Initiatives for Carbon Neutrality

Outline of Climate change Information Disclosure

We believe that responding to climate change issues is one of our most important management issues. To this end, we are stepping up our efforts to further enhance initiatives for reducing GHG emission beyond the boundary of Business Units.

In May 2002, we expressed our support for the recommendations of the Task Force on Climate-related Financial Disclosure (TCFD*[1]), disclosed relevant information, and set CO_2 emission reduction targets that conform to the SBT*[2] 1.5°C level (SBT certification is currently under application).

Going forward, we will undertake initiatives to reduce CO_2 emissions from our construction activities. By promoting the construction of offshore wind power facilities and the conversion of buildings into zero energy buildings (ZEB), we will strive to achieve carbon neutrality by 2050 through our core businesses.

TCFD TASK FORCE ON CLIMATE-RELATED FINANCIAL DISCLOSURES

For more information on climate change-related disclosures based on TCFD recommendations
https://www.penta-ocean.co.jp/english/sustainability/environment/tcfd.html

*1 TCFD: Task Force on Climate-related Financial Disclosures (TCFD) is a framework established by the Financial Stability Board at the request of the G20 countries to encourage companies and others to disclose information on governance, strategy, risk management, metrics and targets for climate change-related risks and opportunities.

*2 SBT: Science-Based Targets: Greenhouse gas emission reduction targets consistent with the levels required by the Paris Agreement, which aims to limit the global temperature rise to well below 2°C above pre-industrial levels, ideally to 1.5℃.

1. Governance

In July 2021, we established; 1. The Carbon Neutral (CN) Promotion Committee chaired by the President and Representative Director, and 2. The CN Promotion office for its designated department, to further enhance initiatives for reducing GHG emission beyond the boundary of Business Units.

The CN Promotion Committee operates under the CSR Committee (chaired by the President and Representative Director), which supervises the company's overall CSR management with focus on ESG (the sustainability management). The Committee plans and formulates basic policies and strategies for the Group's initiatives to tackle global climate change issues, and deliberates climate related matters based on the monitoring results of the progress of each measure. The Committee decisions are reported to and discussed at the CSR Committee. The Committee decisions on policies and strategies are incorporated into business plans of each Business Unit, the company-wide annual plans and mid-term plans, and they then progress towards their implementation. The Board of Directors receives reports from the CSR Committee and supervises all sustainability-related issues including climate-change issues.

The implementation of measures to address climate change issues will be continuously monitored by the Carbon Neutrality Promotion Committee in order to review and improve our policies and strategies.

2. Strategy

In the construction industry, CO_2 emissions from construction activities are relatively small compared to other industries. However, the marine civil engineering work, which is one of our fortes, is characterized by higher CO_2 emissions than other construction work and civil engineering work performed on land, because of the use of work vessels.

Therefore, the impact of climate-related policy changes and tighter regulations on our corporate management is relatively large compared to our industry peers. For that reason as well, we believe that our response for climate change issues to be one of our most important management issues.

As part of our initiatives to tackle these issues, we have identified the risks and opportunities that climate change may pose to our group, and performed scenario analyses.

As a result of the analyses, we expect to see an increase in capital investment in maintenance, renewal, and new construction of work vessels to achieve their carbon neutrality. We believe, however, that we will witness more business opportunities for our company that outweigh these drawbacks. The opportunities include the promotion of offshore wind power facility construction in the civil engineering field, and the promotion of ZEB technology application in the building construction field. As a company with distinctive strengths in marine civil engineering technology and as a front runner in offshore wind power facility construction, we will contribute to the expansion of renewable energy supply in Japan.

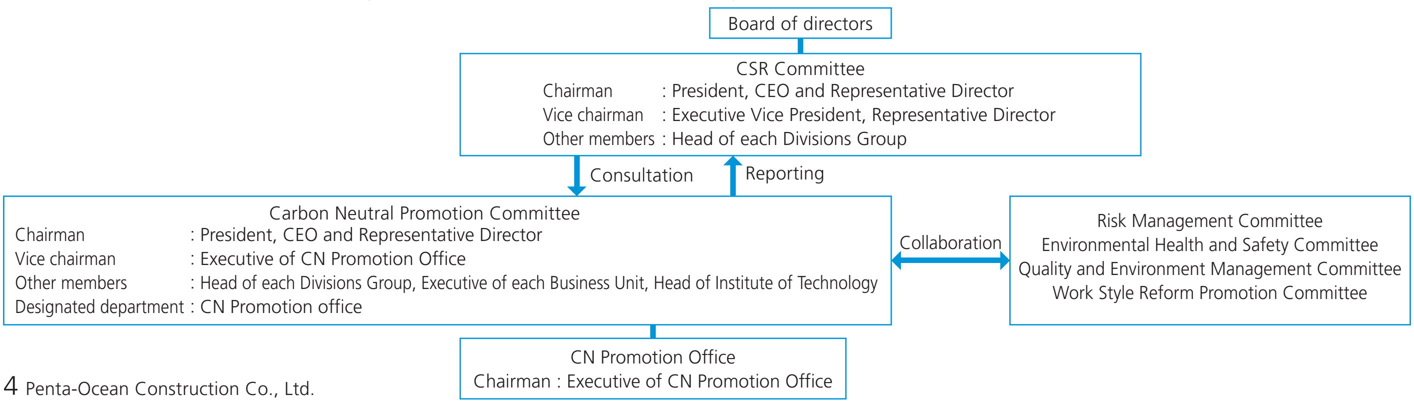
We will incorporate the risks and opportunities identified through the above scenario analyses into our annual business plan as well as the next mid-term management plan (FY 3/24 – FY 3/26), and ensure their implementation, in order to contribute to the development of a sustainable society.

3. Risk Management

The Risk Management Committee, established under the CSR Committee and chaired by the President and Representative Director, is the core of our risk management system. They systematically categorize risks assumed in our business activities, assign a department in charge for each risk, and conduct overall risk management.

The CN Promotion Office is the department in charge of climate change risks. They identify, evaluate risks and implement countermeasures against them from a long-term perspective.

The results of deliberations of the CN Promotion Committee are reported to and discussed at the CSR Committee, and the activities of the CSR Committee are reported to the Board of Directors, which oversees the implementation of climate change risk management. In the event of the occurrence of climate change risk, it is promptly reported to the supervising department, determined according to the degree of impact on corporate management (major risks are reported to the Board of Directors). As described above, we have a system in place to respond to risks in a timely and appropriate manner.



Risks and Opportunities

Categories		Climate change	Impact on businesses	Scale of impact 1.5℃	Scale of impact 4℃
Transition risks and opportunities	Risks	Policy changes and regulation tightening on CO_2 emission reduction	•Increase of climate change response costs for construction and other business activities (in particular, costs to reduce CO_2 emissions from construction machinery and work vessels) •Increase of procurement costs for construction materials (cement and steel), which have high CO_2 emissions during manufacturing process •Further increase in climate change response costs and construction costs due to the introduction of a carbon tax	Major	Minor
			•Increase in costs due to tightening of Energy Efficiency Act and mandatory ZEB application	Medium	Minor
	Opportunities	Increased construction demand related to renewable energy and energy conservation	•Increase in demand for the construction of offshore wind farms •Increase in demand for the construction of ZEB buildings/ZEB technology application	Major	Minor
Physical risks and opportunities	Risks	More intense and frequent natural disasters (high waves, storm surges, and torrential rains caused by typhoons and low-pressure fronts)	•Extension of construction period and increase in construction costs due to damages by disasters made during construction •Supply constraints due to disruptions in the supply chain for construction materials and equipment	Medium	Major
		Decrease in construction productivity due to bad weathers/conditions caused by rising sea temperature	•Increased risk of process delays and higher construction costs due to lower utilization rates, especially in marine civil engineering work	Medium	Major
		Decrease in construction productivity during summer time caused by temperature rise	•Increased risk of workers' heat stroke on construction sites •Decreased productivity due to increased frequency of break times to prevent heat stroke	Medium	Major
	Opportunities	Increase of construction demand related to the national resilience plan	•Increase in construction demand for disaster prevention, disaster mitigation, and national resilience •Increase in demand for disaster recovery work	Major	Major

