Energy Business

Medium-term Management Plan

Business Segments



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Overview

In an effort to keep up with changes in society, we, as Japan's leading company focusing on zero-carbon energy, are making the most of renewable energy for use as main power source, maximizing the use of nuclear power and opting for zero-carbon power sources, including zero-carbon thermal power generation and zero-carbon hydrogen utilization. At the same time, we are committed to mobilizing our resources to help customers and society realize zero-carbon operations by proposing and providing optimal solutions, examining and demonstrating approaches to create a hydrogen-driven society.

In addition to establishing a system of seven nuclear reactors with a primary focus on safe and secure operation, we will create a competitive power source portfolio, rationalize fuel procurement and supply-demand balancing, and promote the introduction of DX-based monitoring and maintenance. All of these are designed to improve the cost structure reform and achieve targets set in the Medium-term Management Plan.

New energy and environmental markets, meanwhile, will be developed and new values will be provided through various solutions to further boost profits.



Business environment

Opportunities

- Create new business opportunities in new and peripheral areas in energy and environmental businesses by accelerating social change: the 3D + D* movement.
- Acceleration in decarbonization and improvements in government policies and institutions
- Sustainable use of nuclear power generation is specified in the cabinet-approved Basic Policy for the Realization of GX
- Introduction of an auction system for long-term decarbonized power sources

* 3D+D: Decarbonization, Decentralization, Digitalization plus Denka electrification

Risks

 While fuel prices increased sharply after the beginning of the conflict in Ukraine, high market prices are currently reaching a plateau, appearing to trend downward, with market volatility increasing.

LNG market trends

(\$/MMBtu) 🌒 JKM 🛛 🔴 JLC



Notes:

JKM: Japan Korea Marker. Platts JKM assessment spot price for LNG referenced in Northeast Asia.

JLC: Japan LNG Cocktail. Japan's average LNG import price.

Business environment



Business strategies



1 Promote thorough cost structure reform to restore profitability in the energy business.

2 Work toward realizing "zero-carbon power sources" including zero-carbon thermal power, nuclear power and renewable energy, as well as verifying and demonstrating hydrogen energy utilization.

3 Provide new value through various solutions to increase profitability, while promoting electrification or *Denka*.

5-year Efforts

1 Restoration of profitability

Cost reduction

- Build a competitive power source portfolio (rationalization of low-operating power sources).
- Optimize power source operations including fuel and electricity market transactions, and minimize procurement costs.
- Promote introduction of a digital technology-based surveillance and maintenance system.

2 Zero-carbon power sources/hydrogen

Nuclear power

- Ensure operation of all seven reactors in our nuclear power plants in a sophisticated manner with safe and secure operations as a basic premise.
- Conduct technical studies of next-generation successor models with an eye on replacement, as well as surveying HTGRs and SMRs.
- Promote the nuclear fuel cycle.

Renewable energy

- Work on new development projects with a focus on offshore wind power.
- Improve existing hydropower plants.

Thermal power

• Conduct technical studies and cooperate on zero-carbon fuel (hydrogen/ammonia power generation) co-firing and CCUS, etc. in the "carbon recycling technology hub."

Hydrogen

• Conduct technical studies and demonstrations for building a hydrogen supply chain in the "hydrogen utilization technology hub" and other purposes.

3 Solutions

Provide new value to meet diversifying customer needs for new lifestyles, zero-carbon emissions, improved resilience, etc.

Household customers

• Provide services combining energy with electric appliances, storage batteries, etc. and platform services beyond energy.

Corporate customers

• Provide total support to on-site renewable energy power sources, zero-carbon menus, etc. aiming to achieve zero carbon.

Communities/e-mobility

- Provide community energy management services to improve resilience.
- Provide package services related to electric mobility.

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Initiatives in fiscal 2022

Restoration of profitability

Rigorous cost structure reforms

Each division is working on a variety of measures, including cutting down overhead and maintenance costs, to improve profits by about 90 billion yen in fiscal 2025.

Concrete measures

Streamlining facility inspection procedures using under-water drones

Conventional inspections, where the submerged parts of hydropower dam discharge facilities (spillway gate wire ropes) were visually inspected by divers, are currently performed using under-water drones; inspection procedures have been streamlined, resulting in reduced inspection costs.

