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[Analysis Report]

Japan's Offshore Wind Power Potential
Territorial Sea and Exclusive Economic Zone

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Renewable Energy Institute

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Author

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About Renewable Energy Institute

Renewable Energy Institute is a non-profit think tank which aims to build a sustainable, rich society based on renewable energy. It was established in August 2011, in the aftermath of the Fukushima Daiichi Nuclear Power Plant accident, by its founder Mr. Masayoshi Son, Chairman & CEO of SoftBank Group, with his own resources.

Introduction

From the perspective of global warming countermeasures and energy security, the deployment of offshore wind power is accelerating around the world. As of the end of 2022, the cumulative amount of offshore wind power installed worldwide was 63.2 GW, and each country and region has set high targets for the introduction of wind power by 2035 and 2050. In Japan, the full-scale introduction of fixed-bottom offshore wind power has begun under the Renewable Energy Sea Area Utilization Act, and studies are underway for the introduction of floating offshore wind power in the exclusive economic zone (EEZ).

Against this backdrop, in order to provide a concrete indication of the potential for offshore wind power deployment in Japan, this report provides estimates of the offshore wind energy potential based on calculations of wind and water depth conditions only, for those sea areas where both wind speed data[1] and water depth data[2] are available. Areas where feasibility was assumed to be difficult, such as areas with water depths exceeding 1,000m along the submarine cable installation route, have been excluded. This report presents the findings for wind power potential for all of Japan, by 10 regional areas, and by prefecture in the sea areas including territorial sea and EEZ in particular. Regarding the assumptions used in the calculations and the results for all cases, please refer to **the analysis results for all cases**.

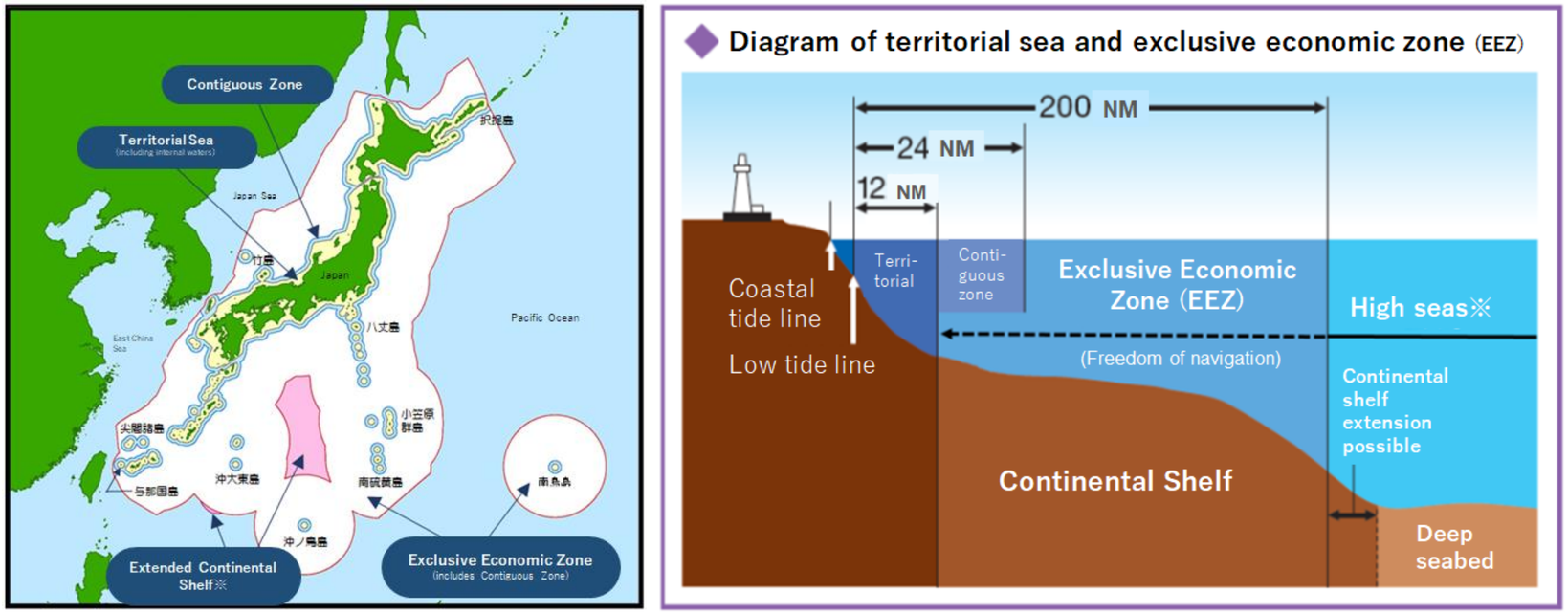


Figure 1 Conceptual Diagram of Japan's Territorial Sea, and Terminology Related to Territorial Sea

