Research Plans

&

Statement of Budget

FY 2014

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Central Research Institute of Electric Power Industry

Contents

On Preparation of FY2014 Research Plans and Statement of Budget

With no indication yet as to when nuclear power plants will resume operations, the electric power industry's business environment remains extremely difficult. Moreover, electricity system reforms and basic energy plans are being revised on the backdrop of continuing demands for stable and affordable supply of electricity, while there is an urgent need to address aging electricity infrastructure and widen the introduction of renewable energy.

Given these situations in the electric power industry, CRIEPI will focus its activities on the following priority areas in fiscal 2014.

Pursue mission as joint research institution for electric power industry

- Given the severe budget restrictions resulting from provisional reductions in benefit income, continuing from fiscal 2013, we will thoroughly streamline various operations and cut costs, and also focus our management resources on projects with the greatest priority based on the needs of the electric utility industry.

- In pursuing our research, we will utilize our "Pool of knowledge," which consists of the human resources, know-how, research facilities and external human networks that CRIEPI has built up thus far, and generate high-quality research results in a timely and unerring manner. This will enable us to provide solutions to the urgent issues and important medium- and long-term problems facing the electric power industry.

- We will strive to further strengthen communication with the electric power industry, and augment our "Portfolio of Research Subjects" with appeal to the industry so that we can contribute to the resolution of issues with foresight, insight and ability to examine problems.

Establish business foundation and research strategies for the future

- In order to fulfill our responsibilities as an industry research institute that supports the electric power industry with our technical skills and problem-solving skills into the future, we will train and hire the human resources so essential to maintaining and developing research capacity, and build and update research facilities. We will also establish the research bases that are at the foundation of these endeavors.

- Keeping in mind that the changes in social situations, such as reforms to the electricity system, will have a different impact on each sector of the electric power industry, we will identify the technology that is indispensable to the stable supply of electric power in the future and the diverse options that will help us prepare for the heightened risks impeding this supply, and develop a research strategy that clarifies the role CRIEPI should play in this process.

As such, we will support the technological foundation of the electric power industry and contribute to the resolution of their issues in our role as an in-house research institute with research facilities and highly skilled researchers with wide-ranging specialties.

Overview of FY2014 Business Activities

Research Activities

Research Plans

CRIEPI has prepared "Primary Issues Facing the Electric Power Industry," which surveys the electric power industry and identifies the issues that should be resolved, and the "Portfolio of Research Subjects," which outlines the actions that CRIEPI should take to resolve these issues. Based on this, we have devised our research plan.

Specifically, we will clarify the respective priorities of each action outlined in the Portfolio of Research Subjects from the perspective of the electric power industry's needs and the role that we should play as a joint research institute, and prioritize the following actions that will contribute to the resolution of the urgent issues facing the electric power industry.

- Respond to the various issues confronting nuclear power generation, including the simultaneous rupture assessment that is part of the screening to determine nuclear power plants' compliance with new regulatory standards, analyze issues resulting from future regulatory and institutional changes and provide support in responding to them, and assess and improve safety in the face of natural external events

- Support in expanding effective use of coal ash and broadening fuel species, which contribute to the inexpensive and stable operation of coal-fired power generation

- Measures addressing aging of electric power distribution facilities and measures countering the risk of natural disasters, as well as system stabilization responding to increased adoption of renewable energy

In addition, we will take a path-breaking approach to the future possibilities of the electric power industry, and reinforce our initiatives to activation on the demand side.

At the same time, we will slow down or postpone research into areas that are not high priorities in terms of their urgency, while still maintaining our underlying research capacity. These include technology development aimed at developing nuclear power reactors that can run for more than 60 years, the development of evaluation technology for the application of

non-conventional liquid fuel to thermal power plants, and the development of component technologies for next-generation electric power distribution facilities, such as All-solid-insulated transformers, superconducting electric power apparatus and SiC semiconductors for power electronics.

In establishing and pursuing research plans, CRIEPI will conduct research on subjects consisting of priority subjects, priority subjects with limited terms and basic technology subjects under the three "Research pillars," described below, which govern our medium-term research directives, and will endeavor to generate timely and effective results.

(1) Establishment of Optimal Risk Management

We will carry out initiatives on "Nuclear Power Plant Safety," "Radiation Risks," "Nuclear Fuel Cycle and Backend Technologies," and "Natural Disaster Reduction on Transmission and Distribution Facilities." We will also evaluate and analyze "Energy and Environment Institutions." These initiatives will help to reduce the risks involved with the stable supply of electricity and facilitate risk management.

(2) Further Improvement of Facility Operations and Maintenance Technologies

We will conduct research on "Nuclear Power Plant Maintenance," "Construction, Operation and Maintenance of Power Generation Facilities," and "Operation and Maintenance of Transmission and Distribution Facilities," and will contribute to the development of more advanced operations and maintenance technology related to the stable supply of electric power.

(3) Development of a Supply/Demand Infrastructure for Next-generation Electric Power

We will focus on "Next-generation Thermal Power Technologies," "Next-generation Power Grid Technologies," and "Energy Utilization Technology," and will make contributions to further enhance the efficiency of electricity supply and electricity use, ensure energy security, and realize energy conservation and low carbonization.

Research Promotion

In pursuing our research, we will focus our efforts as follows.