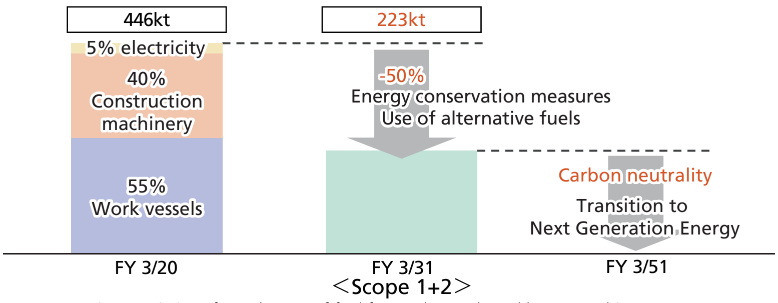
Measures

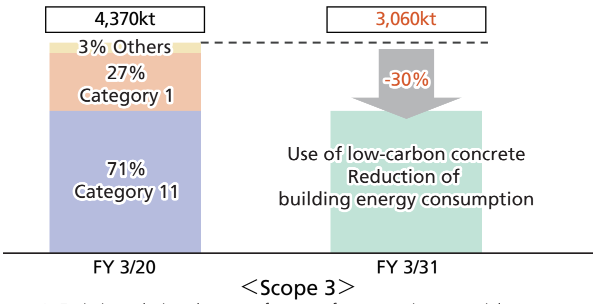
Categories		Climate change	Measures
Transition risks and opportunities	Risks	Policy changes and regulation tightening on CO_2 emission reduction	•Reduction of CO_2 emissions from construction machinery and work vessels (Scope 1) Improving construction efficiency: electrification, use of ICT, and promotion of automatic and autonomous construction Fuel decarbonization: from low-carbon to zero-carbon (Short-term) Use of additives to improve fuel efficiency (Mid-term) Use of alternative fuels (BDF, GTL) Utilization of renewable electricity (including electricity supply from land and rechargeable batteries) (Long-term) Introduction of hydrogen, ammonia, and other next-generation energies
			•Reduction of CO_2 emissions (Scope 2, 3) Promotion of the renewable electricity use at onsite offices, etc. (Scope 2) Promotion of introduction of CO_2 adsorption materials and low-carbon concrete, etc. (Scope 3) CO_2 fixation by solidification of dredged sediments (Scope 3)
	Opportunities	Increased construction demand related to renewable energy and energy conservation	•Strengthening offshore wind power construction initiatives (e.g., capital investment in equipment for offshore installation vessels and other large work vessels) •Promotion of ZEB proposals, design, and construction of ZEB buildings •Trial use of hydrogen at company-owned facilities •Issuance of green bonds for capital investment
Physical risks and opportunities	Risks	More intense and frequent natural disasters	•Establishment of BCP system and regular implementation of disaster drills (for BCP and tsunami)
		Decrease in construction productivity due to severer weathers/conditions caused by rising sea temperature	•Advanced weather and metocean forecasting systems
		Decrease in construction productivity during summer time caused by temperature rise	•Improving productivity by saving labor on sites (contribution to CO_2 reduction) Actively using precast concrete for concrete work and promoting DX (digital transformation)
	Opportunities	Increase of construction demand related to the national resilience plan	•Development and practical application of technologies that contribute to the national resilience plan

4. Metrics and Targets

With the aim of achieving carbon neutrality by 2050, we have set a CO_2 emission reduction target in May 2020 with the base year of FY 3/20, including our overseas operations, which account for the majority of our CO_2 emissions. Our CO_2 emission reduction targets are consistent with scientific findings, and we are currently applying for SBT certification.

POC Group's targets for CO_2 Reduction





*Scope 1: Direct emissions from the use of fuel for work vessels and heavy machinery
*Scope 2: Indirect emissions from the use of purchased electricity and heat
Scope 3: Indirect emissions in the supply chain (classified as Categories 1-15)

Category 1: Emissions during the manufacture of construction materials
Category 11: Emissions during use of the building after completion and delivery

Initiatives for Carbon Neutrality

Roadmap to achieve carbon neutrality (CN)

(Short term) **Low carbonization** | (Mid-term) Low carbonization

Fuel efficiency improvement (Scope1)

- Engine-idle reduction, energy saving training, and ensuring proper maintenance of vessels and machinery
- **Promotion of the on-site use of K-S1 and other fuel efficiency improvement additives**
- Study to adopt

Improvement of construction efficiency (Scope1)

- **Improving construction efficiency through the use of ICT technology** for land-based construction machinery
- Tracking the market trend of electrified land-based construction machinery – Promoting their on-site use
- Conducting studies for **the electrification of cranes and winches on work vessels** and the development
- **Exploring automatic and autonomous**

New Energy (Scope1)

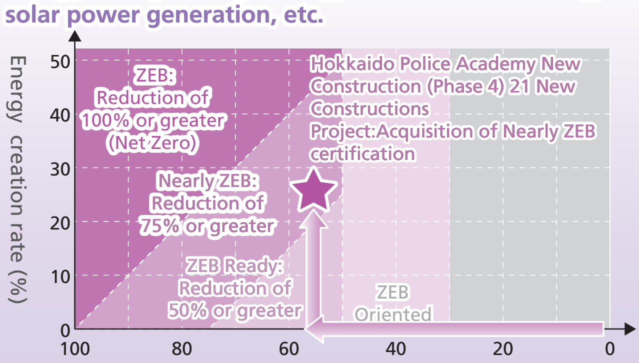
- Tracking technological trends, such as engine development, for the introduction of new energy sources
- Discussion on the course of action as to the development of carbon neutral ports (CNP) as import and storage hubs for new energy
- **Utilization of alternative fuels**
- **Onshore power supply** (work
- Utilization of by-product hydrogen

*1 Biodiesel fuel: Fuel made from biological

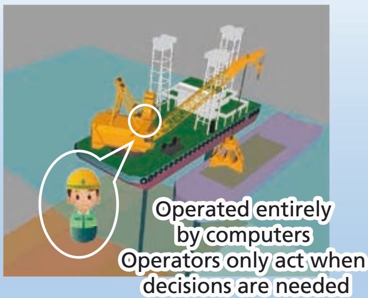
Energy Conservation and Energy Creation (Scope 2)