Source: Japan Coast Guard, Jurisdictional marine zone information

1. New Energy and Industrial Technology Development Organization (NEDO): NeoWinds (offshore wind map)
2. Japan Coast Guard: Japan Oceanographic Data Center 500m Gridded Bathymetry Data (J-EGG500)

Japan's Offshore Wind Potential: Calculation Conditions and Results

Potential values vary depending on the assumption of the annual average wind speed, the water depth, and the sea surface area.

By water depth, the fixed-bottom type is for water depths of less than 50 m, the semi-submersible floating type is mainly used for water depths of 50m or more but less than 100 m, and various types of floating type technologies are used for water depths of 50m or more but less than 200m and 50m or more but less than 300 m.

In the case of water depths of less than 200 m or 300 m, the potential increases by about 1.4 times when the contiguous zone within EEZ is added to the area only in the territorial sea and the potential increases by about 2.0 times when the entire EEZ is added.

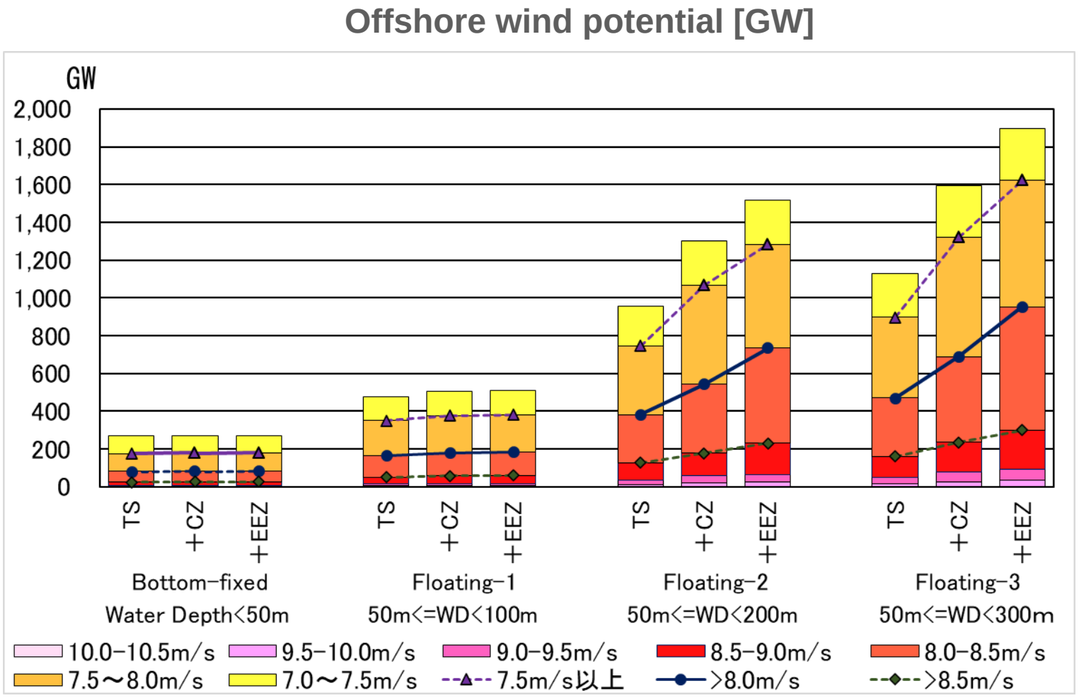
However, since the increase in water depth and distance from shore increases construction and installation costs, from the viewpoint of business feasibility, the following criteria were set as the basic requirements: for the fixed-bottom type, annual wind speed of 7.5 m/s or higher and territorial sea only; for the floating type, annual wind speed of 8.0m/s or higher, territorial sea plus the contiguous zone in EEZ, and water depth of 50m or higher but less than 200m.。

In that case, a potential of 176 GW was obtained for the fixed-bottom type and 542 GW for the floating type. Furthermore, the study also examined water depths of 50 m or more but less than 300 m, resulting in a potential of 952 GW for the territorial sea plus entire EEZ. Details are given below.

