

◆◆◆ GHG Reduction ◆◆◆

**A Contribution of the Shipbuilders in Japan toward
Renewable Energy Development**

***- Fukushima Floating Offshore Wind Farm
Demonstration Project -***

**27 Nov. 2014
8th ASEF Jeju, Korea**

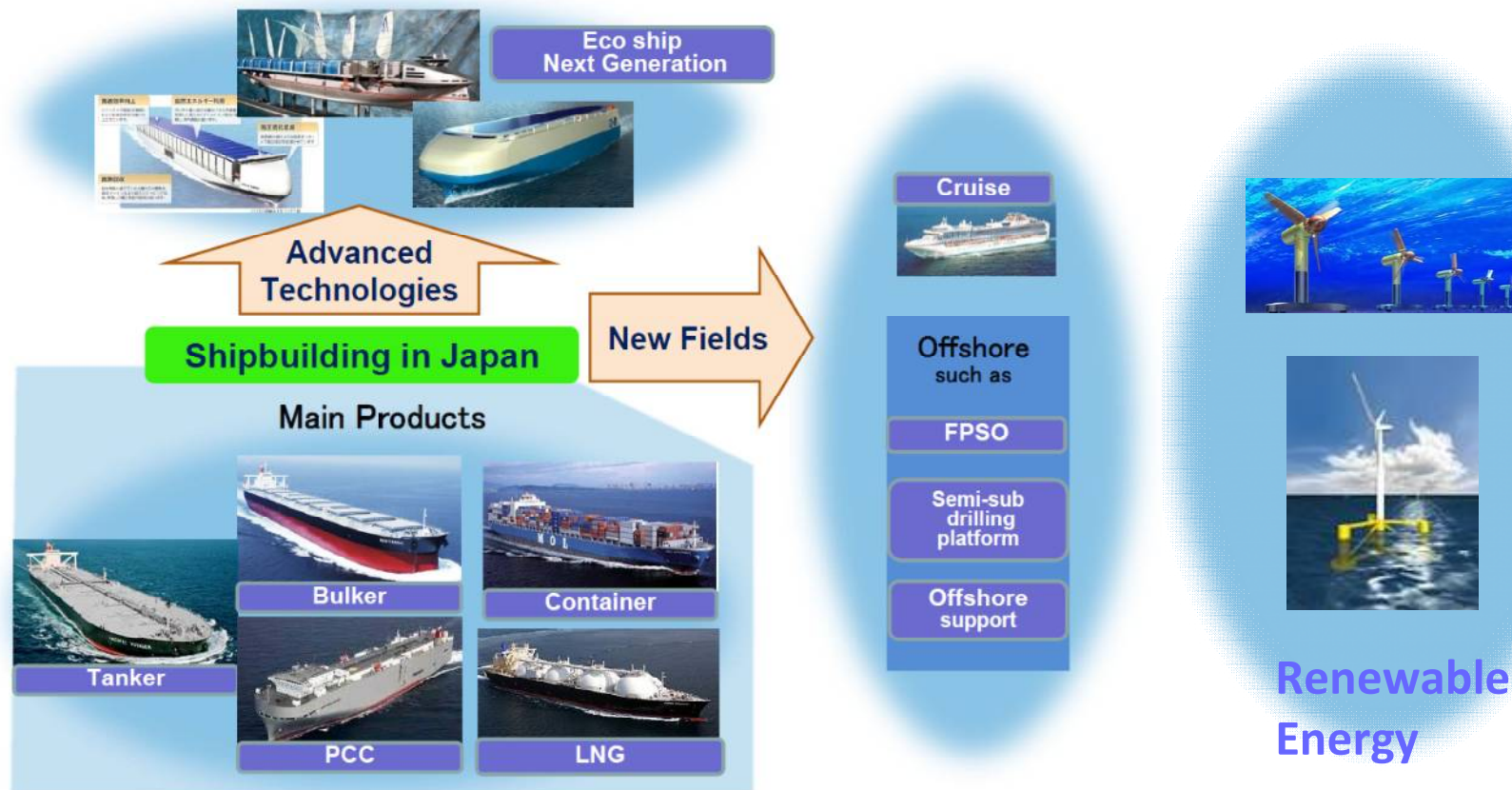


**Akihiko IMAKITA Dr. Eng.
Mitsui Engineering & Shipbuilding Co., Ltd.**

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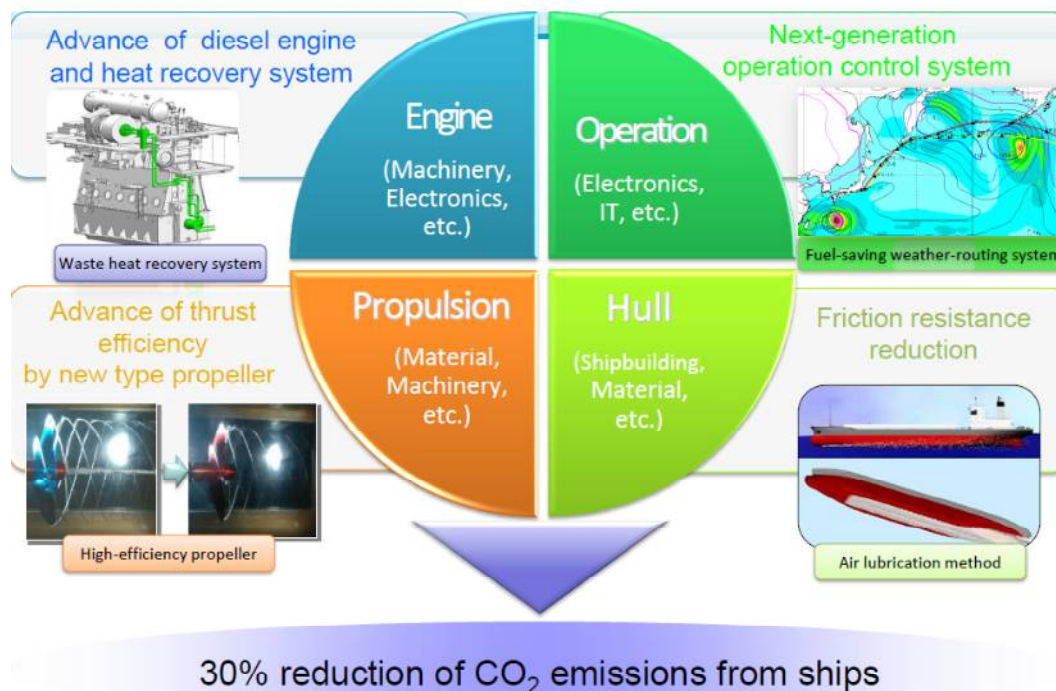
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1. Expanding Business Fields of Shipbuilders in Japan



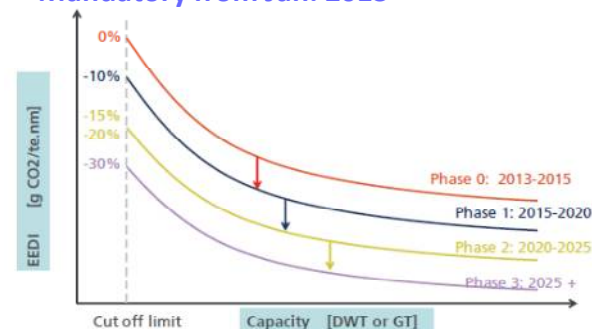
Faced with severe markets and global environmental concerns, shipbuilders in Japan are diversifying the business fields from conventional merchant ships to more eco-friendly ones plus new fields such as renewable energy development.

2. GHG Reduction ◆ Eco-ship Developments

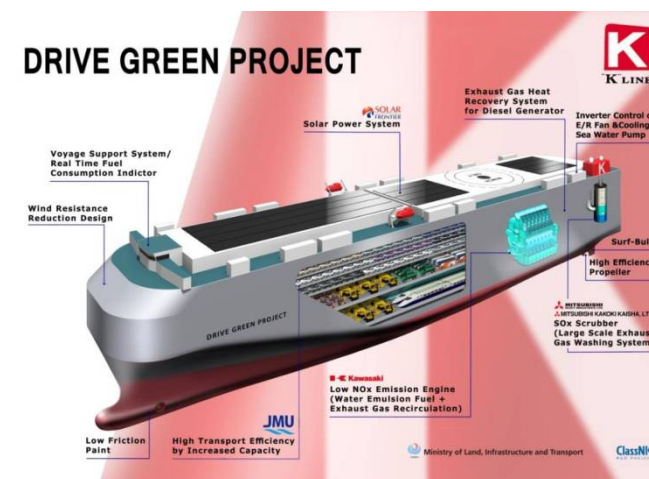


EEDI Regulation

Mandatory from Jan. 2013



DRIVE GREEN PROJECT