- Further augment an appealing “Portfolio of Research Subjects,” which includes research on issues that the electric power industry will likely face in the future, based on mutual understanding with the industry

- Strengthen the research structure so that we can constantly produce high-quality results while still keeping research costs down

- Maintain and strengthen research capacity and ability to resolve issues by carefully selecting and steadily introducing and updating large-scale research facilities, which are essential to resolving the electric power industry’s issues, and building human networks with domestic and international research institutes

Administration and Workforce

In light of the difficult budget conditions, we will reexamine the need for all operations and continue to cut costs across all operations, including personnel costs. At the same time, we will steadily establish the research bases that are essential to maintaining and enhancing our future research capacity by selling asset holdings and replacing them with profitable assets.

Moreover, we will focus on encouraging employees to exercise their skills and on hiring and retaining diverse personnel in accordance with business development, and will disseminate research results and research capacity effectively to the electric power industry and the public as we strive to pursue operations in a sound and strict manner.

Income and Expenditure Budget

Business activity income is expected to amount to 26.24 billion yen, the total of 23.56 billion yen in donation income, which accounts for most of CRIEPI’s revenue and was reduced as in fiscal 2013 due to temporary measures, and business income and other income. Business activity expenditures will total 29.7 billion yen, the total of 27.88 billion yen in business expenditures and 1.81 billion yen in management expenditures. This is a 3.45 billion yen decrease over the previous fiscal year. Non-business activity income will be down 230 million yen as a result of loss on retirement of equipment and other capital. Accordingly, we

expect general net assets to decline 3.69 billion yen.

Designated net assets, whose use is restricted, are expected to decline by 190 million yen as a result of 50 million yen in subsidies and a 240 million yen transfer to general net assets.

As a result, net assets are expected to fall 3.88 billion yen in the current fiscal period (the total of fluctuations in general net assets and designated net assets), which will result in a 37.36 billion yen balance of net assets at the end of the fiscal year.

Research Plans

Research Activities

I. Research Plans

1. Priority subjects and priority subjects with limited terms

CRIEPI has selected issues from among the technologies that we believe are essential or will be essential for the electric power industry that it will prioritize in addressing, maintaining and continuing, and expanding. We pursue research on these 35 priority subjects. Those priority subjects into which CRIEPI's comprehensive resources should be invested for a quick resolution are designated "priority subjects with limited terms" (10 subjects).

CRIEPI's fiscal 2014 plan newly designates the three subjects of "Institutional Environments surrounding Nuclear Industry," "Development of Technologies for Increasing the Use of Coal Ash" and "Development of Accurate Power Output Estimation and Forecast Techniques of Photovoltaic Power Generation" in order to reinforce research contributing to the resolution of urgent issues facing the electric power industry. We completed research on "Evaluation of the Feasibility of Demand Response Suitable for Japan" and "Next-Generation Communications Network Systems" in fiscal 2013 with the achievement of the objectives for the period. In fiscal 2014, we will address "Assessment of the Value of Next-generation Demand Management" and "Demonstration and Common Specification of Next-generation Communications Network Systems."

Priority subjects and priority subjects with limited terms that should be addressed together have been grouped into 11 subject groups so that research can be carried out effectively. In this process, "Nuclear Power Plant Safety" and "Nuclear Power Plant Maintenance" have been identified as the most prioritized subjects, and the special research teams are established in fiscal 2012. The teams will marshal the expertise across several specialized fields in an integrated manner to enhance research activities.

Below we outline the main research plans for priority subjects and priority subjects with limited terms for each subject group.

(1) Establishment of Optimal Risk Management

With the aim of reducing risks and management associated with the stable supply of electricity, CRIEPI evaluates the impact that social and economic changes and natural phenomena have on the electric power industry, and addresses subjects that offer solutions, including social systems and frameworks.

Specifically, we address subjects related to enhancing the safety of light water reactors and identifying radiation risks, and will continue to focus on developing technology that could alleviate these risks an urgent issue for the electric power industry. Moreover, we will steadily promote research contributing to effective natural disaster countermeasures at electric power transmission and distribution facilities and research on ways of supporting radioactive waste disposal operations. CRIEPI engages in research related to the evaluation and proposal of energy and environmental policies that can achieve social consensus from a scientific and objective perspective.

Nuclear Power Plant Safety

- Evaluation of LWR System Safety: CRIEPI performs severe accident (SA) analyses for representative plants and evaluates the effectiveness of measures quantitatively taken to address these SAs. Based on these results, we support decision making to deploy safety measures at nuclear power plants. We have also introduced a test facility for fuel coolability in light water reactors (LWRs) to visualize coolant flow in the complex fuel bundle geometry. We also work to improve the accuracy of safety evaluation codes.
- Assessment of Natural Hazards to Nuclear Facilities: CRIEPI is working to establish a method for assessing hazards related to the scale of natural external phenomenon and the frequency of occurrence, which is essential in assessing the safety of nuclear power reactors. To this end, we develop scale assessment models for interrelated earthquakes, a method for assessing the scale of tsunami through tsunami deposits, and a method for predicting ash fall taking into account the scale of the volcanic product and weather conditions.
- Fragility Assessment of Nuclear Facilities against External Natural Phenomena: Through large-scale hydraulic tests utilizing a tsunami and flood channel introduced in fiscal 2013, we will scientifically examine methods of evaluating

tsunami hydrodynamic force and driftage collision force. We will also develop a probabilistic risk evaluation method that takes this impact into account. In addition, we will develop a new geotechnical analysis method in order to assess the stability of the foundation and surrounding slopes when an earthquake occurs based on actual conditions. We will use the expanded centrifugal vibrating table to test its effectiveness. Moreover, we will continue vibration experiments on important equipment using the resonant oscillation table to verify the acceleration at which equipment function can be maintained.

