October 4, 2023

Renewable Energy Use and Challenges

Promoting Offshore Wind Power Generation to Achieve Carbon Neutrality by 2050

TODA CORPORATION

Imai Masanori
Chairperson and Representative Director, Toda Corporation
Co-chair, Japan Climate Leaders' Partnership (JCLP)
Vice President, National General Contractors Association of Japan

Profile

今井　雅則　　Imai Masanori

Chairperson and Representative Director, Toda Corporation

- Career -

1952 Born in Sakai, Osaka
1978 Completed the master's program in architecture, Graduate School of Engineering, Osaka University
1978 Joined Toda Corporation
2013 President & Representative Director
2021 Chairperson & Representative Director

- **Engaged in the construction industry for more than 40 years since joining**

- **Currently belongs to the following organizations and focuses on the development of the construction industry and the realization of a carbon-neutral society.**
  - Co-Chair, Japan Climate Leaders' Partnership (JCLP)
  - Vice-Chair, Eco-First Promotion Council
  - Chairperson, Japan Construction Occupational Safety and Health Association
  - Vice President, National General Contractors Association of Japan
  - Chairperson, the Associated General Contractors of Tokyo

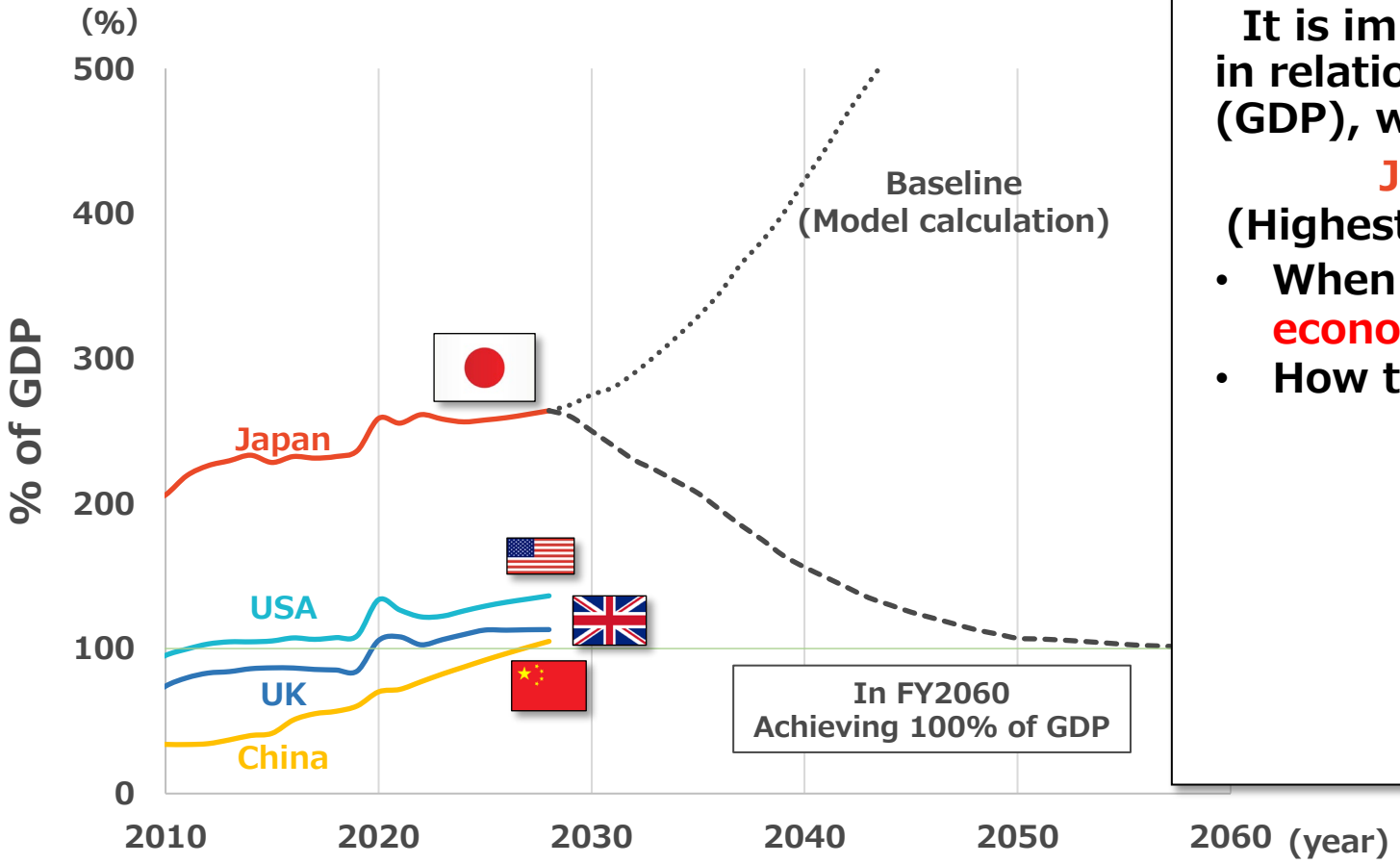
- **Engaged in floating offshore wind power generation business in 2007 and started commercial operation in 2015**

→ Japan's first floating offshore wind power generation project started off the coast of the Goto Islands in Nagasaki Prefecture

- **Currently working towards the industrialization of floating offshore wind power**

①Government Debt

General Government Debt: GDP ratio



GDP ratio

It is important to know the total amount of debt in relation to the size of the country's economy (GDP), which is the source of tax revenue.