Unit：GW	Fixed-bottom Water depth：less than 50m			Floating - 1 Water depth：50m or more, less than 100m			Floating - 2 Water depth：50m or more, less than 200m			Floating -3 Water depth：50m or more, less than 300m		
	Territorial Sea	Territorial Sea + Contiguous Zone	Territorial Sea + EEZ	Territorial Sea	Territorial Sea + Contiguous Zone	Territorial Sea + EEZ	Territorial Sea	Territorial Sea + Contiguous Zone	Territorial Sea + EEZ	Territorial Sea	Territorial Sea + Contiguous Zone	Territorial Sea + EEZ
Annual average wind speed 7.5m/s or higher	176	180	180	351	377	381	747	1,066	1,281	897	1,321	1,621
Annual average wind speed 8.0m/s or higher	81	85	85	165	180	184	381	542	733	470	690	952
Annual average wind speed 8.5m/s or higher	24	26	26	50	58	61	127	178	229	160	236	300

Table 1: Offshore Wind Potential Results for Japan
Source: Created by Japan Renewable Energy Institute

Japan's Offshore Wind Potential: Calculation Conditions and Results



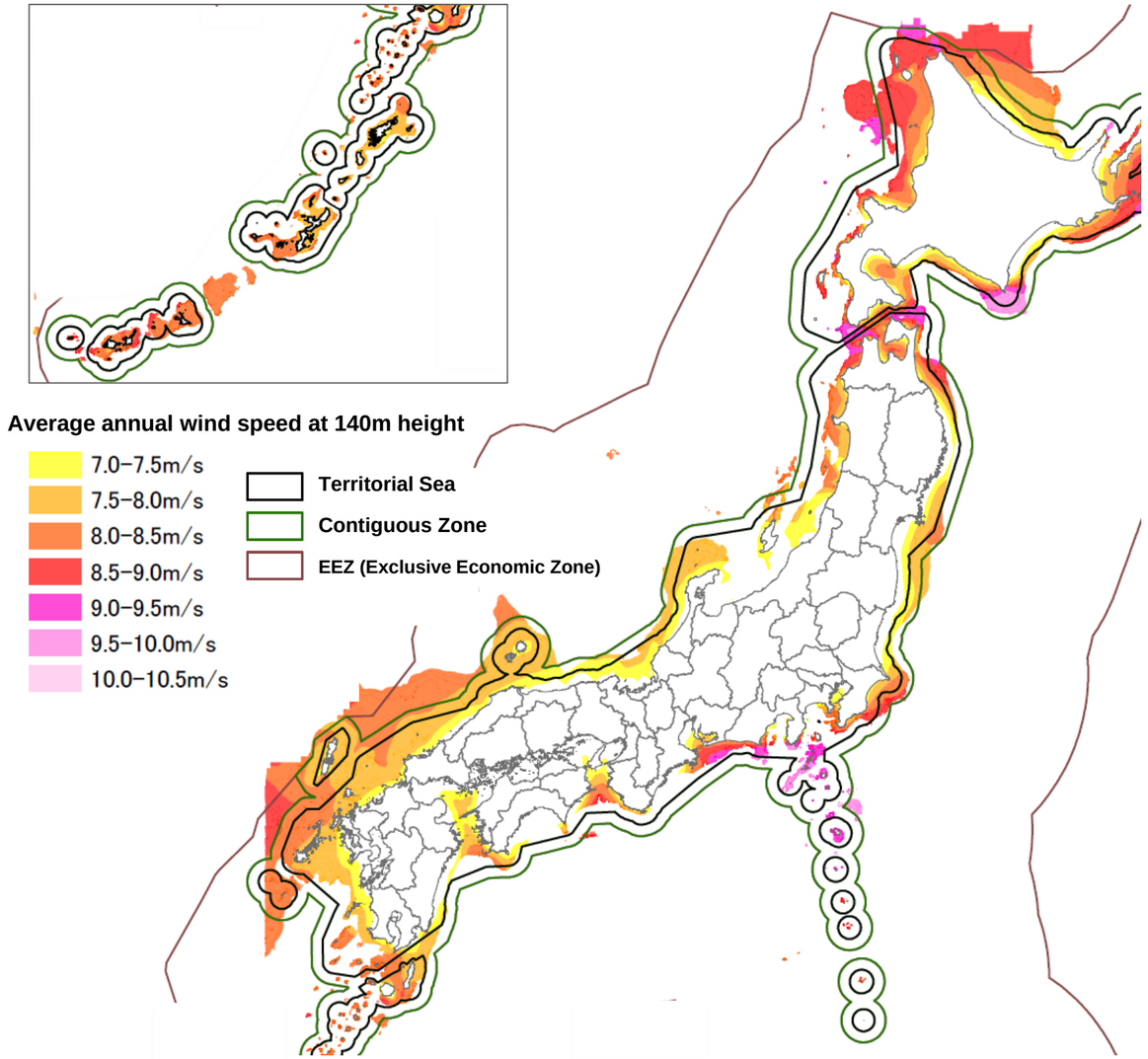


Figure 2 Japan's Offshore Wind Potential (water depth less than 300m)
