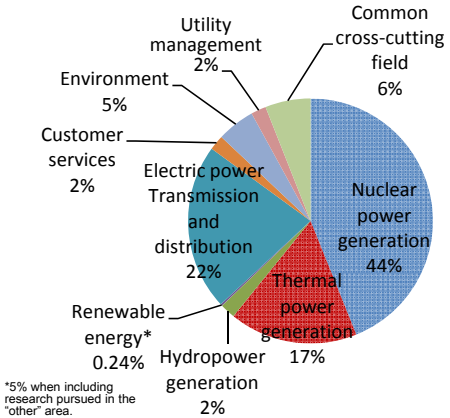
● : Major categories grouping research subjects related to each field
■ : Sub-categories grouping research subjects related to major categories
▪ : Names of research subjects
▽ : Research subjects promoted in research issues in other fields (listed multiple times)

2. Research plans

2-1. Overview of research plans

In addition to accurately ascertaining changes in the external environment affecting the electric power industry and conducting research aimed to consistently improve safety at electric power facilities and implementation of rational maintenance and operation, CRIEPI, in its research, also endeavors to create new value related to the supply and use of energy, including electrical power.

In fiscal 2017, CRIEPI designated 109 research subjects, and will undertake research target at meeting their respective objectives.
We will introduce an overview of research plans in each field from nuclear power generation, thermal power generation, hydropower generation, renewable energy, electric power transmission and distribution, customer services, environment, utility management, and common cross-cutting field. As shown in the pie chart on the right, much of the research budget has been focused on the three fields of nuclear power generation, thermal power generation, and electric power transmission and distribution, steadily promoting the value creation.



Percentage of Fiscal 2017 Research Budget Allocated to Each Field

Refer to p.8-9 "2-2. List of research subjects"

Nuclear power generation

CRIEPI will give a technical support to the utilities' activities to conform to the new regulatory requirements for restarting the nuclear power plants. In addition, for the utilities to strive for a voluntary and continuous safety improvement after the restart, CRIEPI will develop probabilistic risk assessment technologies for various hazards including internal events such as fire and flood as well as natural external events such as earthquake and tsunami which are characteristic of Japan. Moreover, we will also deal with the improvement of the structural integrity evaluation methods and/or the nondestructive inspection techniques for core internals, components, and piping to ensure safe operation of LWRs. Furthermore, we will conduct a genetic level research to assess the health effect of low-dose and low-dose rate radiation exposure and reflect the results on the radiation protection. Besides, we will continue the studies to support radioactive waste disposal program and nuclear fuel cycle business, and start studying the key technologies required for decommissioning of nuclear facilities.

Thermal power generation

CRIEPI will conduct research aimed at the early introduction of next-generation thermal power technologies such as the development of the elemental technologies of the IGCC system with CO_2 capture, results in both improving efficiency and mitigating environmental load of coal-fired power generation plants. Moreover, we will also work to develop technology to maintain and improve the capabilities of environmental measures facility to address smoke and water emitted from power generation plants, and fuel diversification technologies. Further, we will work to develop technology to improve load following capabilities for introducing the large amount of naturally varying power sources, such as solar power energy. Alongside this, we will promote the following R&Ds related to diagnosis and maintenance techniques applicable to existing facilities; •life assessment technology for high chromium steels, •preventing technology for corrosion and corrosion fatigue on feed water and steam system components, •nondestructive inspection techniques for materials with strong difficulty in ultrasonic flaw detection exposed to elevated temperature, and •development of stand-alone sensors to monitor the degradation of components over a long period.

Hydropower generation

CRIEPI will develop disaster prevention technology for hydropower facilities to guard against natural disasters, such as large-scale earthquakes and floods, and technology for preventive maintenance and fatigue diagnostics aimed at the continued utilization of ageing hydropower generation facility. Further, we will strive to develop technology for operational management of the hydropower facility such as optimal sediment management technology which takes account of environmental aspects in addition to water utilization.

Renewable energy

CRIEPI will continue to strive for power grid stabilization corresponding to the high integration of renewable energy, such as solar power energy. Further, with the aim of spreading the use of mixed combustion of biomass in coal thermal energy, we shall assess the environmental load and the pulverization and combustion of biomass fuel of an improved quality that has been molded to make use easier.

Electric power transmission and distribution

CRIEPI will perform the impact analysis of the future dynamic stability in both transmission and distribution network with high penetration of renewable energy sources and develop the countermeasure to cope with the future technical challenges. In addition, we will improve the functionality of the power system analysis tools in order to ensure the reliable power system operation with the introduction of wider system operation due to the reformulation of power systems.
Further, we will promote the development of technology for equipment soundness such as degradation diagnosis methods for ageing power cables, and means to assess the soundness of electric power transmission towers. Additionally, we will continue to strive towards the establishment of rational technology as a lightning damage countermeasure for power equipment in which there is becoming more and more compatibility with information transmission instruments and practical technology for the washing of PCB contaminated transformer, as well as contributing to the operational support and design rationalization for equipment. Moreover, we will strive for technological development against risks from natural disasters such as earthquakes and typhoons, and human risks such as cyberattacks.

Customer service

CRIEPI will further the development of high-efficiency instruments, such as heat pumps in order to promote energy conservation through electrification in the consumer, industrial, and transportation sectors, and, with a target of spreading those instruments, we will implement instrument capability assessment tests and high temperature environment simulations, and these will be reflected in regulatory standards. Furthermore, we will propose a way to utilize energy related customer information such as smart meter data, and contribute in enhancing customer satisfaction through power demand management and value added services. And we will also propose strategies to utilize customer-side energy resources such as roof-top PV generators, battery storage and controllable heat pumps to enhance the economic values in the Post Fit Era.

Environment

CRIEPI will analyze and assess domestic and overseas countermeasure for global warming, and propose the best possible way to appropriate measures. Further, we will strive to develop more efficient methods and new techniques of environmental impact assessments for power stations, assess the health risks of electromagnetic fields in electric transmission and distribution equipment, and make impacts of thermal generation exhaust gases on ambient concentrations of $PM_{2.5}$, which is one of the criteria air pollutants.

Utility management

In light of ongoing development of 'electricity system reform' characterized by introduction of capacity mechanism, non-fossil value transaction, base load power market as well as revision of the utilization rule of regional interconnection, CRIEPI will present insights from theoretical analyses coupled with evaluation of overseas preceding cases while taking specific circumstances unique to Japan well into consideration, and thereby provide support towards the detailed design of electric power system.

Common cross-cutting field

With the aim of ensuring the smooth operation in the supply and demand of energy which is becoming more complex accompanying the proactive utilization of dispersion-type powers sources, such as solar energy in the demand side, CRIEPI will strive for the technical development of demand response, for example, to bring about total optimization in the harmonization of supply and demand which links the supply and demand side to the system side. Further, we will strive for the technical development with the aim of applying AI (artificial intelligence) technology and IoT (Internet of Things) in, for example, energy conservation diagnostics for status monitoring systems, buildings, factories and households with the aim of rational maintenance management in ageing energy generation equipment, such as transmission line towers, etc.

Refer to p.22-23 "2-4. Close-up"