

Potential for Introduction of Wind Power Generation and Mid/Long Term Installation Goals (v3.2)



February 22, 2012

General Incorporated
Association

JAPAN WIND POWER
ASSOCIATION

<http://jwpa.jp>

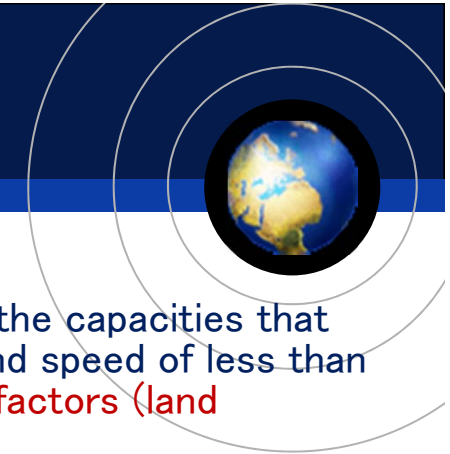


Reports on Theoretical Capacities of Energy Resources and Potential



- Ministry of Economy, Trade and Industry
 - ☞ Basic Study on New Energy Introduction: January 2000
 - Practical potential was reported as 6.4 GW. These data had been the basis for setting the installation goals.
 - ☞ Basic Study Project on the Promotion of Alternative Energy Introduction: February 2011
 - ☞ http://www.meti.go.jp/eti_lib/report/2011fy/E001771.pdf
 - The latest methods of analysis and a variety of numerical data on national land were employed.
 - The potential was calculated under several scenarios and project IIRs.
- Ministry of the Environment
 - ☞ Study of Potential for the introduction of Renewable Energy for FY 2009: March 2010
 - ☞ <http://www.env.go.jp/earth/report/h22-02/index.html>
 - The latest methods of analysis and a variety of numerical data on national land were employed.
 - ☞ Study of Potential for the introduction of Renewable Energy for FY 2010: March 2011
 - ☞ <http://www.env.go.jp/earth/report/h23-03/index.html>
 - The latest methods of analysis and a variety of numerical data on national land were employed.
 - The potential was calculated under several scenarios and project IIRs.
 - ☞ Potential Map for the introduction of Renewable Energy : March, 2011
 - ☞ <http://www.env.go.jp/earth/ondanka/rep/index.html>
 - Displayed on Google Earth (with lower resolution due to display speeds)

Definitions of the Terms



- **Theoretical Capacity of Energy Resources**

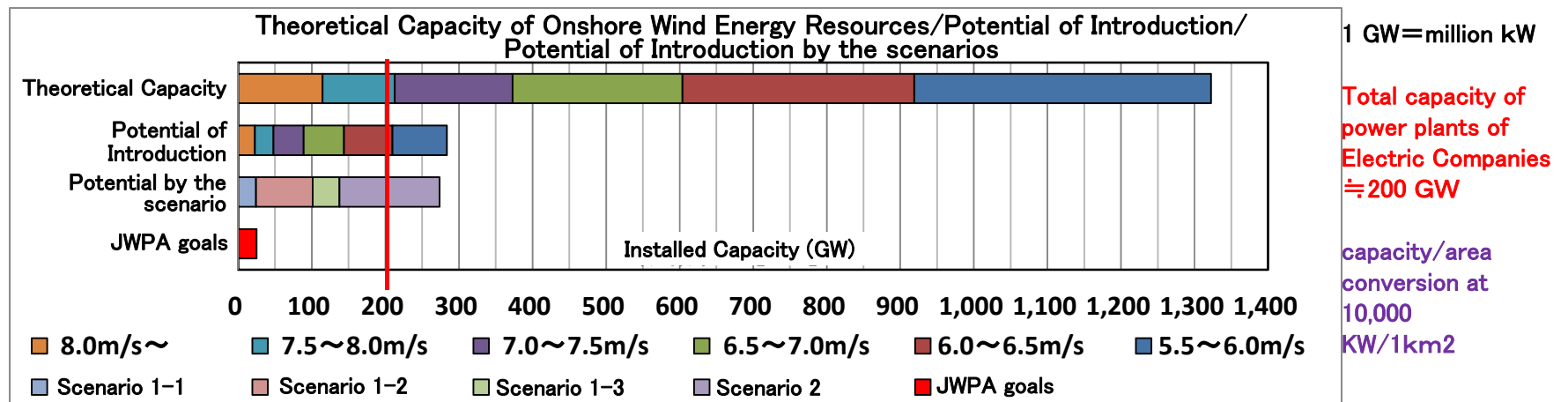
- The theoretically calculated capacity of energy resources, except for the capacities that are obviously impossible to utilize (for example: wind energy with a wind speed of less than 5.5 meters/second) and **with no consideration for the various limiting factors (land applications, application technologies, laws, and regulations).**

- **Potential for Introduction**

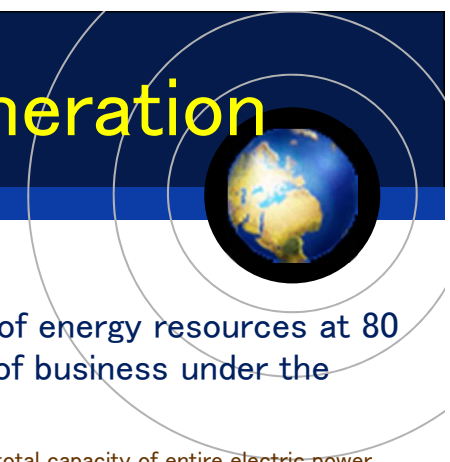
- The capacity of energy resources with consideration for the various limiting factors of recovery and application of energy; **the potential for introduction under particular social conditions at a time.**