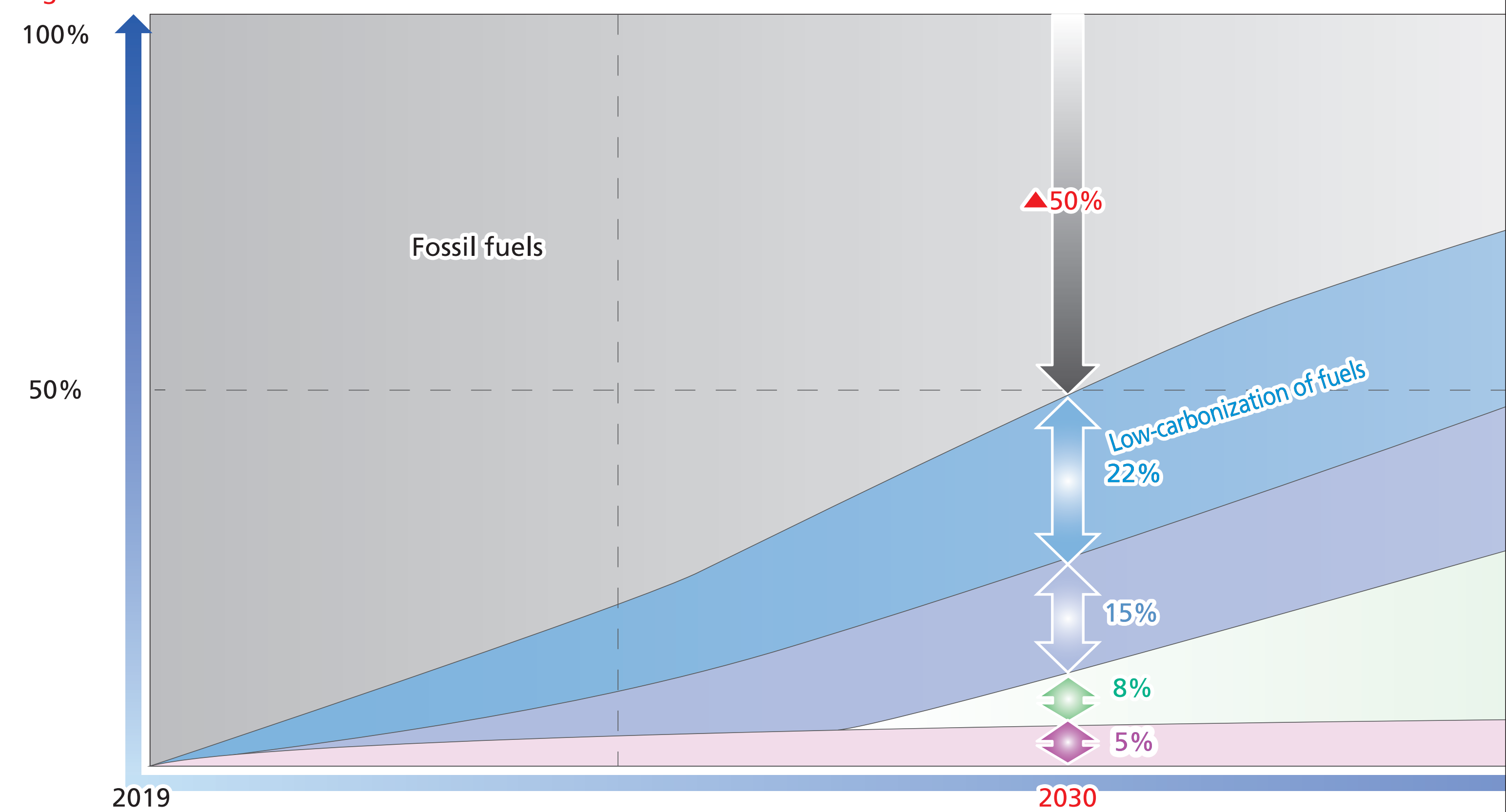
- **Promotion of ZEB conversion of construction offices,** etc.

Energy saving through energy conservation + energy creation through solar power generation, etc.



Concept of automatic and and electronically controlled





by 2050 (Scope 1 and Scope 2)

to decarbonization

(Long-term) **Decarbonization**

dual fuel engines, etc. - Research and development - On-site implementation

and work vessels, and promoting more efficient energy use through the enhancement of work vessel equipment.

of large rechargeable batteries and fuel cells.

operations by electrification of work vessels (from program development to on-site implementation)

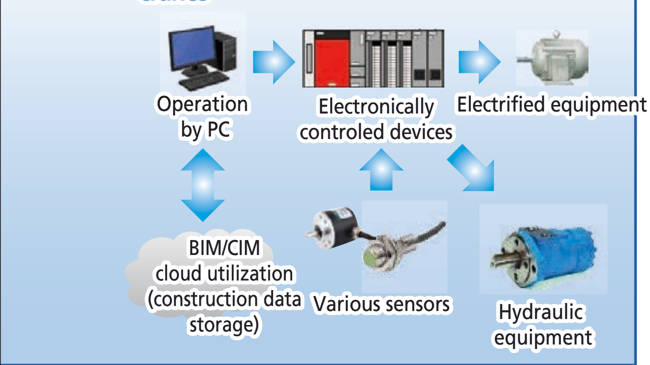
such as BDF*1 and GTL*2
vessels)
and ammonia, trial use of green hydrogen

- Introduction of work vessels and land-based construction machinery which run on new energy
- Utilization of green hydrogen and ammonia
- **Utilization of surplus electricity from offshore wind power generation** (land-based power generation and green hydrogen utilization)

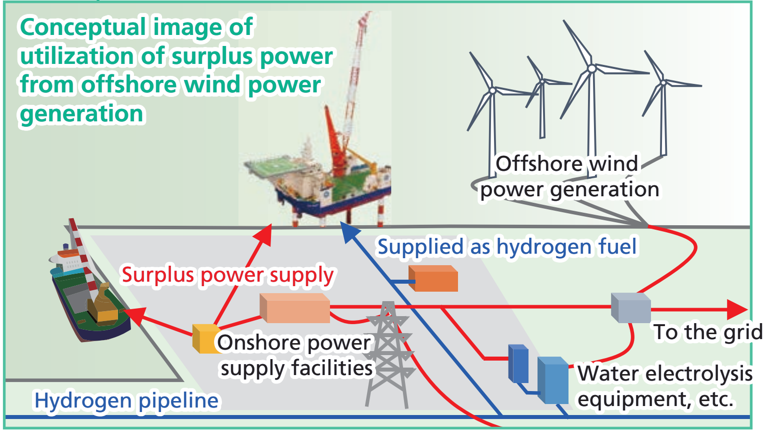
derived oil as a raw material.

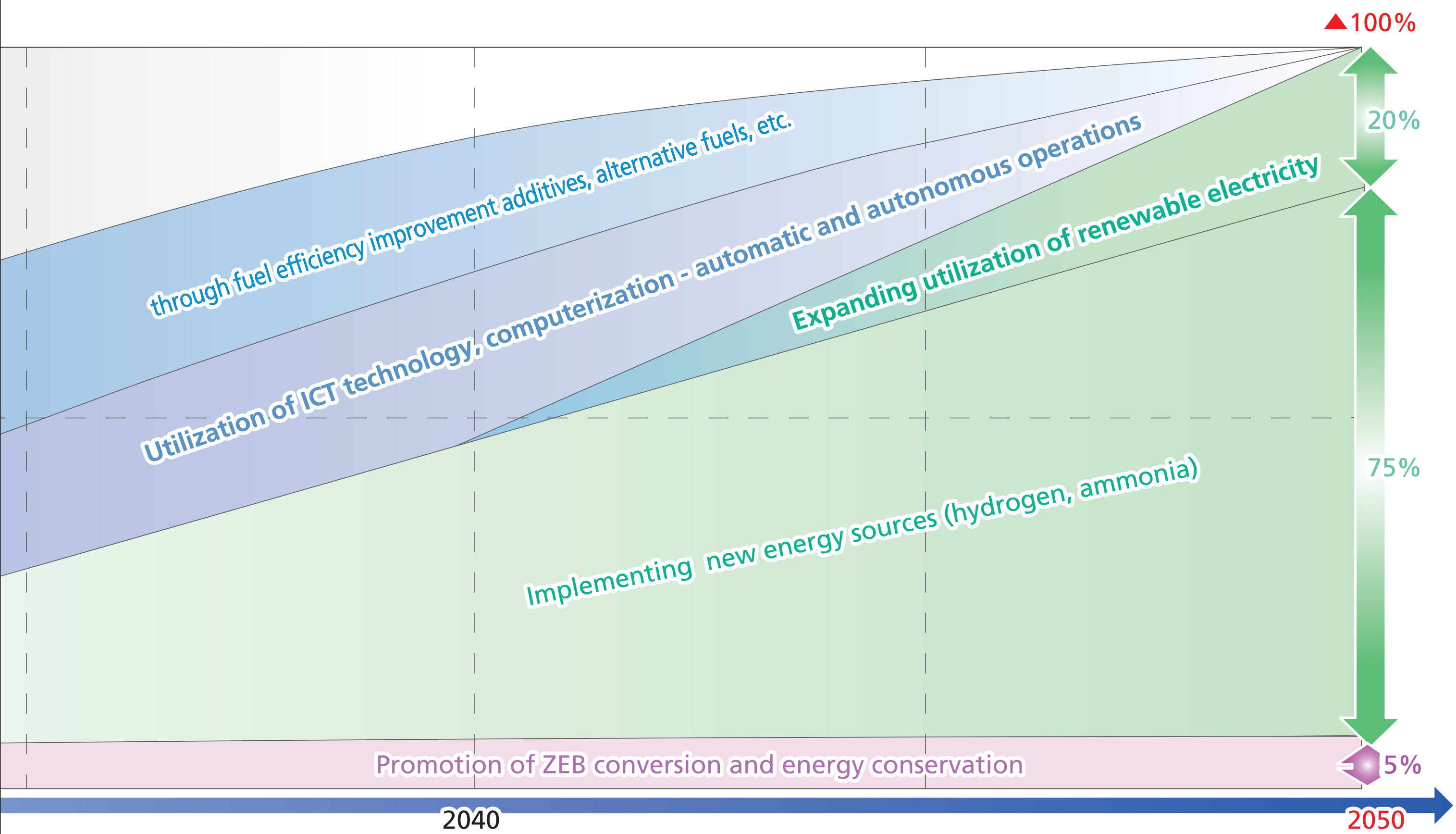
*2 Gas to Liquids: Natural gas-derived alternative fuel to diesel fuel