- Development of Environmental Diffusion Evaluation Methods and Long-term Behavior of Radioactive Materials: We will refine the model to assess the atmospheric diffusion of radioactive substances used to assess the safety of nuclear power facilities, thus enabling the evaluation of atmospheric diffusion and the deposition of radioactive substances.
- Establishment of Methodologies to Evaluate Fires in Nuclear Facilities: In order to establish fire defense systems at nuclear power facilities, in addition to the experiments using high-voltage power panels implemented in fiscal 2013, we will carry out arc fire experiments on low-voltage power panels. Based on these results, we will present rational arc fire countermeasures.

Radiation Risks

- Quantitative Evaluation of Low-dose Radiation Risk and Reflection to Radiation Protection Systems: We will establish biological mechanistic models for radiation carcinogenesis in terms of the accumulation of radiation effects that can explain the dose rate effects (even with the same exposed dose, the impact differs depending on the dose per unit time, i.e., the dose rate) shown in epidemiological studies of residents in areas with high natural background radiation in China and India. We will accumulate experimental data to prove their validity.

Nuclear Fuel Cycle and Backend Technologies

- Systematization of Long-term Safety Evaluation for Radioactive Waste Disposal: We are working on expanding applications of a quality evaluation method for cement-type engineered barriers developed for subsurface disposal to the near-surface concrete pit disposal, which is slated to undergo a safety review. In addition, we will develop a method to measure the montmorillonite content, which

has low permeability, contained in the materials of clay-type engineered barriers in order to evaluate quality of this barrier accurately.

- Development of Long-term Storage/ Management Technologies for Spent Fuel: With the aim of establishing a technology to monitor the soundness of dry storage canisters for spent nuclear fuel, we will build a measurement system in which a sensor is inserted within a concrete cask, and will be raising the applicability of a method that uses lasers to measure the salt concentration on the canister surface, which causes stress corrosion cracking (SCC), on the front lines.

Natural Disaster Reduction on Transmission and Distribution Facilities

- Development of Prediction Methods of Weather/Climate Affection to Electric Power Facilities: We are raising the accuracy of a method to determine regions with similar tornado frequency and a model to evaluate the speed of tornado missiles with the aim of developing a safety assessment for nuclear power plants. We are also refining the tornado impact assessment methods currently available. In addition, we are examining the application of a system currently in development that predicts short-term rainfall to cases of torrential rainfall in order to operate and manage hydropower dams through rainfall and flood projections. We will work to improve the accuracy of the projections.

- Demonstration of Preventive and Mitigating Measures against Snowstorm Damage to Transmission and Distribution Facilities: We will compile data from the operation of the nationwide local snow damage measurement systems, including the full-scale test facilities for snow-storm damage to overhead transmission lines, set up in fiscal 2013 in the Kushiro area. We will clarify the meteorological conditions that result in snow damage, such as heavy snow accretion and galloping, and develop a method for identifying regions that incur snow damage.

- Risk Management against Lightning: In order to increase the accuracy of lightning risk assessment methods, we will continue to collect lightning observation data, such as stroke currents and resulting electromagnetic fields within structures, as well as leader development characteristics, on lightning hitting tall structure, and will refine lightning parameters. In addition, we will develop an analytical model to quantitatively assess important induced surges in the established rational lightning protection designs. taking into account the electromagnetic immunity level of

control lines at substations and other facilities.

Energy and Environment Institutions

- Well-functioning Electricity Market and Neutralization of Network: We will analyze the impact of the legal separation of electric power transmission from generation and supply, and identify the risks involved in this unbundling. We will clarify the risks of market monitoring and asymmetric regulation and the role that new regulatory system would have, and propose an approach to electric power system reform that is desirable for society.
- Institutional Environments surrounding Nuclear Industry: We will analyze the nuclear power regulatory system and enforcement of regulations in terms of whether engineering and scientific knowledge is appropriately reflected, and propose remedial measures. We will analyze the business risks of nuclear industry resulting from regulatory system and policy changes. For example, with the reforms to the nuclear third party liability system, we will propose a mechanism to balance operators' predictability with compensation for victims, and support the nuclear industry in addressing these system reforms.
- Climate Change Policy: We will propose a package of measures for Japan's greenhouse gas countermeasure system consisting of energy-conserving measures with high cost-benefit effectiveness, renewable energy measures, technology development measures and carbon price measures that are mutually consistent.
- Scientifically and Economically Rational Scenarios to Reduce CO_2 Emissions: Based on knowledge in the IPCC's Fifth Assessment Report (AR5), we will update the evaluation methods for climate scenarios that have already been developed, and propose a long-term scenario for realistic CO_2 emission reductions and energy use technology.

(2) Further Improvement of Facility Operations and Maintenance Technologies

In order to provide technical support for the stable supply of the electricity that supports public live and economic activity, we will carry out research and development to enhance the effectiveness and economic value of power generating facilities and electric distribution facilities.

Specifically, we will steadily develop multi-purpose supporting technology for the preservation and management of light water reactors, essential to their ongoing operation, as well as technology supporting the construction, operation and maintenance of thermal and hydro power generating facilities and electric power transmission and distribution facilities.