- **Potential for Introduction by Scenario**

- The capacity of energy resources by a particular scenario (hypothetical conditions) relating to income and expenditures for the business applied to the potential for introduction; **the potential for introduction under particular scenarios for income and expenditures for the business.**



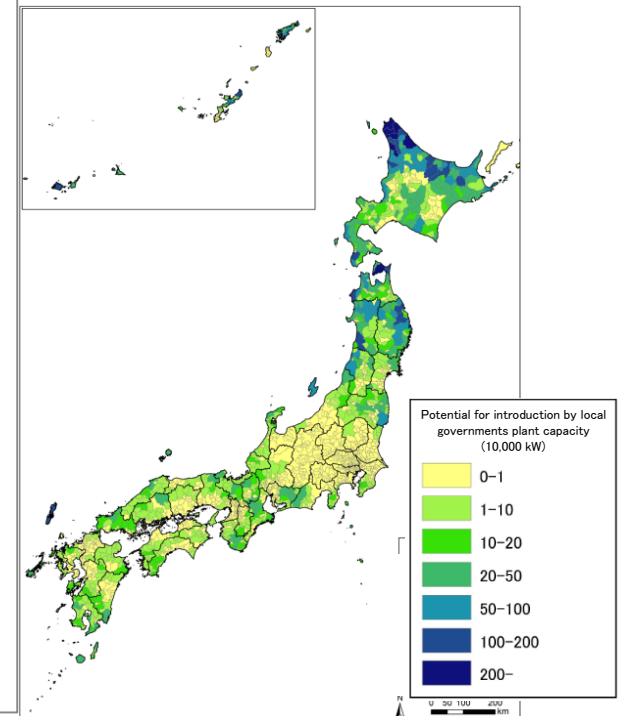
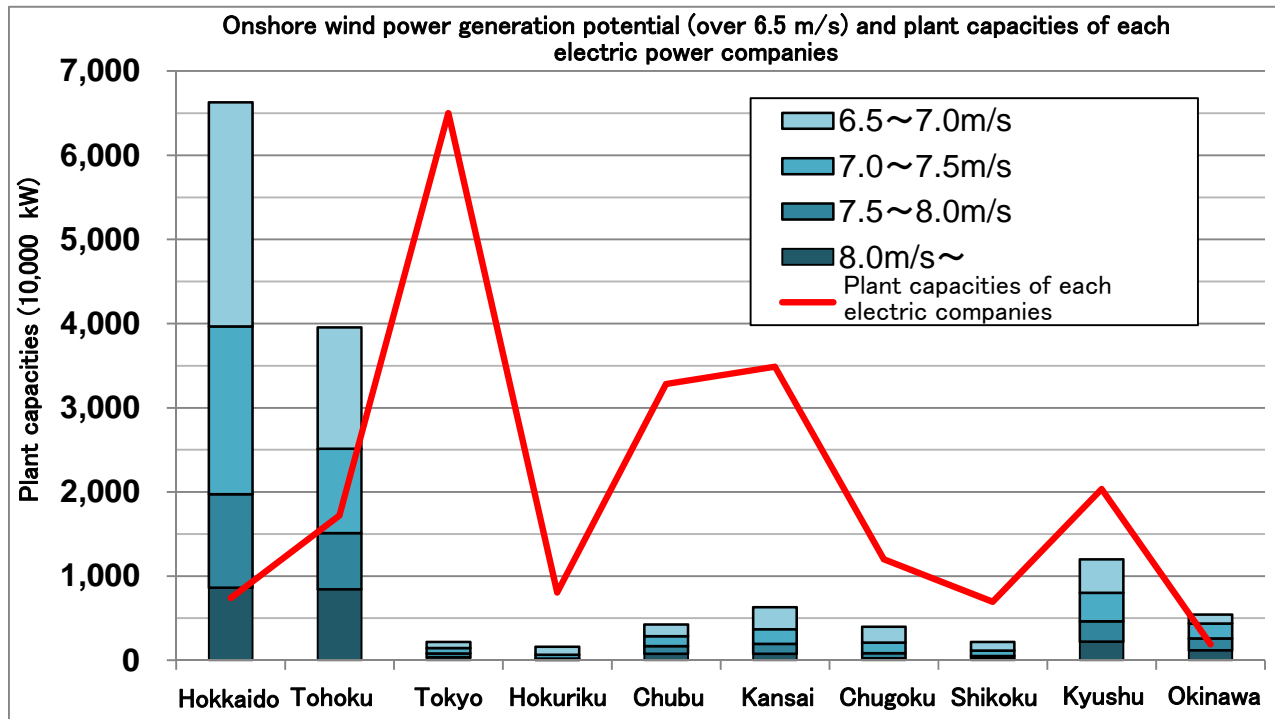
Potential for Onshore Wind Power Generation



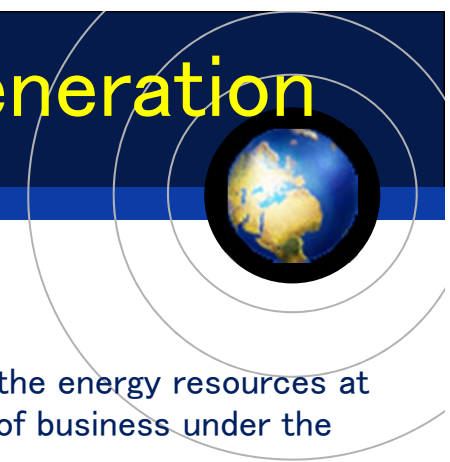
- Most of the potential is concentrated in Hokkaido, Tohoku, and Kyushu.

