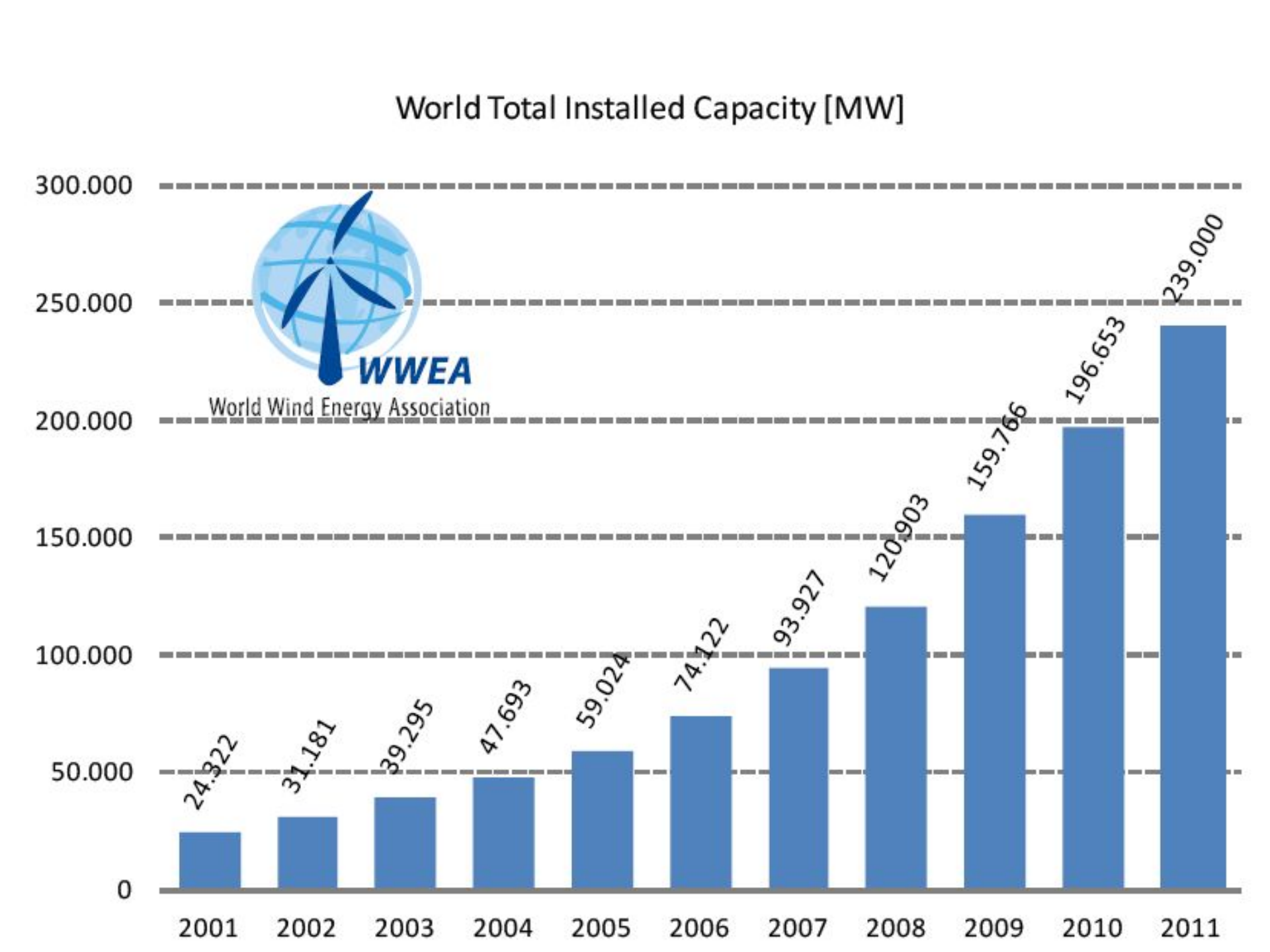
JST Japan & Denmark embassy, Fukuoka, 2012

RECENT DEVELOPMENT AND CHALLENGES OF WIND TURBINE TECHNOLOGY

Chuichi Arakawa
The University of Tokyo

Kamisu, Japan / 2MW x 7

・This wind farm withstood Tsunami on 3.11
・7 units of 2MW Wind Turbine
・Being developed as private sector for future such as more 7 units and Giga-watt farm


World Total Installed Capacity [MW]
300.000
250.000
200.000
150.000
100.000
50.000
0
WWEA
World Wind Energy Association
24.322
31.181
39.295
47.693
59.024
74.122
93.927
120.903
159.766
196.653
239.000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011

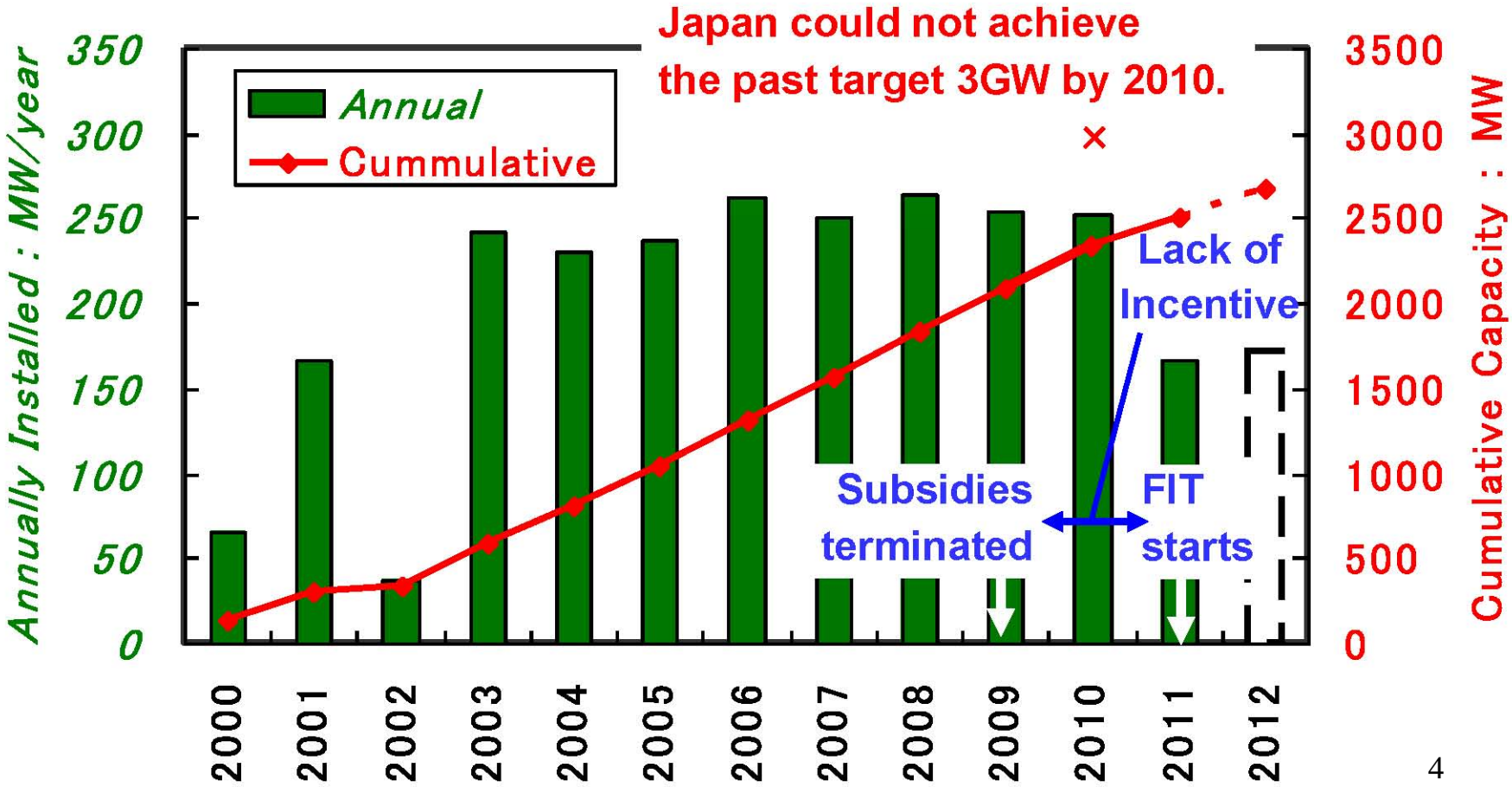
Country	Total Capacity end of 2011 [MW]	Added Capacity 2011 [MW]	Total Capacity end 2010 [MW]	Added Capacity 2010 [MW]	Total Capacity end 2009 [MW]
China *	62.733	18.000	44.733	18.928	25.810
USA	46.919	6.810	40.180	5.600	35.159
Germany	29.075	2.007	27.215	1.551	25.777
Spain	21.673	1.050	20.676	1.515	18.865
India *	15.800	2.700	13.065	1.258	11.807
Italy *	6.747	950	5.797	950	4.850
France	6.640	980	5.660	1.086	4.574
United Kingdom	6.018	730	5.203	962	4.245
Canada	5.265	1.267	4.008	690	3.319
Portugal *	4.290	588	3.702	345	3.357
Denmark	3.927	180	3.803	309	3.460
Sweden	2.816	746	2.052	603	1.450
Japan	2.501	167	2.334	251	2.083
Rest of the World*	24.200	6.000	18.201	3.191	15.010
Total*	238.604	42.175	196.629	37.642	159.766