Nuclear Power Plant Maintenance

- Structural Integrity Evaluation of Reactor Pressure Vessels and Core Internals: We will establish a method for assessing fracture toughness using miniature specimens that can be taken from used surveillance test specimens, with the aim of effectively using surveillance test specimens based on the Master Curve approach. This method can directly measure the fracture toughness of reactor pressure vessel steels.
- Integrity Evaluation of LWR Components and Piping: We have developed software to predict pipe wall thinning caused by flow accelerated corrosion (FAC) or liquid droplet impingement erosion (LDI) based on their mechanism. We will validate the software, FAC and LDI Prediction Software for Pipe Wall Thinning (FALSET), using plant data to apply it to the pipe wall thinning management.
- Integrity Evaluation of Cable Insulation used in Nuclear Power Plants: Based on the results of accelerated aging tests (irradiation tests) by controlling the additives in the cable insulating materials and the environments, we will elucidate the cable degradation mechanism with a focus on antioxidant behavior and develop a degradation prediction method. We will validate the degradation prediction method to apply it to actual instrumentation cables.
- Development of Nondestructive Inspection Techniques for LWR Components and Piping: To establish a dissimilar metal welds performance demonstration (PD) system, we will develop manufacturing methods for the PD test specimens containing simulated stress corrosion cracking (SCC) in the welded joints. Using

phased array ultrasonic testing methods, we will develop more accurate methods to measure SCC depth in the dissimilar metal welded joints.

Construction, Operation and Maintenance of Power Generation Facilities

- Development of Life Assessment Technology for High Temperature Structural Components of High Chromium Steels: We will carry out bending-internal pressure creep tests of 9 chromium steel welded pipe test specimens with the aim of developing facility diagnostic technology for high-temperature equipment made of high-chromium steel at thermal power plants. We will clarify the corrosion form based on non-destructive inspection, structure observation and numerical analysis results. We will also develop a method for assessing the impact that repair welding techniques have on the creep life of 9-chromium steel welded parts.
- Development of Comprehensive Atmospheric Assessment Method for Thermal Power Plants: We will add compatibility with coal-fired thermal power (SOx, particulate matter) and meteorological data analysis functions to the support tool for atmospheric environmental assessment for use with existing thermal power generation, and enhance its applicability on the frontlines. In addition, we will develop a tool for generation source analysis, such as photochemical oxidants and fine particulate matter ($PM_{2.5}$), in order to assess the impact of secondary air pollution on thermal power generators.
- Development of Technologies for Increasing the Use of Coal Ash: We will develop a fast quantification method for SiO_2 in fly ash and a fast method to assess the pozzolanic activity of fly ash for use in concrete. We will also develop a fast and simple quantification method for trace substances in coal ash and an environment safety evaluation method looking at the transfer of trace substances from products using coal ash to the soil with the aim of expanding the use of coal ash in the public works sector.
- Development of Technologies of Environmental Impact Assessment for Biodiversity Conservation: We will undertake local studies to closely examine our developed method for estimating the habitats of rare species (important species) with the aim of developing an impact assessment method for important species in environmental impact assessments at the planning stage. Moreover, we will develop 3D software for bird flight trajectories, and propose a survey method compliant

with environmental assessments for wind power generation and an impact assessment method to evaluate bird collision risk.

- Synthesis System of Numerical Analysis for Current and Sediments in Rivers and Reservoirs: We will develop an integrated system for flood and sediment behavior projection that adds functions to analyze and predict watershed sedimentation and water quality conditions to the existing system predicting rainfall intensity and discharge, with the aim of encouraging the rational dam operations by predicting the behavior of sediment in rivers and reservoirs.

Operation and Maintenance of Transmission and Distribution Facilities

- Maintenance and Management Technologies of Aged Transmission and Distribution Facilities: We will continue to reinforce the degradation database by accumulating data on degradation characteristics, remaining life and abnormal diagnoses for underground cables and power transformers. In addition to improving this database, we will add more information, such as facility operations, maintenance and inspections, and facility dependability in the event of natural disasters, and will develop a tool for assessing the dependability of equipment.
- Development of Soundness Assessment Technologies of Aged Transmission Towers: We will develop an inspection system to detect corrosion and degradation inside the steel pipes of overhead transmission towers, and build a framework for the soundness of aged towers. In addition, we will clarify the seismic performance of overhead transmission towers against high-level earthquake motions until the loss of transmission functionality in order to assess earthquake safety.

(3) Development of a Supply/Demand Infrastructure for Next-generation Electric Power

To prepare for, minimize and overcome future risks, we develop next-generation technical foundation that will enable greater efficiency and energy security in terms of both energy supply and energy use, and will address issues facing energy conservation and low-carbon systems.

Specifically, we will proactively develop technology for the effective use of low-grade resources in thermal power generation. In addition, we will develop technology such as next-generation grids enabling the smooth introduction of solar power and other sources of renewable energy into the power system, as well as technology that promotes the efficient use of energy, such as heat pumps.

Next-generation Thermal Power Technologies

- Improvement of Operation and Control Technologies to Diversify Fuel Types for Pulverized Coal Fired Power Plant: In order to encourage the use of bituminous coal, which is hard to grind at existing thermal power plants, we will clarify the appropriate conditions for its use, such as blending coal conditions, pulverization conditions and combustion conditions, through combustion tests using the coal combustion testing facility installed in fiscal 2013. In addition, we will clarify the corrosion resistance effect of a sulfidation corrosion resistant coating (already developed) to grooving corrosion through on-site testing in order to lower maintenance costs.
- Advancement of Utilization Technologies for Low Rank Energy Resources: With the aim of expanding the utilization of biomass co-firing in the existing coal-fired power plants, a biomass carbonization test facility was installed in fiscal 2013. The carbonization conditions of biomass suitable for high co-firing rate use in the coal-fired power plants have been defined by the carbonization test results of biomass with this test facility.