Onshore wind power generation potential * calculated from the theoretical capacity of energy resources at 80 meters high. The average wind speed exceeds 6.5 meters/second for the feasibility of business under the consideration of social limiting factors as listed below;

- Without consideration of the capacities of the electric power companies: 143.76 GW (0.76 times total capacity of entire electric power plants)
- Total capacity of electric power companies as the upper limit: 59.05 GkW (0.29 times total capacity of entire electric power plants)
- In addition to the above, the rate of development around 50%: 30.00 GW (0.15 times total capacity of entire electric power plants)



Potential for Offshore Wind Power Generation (including islands)

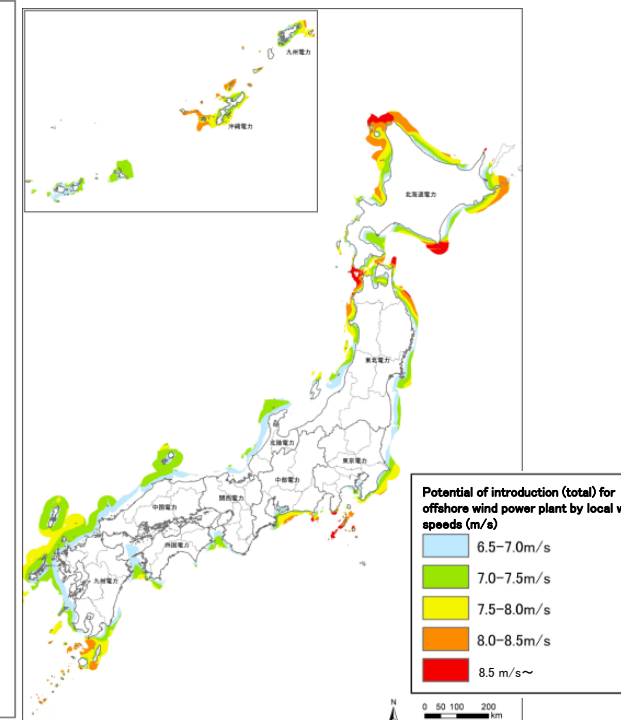
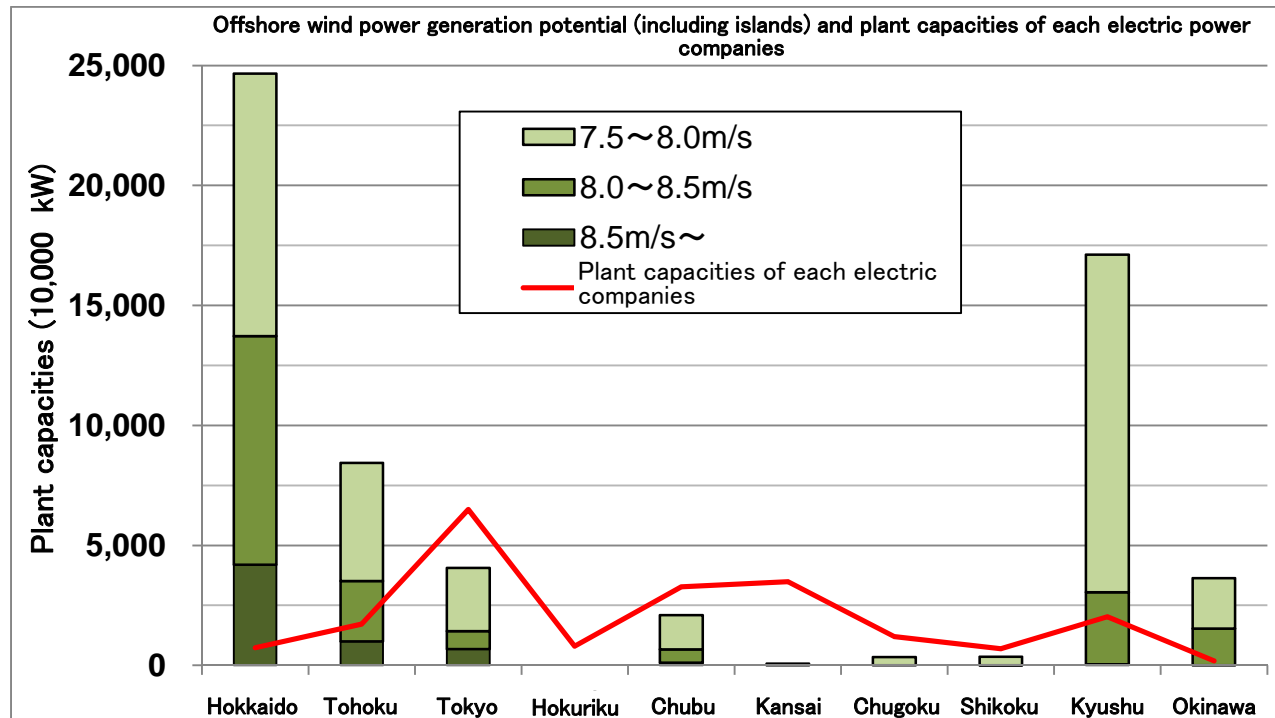


- The potential is higher than onshore.