*- Preliminary Data

Wind Power Generation in Japan

Latest wind Power Statistics in Japan (at the end of 2011)

- Total installed wind generation : 2,501MW, 1,832 units
- New wind generation installed : 167 MW / year
- Total electric output from wind : 4246 GWh / year
- Wind generation share of national electric demand : 0.5 %



Ref: Japan Wind Power Association

New Guideline for Wind Turbines in Japan and Asian Area

Typhoon Attack

Miyako Island was hit by huge Typhoon #14 on 11.Sep.2003 and all 7 WT were destroyed; 3 fallen down, 3 lost blades, 1 lost nacelle roof

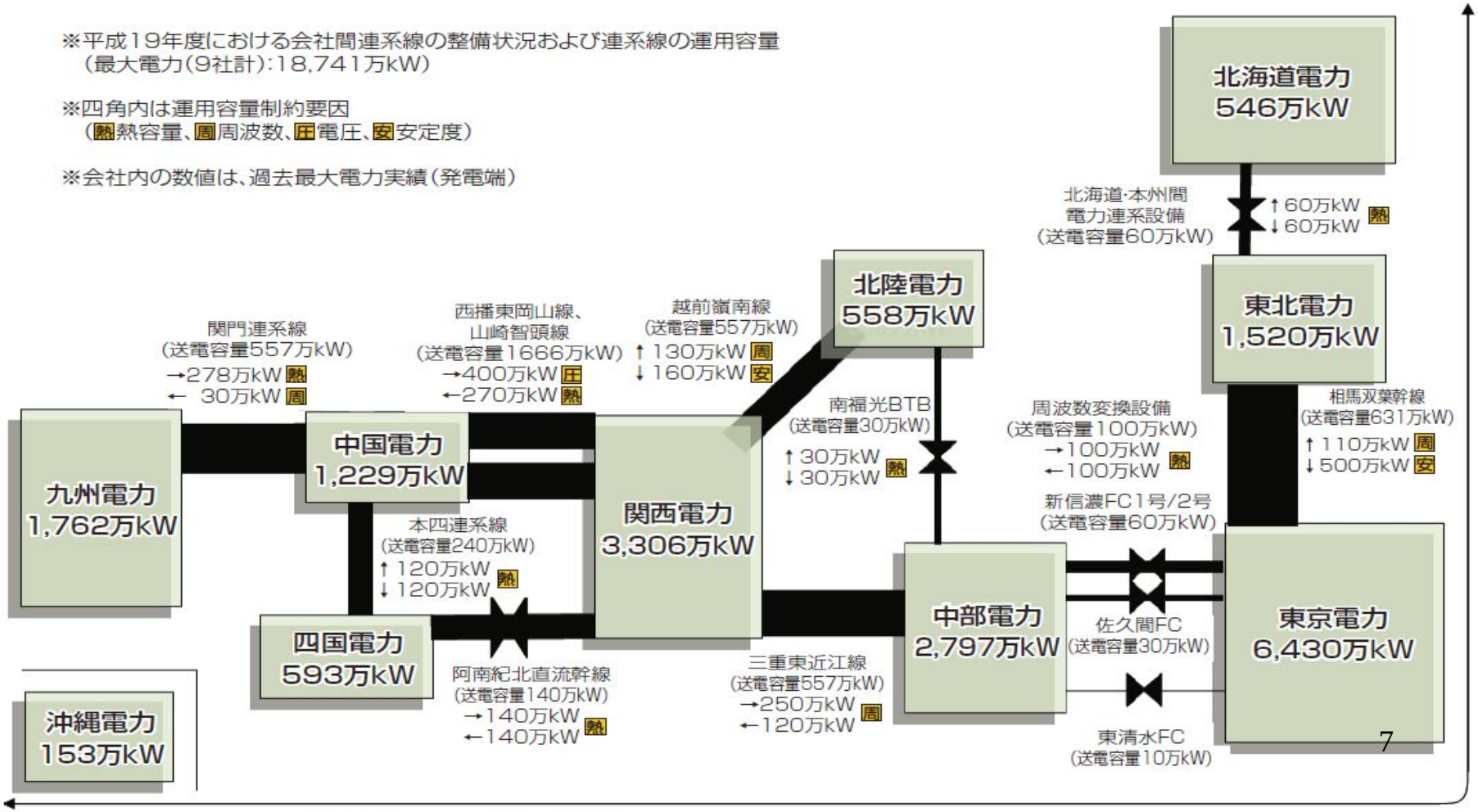
NEW MW-class Machines in Japan

MWT92 (MHI) 2.4MW WT

SUBARU 80/2.0 (FHI) 2 MW WT

Grid Connection in Japan

- Wind power was not allowed to use grid connection between each area.
- Wind potential exists strongly in Hokkaido, Tohoku and Kyushu.