Source: Created by Japan Renewable Energy Institute

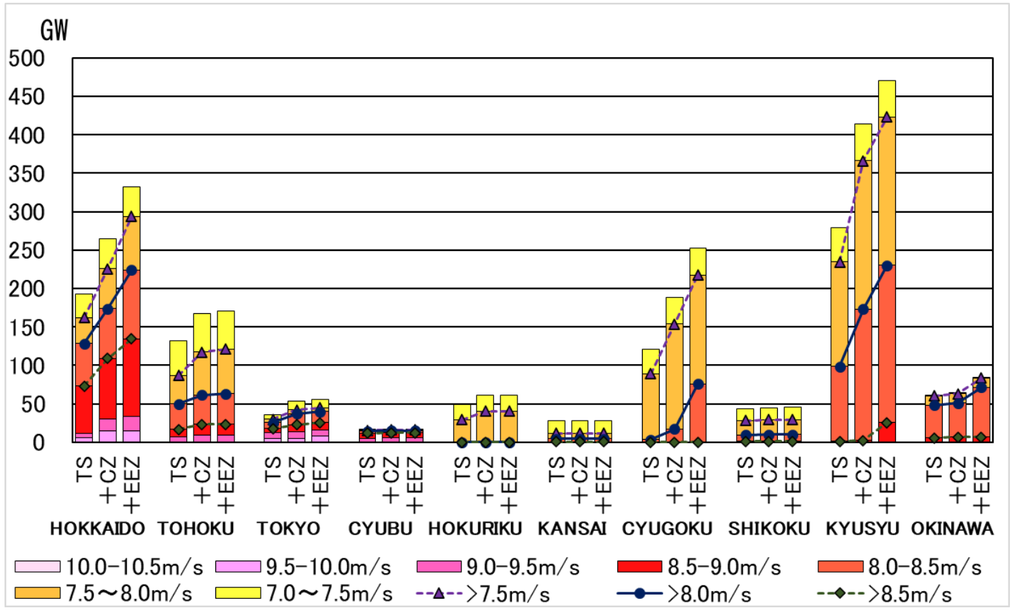
FOW potential: By 10 regional areas

The floating offshore wind potential in the ten regional areas in Japan was as follows:
(For the calculation results of the fixed-bottom type and the floating type with different water depths, see **the analysis results of all cases**)

The calculation results for the potential for territorial sea plus contiguous zone in EEZ, with water depths of 50 m or more but less than 200 m and annual average wind speeds of 8.0 m/s (7.5 m/s) or higher, were 542 GW (1,066 GW).

- Hokkaido: 173.5 GW (7.5 m/s or more 225.9 GW)
- Tohoku: 61.4 GW (7.5 m/s or more 117.1 GW)
- Tokyo: 37.2 GW (7.5 m/s or more 42.2 GW)
- Chubu: 15.2 GW (7.5 m/s or more 16.2 GW)
- Hokuriku: 0.0 GW (7. 5m/s or more 40.2 GW)
- Kansai: 4.2 GW (7.5 m/s or more 11.7 GW)
- China: 17.1 GW (7.5 m/s or more 153.9 GW)
- Shikoku: 9.8 GW (7.5 m/s or more 29.3 GW)
- Kyushu: 173.0 GW (7.5 m/s or more 366.0 GW)
- Okinawa: 50.9 GW (7.5 m/s or more 62.9 GW)