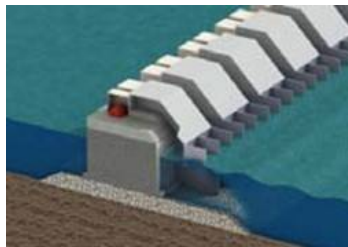
Feb. 2014, K Line ordered 7500 PCC.

Mandatory IMO EEDI application has started. The combination of various newly developed technologies (in Hull, Propulsion, Engine, Operation aspects) enables yards to design the sophisticated eco-friendly ships.

3. GHG Reduction ◆ Renewable Energy Developments



Wave Power Buoy
Generators (MES)



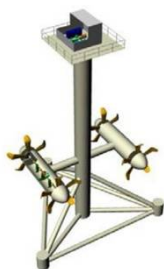
Oscillating Water
Column Wave Power
Generator (MHI Eng.)



Bottom-mounted
Tidal Current
Generators (KHI)



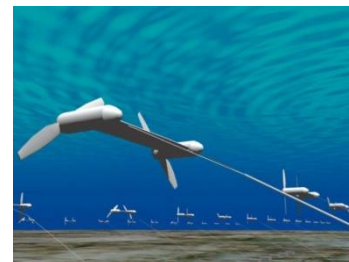
Floating Wind-Tidal
Current Turbine
(MODEC)



Hydraulic Tidal
Current Generator
(Sasebo H.I.)



Floating Thermal
Conversion Generator
(JMU)



Moored Current
Generators (IHI)



Floating Wind turbine
Fukushima Project
(MES, JMU, MHI, etc)

Various renewable ocean energy projects (FS, R&D, experimental demonstration) are now going on. Some shipbuilders and subsidiaries are actively involved in each project.