(Distance from shore: less than 30 km, depth of the water: less than 200 m)

Offshore wind power generation potential * calculated from the theoretical capacity of the energy resources at 80 meters high. The average wind speed exceeds 7.5 meters/second for the feasibility of business under the consideration of the social limiting factors as listed below;

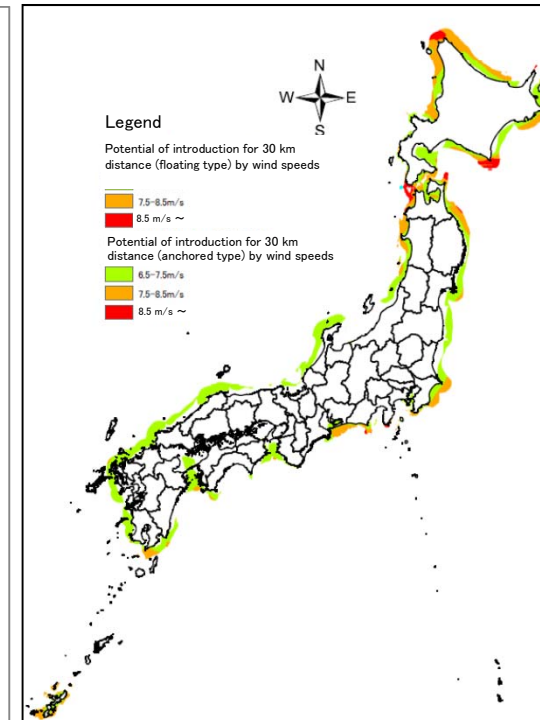
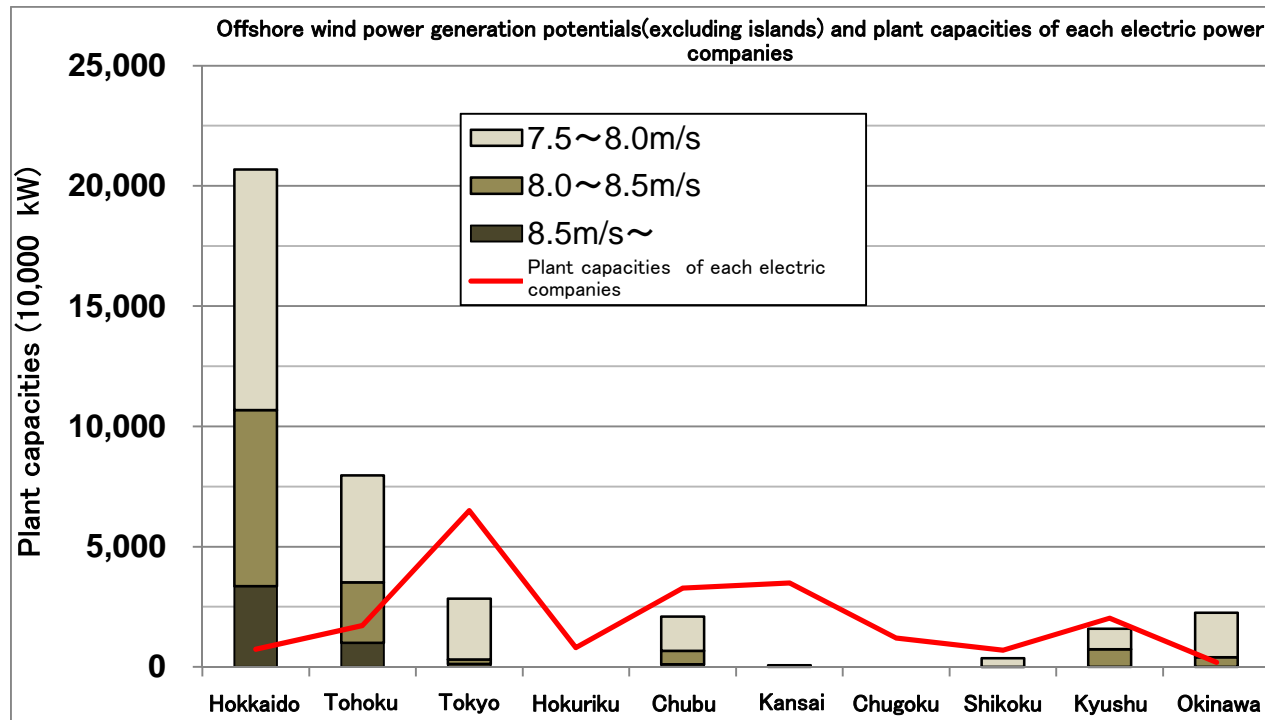
- ∞ Without consideration for the capacities of electric power companies: 607.84 GW (2.94 times total capacity of entire electric power plants)
- ∞ Total capacity of electric power companies as the upper limit: 116.12 GkW (0.56 times total capacity of entire electric power plants)
- ∞ In addition to the above, the rate of development around 25%: 30.00 GW (0.15 times total capacity of entire electric power plants)



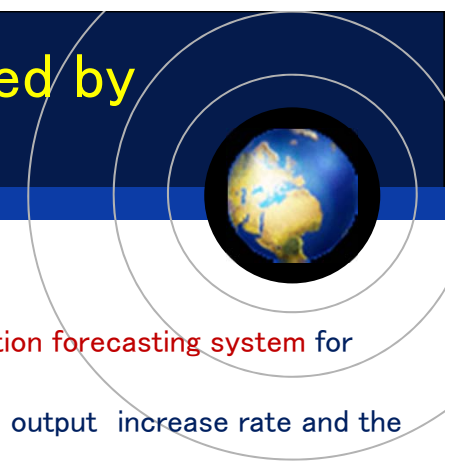
Potential for Offshore Wind Power Generation (excluding islands)