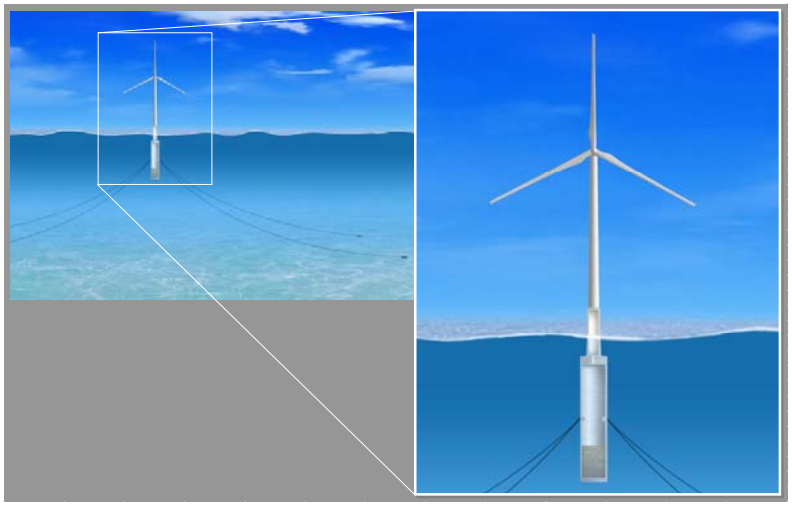


NEDO R&D Offshore Windpower Generation

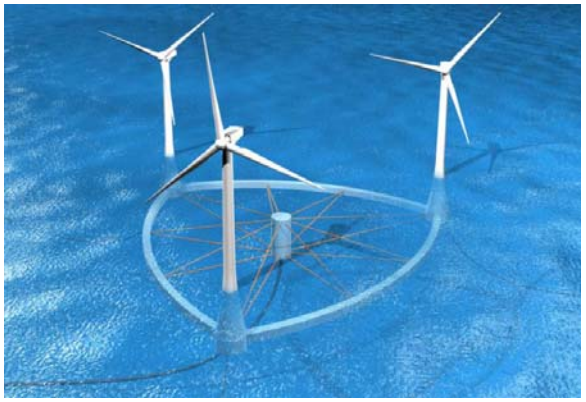
- Offshore Windturbine Demonstration PJ
  - 2.4MW at Choshi, 2MW at Hibikinada in 2012
- Offshore Windfarm Feasibility Study
  - 4 districts are chozen in 2011.
- Super Large Windturbine Development
- Ocean Energy Potential Study
- Floating Offshore Windturbine Basic study

However, we have delay of more than 10 years for offshore in Europe.
Furthermore, the national project is planned to have only one turbine.
We should accelerate wind power to cover nuclear in high speed.