4. Fukushima Floating Offshore Wind Farm Demonstration Project

4.1 Outline

Fukushima Floating Offshore Wind Farm Demonstration Project (Fukushima FORWARD)



<http://www.fukushima-forward.jp/english/index.html>

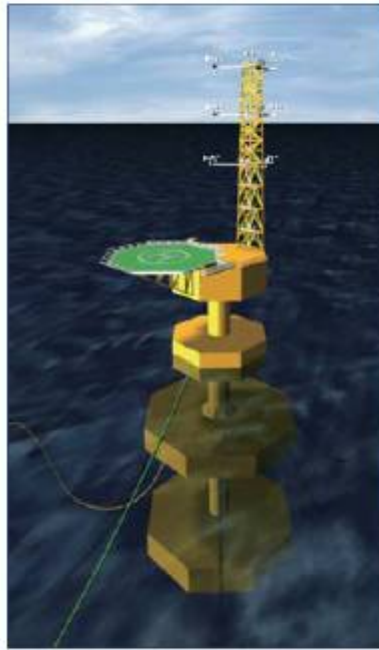
Fukushima floating offshore wind farm demonstration project (Fukushima FORWARD) is funded by the Ministry of Economy, Trade and Industry.

Scope of FORWARD

Phase I (2011~2013)

Phase II (2014~2015)

Floating Substation



Compact Semi-Sub
(2MW)



Advanced Spar
(7MW)



V-shape Semi-Sub
(7MW)



Three key factors for success

Technical Challenge / Social Acceptance / Recovery of Fukushima

Design / Test / Optimization

Cost efficiency / Standardization / Industrialization

Consortium

FORWARD member	Main role
Marubeni Corporation [Project integrator]	Feasibility study, Approval and licensing, O & M, Collaboration with fishery industry
The University of Tokyo [Technical adviser]	Metocean measurement and prediction Technology, Marine navigation safety, Public relation
Mitsubishi Corporation	Coordination for grid integration, Environmental impact assessment
Mitsubishi Heavy industries, Ltd.	V-shape semi-sub(7MW)
Japan Marine United Corporation	Advanced Spar, Floating Substation
Mitsui Engineering & Shipbuilding Co., Ltd.	Compact Semi-sub(2MW)
Nippon Steel & Sumitomo Metal	Advanced steel material
Hitachi Ltd.	Floating Substation
Furukawa Electric Co., Ltd.	Large capacity undersea cable
Shimizu Corporation	Pre-survey of ocean area, Construction technology
Mizuho Information & Research institute, Inc	Documentation, Committee Operation



4.2 2MW floating wind turbine “Fukushima Mirai”



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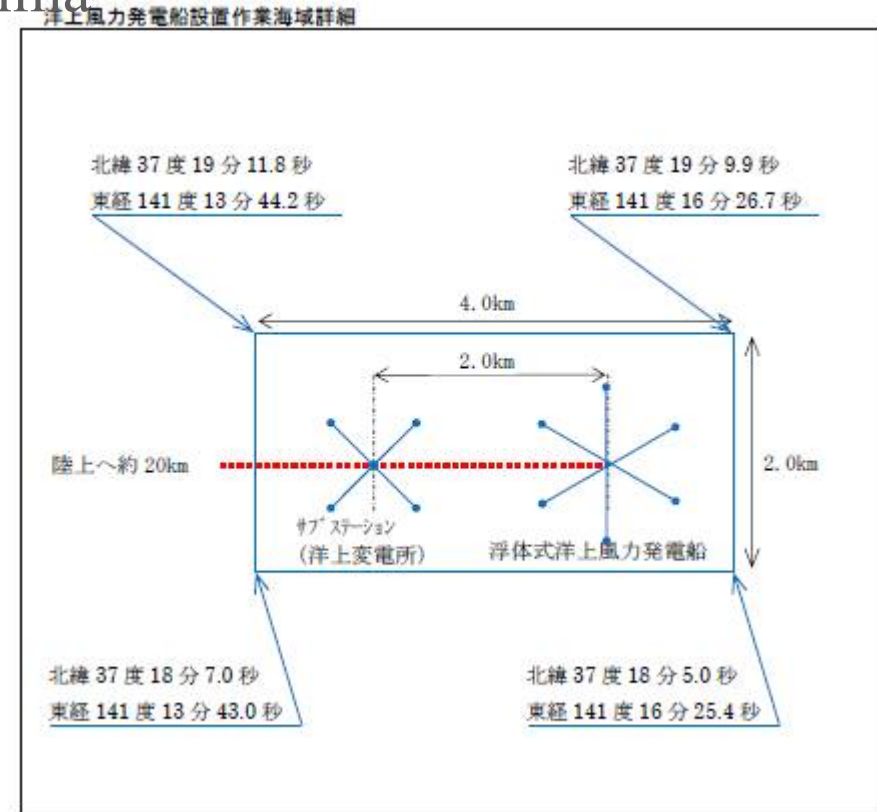
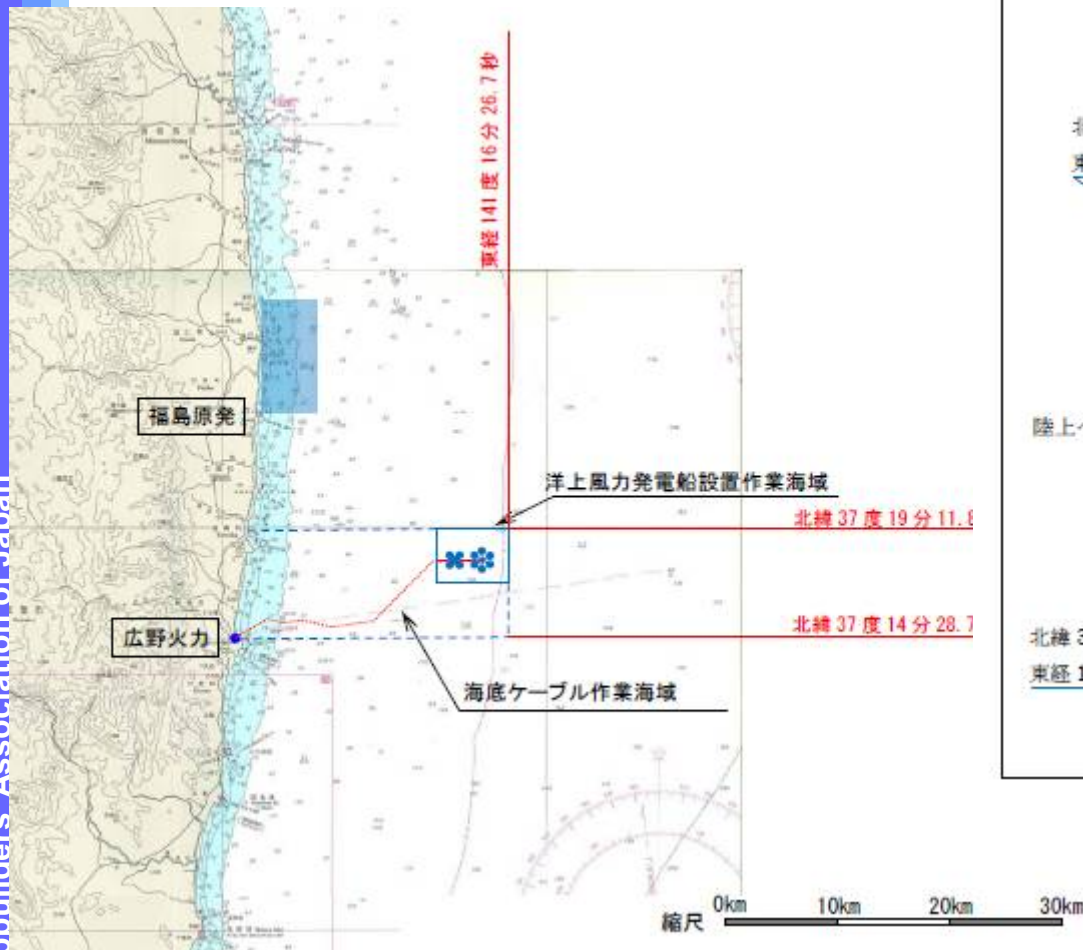
4.2.1 Introduction