- The potential is higher than onshore. (Distance from shore: less than 30 km, Depth: less than 200 m)
 - Offshore wind power generation potential * calculated from the theoretical capacity of the energy resources at 80 meters high. The average wind speed exceeds 7.5meters/second for the feasibility of business under the considerations of the social limiting factors as listed below;
 - Without consideration for the capacities of electric power companies :378.25 GW (1.83 times total capacity of entire electric power plants)
 - Total capacity of electric power companies as the upper limit: 95.96 GkW (0.56 times total capacity of entire electric power plants)
 - In addition to the above, the rate of development around 33%: 30.00 GW (0.15 times total capacity of entire electric power plants)



Mid/Long Term Installation Goals (estimated by JWPA)



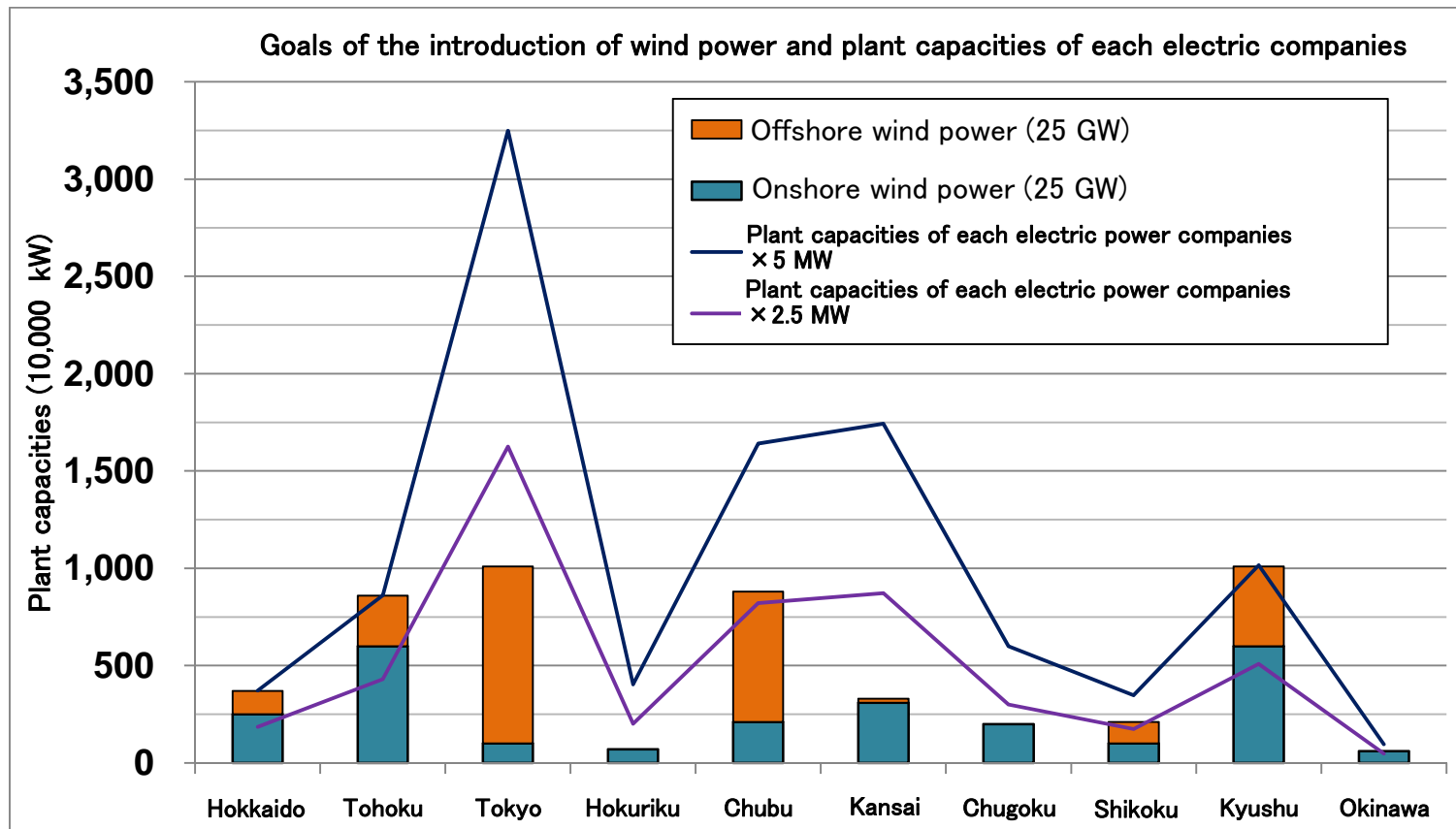
- **Installed capacity of 50 GW by 2050 (supply more than 10% of total power demand)**
 - ☞ Utilize the **wide area coordinative operations of electrical grid** by applying the **power generation forecasting system** for weather prediction.
 - ☞ Utilize the **control functions of wind turbines** such as the limitations of maximum output and output increase rate and the power factor (voltage) control.
- **Limiting factors considered in setting goals**
 - ☞ Less than 1/2 (50%) of the capacity of electric power companies. For Okinawa, less than 1/3.: **Electrical grid problems**
 - ☞ The rate of development for the potential of onshore wind power – less than 1/2 (50%): **Certainty**
 - ☞ The rate of development for the potential of offshore wind power (excluding islands) – less than 1/3 (33%): **Certainty**
- **Estimated goals for each electric power companies**