autonomous operation with electrified cranes



Conceptual image of utilization of surplus power from offshore wind power generation



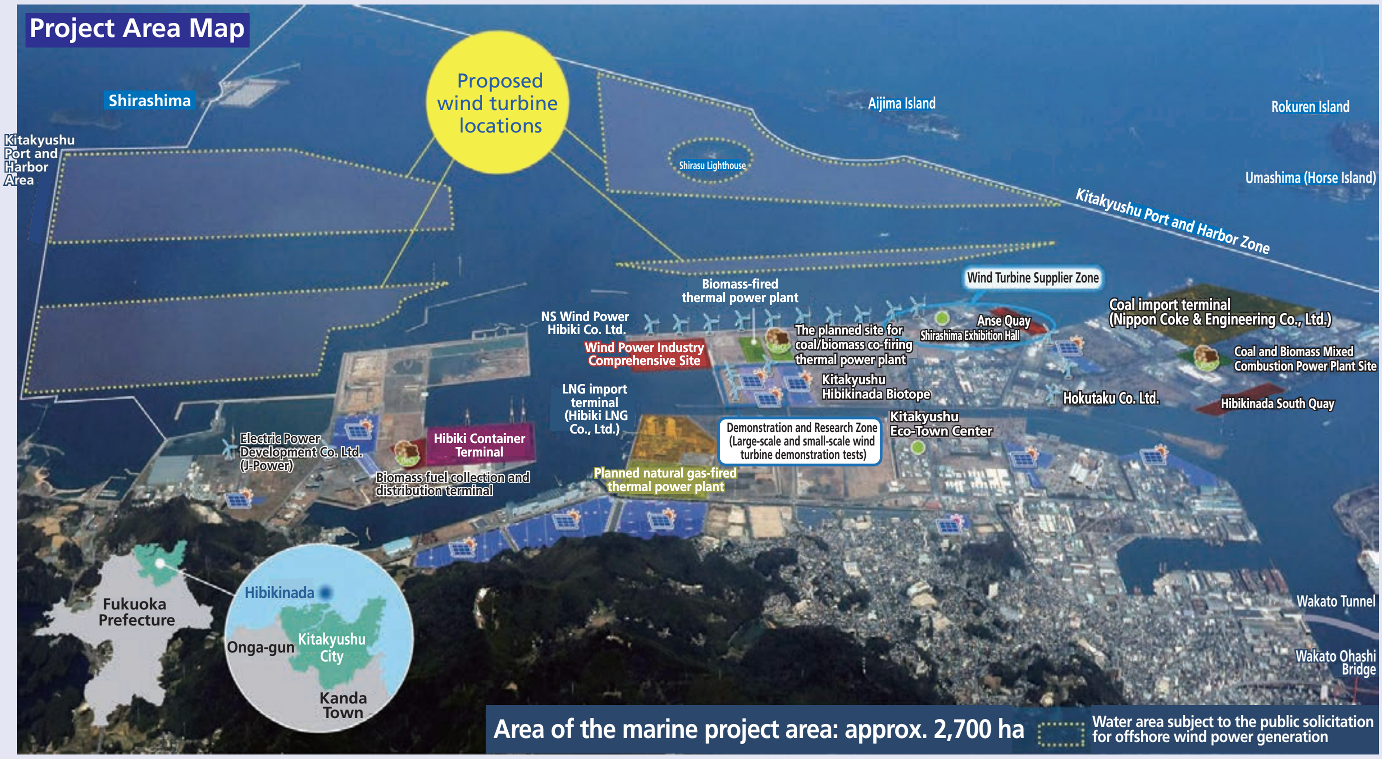


Offshore Wind Power Initiatives

Kita-Kyushu Hibikinada Offshore Wind Power Project : We Acquired the Preferential Negotiation Rights for Offshore Construction

We were selected as the preferred bidder for offshore construction for a large-scale wind farm project (operator: Hibiki Wind Energy Co., Ltd.) in which we will install 25 wind turbines (9.6 MW class) to generate approximately 220 MW of electricity on approximately 2,700 ha within the port area of Hibikinada district of Kitakyushu Port. The project includes: (1) Offshore civil works such as wind turbine foundation work and installation, cable laying, and (2) O&M*1 (Construction of the base port)

*1 O&M: Operation & Maintenance



Project Outline (Source: Hibiki Wind Energy Co., Ltd. website)

(1) Wind turbine foundation and marine works
In charge of marine civil works, including foundations and installation of 25 bottom-fixed-type wind turbines
Preferential negotiator: Penta-Ocean Construction Co., Ltd. and Nippon Steel Engineering JV

(2) O&M base port construction
Establishment of base a port for the operation and maintenance of the wind farm
Preferential negotiator: Penta-Ocean Construction Co., Ltd. and Wakatsuki Construction JV

- The company-owned offshore installation vessel*2 equipped with a large crane will be used for the foundation and installation of the wind turbines.
- Construction is to begin in FY 2022.

*2 Offshore Installation Vessel or Wind Turbine Installation Vessel (Called a Self-Elevating Platform in Japan)

Strengthening the Management System (Operation, Maintenance and Crewing) for Vessels Involved in Offshore Wind Power Construction and Maintenance

In August 2022, we signed a Memorandum of Understanding (MOU) with K Line Wind Service Co.Ltd. (KWS) to collaborate in vessel management in the field of offshore wind power construction and maintenance.

POC is a front runner in marine civil engineering and offshore wind construction, and KWS has extensive expertise and know-how in operating various types of carriers and offshore support vessels at home and abroad, as a member company of the Kawasaki Kisen Kaisha Group. Both companies will draw on their expertise in each respective area and ample management resources to collaborate on the management (operation, maintenance and crewing) of vessels used in offshore wind construction and maintenance works.

K Line Wind Service Ltd..

K Lind Wind Service, Ltd. was established in June 2021 as a joint venture between Kawasaki Kisen Kaisha, Ltd. and Kawasaki Kinkai Kisen Kaisha, Ltd. to contribute to the field of offshore wind construction and maintenance works, by leveraging the proven track record of the Kawasaki Kisen Kaisha Group in the offshore vessel operations and offshore support vessel services both in Japan and overseas. Kawasaki Kinkai Kisen Kaisha and POC have been building a cooperative relationship through the construction and operation of the offshore support vessel “KAIKO” (6,000hp, operating since 2021) for towing POC’s “CP-8001.”