Japan's debt is more than twice GDP

(Highest level among major developed countries)

- When public debt exceeds 90% of GDP, economic growth declines by 1%
- How to achieve 100% of GDP by 2060

Consumption tax rate 30% increase

or

Improvement in income and expenditure of 14% of GDP:70 trillion yen

Utilization of natural energy

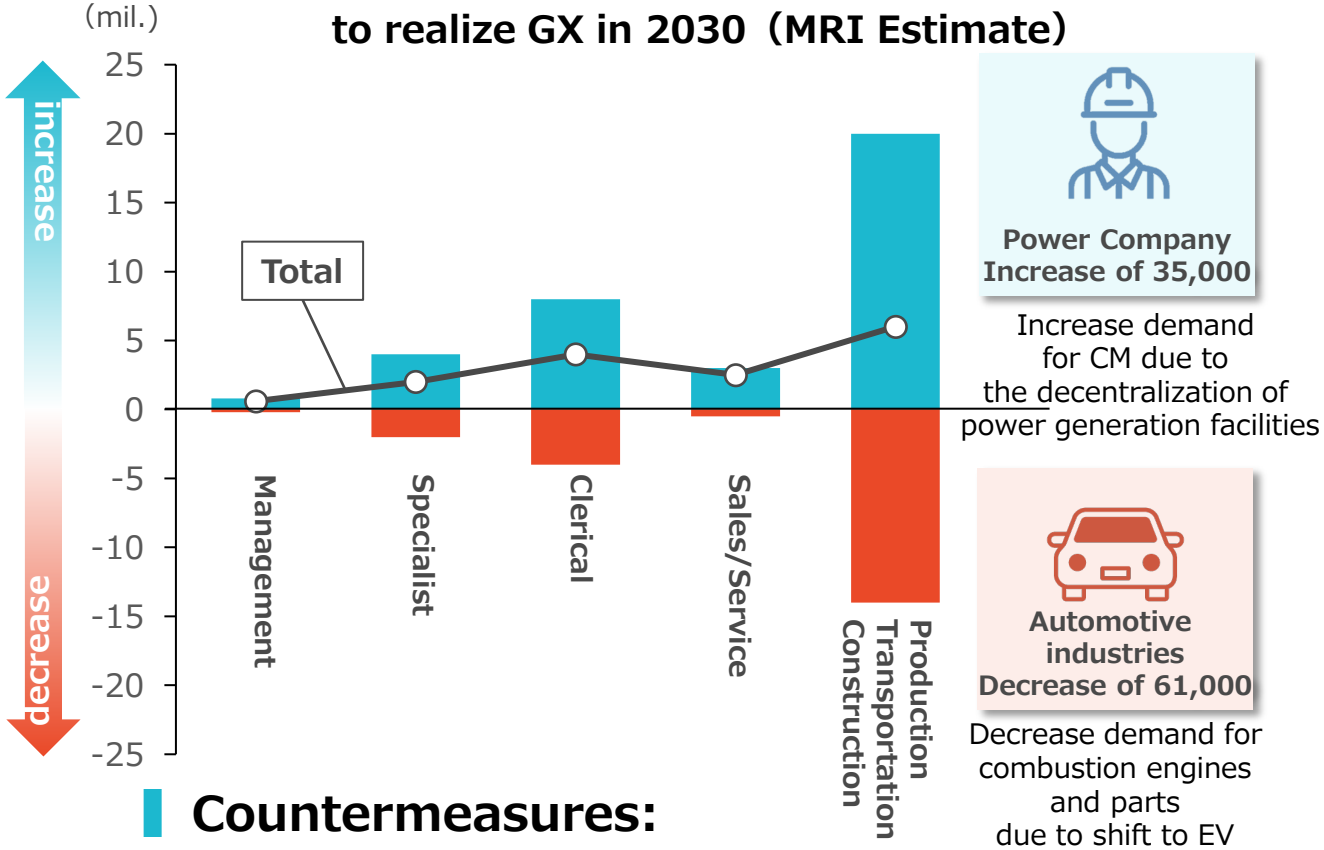
can be one of the tools to improve government debt and economic growth

CHART : prepared from WORLD ECONOMIC OUTLOOK
(https://www.imf.org/external/datamapper/GGXWDG_NGDP@WEO/OEMDC/ADVEC/JPN/GBR?year=2028&yaxis=lin)

② Decline in the Working Population and Tight Demand for Human Resources

Demand for Human Resources for GX

The Demand for Human Resources of Japan to realize GX in 2030 (MRI Estimate)