Meanwhile, our digital technology, including the use of these drones, is shared with others through our group companies, contributing to safe and efficient maintenance/ management of infrastructure installation.

Streamlining monitoring inspections using robots and AI

A system for monitoring thermal power generation facilities has been built with AI technology, using robots and sensors. We have confirmed that the system can detect oil leakage and abnormal heat/sound from devices at the same or higher levels than by human inspectors in real time. We aim to further improve productivity with this human-digital hybrid system.

2 Zero-carbon power sources/hydrogen

Approaches to nuclear power generation

Establishing a system of seven nuclear reactors and continuing safe and secure operation

Maximizing utilization, with priority given to safety

As we are committed to realizing green transformation (GX) to achieve carbon neutrality by 2050, we will maximize the use of nuclear power generation and balance the 3Es (Energy security, Economy and Environmental conservation; decarbonization), prioritizing safety.

With the share of nuclear power in the power generation mix maintained at certain levels, we will continue to contribute to preserving Japan's technology and human resources for nuclear safety.

At the same time, we will proactively engage in communication with the public, including communities near the plant sites, an indispensable measure for public relations in promoting understanding of power plant operations.

Concrete measures

Promotion of safety improvement measures

Large-scale safety improvement work has been completed to comply with new regulatory requirements set in accordance with lessons learned from the accident at the Fukushima Daiichi Nuclear Power Station; nuclear power plants proven to be safe are already in operation.

In addition to complying with the new regulatory requirements, self-imposed safety measures are being practiced.

Examples of voluntary safety improvement measures in fiscal 2022:

• An external power failure detection system voluntarily installed is in operation to deal with accidents similar to the single phase failure (electrical accident) that occurred in the US.

Achieving over 40 years of operation

In applying for an operation period extension for 40 years from the starting month, in addition to special inspections carried out for reactor vessels and other equipment, we have carried out technical evaluations of degradation from age and confirmed that the durability and safety of important facilities could be assured even over an operation period of 60 years.

Mihama Nuclear Power Station Unit 3 restarted in 2021, complying with new regulatory requirements. It is the first 40-year-old reactor in Japan to be restarted. Takahama Nuclear Power Station Unit 1 was also restarted in August 2023, to be followed by Unit 2 in September of the same year (scheduled as of August 31, 2023). Takahama Nuclear Power Stations Units 3 and 4, meanwhile, underwent special inspections required for exceeding 40 years of operation, and in April 2023 we applied for an operation period extension for 60 years.



Takahama Nuclear Power Station

Interim storage facilities

Spent fuels are stored in a spent fuel pool inside power stations for a certain period of time and then transported to a reprocessing plant. In case the pool is filled to capacity, the power station cannot be operated. For this reason, spent fuels have to be taken out in a planned manner. Installation of an interim storage facility, in which spent fuels are temporarily stored, enables the stable operation of power plants into the future. With the "Plan to promote measures for spent fuel" set up in 2015, we are working on selecting the candidate sites for interim storage facilities outside Fukui Prefecture, to be finalized by the end of 2023 for planned commencement around 2030.

Communicating with the public, including communities near the plants

Our communication program includes visiting residents in communities near the plants, offering tours in-person and online, holding external events, and participating in presentation meetings.

Addressing challenges with replacement in mind

Review of options such as next-generation light-water reactors, high-temperature gas-cooled reactors and SMRs*

Maintaining the share of nuclear power in the power generation mix at certain levels is key to creating a zero-carbon society, and inevitably involves new installation, expansion, and replacement. We cooperate with plant manufacturers in designing next-generation light-water reactors with improved safety and efficiency in preparation for future replacement while reviewing possible options such as high-temperature gas-cooled reactors and SMRs, monitoring the latest development trends at home and abroad. * Small Modular Reactors

Initiatives prioritizing safety

To prevent the lessons of the Mihama Nuclear Power Station Unit 3 accident from fading away

On August 9, 2004, an accident involving the rupture of secondary system piping occurred at Mihama Nuclear Power Station Unit 3. Based on the President's Declaration "Ensuring safety is my mission, and the mission of the Company," we have strictly implemented recurrence-prevention measures, with a firm determination that we shall never cause such accidents. The Nuclear Power Division has established Five Basic Principles as preventive measures that form part of our quality policy concerning the operation of nuclear power businesses with safety as the top priority. These measures are revised as necessary for safety improvement purposes. Making every August 9th our "Safety Vow Day," every employee observes a moment of silence. We are working to cultivate a safety culture in order to implement business management with safety as the top priority and prevent the lessons of the Mihama Nuclear Power Station Unit 3 accident from fading.

