



Japan's Floating Offshore Wind Projects: An Overview



Market Background

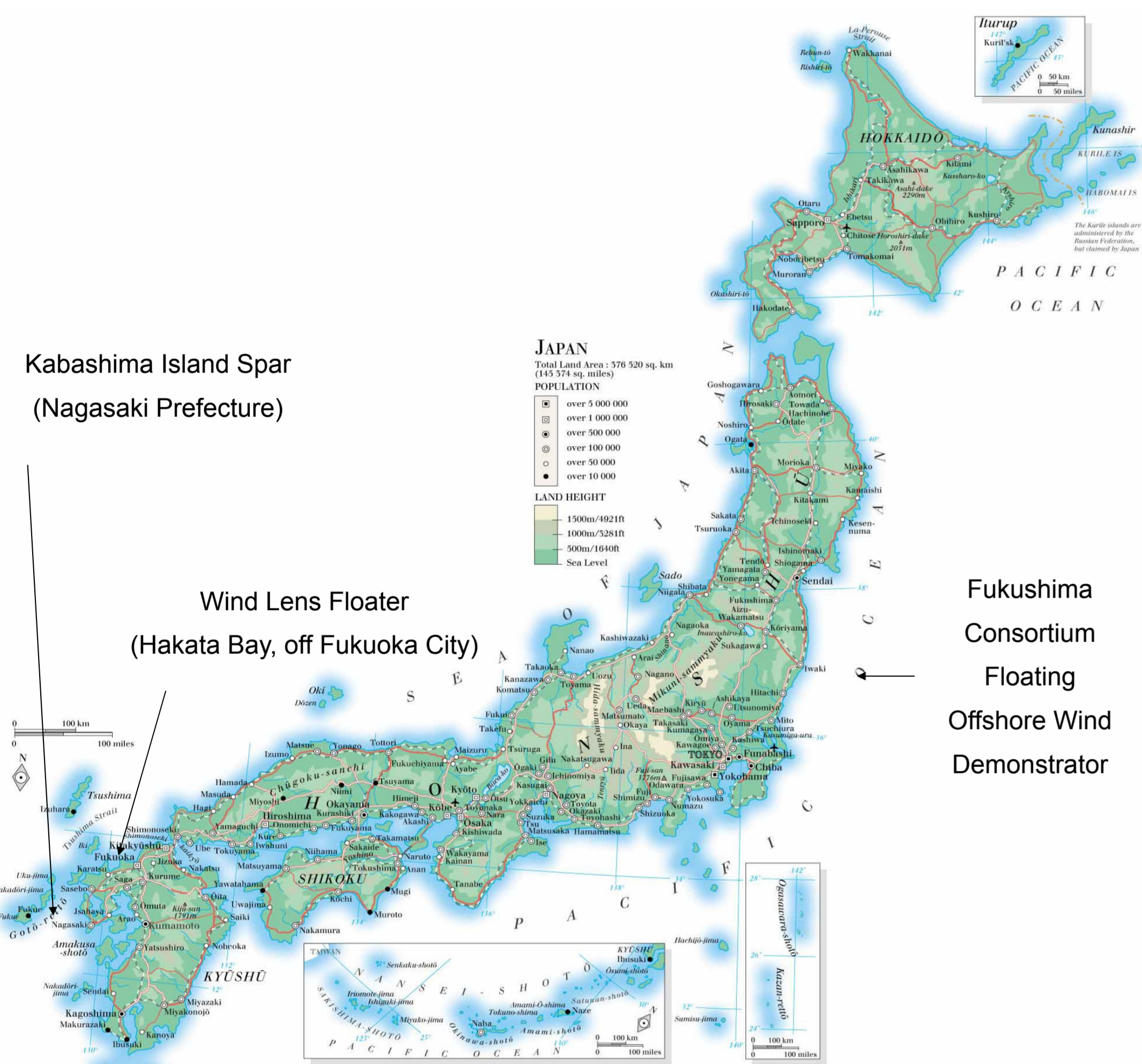
In recent years, discussion of floating offshore wind technology has focused on Europe and the United States as governments there increasingly support research and development. It was little known across the industry that another country had been quietly researching floating offshore wind foundation technology: **Japan**. For more than a decade, Japanese academic institutions, government organizations and private industry have developed numerous designs for floating foundations. Very little was published in English, but a wealth of information has long been available in Japanese. Yet as a country better known for its historic dependence on nuclear power, at least until March 2011, Japan was neither on the global offshore wind industry's radar, nor did the country promote itself as a player in this field. But with 80% of Japan's offshore resources in water depths of 100+ meters, government and industry always knew that floating foundation technology is a requirement to develop these resources and therefore invested in numerous R&D.