Next-generation Power Grid Technologies

- Power System Security Assessment with High Penetration of Photovoltaics: We will clarify the influence of high penetration of PVs on the dynamic stability of networks during system failures through tests using power system simulators and carrying out a CPAT simulation incorporating a power condition system (PCS)

model for use with PVs (already developed).

- Development of Accurate Power Output Estimation and Forecast Techniques of Photovoltaic Power Generation: For practical utilization in the demand and supply operation of the utilities, a real-time power estimation method in grid-connected photovoltaic systems will be improved, supplementing solar radiation network data with additional data, such as satellite images. In the prediction of solar irradiance for the next several days, we will improve our prediction method for obtaining more accurate results in the case of a sudden change in weather and evaluate the reliability of the predicted results using a statistical method.
- Development of Next Generation Distribution Network Techniques: We will use simulation analysis and experiments to clarify the impact that the reverse power flow from distribution system to the secondary system will have on voltage variations, following deregulation. We will also add evaluation functions, such as the judgment of the need for reverse flow countermeasures and calculation of PV interconnection capacity, to existing comprehensive analysis tools for power distribution systems and work to improve its applicability on the frontlines.
- Demonstration and Common Specification of Next-generation Communications Network Systems: We will put together specifications and evaluation methods for demonstration devices as preparation for field tests of the wide-area power system monitoring, protection and control networks used in multi-purpose and standard technology. We will also identify issues for security measures.
- Assessment of the Value of Next-generation Demand Management: We will clarify the issues in the event that demand response (DR) is used as a means of curbing the voltage spikes which can occur with the introduction of large volumes of PV. We will also study trends of ancillary-type DR (supporting frequency adjustment and reserve power supply) in the US, and outline the issues and assess its feasibility when implemented in Japan.

Energy Utilization Technologies

- Development and Evaluation of Advanced Heat Pumps: We will evaluate the steam generation capacity and COP (energy consumption efficiency) of an industrial-use steam-generating heat pump developed by power companies using the test facility for development and evaluation of heat pumps installed in fiscal 2013. We will also

jointly develop an industrial-use CO_2 refrigerant heat pump hot air dryer with a manufacturer.

- Establishment of Evaluation Technologies for High Performance Secondary Batteries: We will confirm the validity of our nondestructive evaluation technique of the degradation of lithium-ion batteries from the measurements of the slight change in the trend of voltage and/or temperature by comparing the more direct and destructive analysis of materials used in the batteries, which will contribute to an accurate prediction of the remaining life time. We will also introduce the Basic Equipment for Battery Performance Test and Material Investigation to aggressively advance our research on the internal materials of large-scale lithium-ion batteries.

2. Basic technology subjects

Basic technology subjects are those that we address with the aim of identifying and resolving issues faced by the electric power industry and maintaining and strengthening our basic research skills that are the source of our problem-solving, using our “Pool of knowledge” made up of knowledge useful on the frontlines, personnel with advanced expertise, sophisticated research facilities and our overseas and domestic human network. Specifically, we will built up data and knowhow through studies, experiments and measurements on site, develop, establish and refine analytical methods and approaches, and conduct basic research to flesh out new concepts. We will also address ground-breaking research that anticipate the needs of the electric power industry and society, and foster new basic research strengths.

We will continue to work closely with the national government and electric power industry to address the Fukushima Daiichi nuclear accident and make our own contributions to resolving technical issues for reactor decommissioning utilizing our basic technology.

We will designate 35 basic technology subjects in fiscal 2014 to capitalize on the strengths and specialized skills of eight laboratories with specific research fields*.

Examples of projects on basic technology subjects

Nuclear power generation

- In order to provide the technical basis for nuclear reactor decommissioning, we will evaluate the characteristics of simulated fuel debris manufactured by melting uranium dioxide, and develop a material accounting technology for fuel debris by applying burnup measurement technology for spent nuclear fuel.
- We will devise a conceptual design for an iodine removal system suited for conditions characterized by fast-moving steam, which is anticipated under severe conditions, to raise the performance of actual filter vents, and will begin component tests.
- We will confirm and examine whether the variation in physical properties of fault material associated with faulting, observed in friction experiments, occurs in actual active faults to establish activity evaluation methods for faults in bedrock.
- We will develop highly accurate dating methods using trace substances for volcanic ash dating back several tens of thousands of years and even several hundred thousand years, and will evaluate eruption histories and fault activities.
- In order to clarify the cause of strong ground motion in a near-source region and to evaluate a seismic-motion level for an unexpected source, we will confirm our estimated basement-motion at Rumoi by using borehole-array observation. We will also carry out basement-motion estimation at other stations and develop an evaluation method for near-source ground motion.
- We will enhance the content of the domestic Probabilistic Risk Assessment (PRA) database for the Japanese light water nuclear reactors. We will also establish equipment and system reliability evaluation methods for PRA, and consider frameworks for reliability data collection at power plants.

Thermal power generation

- We will establish non-destructive testing techniques for various kinds of damage and degradation to thermal barrier coatings, and develop a method for estimating temperature distribution in gas turbine rotating blades in the startup/shutdown process
- We will carry out microstructure observation and creep tests on welded portions of

high chromium ferric steel elbow pipe which was used for more than 100,000 hours in a commercial thermal power plant, and evaluate the cause of creep strength reduction in long time periods.

- We will conduct experiments using a natural seawater flow system simulating cooling water systems at power plants to establish the optimal countermeasures such as chlorine injection techniques to prevent marine fouling organisms.
- We will examine the practical performance of the bioreactor and the automated monitor for controlling selenium in wastewater through demonstration tests at power plants, with the aim of developing efficient wastewater management technology for coal-fired thermal power plants.