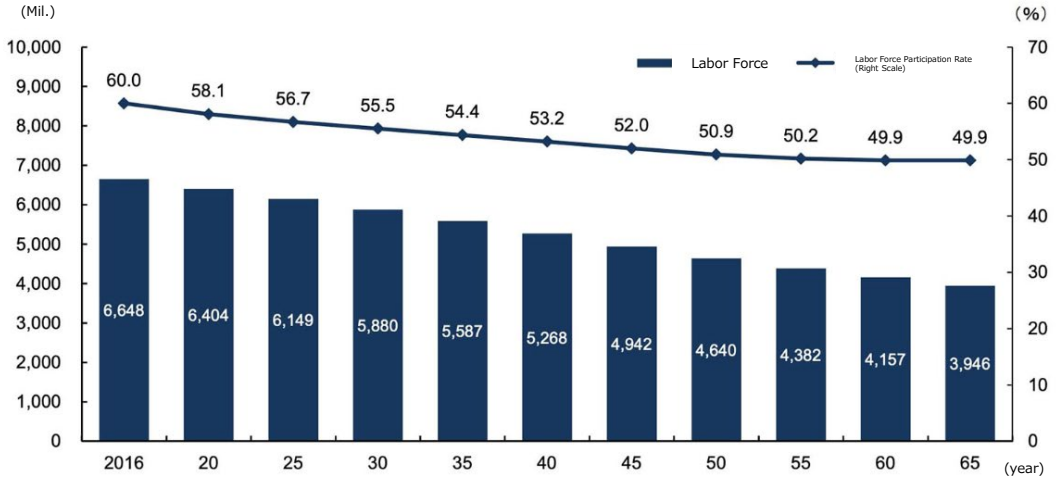
Power Company Increase of 35,000

Increase demand for CM due to the decentralization of power generation facilities

Automotive industries Decrease of 61,000

Decrease demand for combustion engines and parts due to shift to EV

The Trend of Working Population



(Remarks) Actual for 2016. After 2020, calculated assuming labor force participation rates by sex and by 5-year age categories are same as in 2016. (For ages 75 and older, the labor force participation rate for ages 75 and older in 2016 was used as that for ages 75-79; for ages 80 and older was calculated as zero.).

2020
About 64 million

40% reduction

2065
About 40million

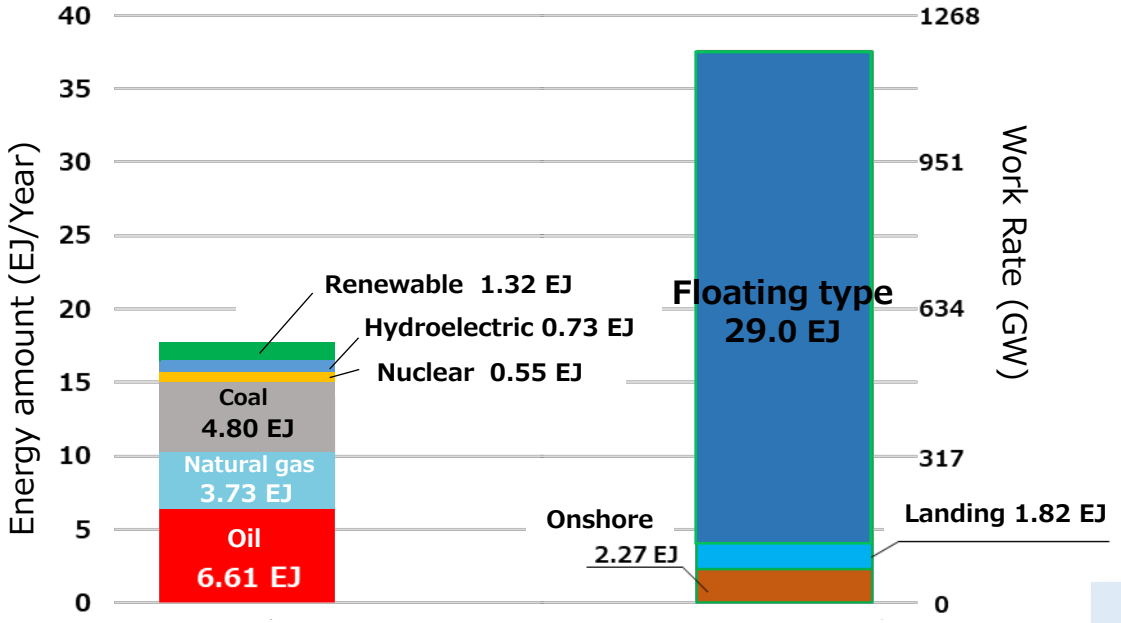
Countermeasures:

- ✓ **Improvement of work style, operational efficiency and productivity (by IT･DX etc.)**
- ✓ **Necessity for high productive industries that contribute to CN**
- ✓ **Necessity for shifting human resources across industries and companies**

Source 1: Mitsubishi Research Institute (MRI) MRI estimates based on the energy supply-demand model and the "2015 Input-Output Table for Analyzing Next-Generation Energy Systems," Waseda University, Smart Society Technology Integration Research Organization, and Institute for Economic Analysis of Next-Generation Science and Technology
Source 2: Compiled by Mizuho Research Institute from Ministry of Economy, Trade and Industry Annual Report on Labor Force Survey (2016) and National Institute of Population and Social Security Research "Japan's Future Population Trends" (April 2017 estimate).