- Project objective is to :
 - help Fukushima to become the center of new industry which will create new employment in this region to recover from the damage of the Great East Japan Earthquake in 2011.

- Objective of “Fukushima Mirai”
 1. Prove validity of design method
 - WT/Floater interaction
 - Mooring
 2. Establish O&M method
 3. Economical evaluation

Site Location

Approx. 20km off the coast of Fukushima





4.2.2 Design

- Unmanned
 - Remote monitoring
(SCADA, alarm, acceleration, inclination, strains)
- Rule
 - Class NK Guide Line
 - 「Guide line for floater with wind turbine」
- Design life: 20 years
 - Fatigue、Painting、Corrosion
- WT
 - Effect of floater oscillation

4.2.2 Design

- Environmental design conditions

“Meteocean Design Condition for Fukushima FORWARD Project “,
T. Ishihara, K. Shimada, A. Imakita,
Grand Renewable Energy 2014 International Conference and Exhibition

Wind: 48.3m/s at hub height

Wave: 11.7m, significant wave height

Current: 1.5m/s

Tsunami: 0.87m/s (horizontal velocity)

Particular of Fukushima Mirai

Floater

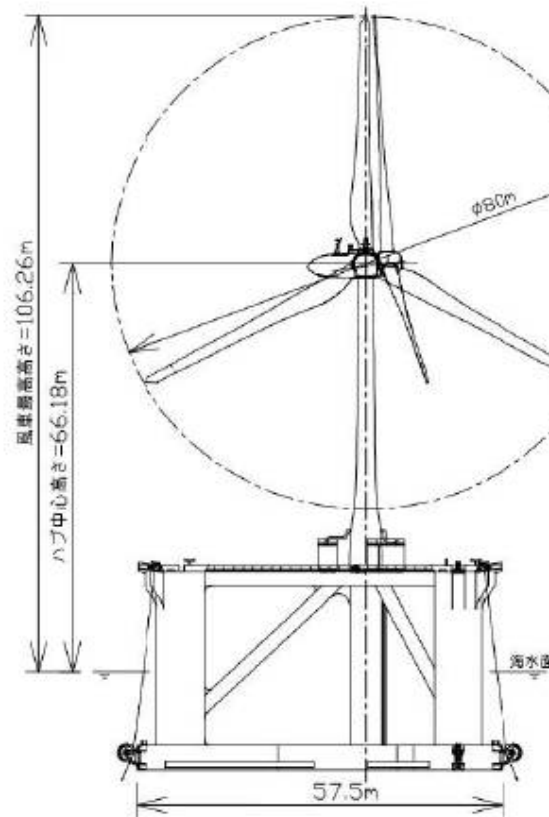
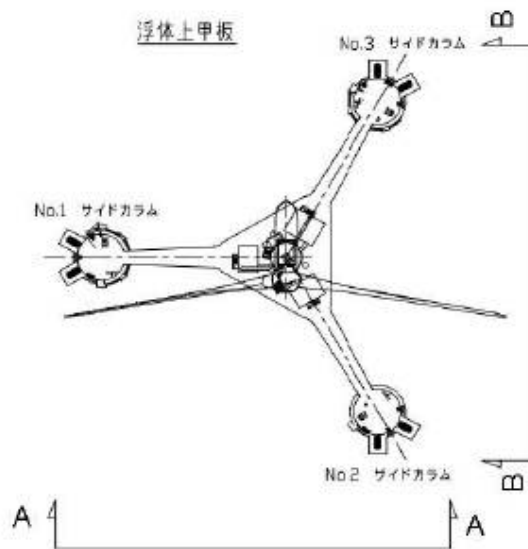
Type	Semisubmersible
Length	57.50m
Width	64.23m
Depth	32.00m
Draft	16.00m
Class	Class NK
Water depth	120m