Domestic Project of Deep Offshore

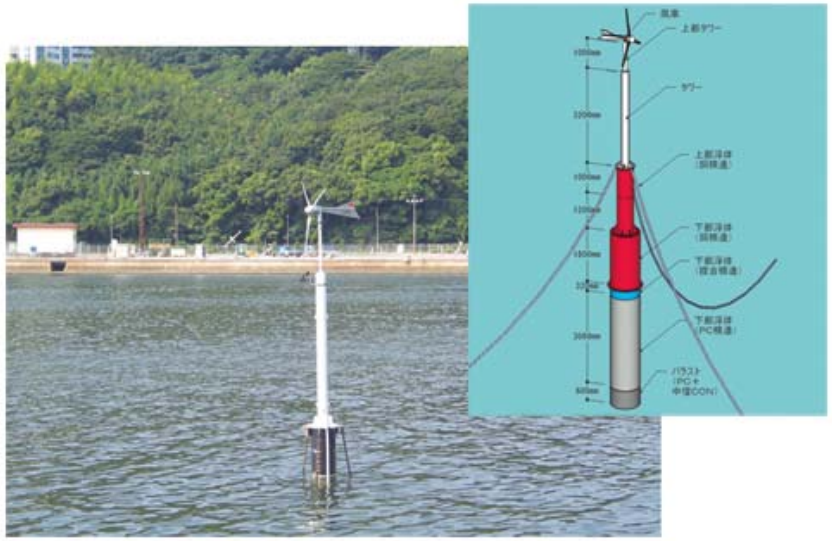


Spar type ; Prof. Suzuki in Uni. of Tokyo



Semi-sub type ; Prof. Ishihara in Uni. of Tokyo, TEPC O, etc

Sailing type ; Environment Institute & Prof. Kinoshita in Uni. of Tokyo

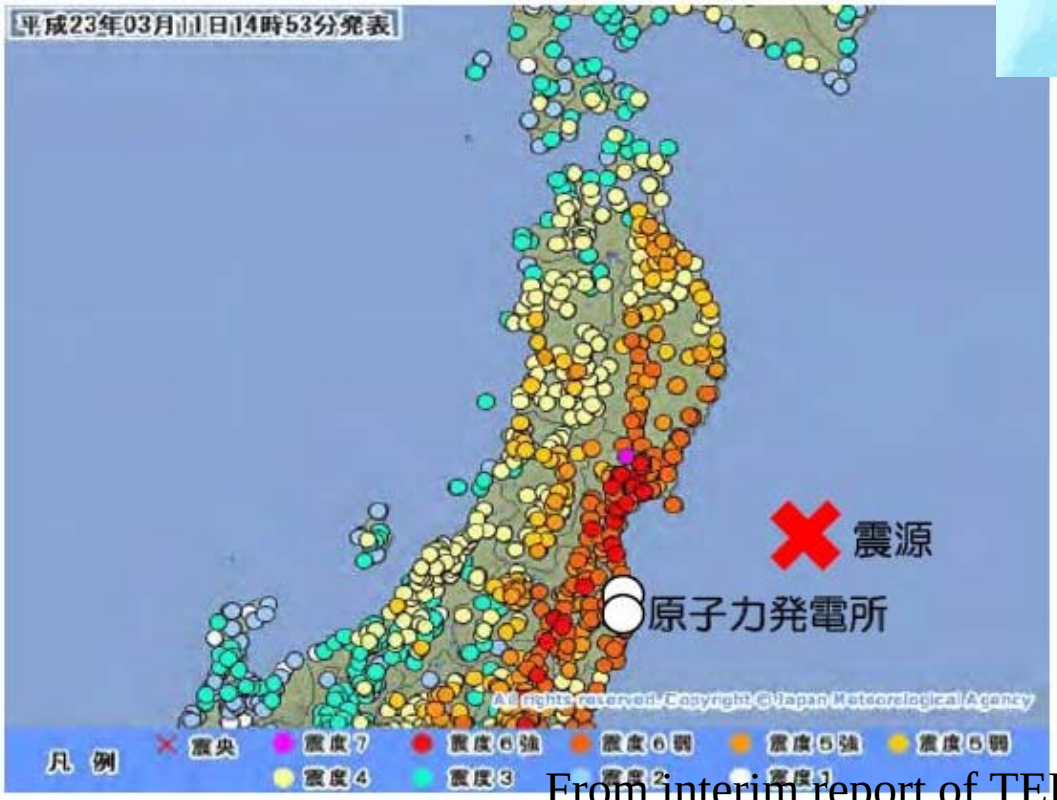


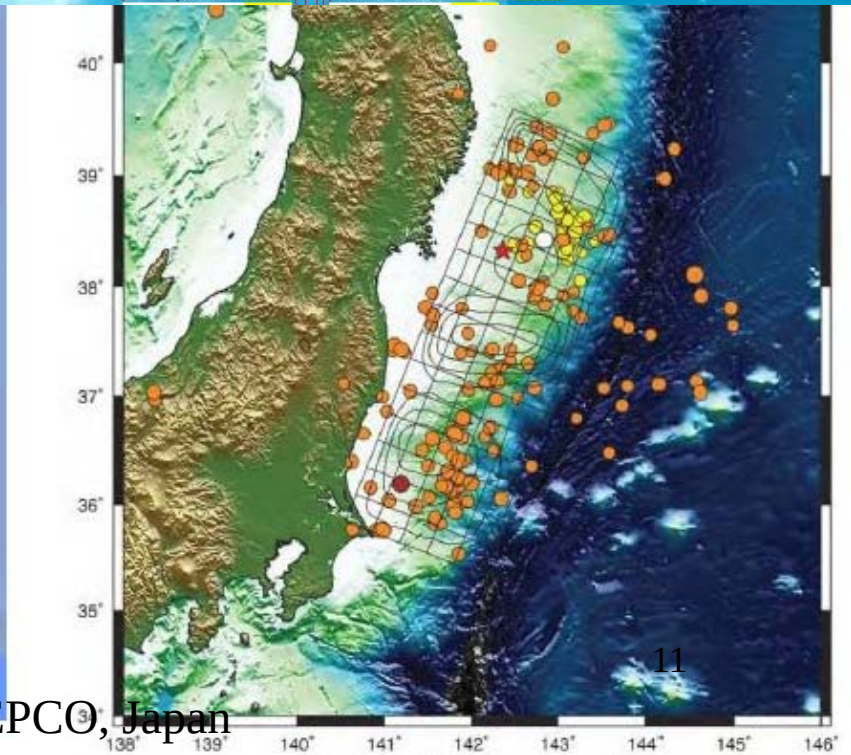
Scale model of Spar type: Prof. Utsunomiya in Kyoto Uni. , Toda-Kensetsu, etc


After the Disaster
on March 11, 2011

2011 Earthquake off the Pacific Coast of Tohoku, Japan

March 11, 2011, Magnitude 9.0
Tsunami reached heights of up to 40.5m and travelled up to 10km.
It caused meltdown of three reactors in Fukushima nuclear power plants.