Establishment of a company proclamation: Commitment to Enhancing Nuclear Safety

In response to the accident at the Tokyo Electric Power Fukushima Daiichi Nuclear Power Station, we established our Commitment to Enhancing Nuclear Safety, which clearly states our idea about nuclear power safety, as a company proclamation, one of our most important company rules. This company proclamation underlines our determination to constantly improve safety in nuclear power generation, whereby all executives and employees fully understand the characteristics and risks of nuclear power generation and always remind themselves of the potential magnitude of an accident, with the President playing a leading role in making company-wide efforts to protect local communities, society and environment.

Concrete measures

Learning lessons from the accident at Mihama Nuclear Power Station Unit 3, we place a premium on nuclear safety. Specifically, the accident at the Tokyo Electric Power Fukushima Daiichi Nuclear Power Station made us aware that our understanding and preparedness for risks unique to nuclear power generation were not necessarily sufficient. We, therefore, established a roadmap to enhance practicing voluntary and continued measures to improve safety in nuclear power generation, with relevant efforts underway.

Boosting the accident response capacity

Comprehensive emergency response drills are conducted at all nuclear power plants as a precaution in the event of a nuclear disaster. In preparation for severe accidents beyond design basis, involving serious cases such as injuries during accident response, efforts are also underway to further improve accident response capacity. These specifically include unscripted drills for participants and quick, appropriate restoration activities based on continuous improvements made by previous drills, all designed to prevent accidents from expanding. At the same time, we are working with five power companies* and affiliates in West Japan to better deal with nuclear disasters.

* Hokuriku Electric Power Company, our Company, the Chugoku Electric Power Co., Inc., Shikoku Electric Power Co., Inc., and Kyushu Electric Power Co., Inc.

Examples of drills:

- We participated in the Nuclear Energy Disaster Prevention Drill held by the national government, where programs for task force management, accident control, evacuation of civilians, and cooperation with relevant institutions are performed to respond to potential power failures caused by earthquakes.
- "Stress training" programs were conducted for plant task force

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members to help them handle severe accidents where a variety of stressful situations occur simultaneously or in succession.

Reliable decommissioning processes

Decommissioning status of Mihama Nuclear Power Station Units 1 and 2 and Ohi Nuclear Power Station Units 1 and 2

The Company plans to conduct decommissioning over four major stages taking a total of about 30 years in accordance with nationwide coordination and fund management by the Nuclear Reprocessing Organization of Japan*. Currently, stage 2 (dismantling of facilities peripheral to reactors) is underway at Mihama Nuclear Power Station Units 1 and 2, and stage 1 (dismantling of equipment in the turbine building and monitoring of residual radioactivity) is underway at Ohi Nuclear Power Station Units 1 and 2. Appropriate measures are in place for decommissioning, with the highest priority given to safety.

* To be renamed on April 1, 2024.

Approaches to renewable energy

Further developing and leveraging renewable energy

Leading Japan in zero-carbon energy production, our Group is committed to proactively developing renewable energy based on its improved development promotion system, focusing on offshore wind power generation, which has great development potential. Through investment of a total 1 trillion yen in domestic projects, we aim to develop 5 GW scale of new development and to achieve 9 GW scale of cumulative capacity by 2040. On the domestic front, for example, we focus on increasing hydropower output and developing solar power, onshore wind power, offshore wind power, biomass power, geothermal power, and hydropower plants, and the total capacity of which stands at about 3.83 GW as of the end of March 2023. We will continue to operate the existing power sources and develop new power sources to help customers and society achieve zero carbon.