Electric company	Plant capacity (10,000 kW)	Onshore wind power (10,000 kW)	Offshore wind power (10,000 kW)	Total (10,000 kW)	Rate of development for onshore (%)	Rate of development for offshore (%)	Rate of wind power capacity (%)	floated type (10,000 kW)	anchored type (10,000 kW)
Hokkaido	742	250	120	370	3.8%	0.6%	49.9%	60	60
Tohoku	1,721	600	260	860	15.2%	3.3%	50.0%	40	220
Tokyo	6,499	100	910	1,010	46.1%	32.1%	15.5%	280	630
Hokuriku	806	70	0	70	44.0%	-	8.7%	-	-
Chubu	3,283	210	670	880	49.4%	32.0%	26.8%	360	310
Kansai	3,488	310	20	330	49.1%	28.7%	9.5%	0	20
Chugoku	1,199	200	0	200	50.0%	-	16.7%	-	-
Shikoku	696	100	110	210	46.3%	30.8%	30.2%	0	110
Kyushu	2,033	600	410	1,010	50.0%	25.8%	49.7%	10	400
Okinawa	192	60	0	60	11.0%	0.0%	31.3%	0	0
Total	20,658	2,500	2,500	5,000	17.4%	6.6%	24.2%	750	1,750

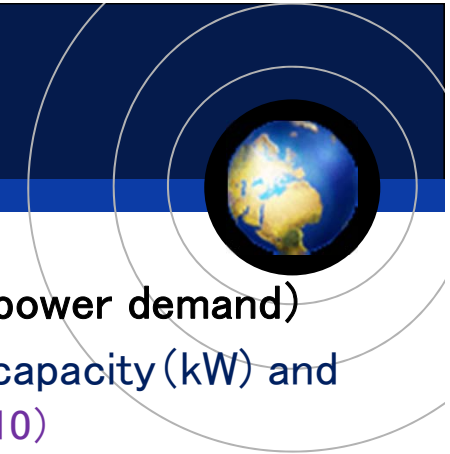
Mid/Long Term Installation Goals (estimated by JWPA)



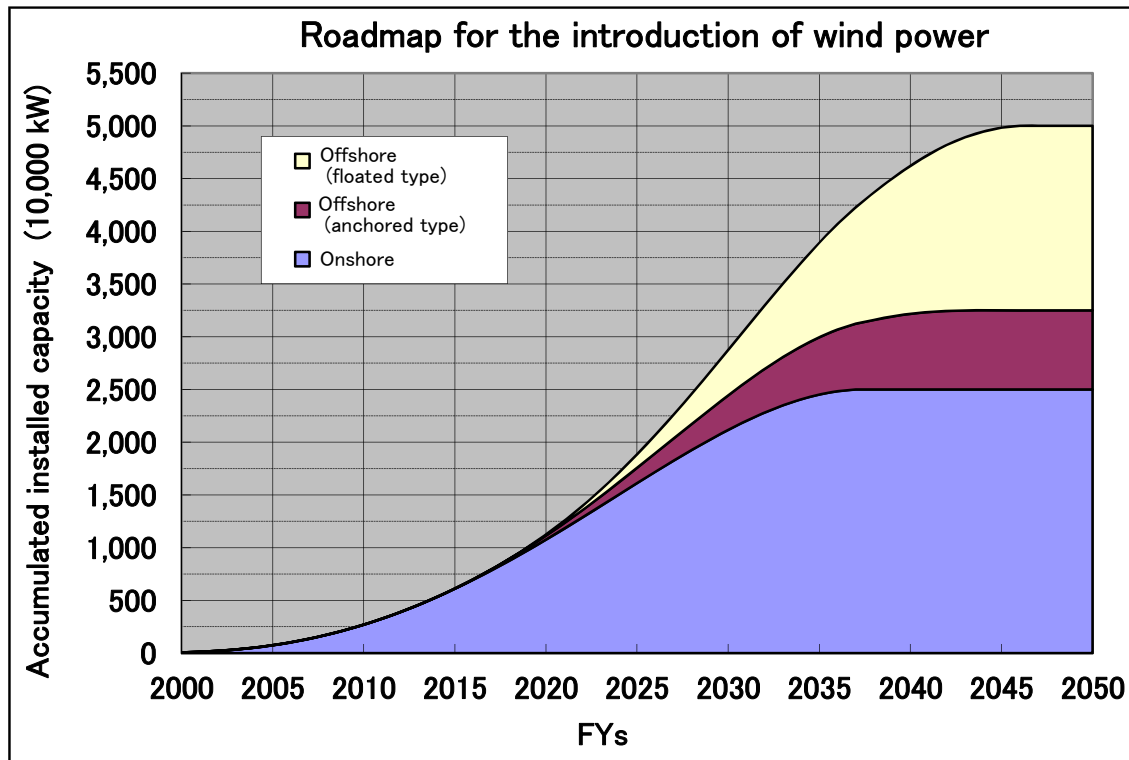
- Installed capacity of 50GW by 2050 (supply more than 10% of total power demand)
 - ☞ Utilize the wide area coordinative operations of electrical grid by applying the power generation forecasting system for weather prediction.
 - ☞ Utilize the control functions of wind turbines such as the limitations of maximum output and output increase rate and the power factor (voltage) control.



Roadmap (estimated by JWPA)

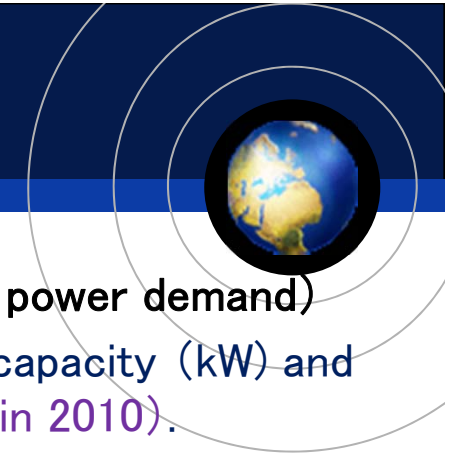


- Installed capacity of 50GW by 2050 (supply more than 10% of total power demand)
 - ☞ In 2050, equivalent to approx. 20% of total electric power plant capacity (kW) and 15% of total demand (kWh) (equal to the actual values of Spain in 2010)
 - ☞ Growth curves of calculated installed capacities for each fiscal year using the tertiary method.