Japan Wind Resources and Energy Demand

Japan Primary Energy Status and Wind Power Reserves (2021)



Primary Energy Consumption in Japan 2021 [1]

17.74 EJ/y

Wind power availability in Japan (capacity utilization: 50%) [3][4][5][6]

Total 33.1 EJ/y

(Ref.) Prefixes of powers of 10

E (Exa) : 10^{18} times

P (peta) : 10^{15} times

T (Tera) : 10^{12} times

G (Giga): 10^{9} times

M (mega) : 10^{6} times

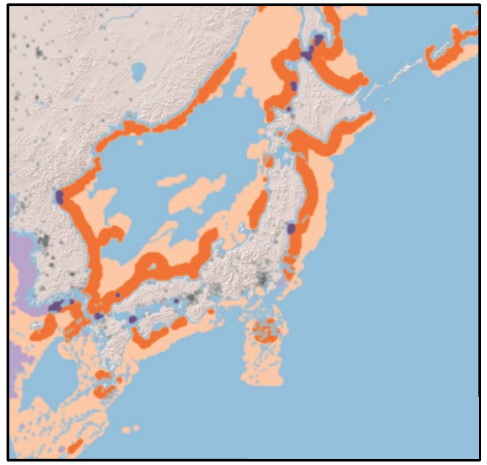
Offshore Wind Resource 29.0 EJ/y

Japan's wind resources have a potential of about 1.8 times its energy demand

➡ Improve the energy balance and establish energy security!

[References] [1] bp Statistical Review of World Energy 2022 [2] World Energy Transition Statistics Electricity: percentage of electricity in total final energy consumption
[3] Percentage of electricity in primary energy (electrification rate), Japan Atomic Energy Relations Organization [4] Compiled by Mitsubishi Research Institute, Inc. based on Ministry of Economy's Trade and Industry Energy White Paper 2019 and Comprehensive Energy Statistics. [5] Ministry of the Environment. Renewable Energy Potential System [REPOS]. (Online) June 22, 2020. (Cited on March 24, 2022.) [6] IEA. [6] IEA. Offshore Wind Outlook 2019.(Online) IEA, November 2019. (Cited December 21, 2020.)

Mass Production and Installation of Offshore Wind Power in Japan



NEAR SHORE (~60km)

Shallow water 30 TWh — 1,141 units(10MW) Fixed-base

More than twice the total power consumption of Japan

Deep water 2,223 TWh — 84,539 units Floating 10MW

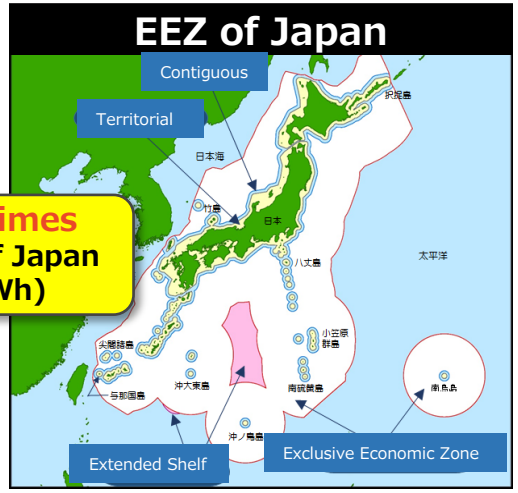
TOTAL POTENTIAL (~300km)

Shallow water 43 TWh — 1,636 units(10MW) Fixed-base

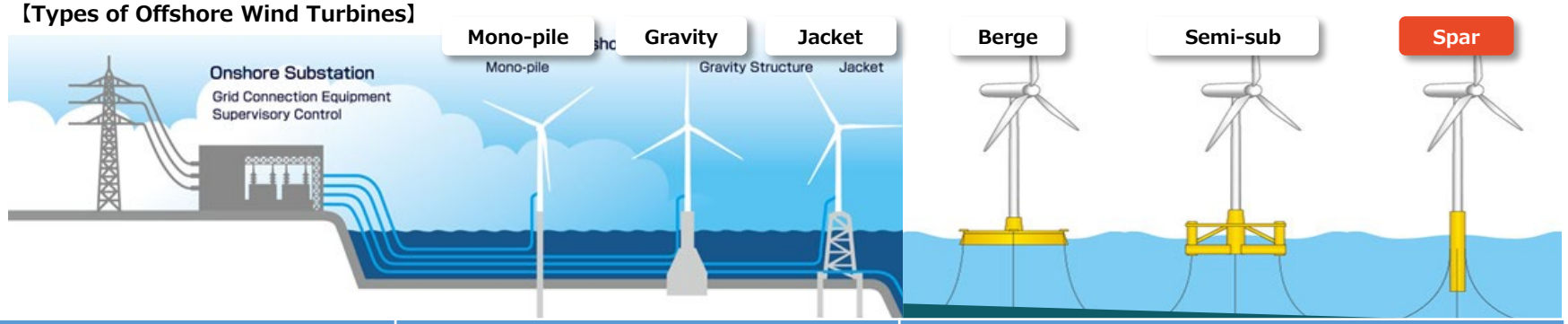
More than 1.8 times primary energy of Japan (4.9 trillion kWh)

Deep water 9,031 TWh — 343,645 units Floating 10MW

Source : IEA 2019



【Types of Offshore Wind Turbines】



	Shallow water	Deep water	
Water depth	10 ~ 60 m	60 m or more	100 m or more
Power generation potential (annual)	43TWh	9,031TWh	
Equivalent number of 10MW machines that can be installed	1,636 pcs.	343,645 pcs.	