Power distribution

- We will clarify the superiority of CRIEPI's Power System Analysis Tool (CPAT) on the assumption that organizations promoting wide-area power administration will utilize it in system operations and planning, and work to make this the standard tool in Japan.
- We will carry out demonstration tests through direct current (DC) power transmission lines on their actual scale at the Shiobara Testing Yard and attempt to expand applications of electrical environment prediction methods for DC overhead power transmission lines as part of efforts to strengthen wide-area interconnection for electrical power systems.
- We will enhance our seismic-response analysis tools for electric-substation equipment based on shake table experiments and their simulations. We will also establish new seismic-resistant design techniques for the equipment and work to reflect those in the design standards.

Sales

- In addition to developing a demand simulator capable of imitating energy demand at the community level, we will calculate the energy conservation margin taking into account residence comfort, and build a database that can be used for energy conservation consulting in the sales department.
- We will examine the current status and issues of asymmetric regulations for existing power companies' electricity rates, based on case studies on electricity markets in the US and Europe. We will also conduct a questionnaire of end-users in

industrial and commercial sectors to assess the merits and demerits of deregulation, such as changes in electricity rates and services.

*Eight research institutes by specialty: Socio-economic Research Center, System Engineering Research Laboratory, Nuclear Technology Research Laboratory, Civil Engineering Research Laboratory, Environmental Science Research Laboratory, Electric Power Engineering Research Laboratory, Energy Engineering Research Laboratory and Materials Science Research Laboratory

II. Research Promotion

1. Strengthen multi-layered communication with electric power companies

- We will go further in our brush-up of research plans, which we done on an ongoing basis since fiscal 2012. We will also work to further augment our “Portfolio of Research Subjects” that will appeal to the electric power industry in order to contribute to the resolution of issues with our foresight, insight and ability to closely examine issues.

- We will participate in various research committees held by CRIEPI, gatherings for an exchange of opinions, and research societies to strengthen communication with electric power companies and thoroughly ascertain information and options at various levels. This will enable us to accurately reflect front-line needs in the “Portfolio of Research Subjects” and our research plans in a timely manner.

- We will clarify our role and research strategies in each research field, keeping in mind that reforms on the electric power system will have a different impact on each division in an electric power company.

2. Further strengthen research structure

- On the assumption that budget constraints will continue, we will rigorously examine research subjects and the number of experiments and continue to cut operating costs in order to generate high-quality results.

- When introducing research equipment, we will examine specifications to ensure that there are no excesses or deficiencies in light of the research plan, and will also cut costs through the efficient use of existing facilities and competitive bidding.

- In order to quantitatively lay out the value of CRIEPI’s research, we will continue to implement research value assessments to calculate the estimated economic value of the research. Moreover, we will have external experts conduct research assessments and work to raise the quality of research results.

3. Maintaining and enhancing research capacity and problem-solving skills

- In order to maintain and build upon our research capacity and ability to solve problems into the future, we will plan the introduction and updates of research facilities that support these capacities from a medium- to long-term perspective, and shape and maintain this on an appropriate scale.

- Given harsh budget constraints, we will introduce carefully selected, large-scale research facilities that are essential in resolving issues for the electric power industry. The main research facilities that we plan to introduce in fiscal 2014 are as follows.

  - Testing facility for fuel coolability in light water reactors: To utilize in research to enhance the safety of light water reactors

  - Extension of centrifuge shaking table: To utilize in the development and testing of a new seismic design method capable of assessing slope failure

  - Low-voltage distribution system coordination testing facility: To utilize in research on maintaining quality and public safety of electric power in a low-voltage distribution system to prepare for increasing introduction of PV/EV (to be completed in fiscal 2015)

  - Basic equipment for battery performance assessment and material adjustment: To utilize in research on internal deterioration of rechargeable batteries, life span estimation and research on materials assessment

  - Updates to electric power system simulator: Updates to deteriorated power generator unit

- With a view to the future, we also consider the need to maintain and develop basic technology capacity and ensure the diversity of our research fields. To this end, we train personnel with advanced expertise in a wide range of fields through long-term dispatch to Japanese and international research institutes and electric power companies.

- We will build and expand a highly effective network with Japanese and overseas research institutes with impressive expertise (such as the US-based Electric Power Research Institute, Électricité de France, Japan Atomic Energy Agency and the Marine Ecology Research Institute) that will complement our scientific knowledge.

4. Management and application of intellectual property

- We will review our approach to intellectual property strategy tailored to the characteristics of our research results and our assumed clients, based on our “Portfolio of Research Subjects.”

- We endeavor to secure, maintain and utilize intellectual property that can be expected to make a significant contribution to society via the electric power industry. We will efficiently pursue license contracts of patents and software. In particular, we will review the need for overseas patents to be submitted and maintained in terms of cost-effectiveness. We will resign overseas patents that are expected to have low utilization.

- We implement Security-Export-Control management, and will strive to ensure compliance with Foreign Exchange and Foreign Trade Act of Japan.

- We will continue to offer a download service of our research reports for free, in order to encourage the broad use of our research output.

- As an academic research organization, we will participate in national and academic committees, thus contributing to the establishment of specifications, standards and technical standards for the energy and environment.

5. Promoting funded research

- We will proactively undertake funded research that meets the needs of the electric power industry, and will promptly provide results that help to resolve issues on the front lines.