From interim report of TEPCO, Japan

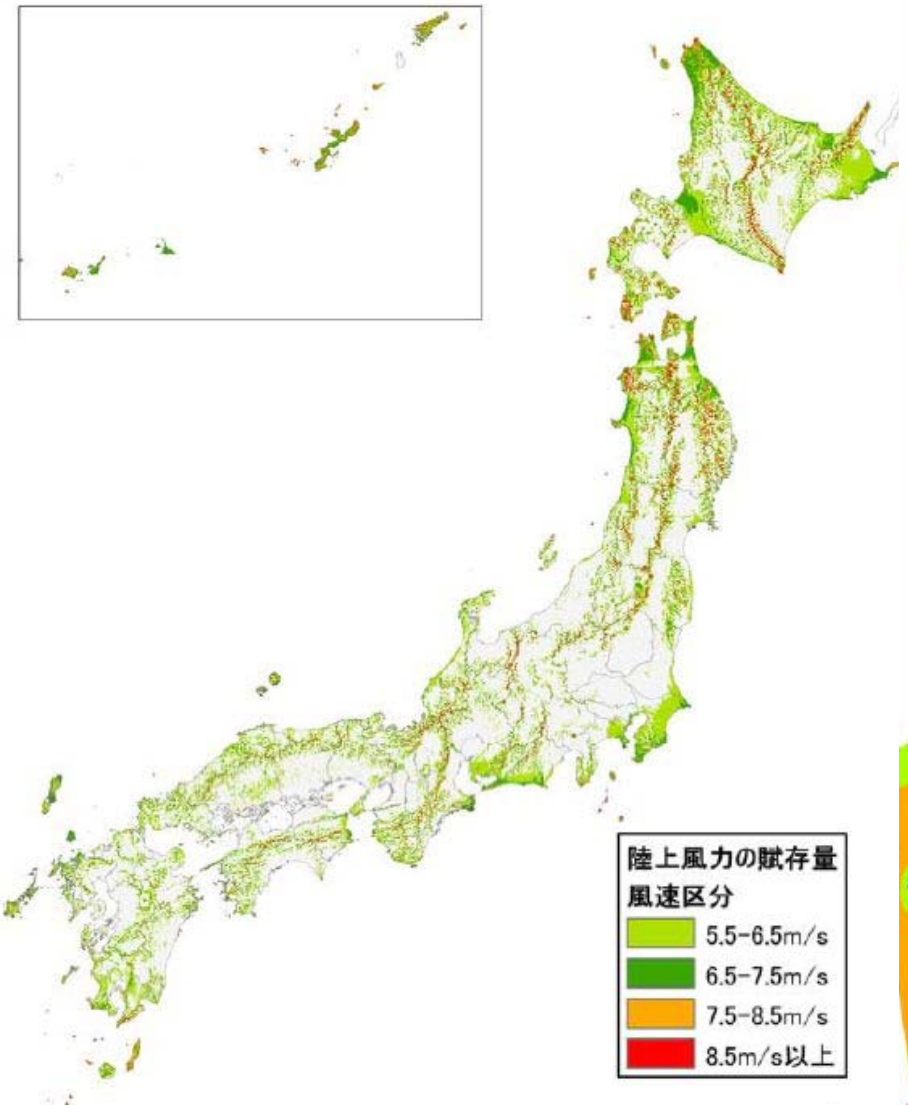
Only 1 WTG was damaged by liquefaction

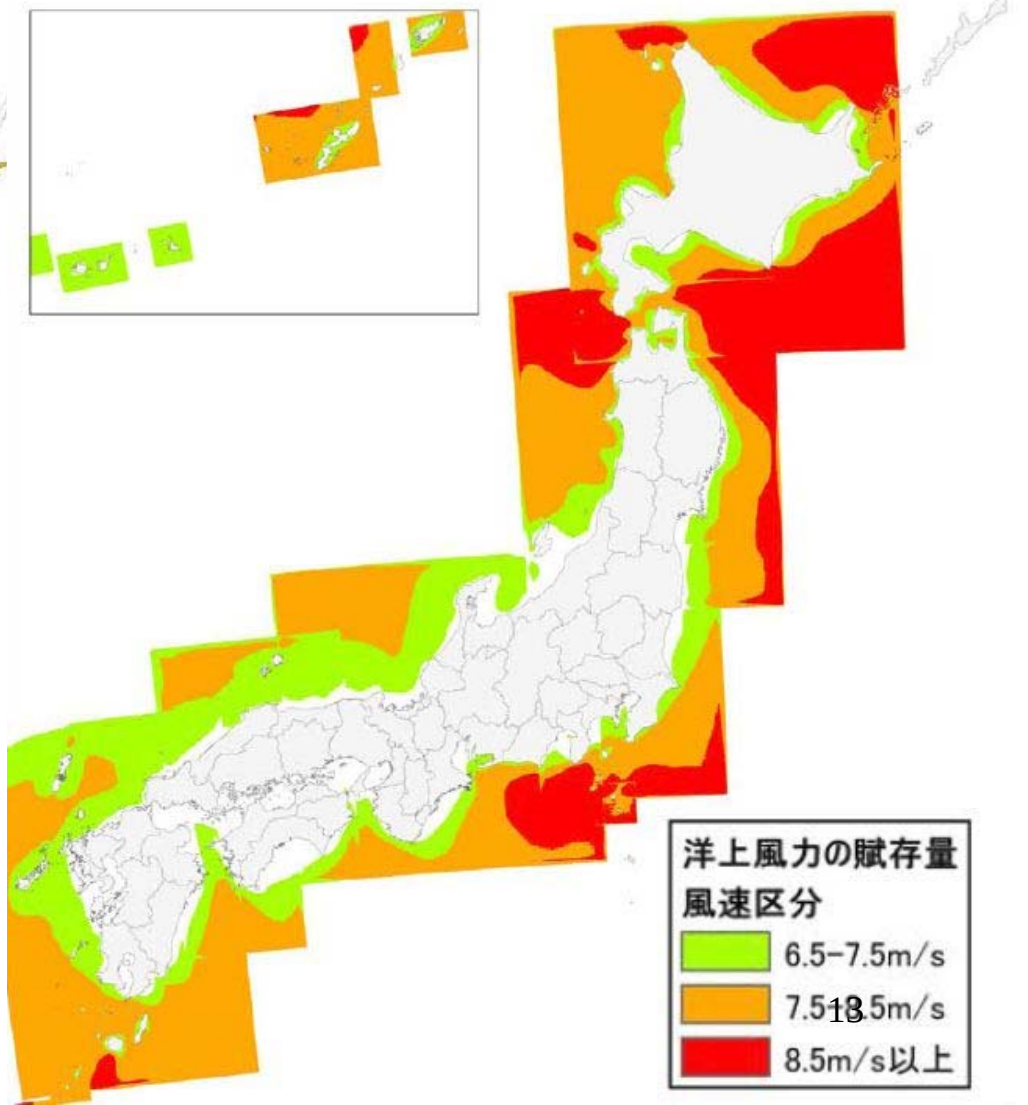
1 WTG at Sumiit Windpower Kashima in Ibaraki Pref. about 300 km far from the epicenter, has been leaned a little by severe liquefaction. This windfarm is consisted by 10 Gamesa G80 2MW turbines, the other 9 turbines are in the normal condition.

Ref: Geotechnical Quick Report on the Kanto Plain Region during the March 11, 2011, Off Pacific Coast of Tohoku Earthquake, Japan
Geotechnical Extreme Events Reconnaissance (GEER), April 5, 2011

Potential Map of Wind Power in Japan

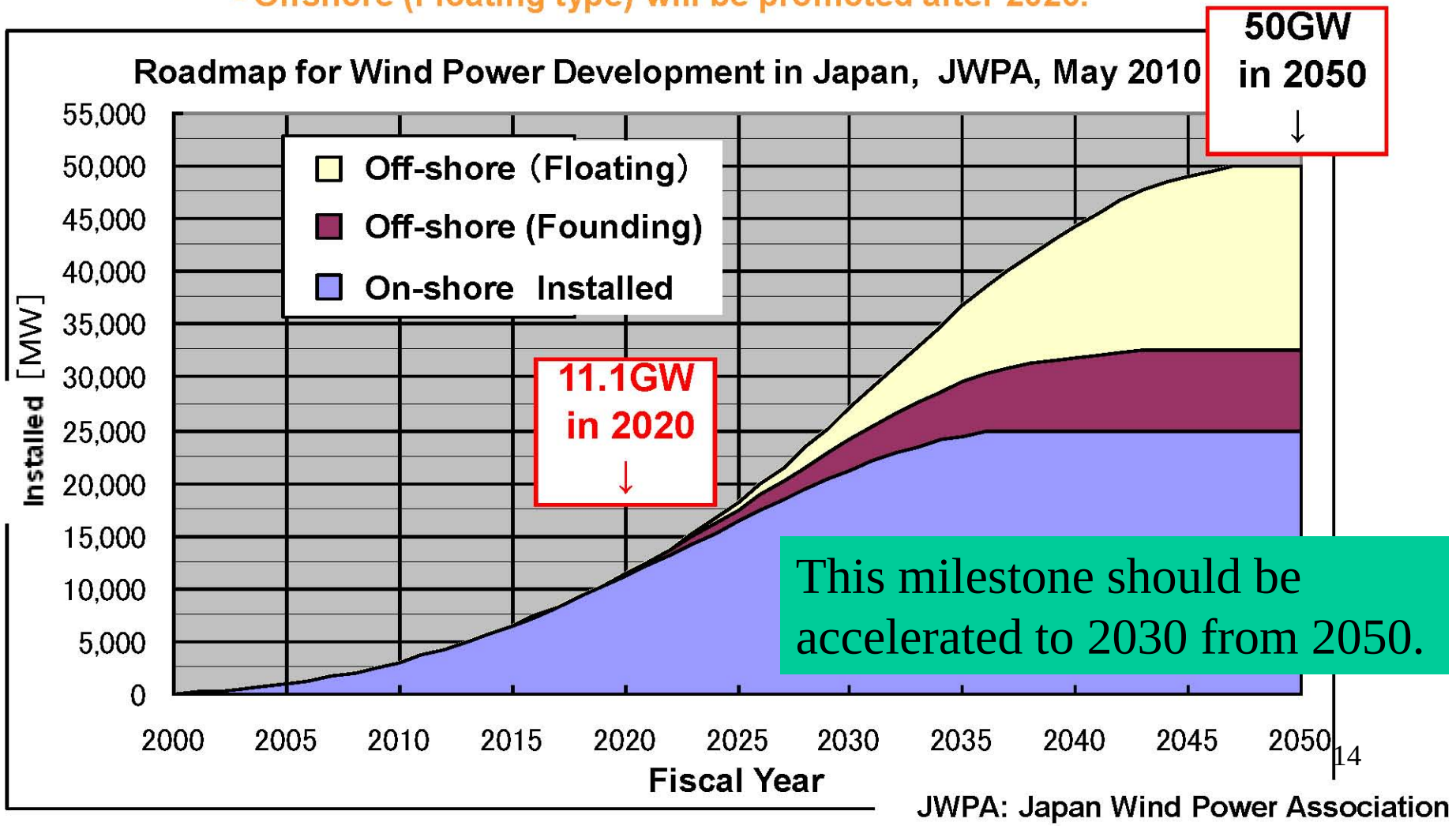
- Report of investigation for renewable energy in Ministry of Environment in 2011
- 280 GW for onshore, 1600 GW for offshore as potential value
- 273 GW for onshore , 141 GW for offshore under some scenario such as half-price





JWPA's proposal to Japanese Government

- Wind power shall supply 10% electricity demand in Japan by 2050.
- Installed capacity shall be 11.1GW in 2020 and 50GW in 2050.
  50GW = On-shore 25GW + Off-shore 7.5GW + Floating 17.5GW
- Offshore (Founding type) will be promoted after 2015.
- Offshore (Floating type) will be promoted after 2020.