Wind turbine

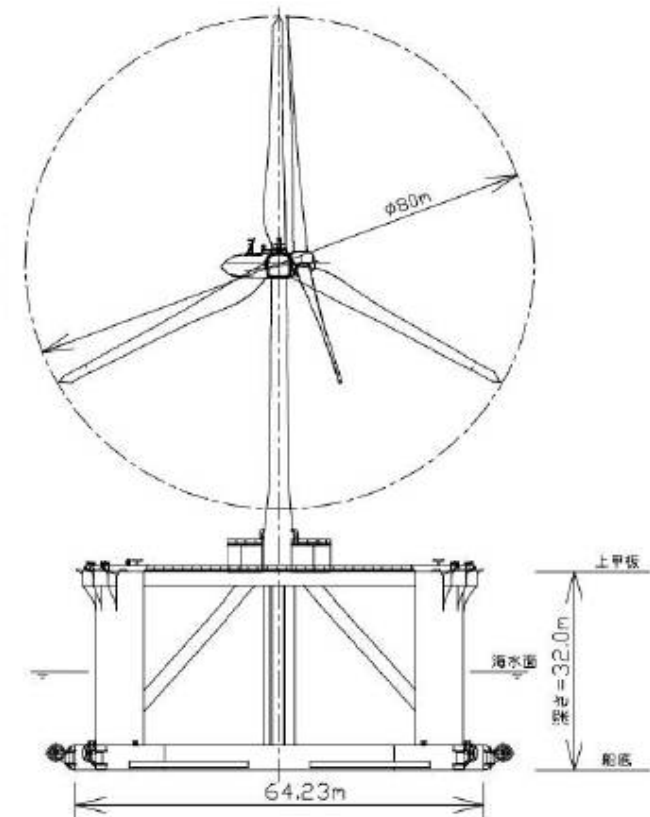
type	Down Wind HWT2.0-80
Output	2,000kW
Quantity	1
Rotor D.	80.0m
No. of Rotor	3

Mooring

Type	catenary
No. of mooring	6
chain	Φ132mm
anchor	High hold capacity drag anchor