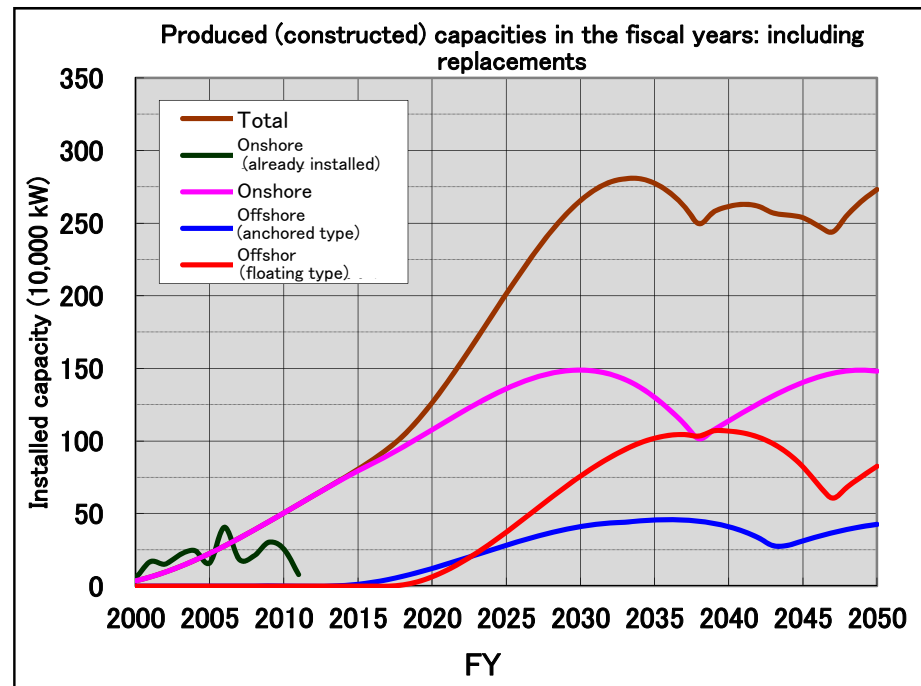
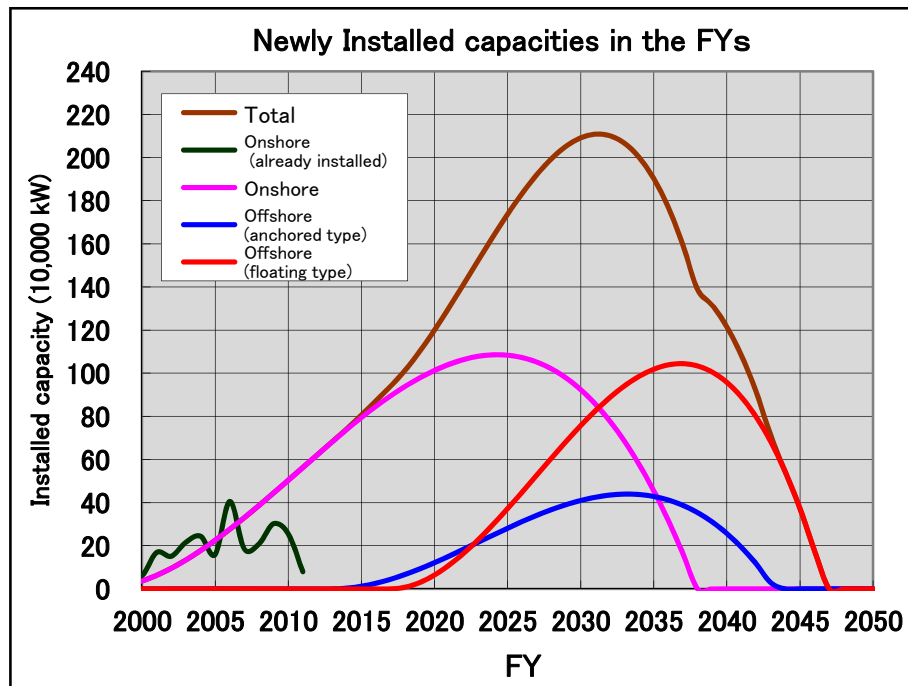


FY	Goals for installed capacities for wind power (10,000 kW)			Total
	Onshore	Offshore (anchored type)	Offshore (floated type),	
2010	242	3	0	244
2020	1,080	40	10	1,130
2030	2,120	330	430	2,880
2040	2,500	720	1,400	4,620
2050	2,500	750	1,750	5,000

Roadmap (estimated by JWPA)