This milestone should be accelerated to 2030 from 2050.

JWPA: Japan Wind Power Association

Feed In Tariff (FIT) in Japan

別添

エネ庁HPに掲載された委員会資料より

電源		太陽光 PV		風力 Wind		地熱 Geothermal			中小水力 Small Hydro	
調達区分		10kW以上	10kW未満（余剰買取）	20kW以上	20kW未満	1.5万ｋW以上	1.5万ｋW未満	1,000kW以上30,000kW未満	200kW 以上1,000kW未満	
費用	建設費	32.5万円/kW	46.6万円/kW	30万円/kW	125万円/kW	79万円/kW	123万円/kW	85万円/kW	80万円/kW	100万円/kW
	運転維持費（1年当たり）	10千円/kW	4.7千円/kW	6.0千円/kW	－	33千円/kW	48千円/kW	9.5千円/kW	69千円/kW	75千円/kW
IRR		税前6%	税前3.2%（＊1）	税前8%	税前1.8%	税前13%（＊2）		税前7%	税前7%	
調達価格1kWh当たり	Price	42.00円	42円（＊1）	23.10円	57.75円	27.30円	42.00円	25.20円	30.45円	35.70円
	税抜	40円	42円	22円	55円	26円	40円	24円	29円	34円
Period for payment		20年	１０年	２０年	２０年	１５年	１５年	２０年		

電源		バイオマス Biomass						
バイオマスの種類		ガス化（下水汚泥）	ガス化（家畜糞尿）	固形燃料燃焼(未利用木材)	固形燃料燃焼（一般木材）	固形燃料燃焼(一般廃棄物)	固形燃料燃焼（下水汚泥）	固形燃料燃焼（リサイクル木材）
費用	建設費	392万円/kW		41万円/kW	41万円/kW	31万円/kW		35万円/kW
	運転維持費（1年当たり）	184千円/kW		27千円/kW	27千円/kW	22千円/kW		27千円/kW
IRR		税前1%		税前8%	税前4%	税前4%		税前4%
調達価格1kWh当たり	調達区分	【メタン発酵ガス化バイオマス】		【未利用木材】	【一般木材（含パーム椰子殻）】	【廃棄物系（木質以外）バイオマス】		【リサイクル木材】
	Price	40.95円		33.60円	25.20円	17.85円		13.65円
	税抜	39円		32円	24円	17円		13円
Period for payment		２０年						

METI Offshore Wind Energy Project, Fukushima （FY2011～15）

Floating offshore wind farm demonstration project
（FY2011 3rd supplementary budget：12.5 billion yen）

Contents of project

Summary / Purpose

○Affected areas in the east , in particular, Fukushima, are recovering from the earthquake damage. These areas are expected to provide large scale job creation due to accumulation of industries focused on renewable energy.

○This project will clarify the safety, reliability and economic potential of floating offshore wind by demonstration and experiments of the world's largest level floating offshore wind power generation system off the coast of Fukushima prefecture.

○After the completion of this project, This project is sought to make a new power generation business through the development of equipment as a result of this project.

By doing so, we aim to make a Japan a hub of wind power and contribute to the industrial revival in Fukushima

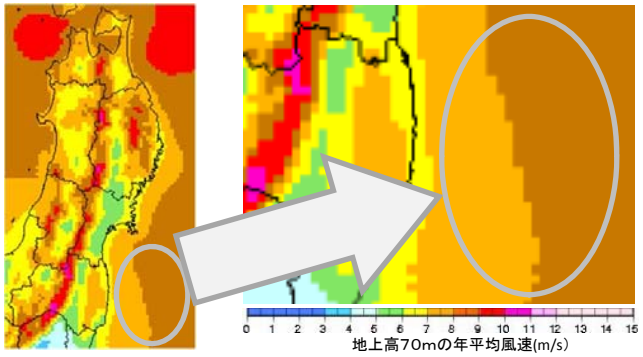
Conditions（applicant, subsidiary rate, etc.）

METI → Entrust → Private Organization , etc

Image of project

○Demonstration area : offshore of Fukushima Prefecture

○Such areas as well as a better wind conditions, are expected to take advantage of the former facilities of the offshore gas field, already being developed or currently in not use, offshore areas of Fukushima Prefecture are favorable.