Japan is now in the process of assuming a much higher profile by installing full scale pilot plants. **Within 2 years Japan has moved from budget approval to 3 commissioned full scale installations.**

More than 70% of the world's offshore wind resource is located in deep water around the world, meaning floating foundations are the long-term future for the offshore wind industry (table).

Japan's growing know-how in floating technology and the full scale pilots installed this year are likely to give it a key strategic edge in penetrating overseas markets as well.

Project Locations

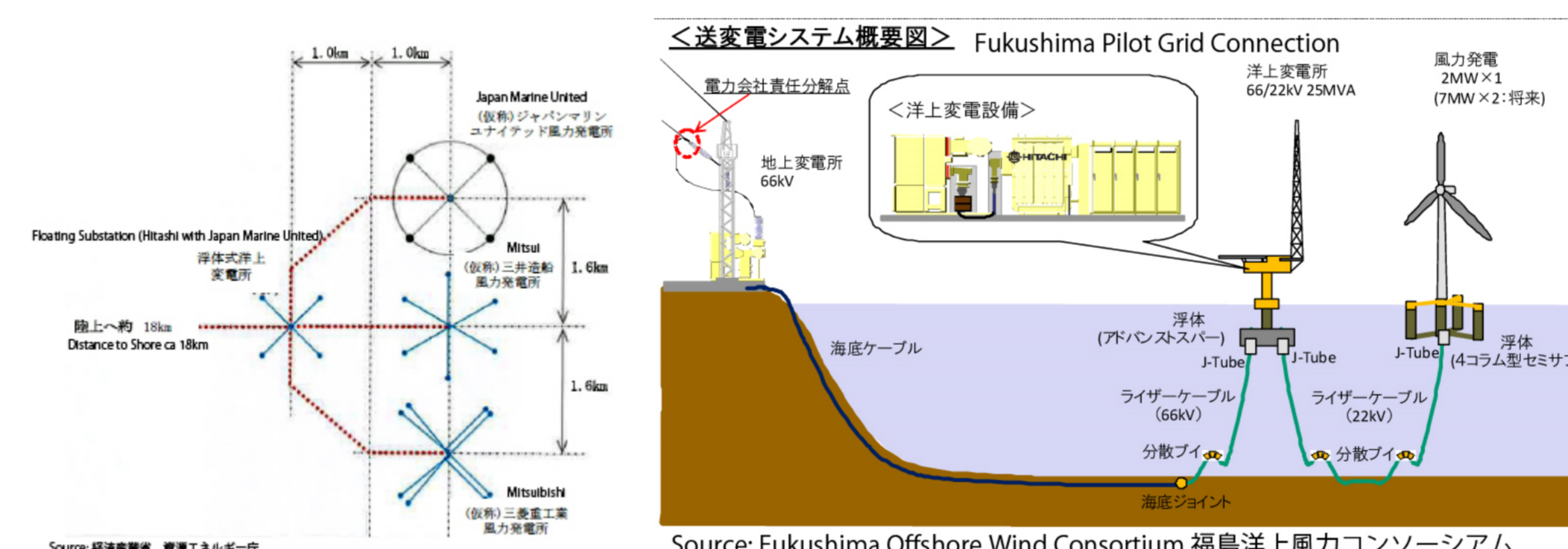


Map Image Source: http://www.vidian.com/maps/maps_of_asia/maps_of_japan/large_detailed_road_and_topographical_map_of_japan.jpg