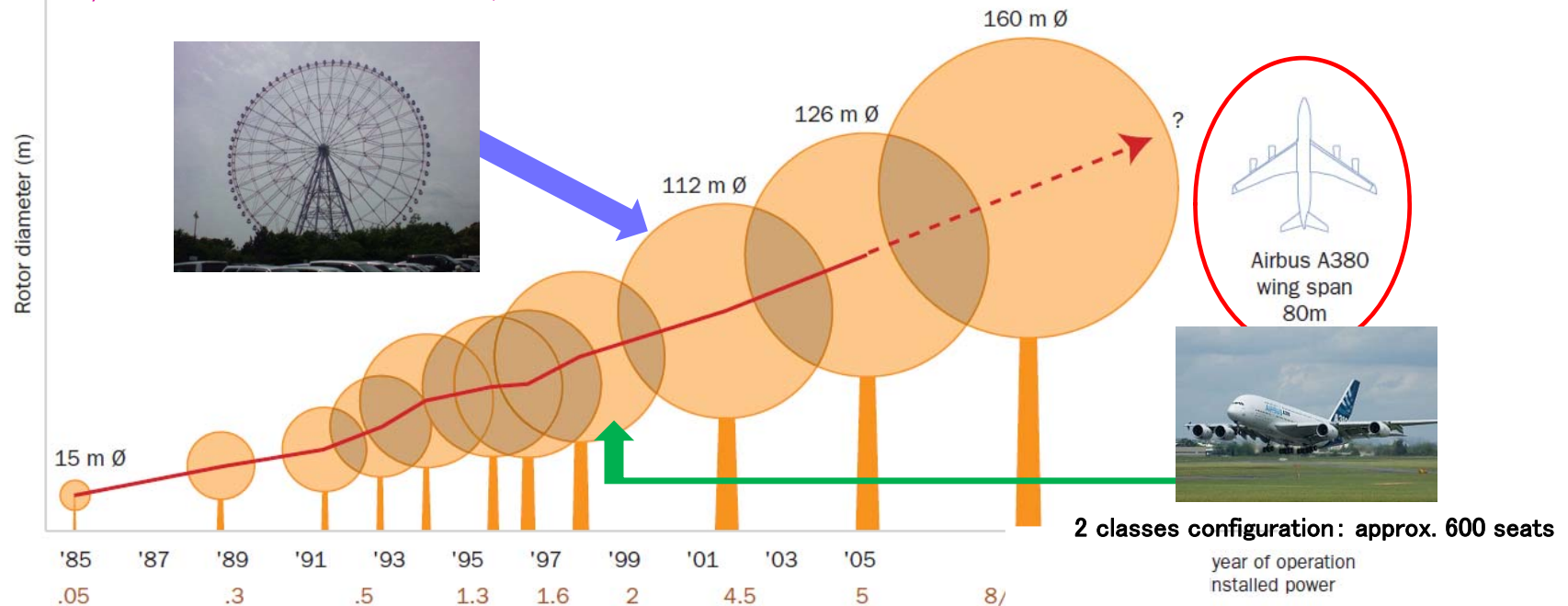


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 - ☞ In 2050, equivalent to approx. 20% of total electric power plant capacity (kW) and 15% of total demand (kWh) (equal to the actual values of Spain in 2010).
 - ☞ Growth curves of calculated installed capacities for fiscal years using the tertiary method.
 - ☞ In consideration with the required replacements in every 20 years, the installed capacity for the years after 2028 will be more than 2.50 GW per year.: Stable industry

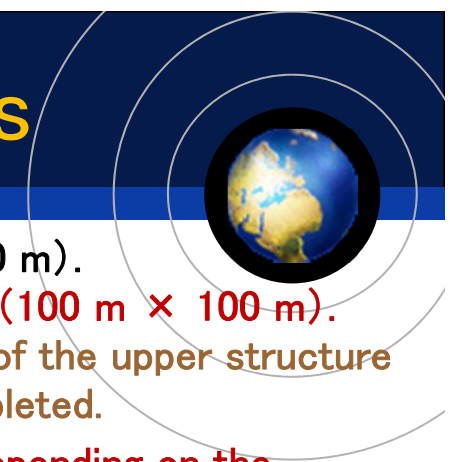


<Reference> The size of wind power generators

- Onshore: 2,000 kW to 3,000 kW
Diameters of the blades: 80–90 m (The height of the top: 120–130 m)
- Offshore: 3,000kW~5,000kW
Diameters of the blades: 90–130 m (The height of the top 130–190 m)
 - ∝ Reference: Distance between the both ends of the wing of AirbusA380 is 80 m (equivalent to 2,000 kW wind turbines)
Diameter of the ferris wheel at Kasai Rinkai Park is 112 m (equivalent to 4,500 kW wind turbines)



< Reference > Required land areas



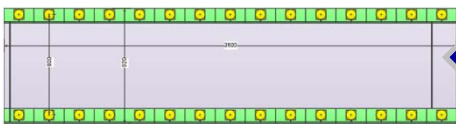
- In the case of constructing one 2,000 kW wind turbine (blade diameter: 80 m). **Required occupied area for the installation work is approx. 1 ha (hectare) (100 m × 100 m).** Only the tower with the diameter of approximately four meters and part of the upper structure of the foundation will remain aboveground after the installation was completed.
- In case of multiple turbines are installed, the required land area **differs depending on the numbers of arrays** in order to keep distances between turbines.

– Land areas

▪ 2,000 kW × 30 turbines × 1 line ≐ 86 ha ⇒ 70 MW/km²

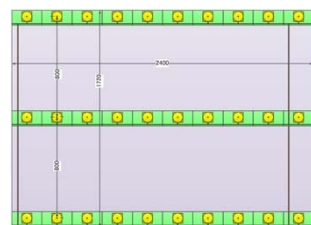


▪ 2,000 kW × 15 turbines × 2 lines ≐ 360 ha ⇒ 17 MW/km²



Lands other than the turbines are installed can be applicable to the other purpose.

▪ 2,000 kW × 10 turbines × 3 lines ≐ 410 ha ⇒ 15 MW/km²



Shonai Town, Yamagata Prefecture



- For the estimate of the potential, **10 MW/km²** was applied for the allowance.

Sample layout of turbines