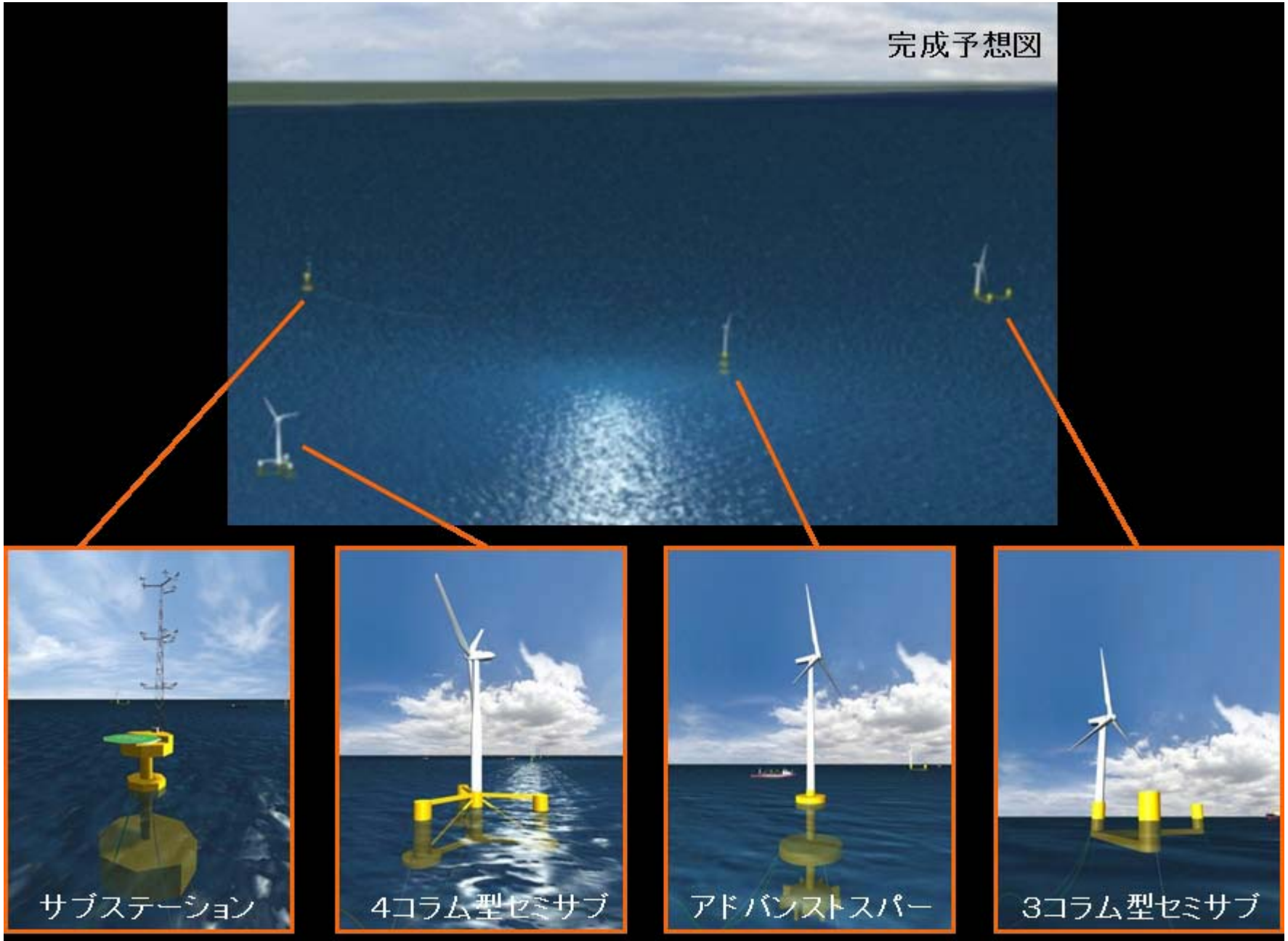


Demonstration assumed area

Image of floating offshore wind power
（provision：MES, Tokyo Univ., TEPCO）

Source : METI, Japan

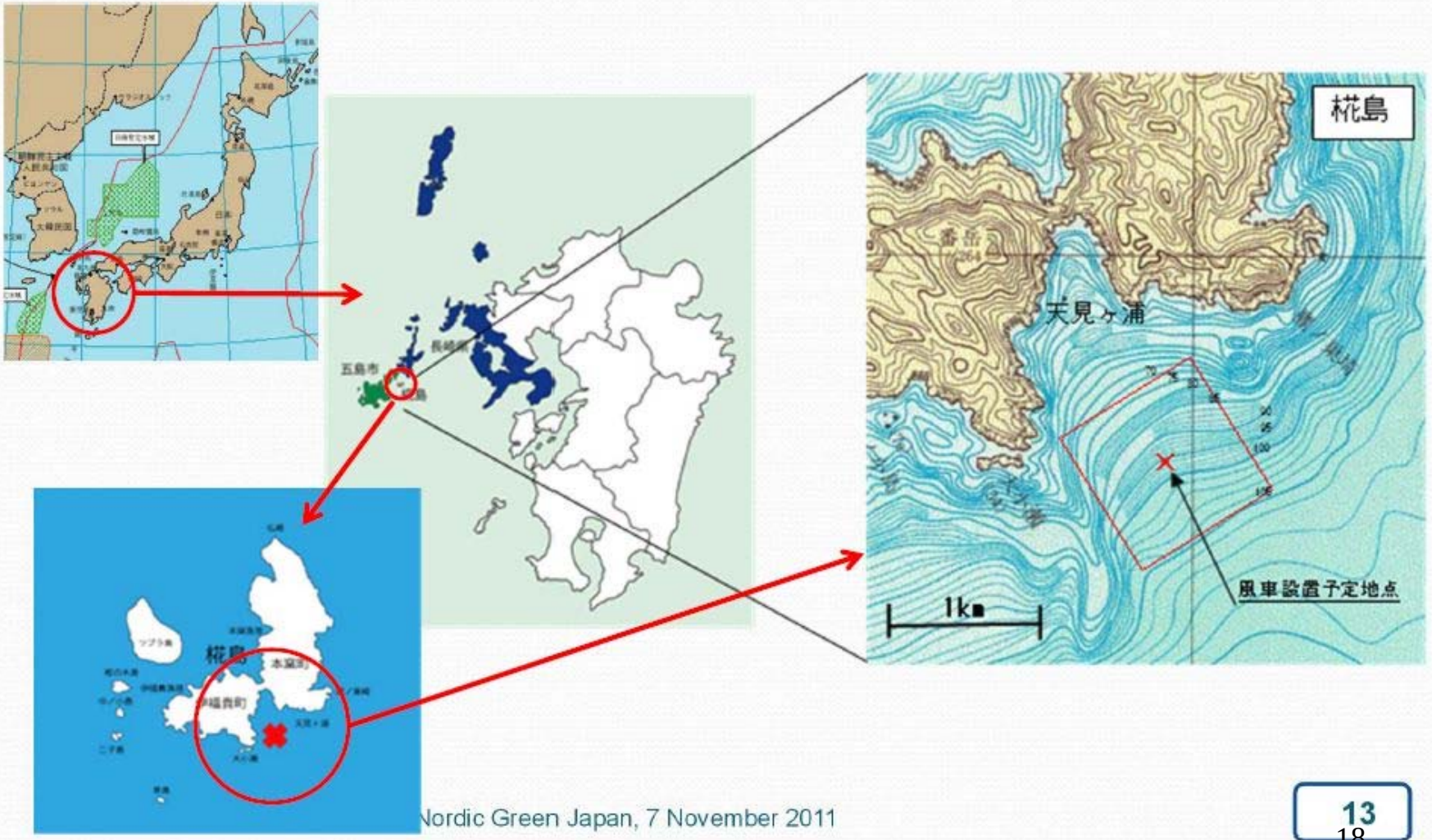
Schematic View of METI Deep Offshore Project, Fukushima



MOE Deep Offshore Project of Spar Type 1

Ministry of the Environment
Government of Japan

Demonstration site – Kabashima Island



Source : MOE, Japan

MOE Deep Offshore Project of Spar Type 2

Full Scale Model

- Hub height: 60m
- Draft: 78m
- PC-Steel Hybrid Spar
- Catenary Mooring

National project of offshore wind in Cho-shi area
By NEDO in October, 2012

From TEPCO Website

First Offshore Wind Farm in the World, 2000

Advanced Offshore Wind in the World

Hywind Project in Norway (2009)
Water depth 200m（120-700m）, Float depth of 100m, Turbine of 2.4 MW