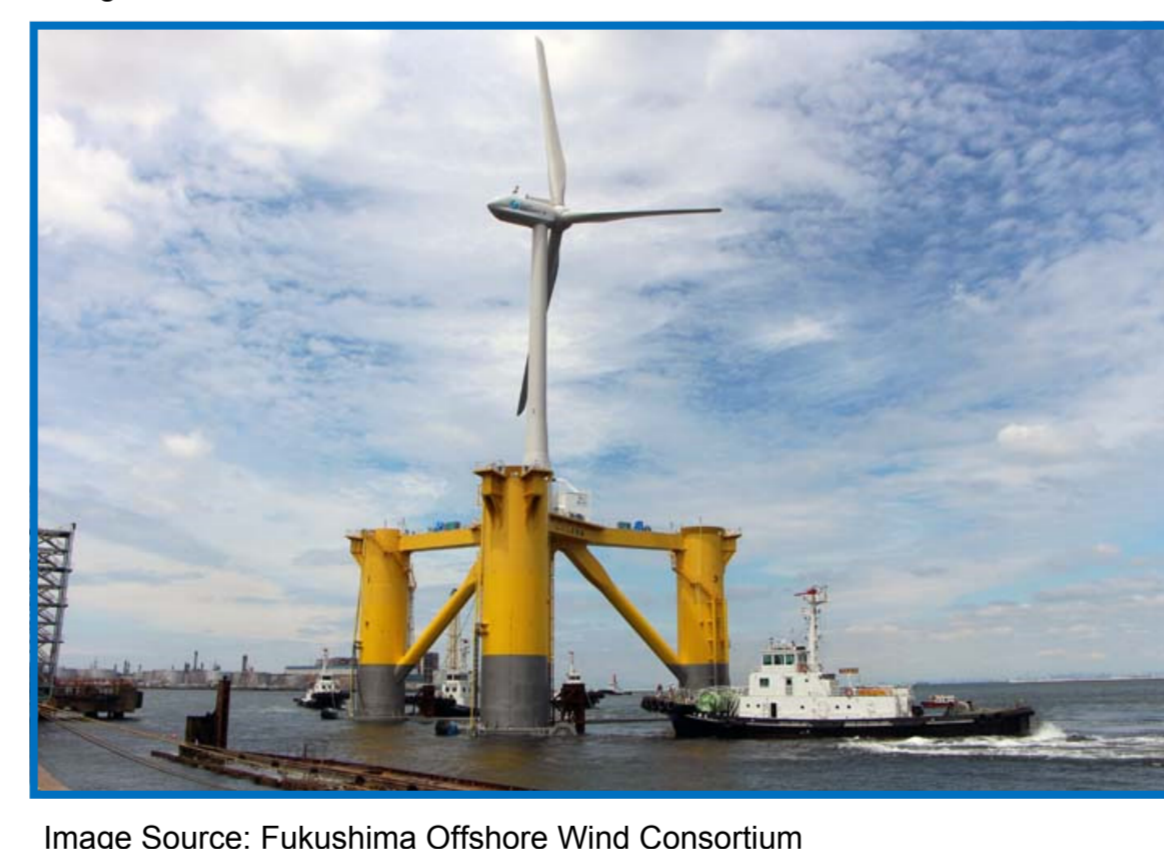
Fukushima Full Scale Project

Foundation Type	Spec	Turbine Type	Technology Provide	Phase
Advanced Spar	25 MVA, 66kV	Substation	Japan Marine United (Foundation); Hitachi (Substation)	1 Installed during August/September 2013 Commissioning November 2013
Semisub	2MW	Downwind Turbine	Mitsui (Foundation), Hitachi (Turbine)	1 Installed during August/September 2013 Commissioning November 2013
Semisub	7MW	Upwind Turbine, hydraulic	Mitsubishi (Foundation & Turbine)	2 Installation planned for 2014/2015
Advanced Spar	7MW	Upwind Turbine, hydraulic	Japan Marine United (Foundation), Mitsubishi (Turbine)	2 Installation planned for 2014/2015