Biomass: Fukushima Iwaki Biomass Power Plant

Solar power:

Banshu Mega Solar Power Plant

Concrete measures

Development status in Japan in fiscal 2022

- In April, 2022, the Group commenced commercial operation of the Fukushima Iwaki Biomass Power Plant, which uses biomass fuels.
- Together with Mitsubishi HC Capital Energy Inc., we participated in a solar power project in Nishimuro-gun, Wakayama Prefecture.
- A consortium consisting of the Company, INPEX Corporation, TODA Corporation, ENEOS Corporation, Osaka Gas Co., Ltd., and Chubu Electric Power Co., Inc. was certified for the first time in Japan for public tender of exclusive occupancy and use for the offshore wind power plant to be constructed in the marine renewable energy power generation facility promotion zone off the coast of Goto City, Nagasaki Prefecture.
- The Company, Marubeni Corporation, Obayashi Corporation,

Tohoku Electric Power Co., Inc., Cosmo Eco Power Co., Ltd., Chubu Electric Power Co., Inc., The Akita Bank, Ltd., Ohmori Co., Ltd., Sawakigumi Co., Ltd., Kyowa Oil Co., Ltd., Kato Construction Co., Ltd., Kanpu Co., Ltd., and Sankyo Co., Ltd. jointly commenced commercial operations at the Noshiro Offshore Wind Farm in December 2022 and the Akita Offshore Wind Farm in January 2023.

- Banshu Mega Solar Power Plant, jointly funded by the Company and ENEOS Corporation, started commercial operation in January 2023.
- In February 2023, the Company started a business providing electricity along with environmental value by developing solar power generation technology for Panasonic Operational Excellence Co., Ltd. and Hydro Edge, one of our group companies, based on a corporate PPA.

Launching offshore wind power projects in Akita Port and Noshiro Port

We have been working on Japan's first project for large-scale commercial offshore wind power plants in Akita Port and Noshiro Port, both in Akita Prefecture, through the special purpose corporation Akita Offshore Wind Corporation (AOW) and in cooperation with Marubeni Corporation, Obayashi Corporation, Tohoku Electric Power Co., Inc., Cosmo Eco Power Co., Ltd., Chubu Electric Power Co., Inc., The Akita Bank, Ltd., Ohmori Co., Ltd., Sawakigumi Co., Ltd., Kato Construction Co., Ltd., Kanpu Co., Ltd., Kyowa Oil Co., Ltd., and Sankyo Co., Ltd.

The Akita Port Offshore Wind Farm and Noshiro Port Offshore Wind Farm are operating as scheduled; the former started commercial operation on January 31, 2023, and the latter on December 22, 2022, both based on the renewable energy feed-in tariff scheme. AOW's offshore wind power generation is now in full swing, with Akita Port Offshore

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Wind Farm in operation. AOW will control the two wind farms over the next 20 years, utilizing an operation and maintenance system based at Noshiro Port.



Left: Akita Port Offshore Wind Farm Right: Noshiro Port Offshore Wind Farm (Source: Akita Offshore Wind Corporation)

Refurbishment of existing hydropower facilities

Hydropower generation, which has a history of over 100 years, has been providing clean energy in a safe and stable manner while co-existing and building mutual trust with local communities. Leveraging our accumulated expertise in hydropower, we conduct timely maintenance to extend the service life of facilities, thereby streamlining overall operations.

Refurbishment, for example, is planned for aging power generation facilities (replacement of water turbine generators) to further extend the service life, with modern equipment and design technology expected to improve their power generation efficiencies. We will systematically refurbish existing hydropower facilities, as hydropower is a key power source that contributes to creating a decarbonized society.

Concrete measures

Power plants under refurbishment (FY 2022)

- Kurobegawa No. 2 Power Station Unit 3
- Before refurbishment 73.6 MW

After refurbishment: 74.7 MW (to be completed in September 2023)

• Kasagi Power Station Unit 1 Before refurbishment: 41.7 MW After refurbishment: 50.8 MW (to be completed in October 2023)

Before refurbishment



After refurbishment



Initiatives of the thermal power division

Challenge for realizing zero-carbon thermal power generation system

We are committed to working on various initiatives to realize the Zero Carbon Vision 2050, specifically by using zero-carbon fuels (hydrogen for thermal power generation, etc.) and introducing CCUS technology.

Concrete measures

Acquiring knowledge on the introduction of hydrogen power generation

Green Innovation Fund Project in the Himeji area

We have been working on feasibility studies since the adoption of the Green Innovation Fund Project^{*1}—Large-scale Hydrogen Supply Chain Development, which was offered by NEDO^{*2} in August 2021. Going forward, after design and manufacture of the system, we will conduct demonstration of power generation by co-firing of hydrogen at the gas turbines installed at the Himeji No. 2 Power Station and aim to establish operational techniques that can be used for social implementation of hydrogen power generation.