Floating offshore wind turbines are needed that can be mass-produced and installed

Floating offshore wind power can be mass-produced, installed and it can be the main source of primary energy.

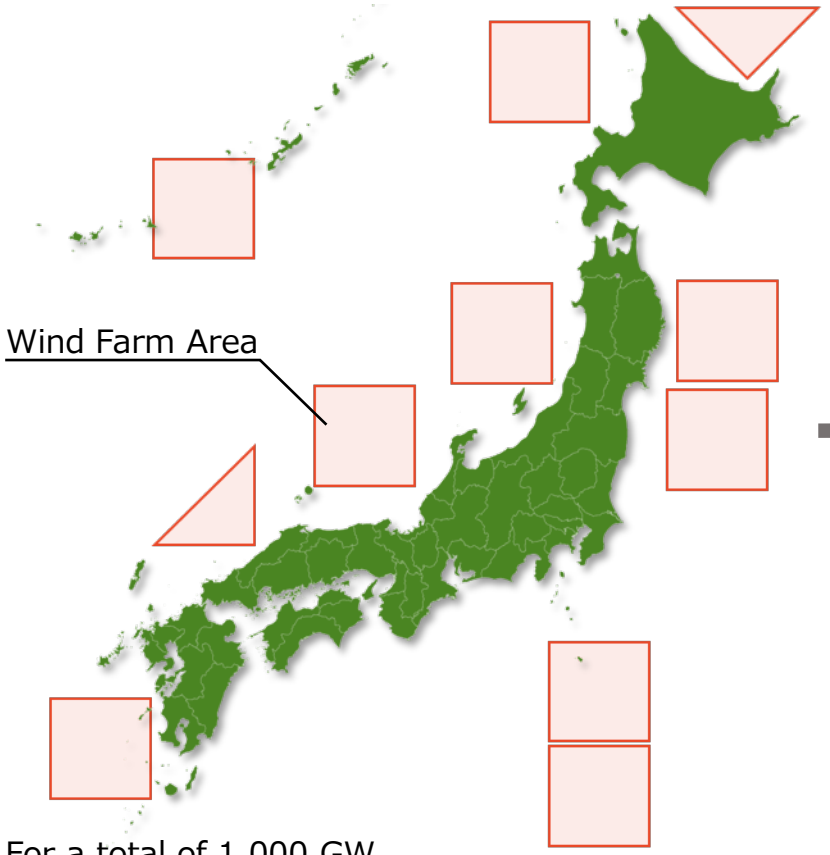
Build large-scale industries with high productivity and establish energy security

A World of Green Energy to Achieve CN in 2050

TODA CORPORATION

2050 Large Scale Offshore Wind Farm

Industry Scale : 18.4 trillion yen/y, 368 trillion / 20 years
(1,000GW・7yen/kWh)



For a total of 1,000 GW,
cover **53.6%** of primary energy of Japan :
(1,000 GW = 2,628 TWh : capacity utilization rate = 30%)

- **Wind power**
  Offshore fix-base
  Onshore
- **Solar**
- **Water**
- **Geothermal**
- **Others**

Challenges for Large Scale Floating Offshore Wind Power Project

- Acquisition, Development and Production of Wind Power Generators
- Offshore expansion of Wind Power
  →Floating complex (Installation of Mega Float)
- Formulation of Marine Spatial Planning
- Survey of EEZ
- Infrastructure Development (Power Grids and Ports)
- Fisheries Promotion and Biodiversity : Consideration for the Environment

Many Issues to be Solved

toward Achieving CN by 2050

Issue 1
Acquisition, Development and Production of Wind Turbines (Countermeasures)

[List of issues]

▶ ① **Acquisition, development and production of wind turbines**

▶ ② Offshore expansion of wind power

Floating complex

(Installation of mega-floats)

▶ ③Formulation of Marine Spatial Planning

Countermeasure 1

Developing, Manufacturing and Maintaining Wind Power Generators all over Japan

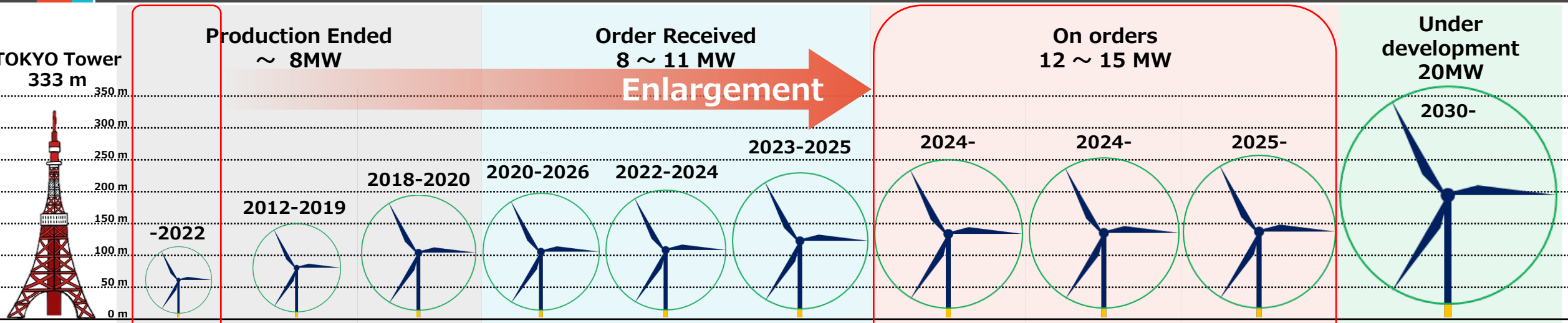
- ✓ Attracting domestic manufacturing bases for large parts such as blades, towers and nacelle assemblies —including licensed production
- ✓ Restructuring of domestic supply chains (expansion of exportable parts)
- ✓ Start design and development of wind power generators focusing on Japan's EEZ
- ✓ Several years of development term and tens of billions of yen in development costs are required for formation building and mass production.
- ✓ Fix and declare medium- to long-term equipment introduction plans to increase the willingness of Japanese companies to participate
- ✓ Entering overseas markets with low-cost and high-quality energy by our own unique advanced technologies