- Project management by Marubeni. Other Consortium Members:
 - Tokyo University (Technical Advisor): Observation of floating body dynamics, development of simulation technology
 - Mitsubishi Corporation: Business research, licensing, environment, fisheries, such as O & M
 - Mitsubishi Heavy Industries, Ltd.: Floating offshore wind power generation facility
 - Japan Marine United: Floating offshore wind power generation facility and for floating substation
 - Mitsui Engineering & Shipbuilding Co., Ltd.: Floating offshore wind power generation facility
 - Nippon Steel Corporation: Steel Supply
 - Hitachi, Ltd.: Offshore substation
 - Furukawa Electric Co., Ltd.: Subsea cable
 - Shimizu Corporation: Construction technology
 - Mizuho Information & Research Institute, Inc.: Project Management and Administration
- Funding: Japanese Government Yen 12.5 Billion (US\$ 123 Million). Estimated total cost Yen 18.8 Billion (US\$ 189 Million). Budget approved November 2011.
- 2 x 7MW turbines (Mitsubishi) and 1 x 2MW turbine (Hitachi)
- Interconnect at Iwaki; power to be purchased by TEPCO
- First hydraulic offshore turbine to be used with floating foundations (Mitsubishi 7MW)
- Water depth 100-200 meter
- Average wind speed 7 m/s at hub height
- 20km offshore Fukushima Prefecture coast



- Japan Marine United Spar:**
- Floating spar with 'reduced vacillation fin' to dampen sway
 - Minimum draft 50 meter
 - Tower height 88.8m
 - Hub Height 106 meter
 - Rotor diameter 167m
 - Spar length 60 meter
 - Connection tower and foundation height 12 meter



- Mitsui Semisubmersible:**
- Design for use with 2MW turbine
 - Width 58 meter
 - Total column length 32 meter of which 16 meter will be submerged
 - Hub height 60 meter
 - Blade length ca. 40 meter
 - Cut out wind speed 25 m/s, cut in 13 m/s
 - RPM 11.1—19.6



- Mitsubishi Semisubmersible:**
- To be deployed with Mitsubishi's 7MW hydraulic turbine
 - Hub height 105 meter
 - Rotor diameter 167 meter
 - Cut out wind speed 21 m/s, cut in 15 m/s
 - RPM 10.3
 - Foundation displacement ca. 26,000 t
 - Column diameter 14 meter