A-A 矢視



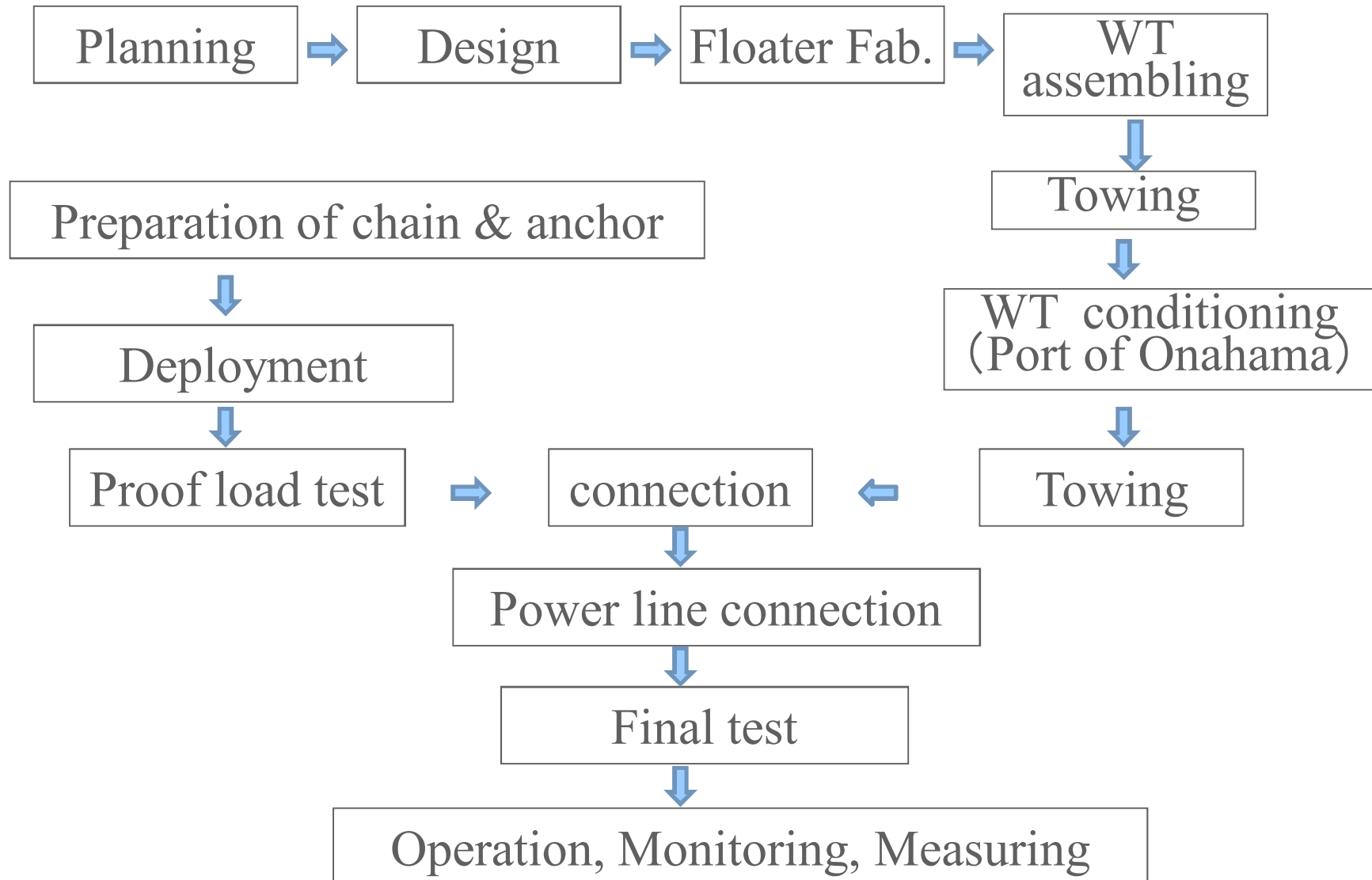
B-B 矢視



“Fukushima Mirai”