Countermeasure 2

Procure overseas products until developing Japan Products

- ✓ Develop business scenarios that increase the sales motivation of global suppliers and procure immediate requirements
- ✓ Enhance local contents available to global suppliers
- ✓ Develop infrastructure environment for pre-assembly, commissioning, installation, and maintenance during transportation and on floating－reducing supply risk for global supplies)
- ✓ Replace sequentially domestic wind turbines with high-performance and low cost

Issue 1
Acquisition, Development and Production of Wind Turbines (Larger Wind Turbines)



Power (MW)	2.1	3.6	8.0	8.0	10.0	11.0	12.0 - 12.6	14.0 - 15.0	15.0	20.0
Maker	HITACHI	Siemens	Vestas	Siemens	Vestas	Siemens	GE	Siemens	Vestas	(predicted)
Model	HTW2.1-80	SWT3.6-120	V164-8.0	SG8-167	V174-10.0	SG11-200	Haliade-x	SG15-236	V236-15.0	
Rotor Diameter (m)	80	120	164	167	174	200	222	222 – 236	236	340
Height (m)	110	150	194	197	204	230	252	252 – 266	266	370
Hub Height (m)	70	90	112	113.5	117	130	141	141 – 148	148	200

Issue 2
Offshore Expansion of Wind Power : Idea of Floating Complex

[List of issues]

▶ ① Acquisition, development and production of wind turbines

▶ **② Offshore expansion of wind power**

Floating complex

(Installation of Mega-Floats)

▶ ③Formulation of Marine Spatial Planning

Floating Complex

Use of Floating Complex

✓ **Manufacturing and Maintenance Base for Floating Offshore Wind Turbines**

Set up manufacturing and maintenance base in offshore wind setting area

✓ **Mooring Base**

- For fuel cell ships and hydrogen ships etc.
- Power supply station for sailing ships (like a gas station at sea)

✓ **Seawater Purification Base－Environmental Preservation**

- Use of shellfish such as farmed oysters, scallops, pearl oyster and others (Aproximately 400 liters of seawater is filtered per day by one oyster)

Reference : Ministry of Agriculture（https://www.jfa.maff.go.jp/j/kikaku/tamenteki/kaisetu/gyogyou_katudou/）

✓ **Hydrogen Production and Storage Plants**

- Electrolysis of seawater by generated electricity－green hydrogen
- Storage of generated hydrogen and oxygen

✓ **Marine Surveillance and Defense Systems**

- Restrict on ships of other countries that sailing territorial waters and contiguous zones

Issue3
Formulation of Marine Spatial Planning (MSP)

[List of issues】

▶ ① Acquisition, development and production of wind turbines

▶ ② Offshore expansion of wind power

Floating complex

(Installation of mega-floats)

▶ **③Formulation of Marine Spatial Planning (MSP)**

How can we proceed with discussions and “agree” on how to use the sea in a way that everyone can follow in the future? What should we pay attention to in this process?
The "**Marine Spatial Plan**“ [1] provides a standard path to follow.

✓ **Designate area for Offshore Wind Farms and Floating Complex**
- For offshore wind power to be established as an industry, predictability in planning is important
- Designation of large areas requires prior agreement on how the area will be used.
- Designation of sea areas on a project-by-project basis does not allow for predictability, and there is a risk of backtracking.

✓ **Creation of MSP**
- Requires open, all-participating consensus.
- It takes a long time to make MSP with agreement of many stakeholders (in 10-year increments)
- We need to start right now and investigation on the current situation is going on.

MDA Situational Indication Linkages (MSIL) https://www.msil.go.jp/msil/Htm/TopWindow.html

✓ **Continuous Review of MSP**
- It must be continuously reviewed in accordance with changes in social conditions even if a plan has been created once.

ex) The ban of fishing in wind farm area ➡ prohibit only windmill perimeter

✓ **Establishment of Special Offshore Wind Zone**
- To promote GX, it’s necessary to build large-scale offshore wind farms without waiting for the establishment of MSP

⇒ **Need to establish special offshore wind farm zones in parallel with the preparation of the MSP**

[Reference] [1]Guidelines for the Consensus Building Process on Ocean Use Ocean Alliance – University of Tokyo
https://www.oa.u-tokyo.ac.jp/program/images/cbm.guideline.pdf

Example in EU ※*Data presented by Isabella at a conference organized by the Renewable Energy Foundation