Offshore support vessel “KAIKO”

A Japanese Offshore Wind Power Construction Leader

In Japan, aiming for the achievement of carbon neutrality by 2050, the Japanese government has set targets for the development of 10 GW of offshore wind power by 2030 and 30-45 GW by 2040. Offshore wind power is expected to increase its supply capacity as a major source of renewable energy, and in this context, the entire country is witnessing a surge in momentum for offshore wind construction.

In this business environment, we aim to become the "front runner in the offshore wind industry," and are actively working to establish a system to meet the growing demands for offshore wind power facilities.

● Wind turbine foundations and installation (Bottom-fixed type)

POC plans to own three offshore installation vessels, including one under construction, in cooperation with other companies.

- **CP-8001 (Equipped with a 800t lifting capacity crane)** Launched in March 2019.
  Shipowner: Penta-Ocean Construction Co. Ltd.
  We have accumulated experience in port construction, offshore wind turbine removal (Hibikinada, Kitakyushu), underwater geotechnical surveys, etc., and accumulated expertise in operating offshore installation vessel ahead of peer companies
- **CP-16001 (Equipped with a1600t lifting capacity crane)** (Scheduled to start operation in March 2023)
  Shipowner: PKY Marine Co. Ltd.
  (Joint venture with Kajima Corporation and Yorigami Maritime Construction)
- **Third offshore installation vessel (Equipped with a1600t lifting capacity crane)** (Scheduled to start operation in 2025)
  Upgrading a foreign-flagged offshore installation vessel to a vessel with a 1600t lifting capacity crane and to reflag it into a Japanese-flagged vessel
  Shipowner: Japan Offshore Marine Co. Ltd.


Kitakyushu Hibikinada offshore wind turbine removal (CP-8001 on the left)

Japan Offshore Marine Co. Ltd.

JOM engages in investigation, engineering, procurement of materials and equipment, and construction related to foundation works of wind turbines, transportation and installation works of wind turbines, and cable laying works for offshore wind farm projects in Japan in cooperation with Penta-Ocean.

・Investment ratio: 51% for Penta-Ocean, 49% for DEME Offshore

JOM
Japan Offshore Marine

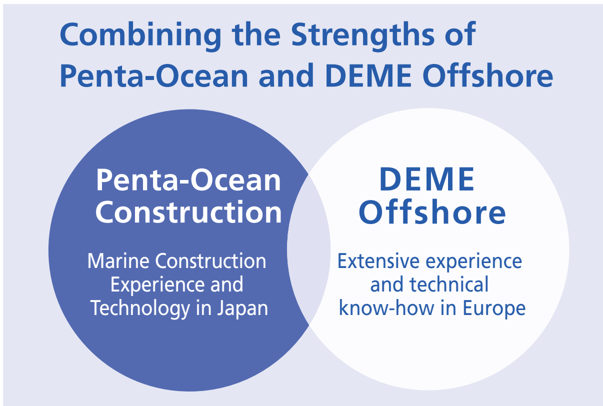

Rendering of CP-16001

- **Collaboration with DEME Offshore**

DEME Offshore, with a leading track record, technology and know-how in the field of offshore wind power construction in Europe, and POC, with abundant experience and technical know-how in offshore civil engineering work under the severe metocean conditions in Japan, collaborated to overcome the severe construction conditions unique to Japan and to realize safe and reliable construction.

DEME Offshore

・Subsidiary of DEME Group, one of the world's leading offshore construction companies
・Pioneer in the field of offshore wind power construction in Europe
・Owns extensive know-how and the latest technology in offshore wind power construction
・Owns a large number of offshore installation vessels equipped with large cranes, which are required for the construction of foundations and installation of wind turbines, as well as a large number of work vessels for cable laying, maintenance, etc.



Conceptual Image of Synergies from the Alliance

● Muroran Factory

・POC's new factory in Muroran is scheduled to manufacture temporary steel structures for offshore wind power construction. The new Muroran Factory is a "100% renewable energy factory" that uses renewable energy to supply all electricity for the entire factory.

● Efforts in Floating Offshore Wind Power Generation

・Participated in the "Research and Development of Technologies to Reduce the Cost of Floating Offshore Wind Power Generation Technology" by New Energy and Industrial Technology Development Organization (NEDO), jointly with TEPCO HD and the University of Tokyo.

⇒In charge of research and study on the rational and efficient construction method of the spar-type floating structure

Initiatives for Carbon Neutrality

ZEB Initiatives

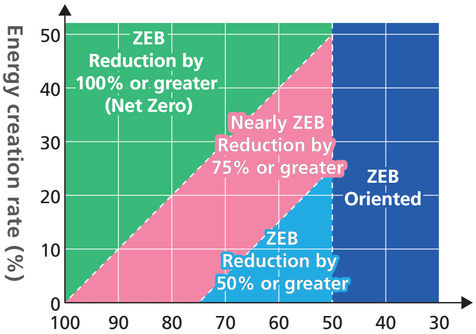
ZEB (Zero Energy Building) Track Records

POC's Institute of Technology continues to develop energy-saving technologies for Zero Energy Buildings (ZEB). Energy monitoring of buildings after the completion of construction with energy-saving technologies has confirmed that ZEB features have been achieved, proving its effectiveness.

● POC's ZEB construction record

ZEB Rank	Project Name	Energy conservation rate	Total floor area
ZEB	Hisamitsu Pharmaceutical Museum (2019)	103%	688m²
Equivalent to ZEB Ready	Penta-Ocean Construction Institute of Technology Experiment Building (2019)	72%	2,115m²
Equivalent to Nearly ZEB	Tokyo Metropolitan Archives Building (2020)	91%	10,259m²
Nearly ZEB	Kyowa Exeo Corporation South Kanto Branch (2021)	75%	1,781m²
ZEB	POC Muroran Factory (2022)	433%	15,596m²
ZEB	Kobe Sumiyoshi Cold Storage Warehouse, Japan Port Industry Co., Ltd. (2022)	106%	17,898m²

● Definition of ZEB



Energy reduction rate (%) relative to the standard energy consumption of the Rational Use of Energy

(Based on materials compiled by the ZEB Roadmap Follow-up Committee in FY 3/19)

Hisamitsu Pharmaceutical Museum (2019)

Roof insulation reinforcement, energy-saving air-conditioning equipment, etc.
Operation control of facilities and equipment by installing various sensors

High energy savings

Maximized solar panel installation on roof surfaces

A large amount of power generation throughout the year

Energy saving rate during the design stage
Energy saving rate: 65%
Energy creation rate: 38%

Actual energy saving rate

115% (2019)	115% (2020)	120% (2021)

Kyowa Exeo South Kanto Branch (2021)

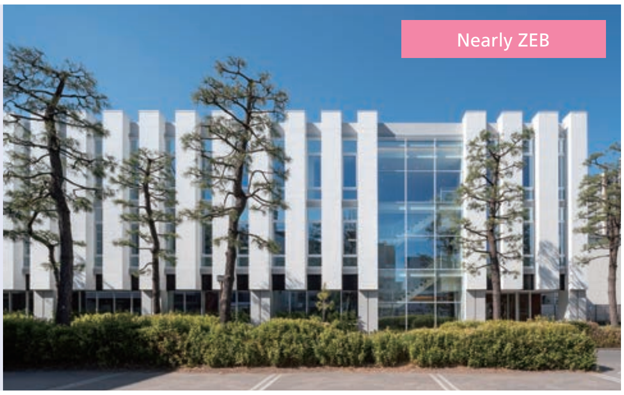
Adoption of energy-saving technologies

High energy savings

Installed an energy management system to monitor and analyze energy consumption during operation.