4.2.3 Construction

Construction Flow



Fabrication of floater



Fabrication of floater

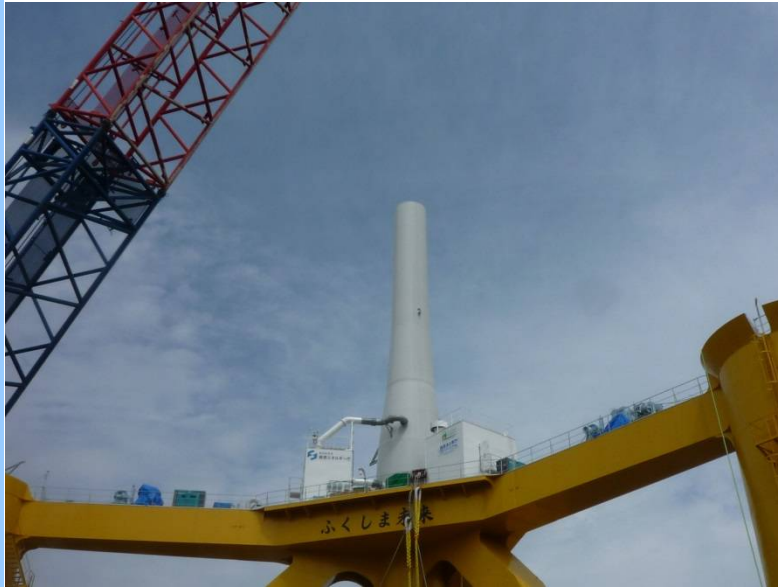


Fabrication of floater

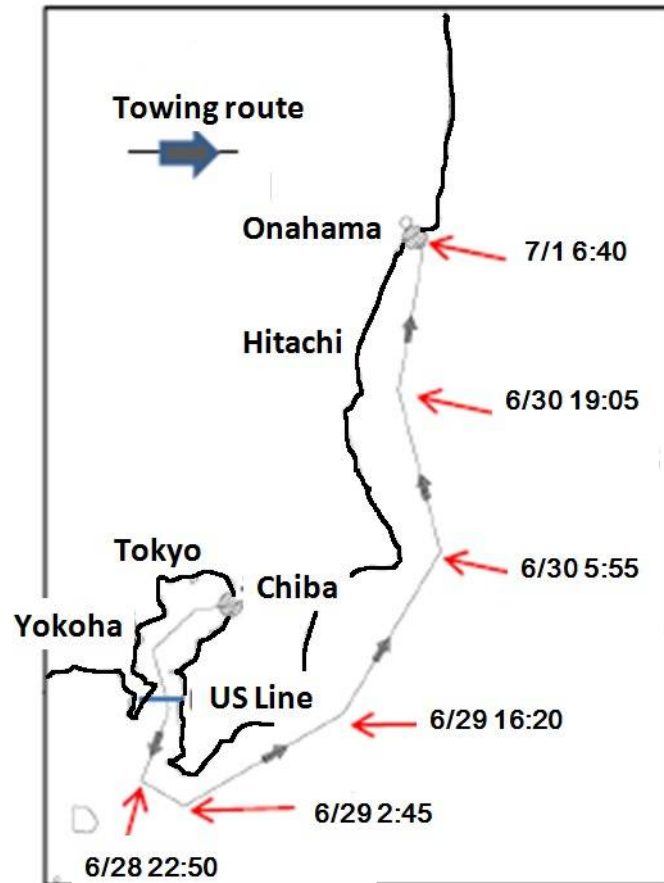


Assembling of WT

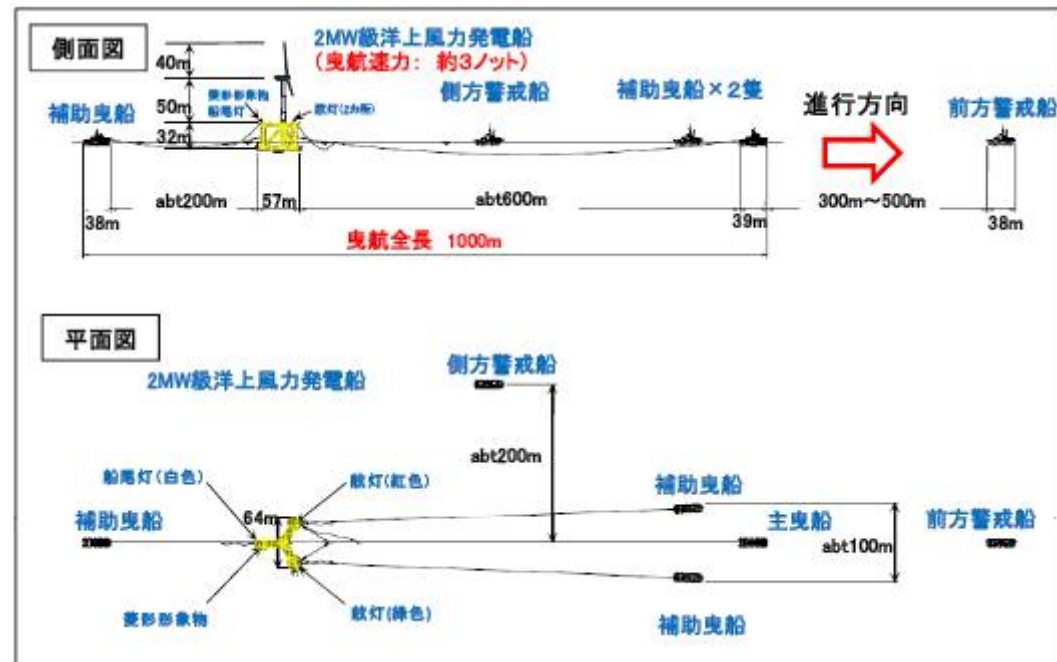




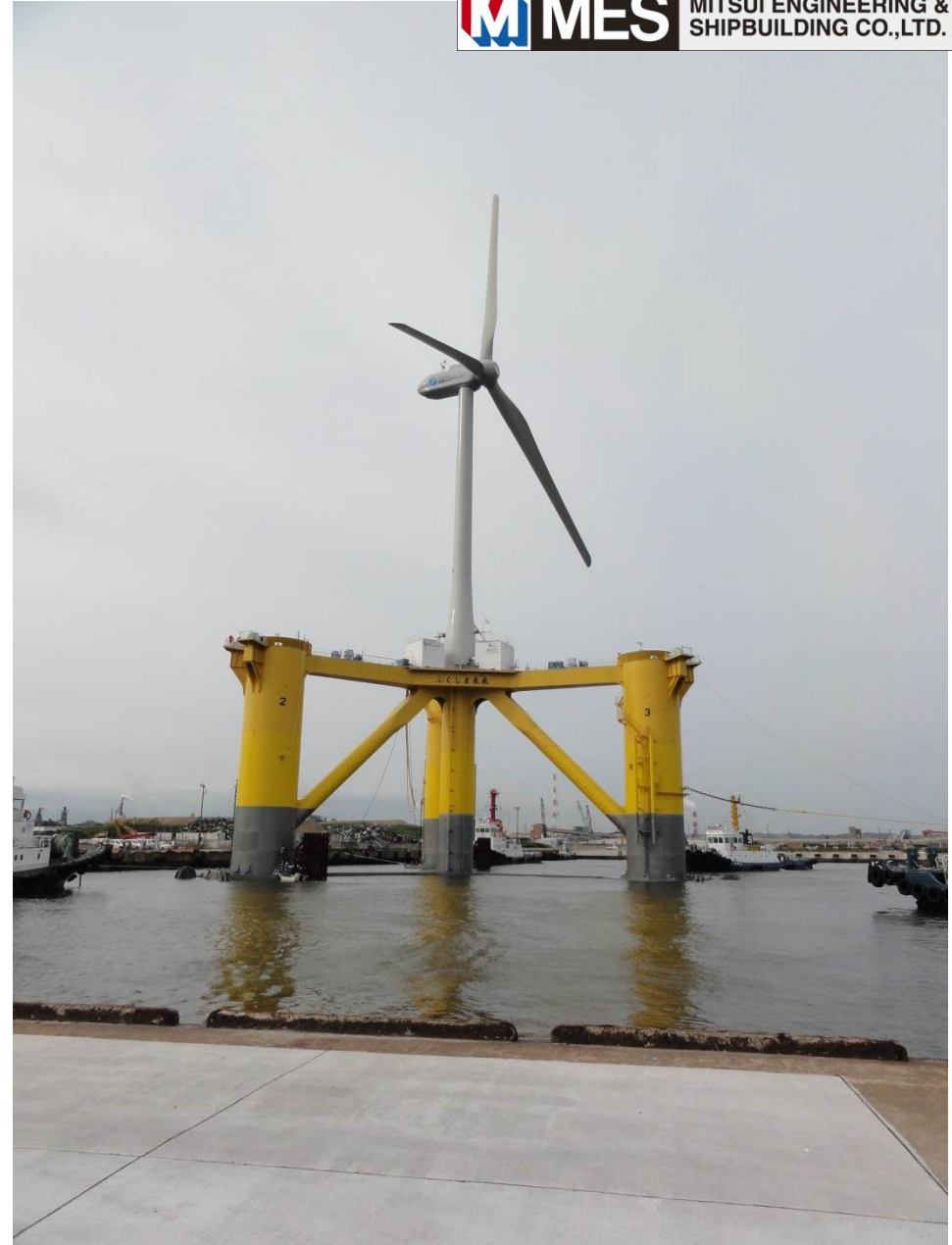
4.2.4 Towing



Towing route

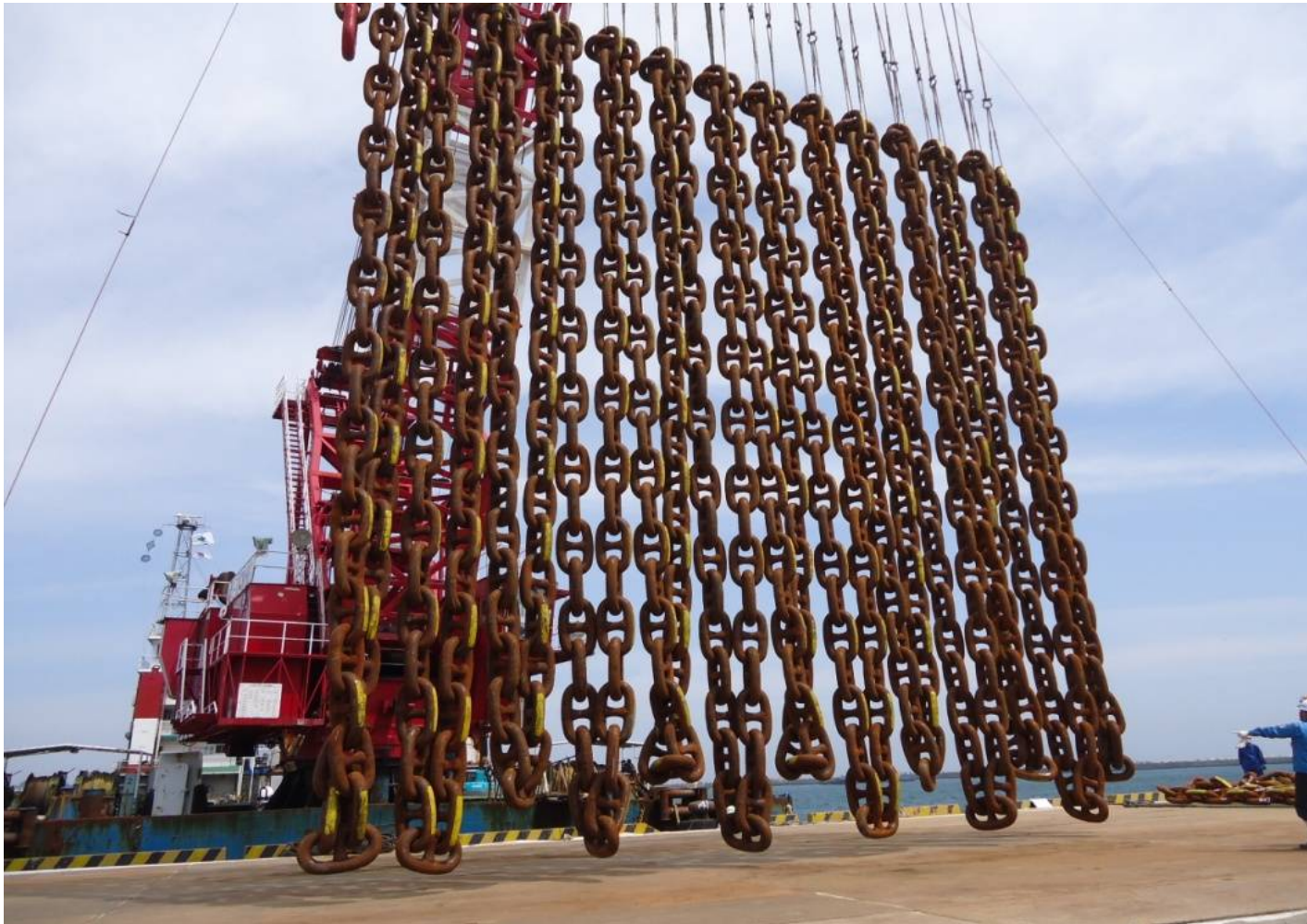


Towing boat arrangement



Dock out ~ Towing ~ Onahama

4.2.5 At quay



Preparation of chain at quay

(Photo credit: Shimizu Shinnittetsusumikin-enji JV (SSE JV))



Preparation of anchor at quay
(Photo credit: SSE JV)

4.2.6 Installation



Chain on board

Laying chain



(Photo credit: SSE JV)





Connecting chain to the floater
(Photo credit: SSE JV)



Power cable connection

4.2.7 Remaining subject

- 1) Fukushima MIRAI started to operate on November 11, 2013
- 2) Field data will be gathered until March 2016

Future subject

- Confirmation of design method
- Cost evaluation for future wind farm

5. Closing Remarks

Ship builders in Japan are contributing to reduction of GHG through;

**Developing , Designing, and Building
More ecological ships**

and

**Plants utilizing renewable energy
above, on, and in the ocean.**

Thank you very much