Photo: Øyvind Hagen / Statoil

Tour to Norway to observe Hywind in last September

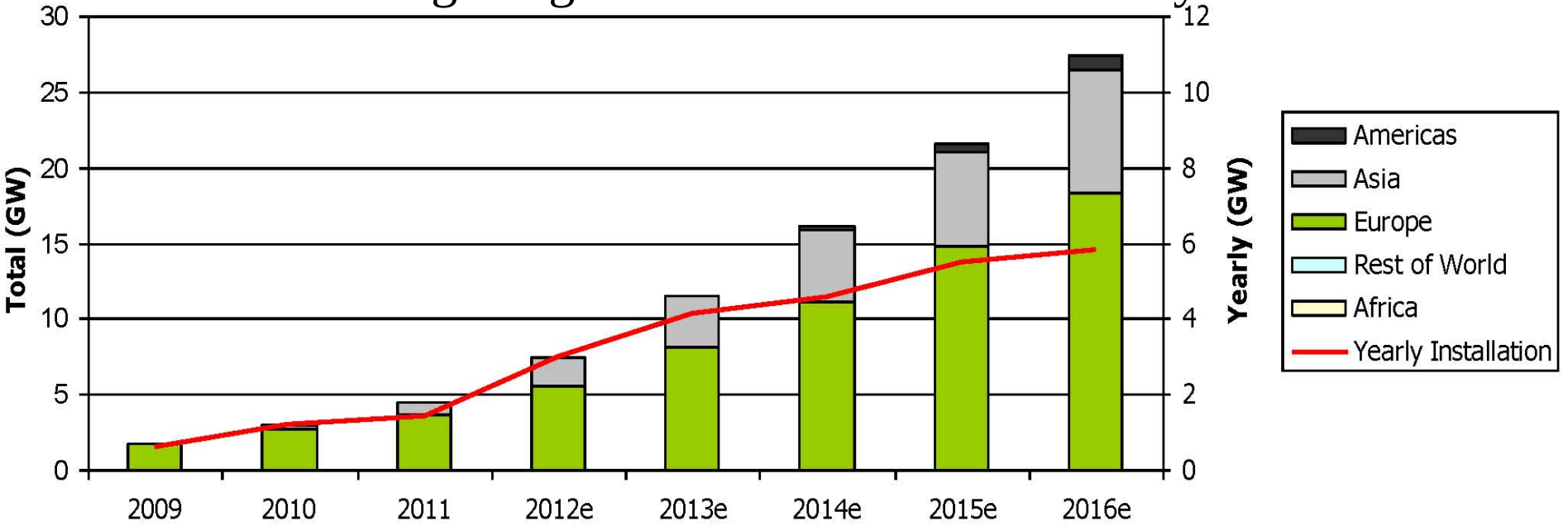

SWAY

Huge global potential for offshore wind

5GW of total accumulation of offshore wind

More that 30% growth rate of year

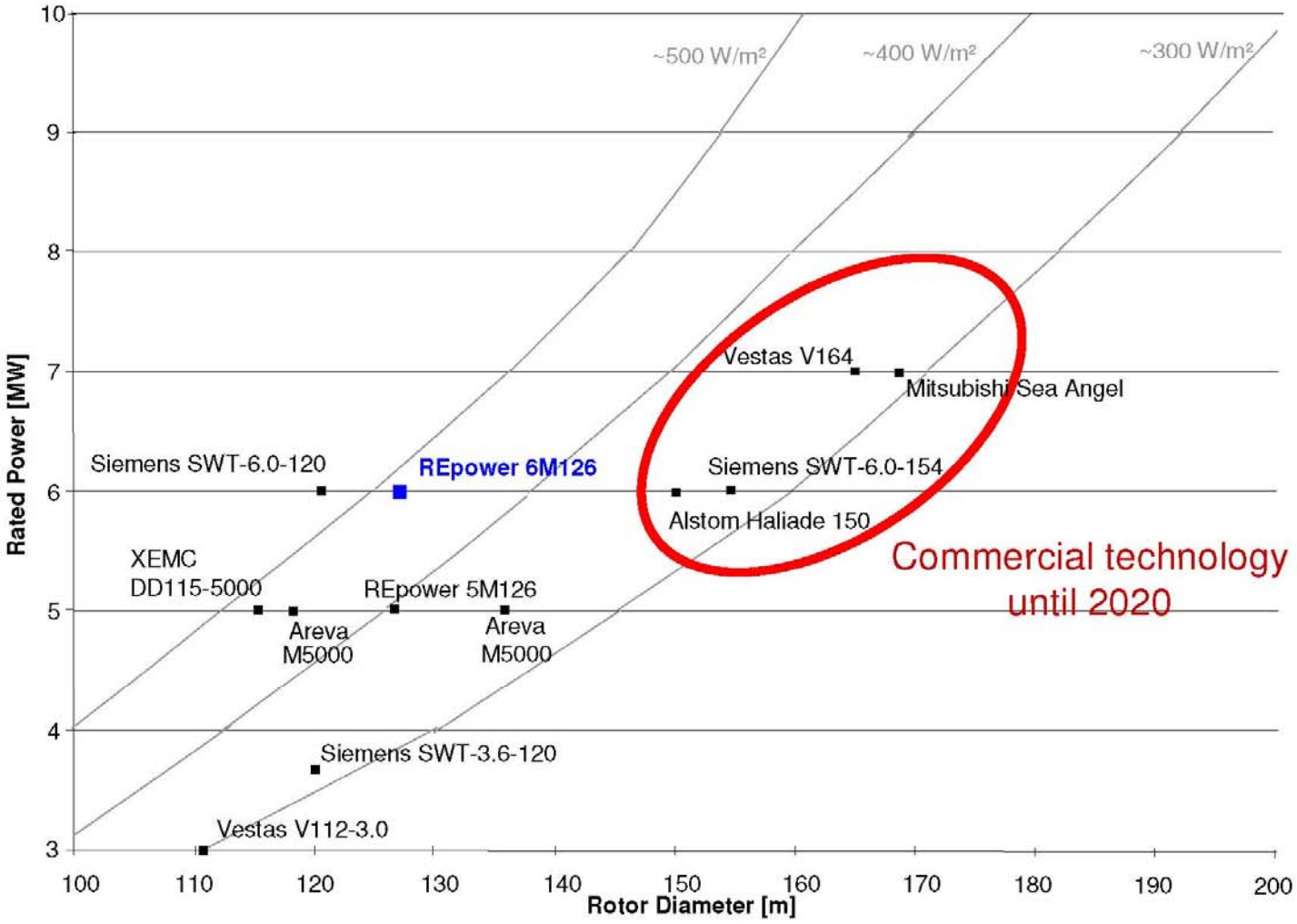
Following the growth of onshore behind 10 years



Source: MAKE, Q3 2011 Market Outlook Update

Global Offshore Wind London 2013 より

Turbine Development- WTG manufacturers will match the goal to reduce COE by increasing the output



Nobert Giese, “Are fast-developing turbines the right approach for offshore?”, Renewable UK 2012, GLOBAL OFFSHORE WIND,

Concluding Remarks

- Roadmap is discussed for wind power with estimation of potential for wind power.
- FIT is expected to work well to develop wind power.
- Primary grid connection of wind power is important with the electric power company using the connections with other areas.
- Offshore wind power has large potential due to the huge area of ocean around Japanese island of EEZ 6th.
- Deep offshore system will be a key technology for future development of wind power and recovery from the disaster.
- Fisherman's right will be reasonably taken into account for cooperating with developer instead of compensation.