Demonstration system process flow



- *1 The 2 trillion yen Green Innovation Fund, set up by the government for NEDO, aims to encourage innovation among companies to achieve carbon neutrality by 2050, subsidizing companies for up to 10 years.
- *2 New Energy and Industrial Technology Development Organization

Acquiring knowledge on the introduction of CCUS CO₂ capture technology research

We are supporting NEDO's project at our Maizuru Power Station, where solid sorbent system CO₂ capture technology is being tested for treatment of coal-fired emissions*¹. The commissioning run started in fiscal 2022 at testing facilities, with full-scale demonstrations scheduled in the second half of fiscal 2023. The solid sorbent system is potentially a great deal more energy efficient than its conventional counterparts in capturing CO₂ and is therefore considered promising nextgeneration capture technology.

Demonstrating CO₂ mass transport

We are supporting another project from NEDO, also at our Maizuru Power Station, where research, development, and demonstrations are underway for CO₂ mass transport*². Specifically, the project, which involves CO₂ liquefaction at the shipping base, includes 1) R&D related to liquefied CO₂ marine transport technology, 2) demonstrations of 90,000 tonne scale CO₂ marine transport, and 3) marine transport feasibility studies for CCUS purposes. CO₂ marine transport demonstrations are scheduled to start in fiscal 2024.

- *1 Development of carbon recycling/next-generation thermal power generation technology / Research and development of CO₂ capture technology / Research on application of advanced CO₂ solid sorbents to treatment of coal-fired emissions
- *2 CCUS R&D and demonstration project / Large-scale CCUS demonstration in Tomakomai / Demonstration of CO₂ transport / Technological development and demonstration of CO₂ marine transport

Using biomass at existing thermal power plants

Aioi Bioenergy in full-scale operation

We established Aioi Bioenergy Corporation, a joint venture with Mitsubishi Corporation Clean Energy Ltd., and started construction work at Aioi Power Station Unit 2 in Aioi City, Hyogo Prefecture in February 2022 to switch the fuel from heavy/crude oil to woody biomass and its full-scale operation started in March 2023. The fuel switch resulted in an output of 200,000 kW, one of the largest biomass exclusive firing thermal power generation capacities in Japan.



* A ventilator that feeds pulverized fuel to burners

Securing procurement of fuel

Our ongoing efforts include securing procurement of fuel, improving flexibility in responding to fluctuations in power demand, and further improving the economic efficiency of the operations.

Specifically, our efforts involve diversifying suppliers and pricing systems, and taking part in the LNG value chain from production to receiving of LNG, including upstream (interest acquisition) and midstream (transportation, etc.) operations, with various business activities underway.

Volatility is increasing in the global fuel market due to strained international relations in the wake of the Ukraine conflict. We will thus continue to focus on international affairs and fuel market trends to secure fuel in a stable and costeffective manner.

Focusing on spot trading for flexible LNG procurement and distribution

We are building information gathering capability and expertise on flexible fuel trading in Singapore, the LNG hub of the Asia Pacific region, to accommodate changes in power demand, etc.

As the LNG market is expanding in sync with globalization, we have relocated our fuel trading hub from Japan to Singapore, extending our reach into the

Atlantic region to improve and shore up LNG procurement and distribution resources.



(NEDO research consignment project in FY 2022)

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Approaches to hydrogen energy utilization

Toward the realization of a hydrogen-driven society

Hydrogen does not emit CO2 when burned and can be produced from renewable energy, etc. for storage and transportation, a characteristic ideal for applications such as power generation, industrial production, and mobility. We are thus working on various research topics, including the hydrogen upstream/downstream supply chain (from production to transportation, storage, use as power generation fuel, and distribution) and hydrogen carriers (liquefied hydrogen, ammonia, etc.). We will utilize policy support planned by the government for hydrogen commercialization to create a hydrogen supply chain by around 2030, where hydrogen is imported for storage at domestic facilities (about 100.000 tonnes as a starter). We are aiming for a 30% share of the domestic hydrogen market in 2050.