FOW potential [GW]－2 (water depth 50m or more, less than 200m)



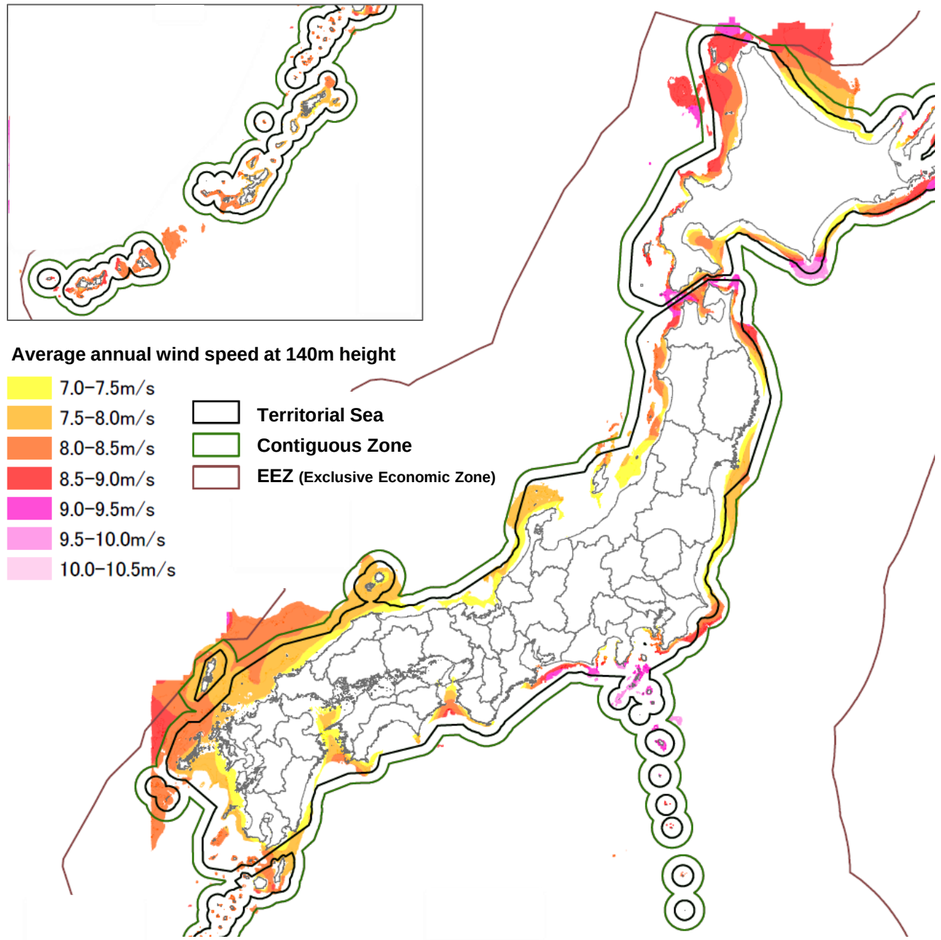


Figure 3 Floating offshore wind potential in 10 regional areas in Japan (water depth 50m or more, less than 200m)
Source: Created by Japan Renewable Energy Institute