Monitoring the effects of adopted technologies and accumulating operational control technologies

Energy saving rate at the design stage
Energy saving rate: 50%
Energy creation rate: 25%



Penta-Ocean Construction Institute of Technology Experiment Building (2019)

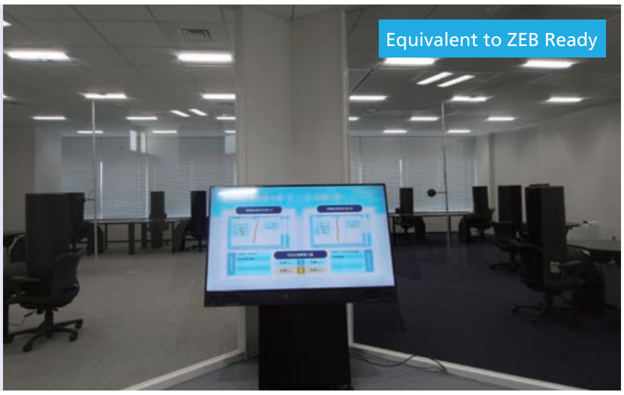
Efficient control of 5 elements (water, air, heat, electricity, and control)

High energy savings

Energy saving rate at the design stage
72%
(energy saving only)

Actual energy saving rate

72% (2020)	74% (2021)



Penta-Ocean Muroran Factory(2022)

We newly constructed the Muroran Factory, which mainly manufactures steel structures for bridges, etc., in Muroran City, Hokkaido. The entire building including the offices is ZEB certified. In addition to its original focus on bridge steel structures, the new factory will play a more significant role as a manufacturing hub for temporary steel structures for offshore wind construction, which is expected to be in high demand in the future.

At the new factory which runs on 100% renewable energy, we will accumulate knowledge on the use of hydrogen energy through the use of by-product hydrogen and the production and use of green hydrogen generated from solar power, and apply this knowledge to our businesses.

New Muroran Factory

- **Energy-saving technology applied to the offices of the new factory**

High energy savings

Energy reduction rate:65%

・Improvement of thermal insulation through the use of resin sashes
・Reduction of lighting load through the use of light-collecting films
・Introduction of high-efficiency air-conditioning units tailored for cold climates, etc.
・Air conditioning control using motion sensors, etc.

- **Energy-creating equipment installed at the new factory**

A large amount of power generation throughout the year

・Photovoltaic power generation system (670 kW output)
・Hydrogen fuel cells (30 kW output)

- **Use and demonstration of hydrogen energy**

・Use of two types of hydrogen: by-product hydrogen and green hydrogen.

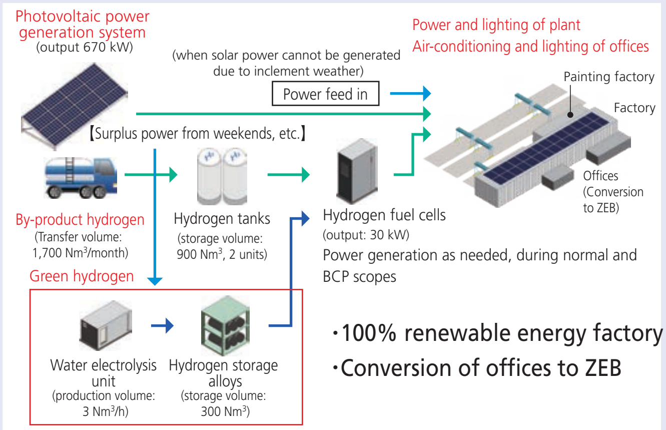


Diagram of energy use at the new factory

By-product hydrogen: Hydrogen produced as a by-product at a plant in Hokkaido is stored in hydrogen tanks and used to generate electricity through fuel cells

Green hydrogen: Hydrogen produced through a water electrolysis system using solar power generation electricity, stored in hydrogen storage alloys, and used in fuel cells to generate electricity


Hydrogen fuel cells


Hydrogen storage alloys


Water electrolysis equipment

Conversion of On-site Offices to ZEB and Acquiring “Nearly ZEB” Certification

At the temporary site office for the new construction of Hokkaido Police Academy (4th phase) 21, which was awarded by the Hokkaido Regional Development Bureau, we achieved an energy conservation rate of 80%, including energy creation by solar power generation, and the building was certified as “Nearly ZEB” under the Building Energy-efficiency Labeling System (BELS).


Temporary site office for the new construction works of Hokkaido Police Academy (Phase 4) 21

Initiatives to Improve Productivity

Utilization of AI

We are developing automated construction technology using artificial intelligence (AI) to increase site productivity, safety and construction quality of buildings, etc.

Applying AI Technology to Autonomously Controlled Backhoes (Domestic Civil Engineering)

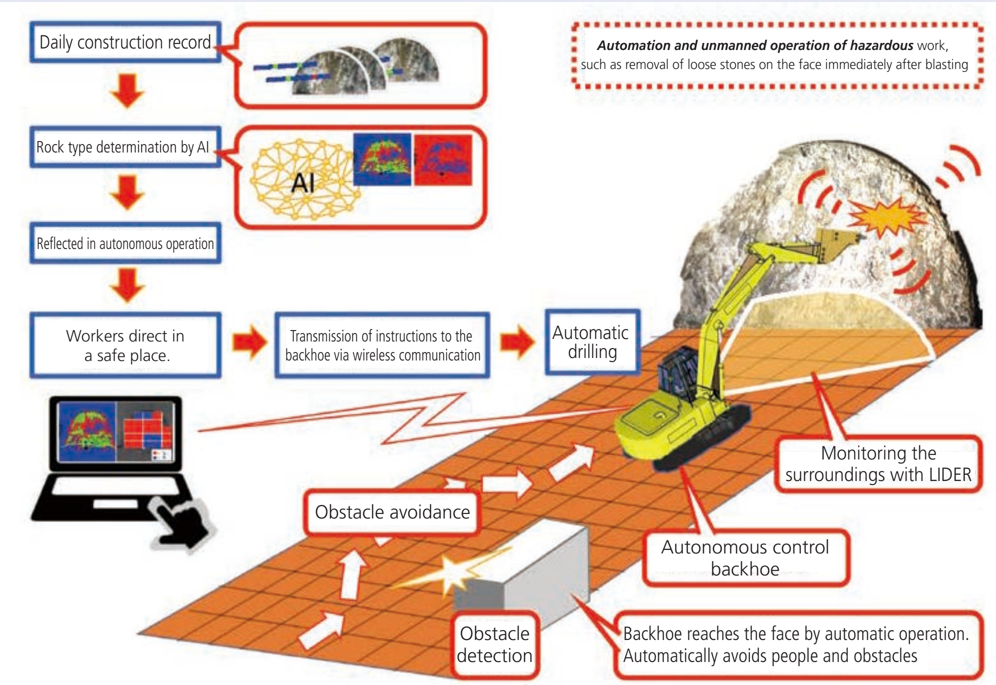
The consortium represented by POC was selected to participate and to represent the "Project on the adoption and utilization of innovative technology to drastically improve productivity at construction sites," promoted by the Ministry of Land, Infrastructure, Transport and Tourism in the FY 3/22.

The consortium:Penta-Ocean Construction, Osaka University, Saigyo Construction, Shoji, Nippon System, No18 Software, and NEXTSCAPE
Trial location:FY 2017-2020 Minokoshi Tunnel Construction (Ehime Prefecture)
Client: Shikoku Regional Development Bureau
Trial technology:(1) Automatic autonomous backhoes for the operations of unmanned and automated to work in mountain tunnel cutting *1, improving productivity and safety.
(2) Utilizing the site model recreated by the digital twin technology in VR-type remote construction sites to reduce paper works and contact opportunities, and promote efficient communication.

*1 In tunnel construction after blasting, rock fragments fall and rock masses (loose rocks) protrude near the tunnel's face.