Source: Excerpts from "Unleashing Japan's Offshore Wind Potential: Focusing on the Use of Offshore Areas and Human Resource Development," Japan Renewable Energy Foundation (https://www.renewable-ei.org/activities/events/20230620.php)

(Demonstration of Floating Offshore Power Generation)

2007

1/100 scale
Two-dimensional tank experiment
(Kyoto University)

2008

1/20 scale
Deep-sea tank experiment
(Maritime Research Institute of Technology and Safety)

2009

1/10 scale
field experiment
(Sasebo City, Nagasaki Prefecture)

2010

Entrusted
Ministry of the Environment
Demonstration Project
(Off the coast of Kabashima, Goto City)

2011

2012

Small-scale testing equipment installed
(1/2 scale, 100kW)

2013

demonstration model installed
(2000kW)

2014

2015

demonstration model moved to offshore Sakiyama

2016

Ministry of the Environment project completed Transferred to Goto City
Start of power generation business

2017

2018

Semi-submersible spud barge (Float Raiser) multifunctional ship completed

2019

2020

2021

Designated as promotion zone wind farm business operator
(16.8MW)

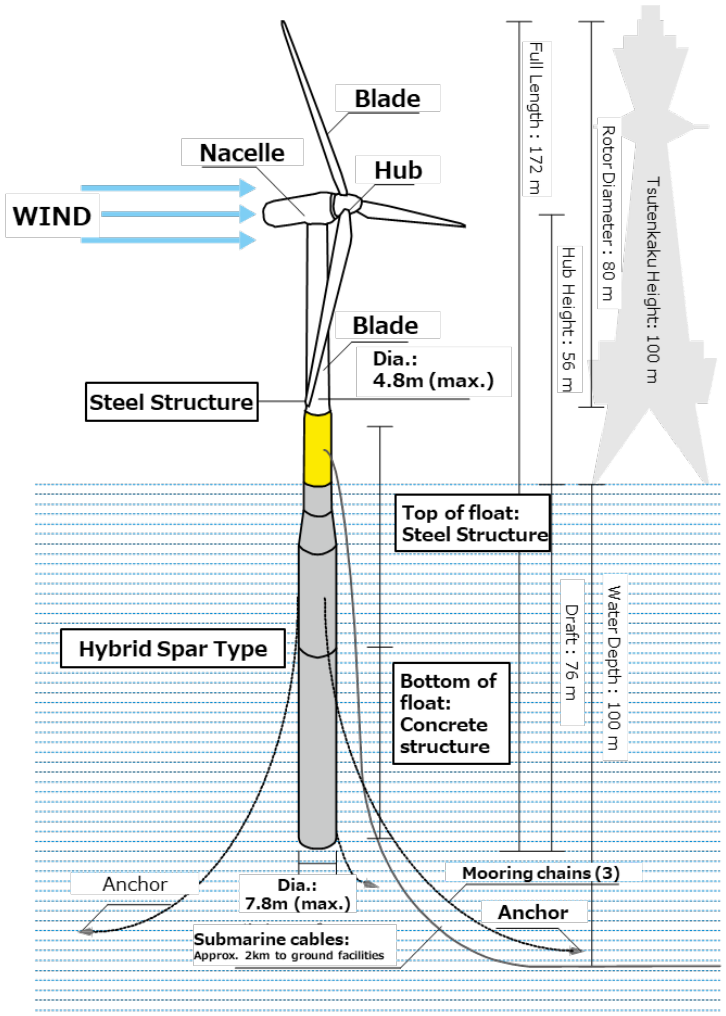
2023

Proceeding construction

Semi-submersible spud stand (float raiser)

multifunction ship

Toda Corporation's Approach (Proprietary Technology: Hybrid Spar Features)



✓ Simple Structure

Contributes to standardization, Mass Production and low cost

✓ Can be built on quays with low ground bearing capacity

The weight per unit area is reduced by lying on its side

✓ Stability

Reduces the influence of waves and wind direction

✓ Low-Cost Design

Using comparatively cheap concrete and steel. Utilize the mechanical properties of each

✓ Construction at Local Companies

Steel parts are made by ironworks and shipyards in Nagasaki
Concrete parts are made by company in Goto City by standardizing structure

Q1. What is the scale of wind turbine?

2,000 kW (enough for about 1,800 households)

Q2.What do you do with the generated electricity?

Connected to the power system of Kyushu Electric Power and supply to residents of Fukue Island and Goto City.

Q3. How many tons does one windmill weigh?

About 3,500 ton. (Stable by ballast material(about 1,400 ton) inside the main body

Q4. Will the windmill collapse? What to do for a typhoon?

Like “Roly-Poly Toy”, it is designed to get up and return to its original state whenever. When a typhoon come and exceed the predetermined wind speed, it parry the wind by stopping the rotation of rotor.