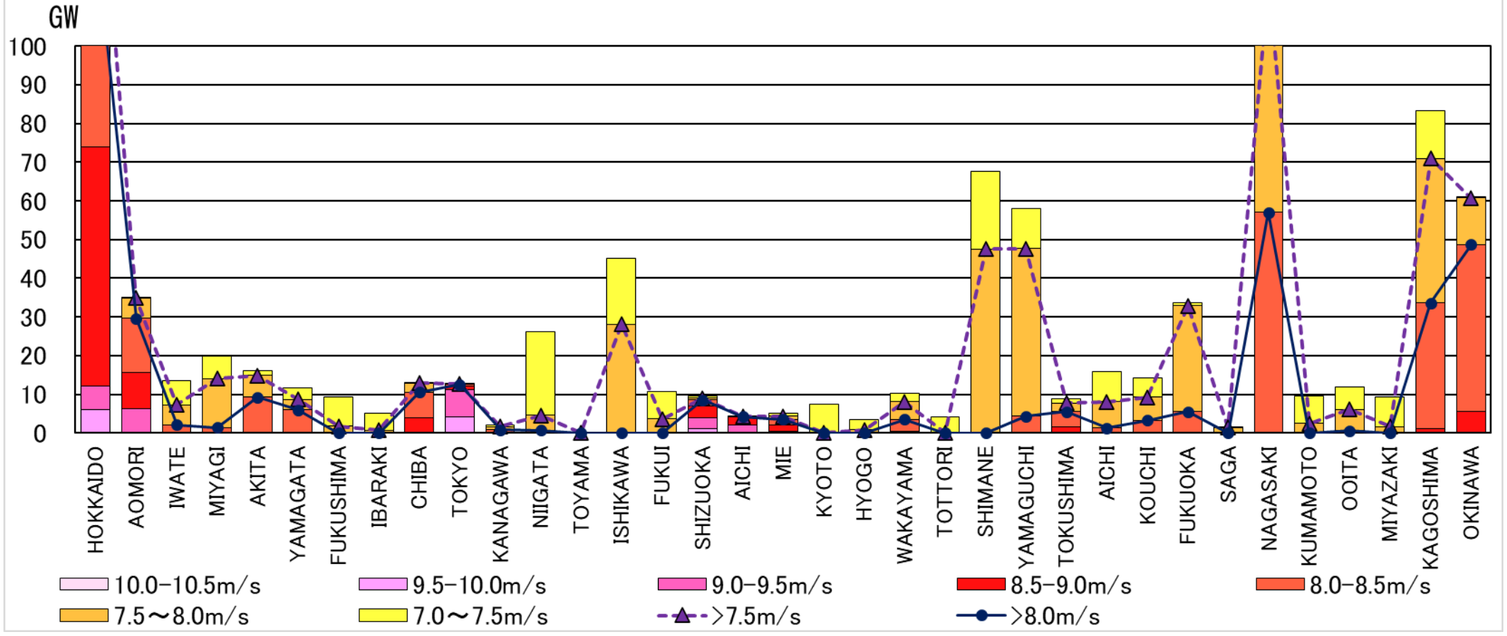
FOW potential: By prefecture

The floating offshore wind potential by prefecture was as follows:
(For the calculation results of the fixed-bottom type and floating type with different water depths, see **the analysis results of all cases**).

The calculated potential for the case of water depths of 50 m or more but less than 200m, annual average wind speeds of 8.0 m/s (7.5 m/s) or higher, and territorial sea only was 381GW (747 GW).

- Hokkaido: 128.9 GW (7.5m/s or more 162.9 GW)
- Nagasaki Prefecture: 57.0 GW (7.5m/s or more 116.1 GW)
- Okinawa Prefecture: 48.7 GW (7.5m/s or more 60.7 GW)
- Kagoshima Prefecture: 33.6 GW (7.5m/s or more 71.0 GW)
- Aomori Prefecture: 29.6 GW (7.5m/s or more6.3 GW)
- Tokyo: 12.6 GW (7.5m/s or more 34.9 GW)
- Chiba Prefecture: 10.6 GW (7.5m/s or more 12.8 GW)
- Akita Prefecture: 9.3 GW (7.5m/s or more 14.8 GW)
- Shizuoka Prefecture: 8.5 GW (7.5m/s or more 9.0 GW)
- Yamagata Prefecture: 5.9 GW (7.5m/s or more 8.6 GW)

FOW potential [GW]－2 (water depth 50m or more, less than 200m)