▶Overview of AI-equipped Autonomous Control Backhoe Technology

Autonomously controlled backhoes equipped with AI for determining rock types automated drilling operation, which is hazardous work, eliminated the need for manual labor and improved the safety and productivity of underground work.



Work image of an AI-equipped autonomously controlled backhoe

Monitor the surroundings by LiDAR*2 and move automatically avoiding people and obstacles

Yard experiment with automatic movement (a backhoe moving automatically, avoiding color cones)

*2 Light detection and ranging: one of the remote sensing technology that uses light

Built-in AI for Rock Type Identification to Determine the Fragility of Rocks and Automatic Drilling Work

Unmanned and automatic drilling operation

Unmanned cockpit

A1-based Technology for Assessing the Residual Strength Piers (Domestic Civil Engineering)

In collaboration with Professor Mitsuyasu Iwanami of the Tokyo Institute of Technology, we have developed a technology for assessing the residual strength of piers using artificial intelligence (AI).

Port facilities exposed to harsh marine environments, such as salt damage, cannot be visually inspected for deterioration in certain areas, such as underwater areas and the undersides piers. As a result, maintenance is frequently a "post-maintenance type," in which measures such as repairs and renewal are taken after problems occur, and there is a need to shift to a "preventive maintenance type" in order to strengthen national resilience and maintain and develop the economy.

This technology employs AI to predict how port piers will be damaged by an earthquake or deterioration over time. It provides indicator that can rationally determine whether or not it can be used, or for how long, and the extent and timing of repair and reinforcement. This contributes will contribute to the promotion of "preventive maintenance type" management.

▶Overview of Residual Strength Evaluation Technology for Piers Using AI

● Building an AI Model that can Evaluate the Residual Strength of Piers

A series of pier structural experiments revealed a relationship between the degree of deterioration and beam bearing capacity, and a structural analysis program was developed to evaluate the bearing capacity of each beam in four stages. AI was trained on over 2,000 conditions and analysis results to automate the assessment of the pier's remaining strength

⇒Significantly reduction in the time required for residual strength assessment (conventional: half a year to one year → this technology: about one week)

● Provided rational judgment indicators such as a repair/reinforcement range and timing

The developed system can simulate the progression of deterioration over time and damage caused by earthquakes according to settings such as the scale and timing of earthquakes. To identify the evaluation of the structural stability, service life, and concrete measures to be taken at present, it can formulate an optimal maintenance management plan while putting into consideration life cycle costs.

⇒Optimizing the life cycle cost of a pier

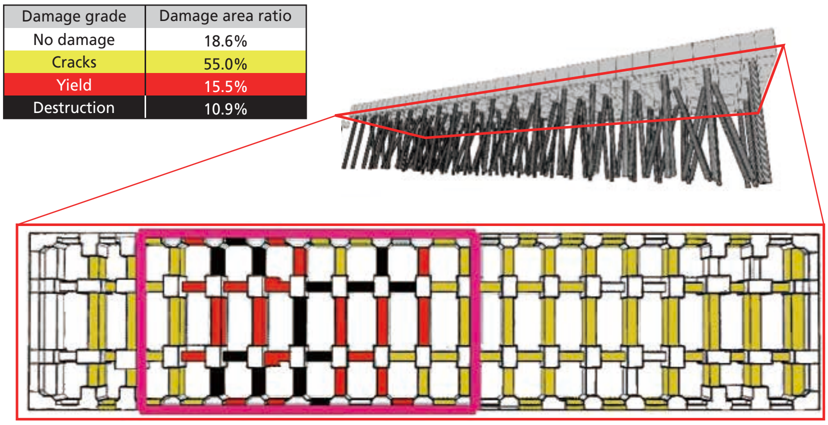
● Combined with our "i-Boat (wireless LAN boat)," Technology, this System Consistently Automates and Saves Labor in the Entire Process from Inspection and Investigation of the Degree of Deterioration to Residual Strength Evaluation.

Inspection timing, earthquake timing, type and scale of earthquake can be selected.

October 2019 | 0 years later | Level 2 seismic motion (plate boundary type)

Determination results;	Damage may develop around beams leading to destruction or yielding.
The period during which it can remain in service	3 years
Specific measures to be taken at present	Service of the restricted area stopped, and detailed inspections were conducted to repair and reinforce the area according to its state of deterioration.

Damage grade	Damage area ratio
No damage	18.6%
Cracks	55.0%
Yield	15.5%
Destruction	10.9%



Clarify the scope of restricted entry measures

System screen of residual strength evaluation technology

▶Features of residual strength evaluation technology for piers using AI

1. Damage prediction possible by level 1 seismic motion*1 and level 2 seismic motion*2.
2. Level 2 seismic motion can be selected from the following two types:
   - Plate boundary type: Earthquake type like the Great East Japan Earthquake
   - Direct inland type: Earthquake type such as the Great Hanshin-Awaji Earthquake
3. Calculates the period during which the pier can remain in service.
4. Proposes specific actions to be taken in the current situation, such as identifying the area that should be off-limits.

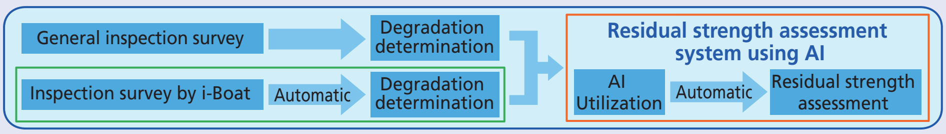
*1 Level 1 seismic motion: An earthquake motion that is likely to occur at least once during the design and service period of the target facility.

*2 Level 2 seismic motion: The largest possible earthquake motion at the target facility

Pier investigation and diagnosis system using i-Boat (wireless LAN boat)

- Taking photos under the pier, which is difficult to see with the naked eye, using a radio-controlled boat (equipped with a camera)
- Specialized system analyzes captured the images and automatically determines the degree of deterioration of the pier.

⇒Combining the automation of inspection surveys using i-boat (green frame) and the residual strength evaluation system using AI (orange frame) automates the entire process of residual strength assessment and saves labor.



i-Boat

Labor-saving Construction

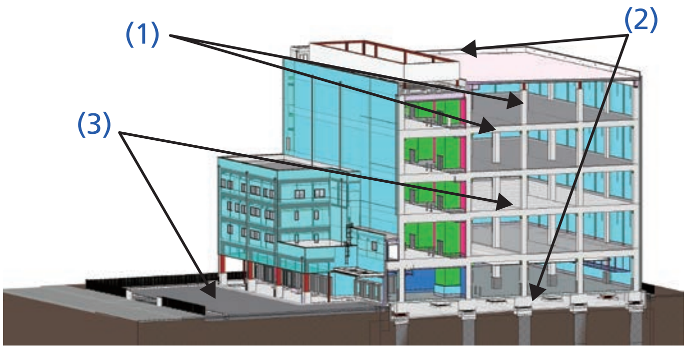
We are actively developing and introducing labor-saving construction methods to improve site productivity, safety, and construction quality.

Labor-saving Using the Precast Construction Method (Domestic Construction)

To address the labor shortage, we are implementing various labor-saving measures. In the construction of the Shin-Funabashi Logistics Center of Tokyo Toyomi Reizo Co., Ltd., the majority of the frame construction was precast method (PCa) to make on-site work safer and more efficient.

In the construction of the frames using conventional methods the quality varied depending on the workers' skills, weather and construction conditions, and there were also process issues, such as the fact that work on the next floor could not begin until the concrete had gained strength after it was placed. To address these issues, we adopted the precast construction method in which factory-manufactured components are delivered to the site and installed. In comparison to on-site work, this method ensured consistent quality and reduced on-site work, resulting in a shorter construction period and improved safety.