Accordingly, we will pursue every possible means and make further efforts into the future to realize a hydrogen society, including adoption of advanced technology and cooperation with various partners to promote hydrogen use in communities and society at large.



We are broadly engaged in technical research and public relations activities to realize a hydrogen-driven society, participating in various projects both on the supply and demand side.



NEDO: New Energy and Industrial Technology Development Organization JOGMEC: Japan Organization for Metals and Energy Security

Overseas Energy Business

Overview

We are participating in a total of 22 projects in the domains of power generation, transmission and distribution across 11 countries. Our first international project was in 1998 when we participated in the San Roque Hydropower Project located in the Philippines. This made us the first Japanese utility to participate in an overseas electric power project. Utilizing our overseas bases including New York, Amsterdam, and Jakarta, we aim to expand our overseas energy business so it can continue to grow as a key cornerstone of the Group's overall earnings.



Power generation capacity by investment ratio (as of the end of April 2023)

2.852 gw

Breakdown: Thermal power: 1.764 GW Renewable energy: 1.088 GW

Overseas power projects (as of the end of April 2023) 22 projects in 11 countries

Business environment

Opportunities

- Opportunities for profitable businesses increase, particularly in emerging countries, where energy demand is on the rise.
- As the initiatives toward decarbonization accelerate worldwide, business opportunities increase in the field of renewable energy.
- Advancement in the use of new technology such as hydrogen, storage batteries, and floating offshore wind turbines as well as digital technology such as AI and IoT expands frontiers for new business opportunities.

Risks

- Decline in the business conditions of thermal power projects due to the further acceleration of global decarbonization.
- Risks where ongoing projects become less profitable due to external factors such as international instability, economic slowdown, policy changes, market fluctuations, and climate change.

Medium-term Management Plan

Business Segments Energy Business

Business strategies

Zero carbon

- Focus on IPP projects mainly in the field of renewable energy.
- Participate in transmission and distribution businesses that contribute to power grid stabilization when large-scale renewables are introduced.
- Participate in businesses utilizing new technologies such as hydrogen, storage batteries and floating offshore wind turbines.

2 Solutions

- Support the reduction of energy costs and the environmental load.
- Support the planning, construction and operations of power stations by combining Al and IoT with our technological strengths.

3 Increase profitability

- Asset portfolio reclassification.
- Apply feedback from overseas operations to domestic businesses.
- Enhance risk management capabilities.

Concrete measures

1 Zero carbon

Three projects in which we participate completed their construction and started commercial operation in fiscal 2022: Triton Knoll Offshore Wind Farm Project (UK), Moray East Offshore Wind Farm Project (UK), and Piiparinmäki Onshore Wind Farm Project (Finland). Another two projects are under construction, gearing up for commercial production: Alajärvi Onshore Wind Farm Project (Finland) and Borkum Riffgrund 3 Offshore Wind Farm Project (Germany)

We are committed to creating a zero-carbon society, leveraging development expertise originating from our energy business.



Piiparinmäki Onshore Wind Farm Project

2 Solutions

A loan agreement was signed in fiscal 2022 for the UK-German power link NeuConnect Interconnector Project, followed by commencement of construction. We are engaged in this project, capitalizing on our technical expertise in installation of extra-high voltage direct current transmission lines, etc. In the Philippines, meanwhile, the San Roque Hydropower Project underwent an overhaul, where we provided technical assistance to employees at the local operating company. The first overhaul has been completed without any accidents or injuries. We continue to provide solutions using our technological strength and expertise.



Loan agreement signed for the UK-German power link NeuConnect Interconnector Project



San Roque Hydropower

3 Increase profitability

Our international business covers Asia, Europe, and North America, expanding operations in the electric business, including thermal/hydro/wind power generation and power transmission/distribution. We will continue to increase the value of our assets by participating in new projects and restructuring our asset portfolio through divestment of projects for which the purpose of participation has been achieved. Being ahead of other Japanese companies in participating in offshore wind power projects, moreover, we are incorporating the knowledge we obtained into our domestic business. Our other efforts include dispatching personnel to projects and footholds abroad to keep track of changes in international relations and other conditions related to business and to optimize business operations, thereby improving risk management. These efforts are expected to boost the profitability of our operations.



Triton Knoll Offshore Wind Power Project