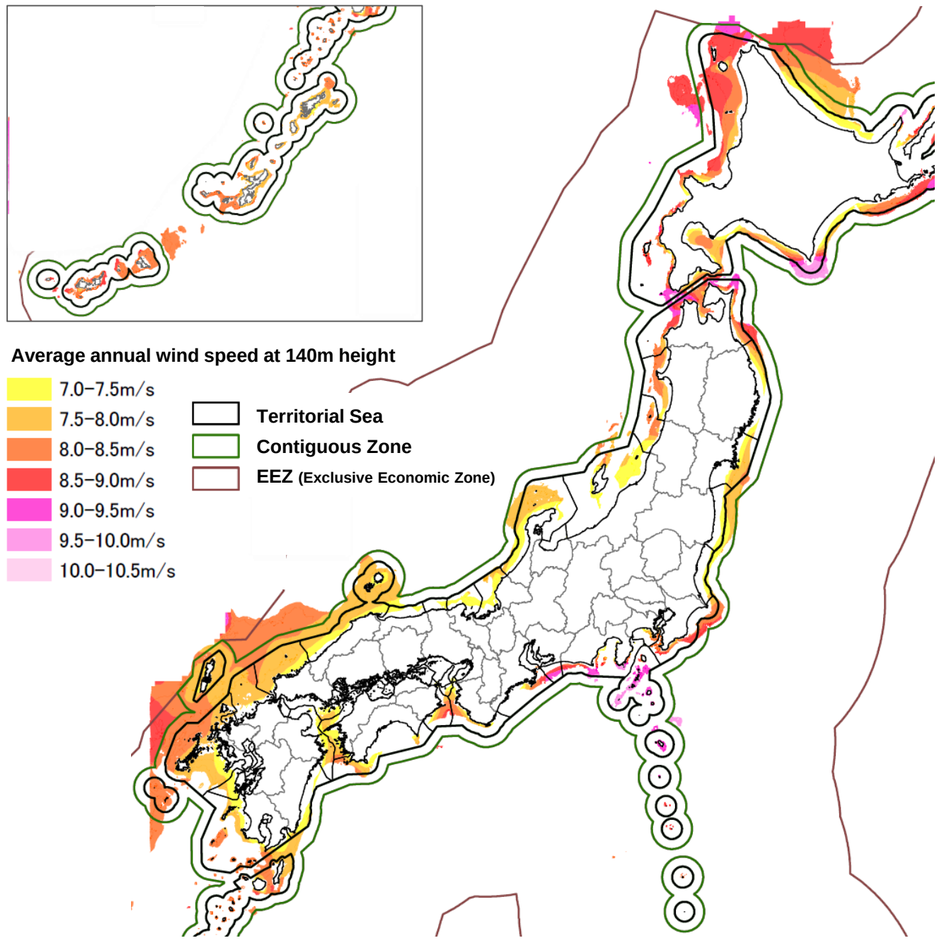


Figure 4 Floating offshore wind potential by prefecture (water depth 50 m or more , less than 200m)
Source: Created by Japan Renewable Energy Institute

Conclusion

In this overview chapter, the potential for floating offshore wind power generation was presented based on calculations from wind speed and water depth conditions only, for areas where both data were available.

On the other hand, the values obtained are not for the entire EEZ, and the actual annual average wind speed may differ slightly from the data used to calculate the potential. It should also be noted that in the actual planning stages of offshore wind power projects, particular attention should be paid to the following aspects.

- Natural and social environmental conditions must be fully considered in order to obtain the agreement of the local communities, including those involved in the fishing industry among others. Major references are listed below.
  - NEDO: NeoWinds (offshore wind map) [1], natural and social environment information
  - Ministry of the Environment: Environmental Assessment Database (EADAS)[2], natural and social conditions
  - Japan Coast Guard: MDA Situational Indication Linkages (MSIL)[3], ocean climate, meteorology, marine safety, maritime affairs, disaster prevention, marine ecosystems, ocean area utilization

- A detailed investigation of the meteorology, ocean climate conditions, and seafloor topography of the target area is necessary.

1. New Energy and Industrial Technology Development Organization (NEDO): NeoWinds (offshore wind map)
2. Environmental Assessment Database (EADAS)
3. Japan Coast Guard: MDA Situational Indication Linkages (MSIL)

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Territorial Sea and Exclusive Economic Zone