- We will receive government funding for research on issues related to specifications and standards that will contribute to the electric power industry. We will also take up the challenge of research that leads the way in resolving future issues that will face the electric power industry in order to refine our research capacity and expand our “Portfolio of Research Subjects.”

- We will facilitate the activities of the PD Center, which gives certification exams for experts of ultrasonic inspection working with nuclear power plant components. We will

also facilitate activities of the High Power Testing Laboratory, which performs short-circuit tests on electric power equipment.

Administration

1. Further cost-cutting

- We will keep routine costs in line with levels in fiscal 2013. To achieve this, we will review all operations to offset higher operating costs due to higher prices and a significant increase in assets for which fixed asset taxes must be paid as a result of our shift to the status of a general administrative corporation. We will suspend or postpone research and streamline operations in order to curb operating expenditures across the board.

- With our commissions and procurement, we will not only use competitive bids in selecting contractors and revise specifications, but will also cancel projects or move them in-house based on a review of the necessity for each operation in order to cut costs on an ongoing basis.

- In order to maintain the research environment while still cutting costs, we will establish a facility environment plan that clarifies priorities.

- We will examine the likelihood that we would use facilities in the future and continue to retire and sell facilities that we do not expect to use in order to reduce future obligations such as maintenance costs and fixed asset taxes. We will also review the need, priority and repairs needed, and clarify medium- and long-term plans for facility maintenance costs in order to find a balance between ongoing use and cost-cutting.

- We will continue with the cuts to salaries at the same level as in fiscal 2013 (30% for executive compensation and 10% for senior officers' and general employees' salaries). Moreover, we will continue with measures to reduce personnel expenses to curb overall personnel expenses.

2. Steady establishment of research bases

- We will steadily move ahead with efforts to consolidated research bases into two bases, one in the Yokosuka area and one in the Komae area, in order to establish the research

environment essential in maintaining and improving our research capacity for the future while also reducing fixed management costs. This will be funded with the income generated from the sale of some of the land in the Komae area in fiscal 2013 and aim for early completion.

- In the Yokosuka area, which we hope will become a “research base for the energy industry technology,” we will design new research buildings to hold the research divisions moved from the Komae area, and will begin construction work this fiscal year (tentative completion date of spring 2016). The move of the No. 7 Research Building (tentative name) and Thermal Hydraulics Building (tentative name) from the Komae area will begin in fiscal 2014 (construction completed in fiscal 2013). In addition, estimates and construction blueprints for the Materials Analysis Building (tentative name) are being prepared and administrative procedures are moving ahead.

- In the Abiko area, which is intended as a “research base for nature and the environment,” we will make and gradually implement specific individual plans for repairs and upgrade work in order to utilize existing facilities and equipment, based on the basic concept for these areas.

- In order to focus research at these two research bases and reduce personnel in the administrative and management divisions, these divisions will be reorganized with the transfer of the Intellectual Property Center and Administrative Support Center functions, currently located in the Komae area, to the Abiko area. We will design specific organizations and systems to be implemented in fiscal 2015. During this reorganization process, we will consider not only streamlining operations to enhance links with the head office functions and strengthening research support systems, but we will consider the development and utilization of personnel taking into account the characteristics of operations and differences in the expertise required for them. Moreover, we will establish a common area in the Abiko facility, where most employees will be transferred.

3. Promoting personnel’s job performance and hiring diverse staff in line with research development

- Extensive support (personal support) of each individual employee is the most important

part of our human resource management, and we will proactively use individual consultations with the Human Resource Department to help raise motivation and utilize human resources.

- We will establish a plan for hiring researchers in light of our “Portfolio of Research Subjects.” Moreover, we will utilize the “special limited-term research position,” introduced from fiscal 2014, in order to accelerate our efforts to address urgent and important subjects. We will also hire researchers with sophisticated expertise that gives them the ability to begin contributing immediately from among the many options available in different fields and industries.

- While we will continue to reduce administrative personnel, we will consider assigning personnel to positions in which they can optimize their abilities, depending on each individual’s suitability, in anticipation of the transfer and reorganization.

4. Effective dissemination of research results and research activities to electric utility and public

- With a focus on trends in the electric utility, which may experience major transformations, we will carry out publicity activities that will enhance CRIEPI’s presence. Specifically, we will provide the media with information based on society’s interests and needs, hold meetings to present research results and publish “CRIEPI News”, “CRIEPI TOPICS” and others in order to continually share our research results on a timely basis.

- In addition, we will strive for a close affiliation with electric power companies, and will also strengthen our public hearing activities by exchanging views with and collecting information from external experts and diverse media. The information obtained through these activities will be used to deepen recognition of issues, improve future research operations and facilitate publicity activities.

5. Sound and rigorous pursuit of business operations

- We will continue efforts to strengthen governance and risk management and establish and improve compliance awareness, as well as ensure sound and rigorous administration with

autonomy.

- We will complete our Plan on Expenditures for Public Benefit within the intended period (fiscal 2012 to fiscal 2014).
- We will continue to enhance information security by strengthening technical measures and educating executive officers.
- We will also augment our business continuity plan (BCP) to prepare for large-scale natural disasters.

Workforce

CRIEPI's basic policy aims to reach an equilibrium point of about 800 employees. Accordingly, we will maintain the current number of research staff, but gradually decrease the number of office staff by streamlining office work. We will endeavor to curb the total workforce by being selective in accepting other staff, such as special visiting researchers (workforce at the start of the fiscal year numbered 845 in fiscal 2011, 836 in fiscal 2012, 821 in fiscal 2013 and 808 in fiscal 2014). Moreover, we are steadily taking steps to reduce the workforce by suspending the employment of temporary contract employees, as well as considering rehiring measures based on the need for operations when rehiring employees who are retiring at the mandatory retirement age.