Global Floating Projects

Project Name	Country	Technology	Min. Depth (meter)	Development Stage	Pilot Plant Stage
Statoil Hywind	Norway	Spar	120-700	Full scale operating since 2009 with 2.3MW Siemens Turbine	Next generation under development.
Principle Power Windfloat	USA	Semisub	50	Full scale operation since Oct 2011 with 2MW Vestas turbine (Portugal)	Additional installations planned in EU and US. US project planned with 6MW Siemens turbines.
Toda Construction et al. Hybrid Spar	Japan	Spar	100	1:2 Scale pilot with 100 kW turbine launched in June 2012	Full scale with 2MW turbine to be commissioned in Fall 2013 (off Kabashima Island)
Japan Marine United Advanced Spar	Japan	Spar	50	Full scale for floating substation at deployment site off Fukushima Coast	Full scale for use with 7MW turbine to be deployed 2014/2015 off Fukushima coast
Mitsui Semisub	Japan	Semisub	N/A	Full scale with 2MW turbine at deployment site off Fukushima coast	Commissioning planned for October 2013
MODEC (Mitsui) Skwid	Japan	Wind and Waver Floater	N/A	Pilot manufacturing in process	Full scale planned for deployment in Fall 2013 off Saga coast
DeepCWind	USA	Semisub	N/A	1:8 Scale pilot launched in June 2013	Full scale with 6MW turbine planned for 2016 off Maine coast
Wind Lens	Japan	Floater	N/A	Scale pilot tested for 12 months in Hakata Bay	N/A
HiPR Wind	EU	Semisub	80; operating draft 20m for 10MW turbine	Design phase	1:10 scale prototype with 1.5MW turbine to be installed off Bilbao, Spain in 2013
Nass et Wind Winflo	France	Semisub	50	Fabrication Planning	Full scale planned for 2014 with 1MW Vergnet turbine (France)
GICON SOF	Germany	TLP	20	Fabrication Study	Full scale planned for 2014 in German Baltic Sea
Technip Vertiwind	France	Semisub	50	1:2 scale model with 35kW turbine ready for testing	Full scale with 2MW turbine planned for 2014 (France)
Pelagic Power	Norway	Floater	N/A	N/A	Full scale planned for 2014 off the coast of Spain
Mitsubishi	Japan	Semisub	N/A	Final design phase	Full scale with 7MW turbine (Mitsubishi) to be deployed off the Fukushima coast in 2014/2015
BlueH	Netherlands	TLP	50	Phase 1 scale model tested in 2008	Full scale with 5MW turbine planned for 2014/2015
Poseidon Floating	Denmark	Floater	40	Scale pilot launched	New pilot planned for 2014/2015
Nautica AFT	USA	TLP	N/A	Simulations in process	Full scale planned for 2014
Ideol Floatgen	France	Floater	35	Prototype in 2013	Full scale with 2MW Gamesa turbine and 3MW Acciona turbine planned for 2014/2015
Technip INFLOW	France	Floater	N/A	N/A	Full scale with 2MW turbine planned for 2015 (France)
Glosten Pelastar	USA	TLP	65	Final design and fabrication study	Full scale planned in UK by 2015
Iberdrola Ergotaí Flottek	Spain	TLP	N/A	Tank tests Nov. 2012	N/A
DIWET	France	Semisub	N/A	In design phase	N/A
GustoMSC Trifloater	Netherlands	Semisub	50	Tank tests completed	N/A
Hexicon Floater	Sweden	Floater	26	In design phase. Costing studies ongoing	N/A
Hitachi	Japan	Semisub	N/A	Technical co-operation agreement with Statoil	N/A
Mitsui TLP	Japan	TLP	60	Design for use with 5MW turbine in process	N/A
Ocean Breeze	UK	TLP	60	N/A	N/A
Sea Twirl	Sweden	Spar	N/A	Scale pilot tested	N/A
Shimizu	Japan	Semisub	25	Simulations completed	N/A
Sway	Norway	Floating Tower	55-400	Scale model test ongoing	N/A
WEMU	Russia	Floater	5	Simulations	N/A
WindSea	Norway	Floater	25-30	Tank tests and simulations completed	N/A