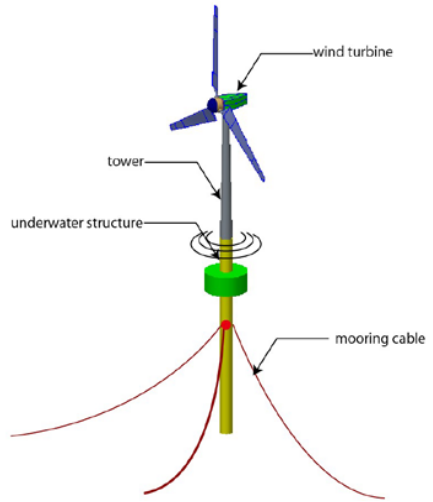
Introduce of Joint Research Chair for Offshore Wind System Integration

TODA CORPORATION

Subject & Solution

Development and integration of elemental technologies required for the industrialization and social implementation of offshore wind power
Driving force to create a new offshore wind industry in Japan

R&D -------Offshore Wind System Integration



- ▶Wind turbine local factory & Supply chain
- ▶Larger size, mass production, and lower cost of floating structure
- ▶Surveys of wind and sea conditions in the EEZ
- ▶Surveys on possible installation areas and mooring methods in the EEZ
- ▶Development of power grid conversion to fuel, storage and transportation
- ▶Development of floating manufacturing plants and maintenance bases
- ▶Energy management in remote islands
- ▶Measures for biodiversity and environment, utilization of marine space

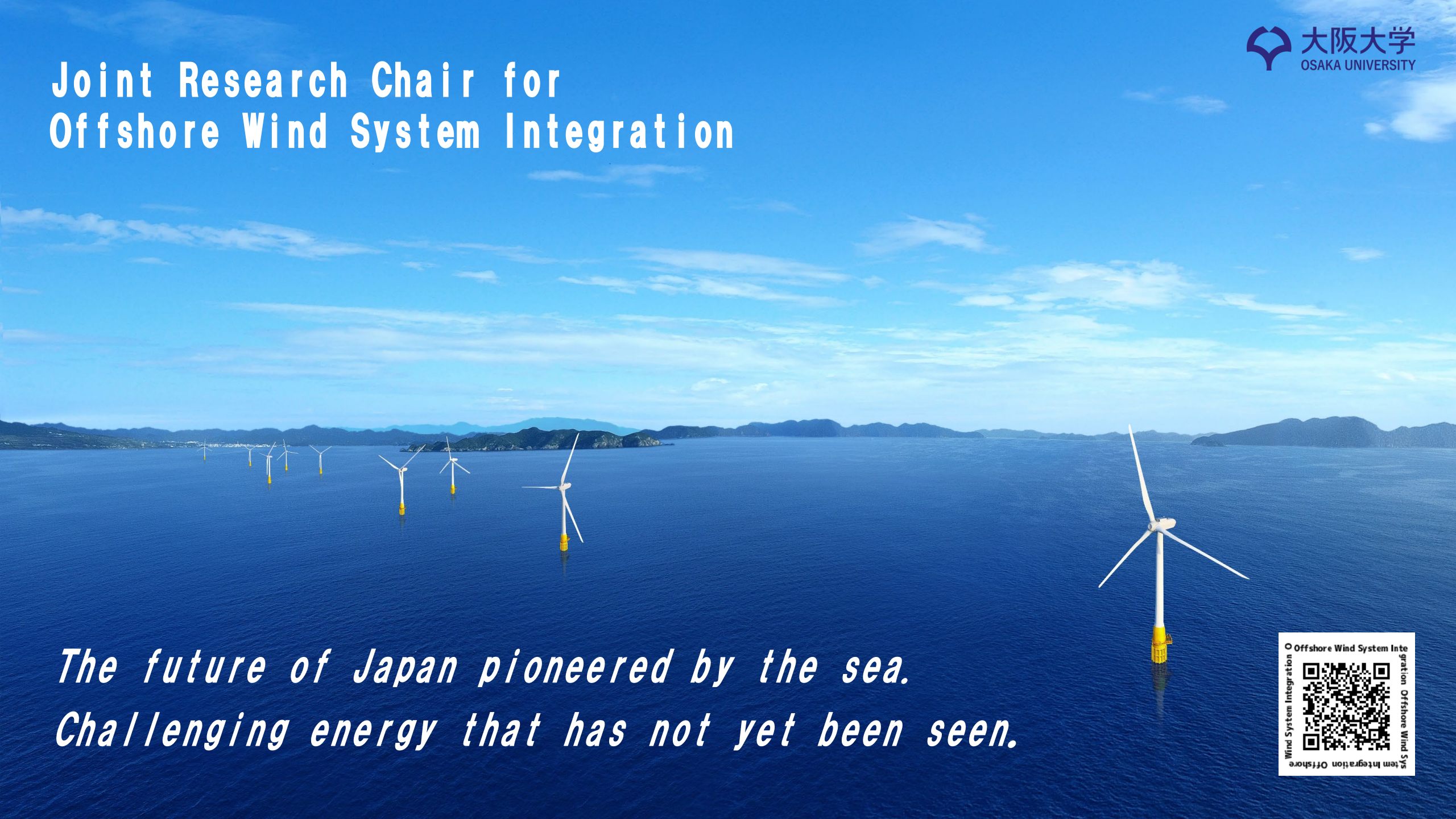
Workshops and Collaborative research

Work on for industrializing offshore wind power with various corporation, research institutes and universities

Laboratory (University of Osaka)

大阪大学
OSAKA UNIVERSITY

Joint Research Chair for Offshore Wind System Integration



The future of Japan pioneered by the sea.
Challenging energy that has not yet been seen.

Offshore Wind System Integration Offshore Wind System Integration