Based on the above policies, the fiscal 2016-2018 workforce plan will be newly established. The workforce at the start of fiscal 2014 is as follows.

(Expected as of April 1, 2014)

Item	Number (people)	Percentage distribution (%)
1. Research	710 *Including one temporary contract employee *Including 14 visiting researchers	87.9
〔Breakdown according to fields〕		〔100.0〕
(1) Electrical Engineering	109	15.4
(2) Civil Engineering and Architecture	103	14.5
(3) Mechanical Engineering	96	13.5
(4) Chemistry	69	9.7
(5) Biology	56	7.9
(6) Nuclear Engineering	43	6.0
(7) Environmental Science	40	5.6
(8) Information and Communication	36	5.1
(9) Socio-economics	49	6.9
(10) Research Support and Management	109	15.4
2. Office work	98	12.1
Total	808	100

Statement of Budget

Budget Compilation

The fiscal 2014 budget for CRIEPI operations was compiled based on research plans. The main points are as follows.

1. Changes in general net assets

(1) Recurring revenue amounted to 26,245 million yen.

- Benefit income from electric utility companies amounted to 23,565 million yen.
- Business revenue stood at 2,350 million yen.

  Of this business revenue, revenue from nationally funded research accounts for 1.5 billion yen.

  Other business revenue, including revenue from short-circuit tests and revenue from joint research, totals 850 million yen.
- Other revenue, such as interest payments, amounted to 90 million yen.

(2) Ordinary expenses amounted to 29.7 billion yen.

- Business costs related to research totaled 27,887 million yen.

  Of these business costs, personnel expenditures such as salaries and retirement benefit costs totaled 9,042 million yen.

  Operating expenses, including consumable costs, outsourcing costs and amortization costs, amounted to 18,845 million yen.
- Management costs related to headquarters operations were 1,813 million yen.

  Of this, personnel expenditures such as compensation for executive officers, salaries and retirement benefit costs totaled 1,018 million yen. Operating expenses, such as consumable costs, totaled 795 million yen.

(3) Non-recurring costs totaled 239 million yen, consisting of losses on the retirement of fixed assets.

2. Changes in designated net assets

(1) Revenue from funded research, including revenue from the Japan Society for the Promotion of Science, is 50 million yen.

(2) Transfers to general net assets totaled 240 million yen due to amortizations related to the designated net assets included in special assets and other factors.

3. Balance of net assets at fiscal year-end

Net assets in this fiscal period fell a total of 3,884 million yen, which is the sum of fluctuations in general net assets and designated net assets. Accordingly, the balance of net assets at the end of the fiscal year was 37,360 million yen.

Budget

The fiscal 2014 budget, compiled based on the above, is as follows.

Fiscal 2014 Budget for Revenues and Expenditures

From April 1, 2014 through March 31, 2015

(Unit: Million yen)

Subject	Budget	Remarks
I Changes in unrestricted net assets		
1. Operating activities		
(1) Recurring revenue		
① Benefit income		
Current benefit income	23,565	
② Business income	2,350	
Funded research business income	1,500	
Other business income	850	
③ Other income	90	
Interest revenue	5	
Facility use fees received	80	
Miscellaneous income	5	
④ Transfers from restricted net assets	240	
Total revenue and gains	26,245	
(2) Ordinary expenses		
① Expenses for projects and programs		
Personnel expenditures	9,042	
Wages and allowances	6,998	
Retirement benefit expenses	1,073	
Welfare expenses	971	
Operating expenses	18,845	
Consumable costs	1,475	
Publication costs	375	
Lighting, heat and water utility costs	1,025	
Outsourcing costs	6,090	
Joint research contribution	950	
Repair costs	1,390	
Rental costs	270	
Tax and dues	550	
Travel and transportation costs	745	
Communication and transport costs	90	
Other operating expenses	755	
Amortization costs	5,130	
Sub-total for expenses for projects and programs	27,887	
② General and administrative expenses		
Personnel expenses	1,018	
Executive officer compensation	128	
Wages and benefits	578	
Retirement benefit expenses	90	
Welfare expenses	134	
Provision for directors' retirement benefits	88	
Operating expenses	795	
Consumable costs	6	
Publication costs	45	
Lighting, heat and water utility costs	28	

Outsourcing costs	116	
Repair costs	13	
Rental costs	342	
Tax and dues	51	
Travel and transportation costs	34	
Communication and transport costs	6	
Other operating expenses	109	
Amortization costs	45	
Sub-total of general and administrative expenses	1,813	
Total expenses and losses	29,700	
Total changes in operating activities for the year	△ 3,455	
2. Changes in non-operating activities		
(1) Non-operating revenue		
Total non-operating revenue	—	
(2) Total non-operating expenses and losses		
Loss on retirement of fixed assets	239	
Total non-operating expenses and losses	239	
Total changes in non-operating activities for the year	△ 239	
Total changes in unrestricted assets	△ 3,694	
Unrestricted assets at beginning of year	40,486	
Unrestricted assets at end of year	36,792	
II Changes in restricted net assets		
① Subsidies received		
Subsidies received	50	
② Transfer to unrestricted net assets	240	
Total changes in restricted net assets for the year	△ 190	
Net restricted assets at beginning of year	758	
Net restricted assets at end of year	568	
III Net assets at end of year	37,360	