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Wind Lens Floater

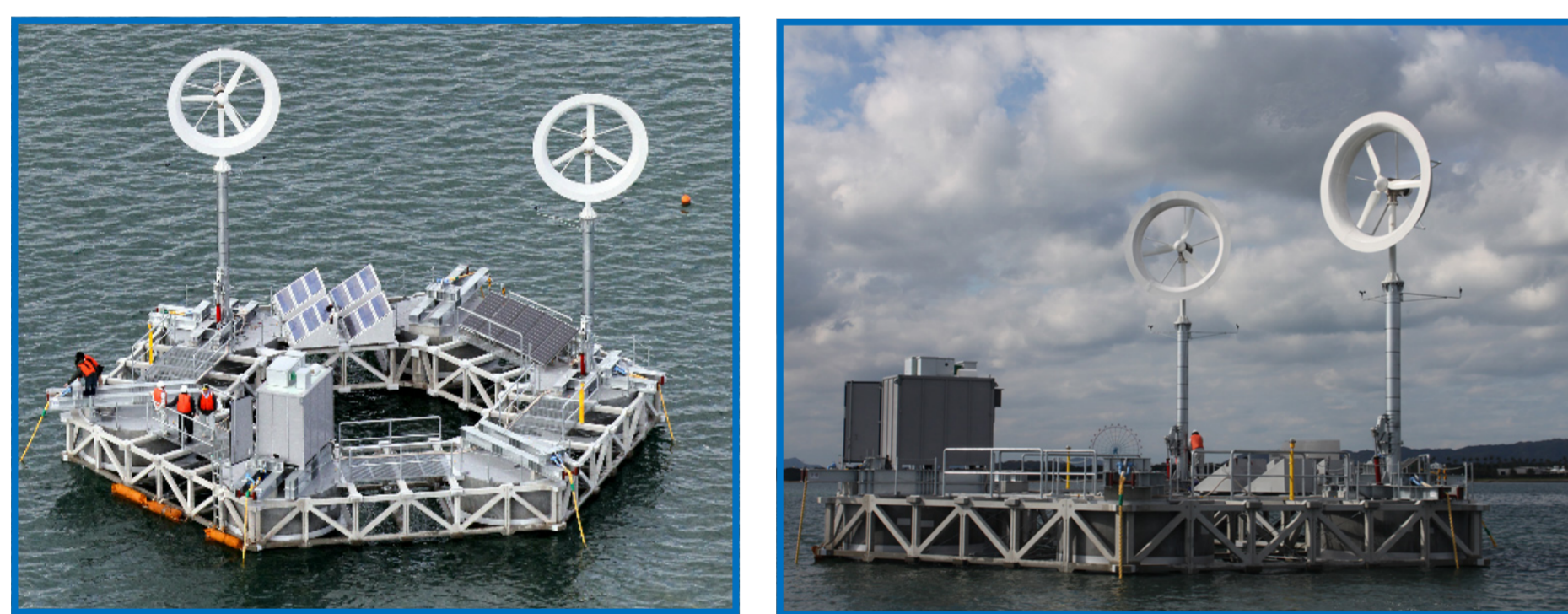


Image Source: Asahi Shimbun, Nikkei Shimbun

- Project by Kyushu University Division of Renewable Energy Dynamics—Wind Engineering
- Initial development of wind turbine with the project
- Launched December 4th, 2011 for 1 year test with scale model of an 18 meter diameter floating platform
- Two 3kW turbines, 600 meters from shore in Hakata Bay (Fukuoka)
- Pilot also includes solar panels.
- Stage 2 will be testing of a 60 meter diameter platform with TLP mooring 2km off the coast.

Kabashima Island Spar



Half Scale— Image Source: Kyoto University, Toda Construction

Full Scale - Image Source: Sankei Media

- Consortium (Toda Construction, Fuji Heavy Industries, Kyoto University, National Maritime Research Institute of Japan—Financed by Japanese Ministry of Environment
- Half Scale pilot with 100kW downwind turbine launched in June 2012
- Turbine manufactured by Hitachi and Japan Steel Works
- Full scale pilot launched in Fall 2013 (water depth of 80-100 m) with 2MW Hitachi turbine
- Full scale total length of 170 meter; Rotor diameter of 80 meter
- Bottom of spar uses 'super hybrid' concrete, developed by Kyoto University and Toda Construction
- Extensive environmental monitoring

Summary

- Japanese industry had limited interest in floating technology commercialization for the domestic Japanese market because of lack of government support and opposition by the powerful Japanese fishing industry. The Great Eastern Japan Earthquake, Tsunami and Fukushima nuclear accident changed the direction. The conservative government continues to support the development of renewable energy, including floating offshore wind. This is also highlighted in the latest 5 year Japan Ocean Policy Plan, issued in April 2013. This includes developing navigational safety standards for floating offshore wind.
- With its strong naval architecture and marine construction resources Japan is likely to become one of the leaders in floating offshore wind.
- Japan has strong representation in the IEA sub-working group on standards for floating offshore wind.
- Japan will most likely export this technology to other markets such as the United States.