[Construction overview]
- Client: Tokyo Toyomi Reizo Co., Ltd.
- Design and construction: Penta-Ocean Construction Co., Ltd.
- Building use: Cold storage
- Structural scale: PCaPC construction, partly steel construction, 6-story structure, 1-story isolation structure



(1) Using the PCa Method in Columns and Beams

On-site work, such as formwork assembly and concrete placement, has been reduced by 90%, and the construction process for each floor by 10 days.

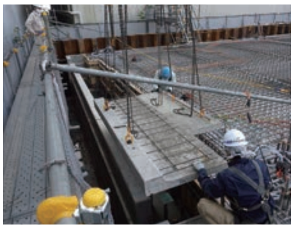

Installation of columns using PCa

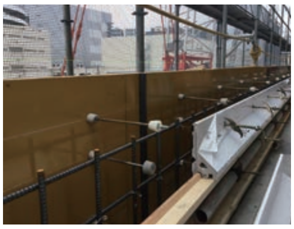

Installation of beams using PCa

(2) Using the Half PCa Method for the Upper Part of the Seismic Isolation Base, Berms, and Parapets

It reduces complex formwork assembly work, shortens work processes, and equalizes quality.
⇒90% less on-site work, and 3 to 5 days shorter process

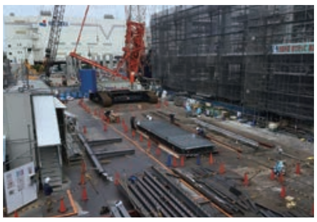

Upper part of seismic isolation foundation using the PCa method


Berms using the PCa method


Parapets using the PCa method

(3) Steel Truss Deck Foundation

Steel truss decks are assembled in a mass in the on-site yard and installed with a crane (conventionally, decks were lifted in bundles and installed one by one).
⇒Improved safety by reducing work at height to 1/10
⇒Shortens the work period by 15 days


Conditions of deck structure


Lifting conditions of deck

Other initiatives to save labor

[Foreman iPad] Lending iPads to the subcontractors' foremen
- Accessing to various information-sharing systems within the scope of authority
- Digitizing work that was traditionally done on paper

○Information sharing items

▶PiCOMS-PCa
PCa Construction Progess Visualization: All procedures, from drawing creation to installation and progress, are displayed on BIM and shared in real time by all parties involved.
→Significant reduction in management of precast construction

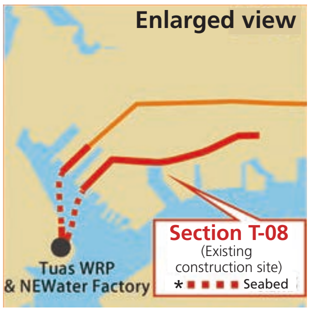
▶Degisite-safety (Developed in-house)
Digitization of the risk prediction sheets, work and layout plans
→Reducing travel time and paperwork

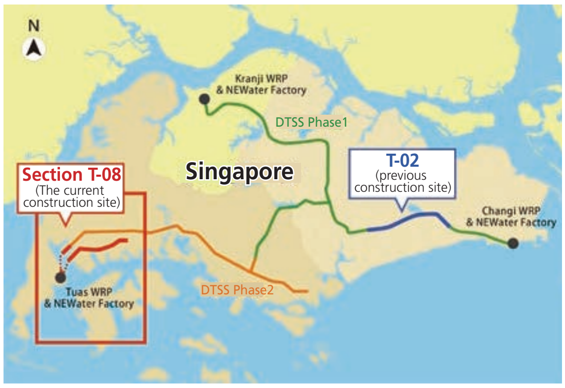
⇒Contributing to work style reform including for employees of subcontractors

Saving Labor and Ensuring Safety by Optimizing the Vertical Shafts and Internal Structure (International)

The Deep Sewer Tunnel Phase 2 T-08 Project, which is currently under construction in Singapore, is to build a 10-kilometer-long main sewer tunnel (shield tunnel) and 10 sewerage facilities.

The sewage facility is a complex three-dimensional structure, with multiple shafts and NATM tunnels planned in the original design. We proposed shafts consolidation and internal structure optimization, which resulted in significant labor savings and safety assurance. Four out of ten sewerage facilities were optimized in this project.





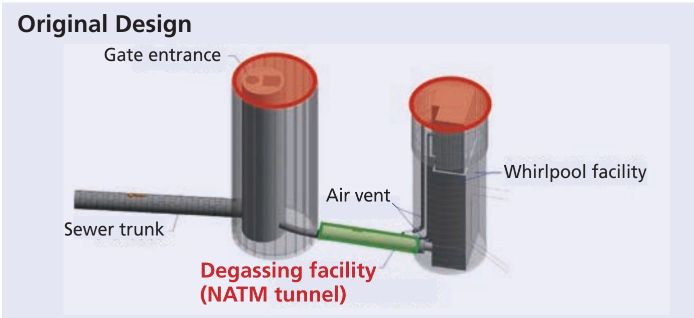
[Construction overview]

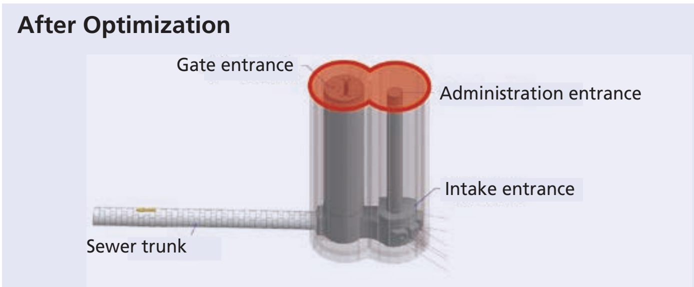
- Client: The Government of Singapore
- Contractor: Penta-Ocean Construction Co., Ltd. and Koh Brothers Joint Venture (JV)
- Tunnel section: Shield construction method
  Approximately 10 km (of which about 3.5 km is in the seabed area)
- Sewage Facilities Department: 10 locations
  Construction depth 45-58 m

Consolidation of shafts…

Placing multiple shafts in a narrow work area reduces the work area on the ground. Shaft consolidation provided a work area and improved workability.

Consolidated shafts (Consolidation of shafts secures work space)

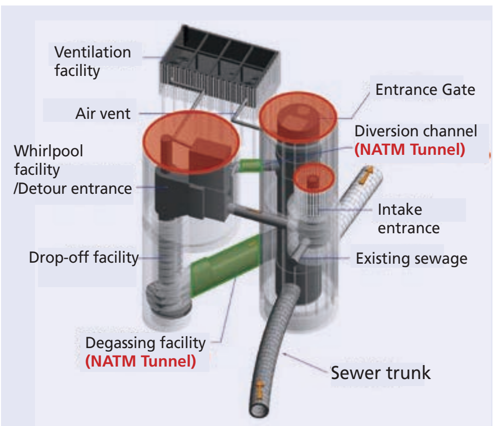




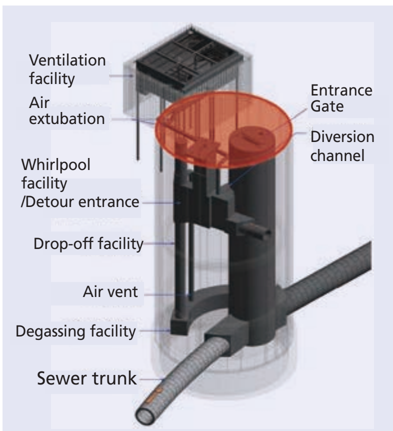
Structural optimization (Omitting NATM tunnels)…

In the original design structure, a conduit connecting the multiple vertical shafts was necessary, and it required the construction of the NATM tunnel, which poses a high safety risk.

In the post-optimization design, construction of the NATM tunnel was omitted by consolidating the shafts and the relevant pipelines were placed inside the vertical shafts, thereby improving construction safety.



Original Design



After Optimization

Top view of driven piles