【Analysis results for all cases】

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1．Potential and Notes

Potential

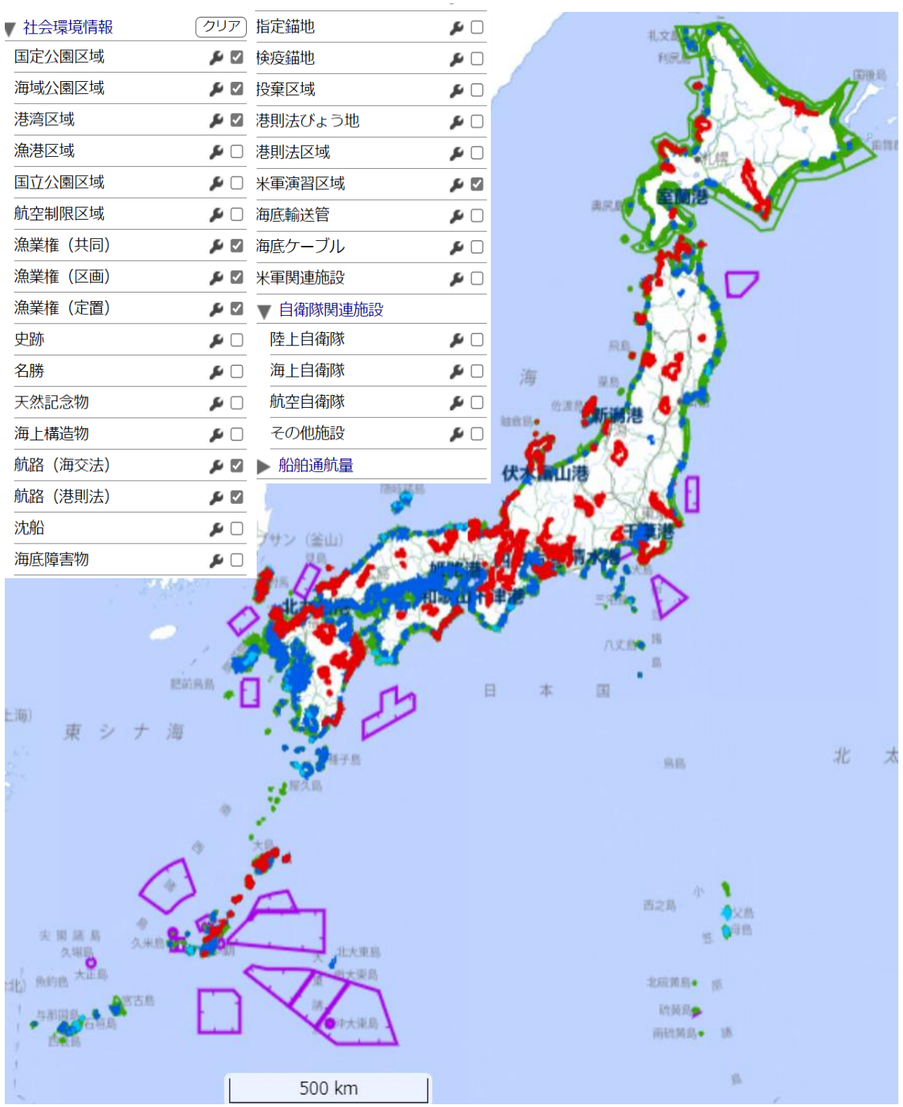
- This potential is calculated from wind speed and water depth conditions only for those sea areas where both data are available.
  - Note that this is not a study that covers the entire Exclusive Economic Zone (EEZ).
  - Sea areas where feasibility was assumed to be difficult, such as areas with water depths exceeding 1,000m along the submarine cable installation route are excluded.

Notes

- In the actual planning stage of projects, the natural and social environment conditions must be fully considered in order to obtain the agreement of the local communities, including those involved in the fishing industry.

  Major references are listed below.
  - NEDO: Offshore Wind Map (NeoWins)[1]
    natural and social environment information
  - Ministry of the Environment: Environmental Assessment Database (EADAS)[2]
    natural and social conditions
  - Japan Coast Guard: MDA Situational Indication Linkages (MSIL) [3]
    marine weather, meteorology, marine safety, maritime affairs, disaster prevention, marine ecosystems, ocean area utilization

- A detailed investigation of the meteorology, ocean climate conditions, and seafloor topography of the target area is necessary.
  - Actual annual average wind speed may differ slightly from the data used to calculate the potential.

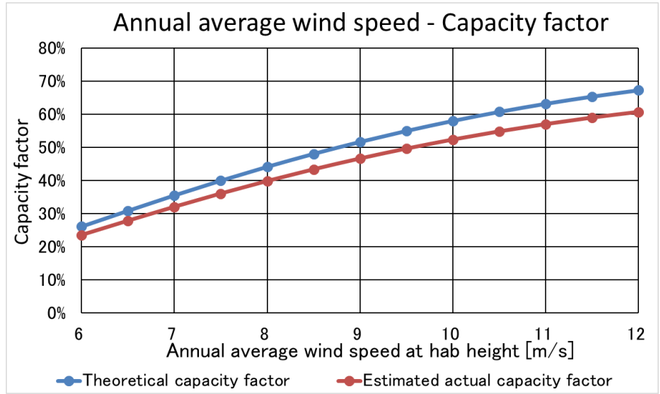


Source: NEDO, NeoWinds (Example shows only areas marked with a check)

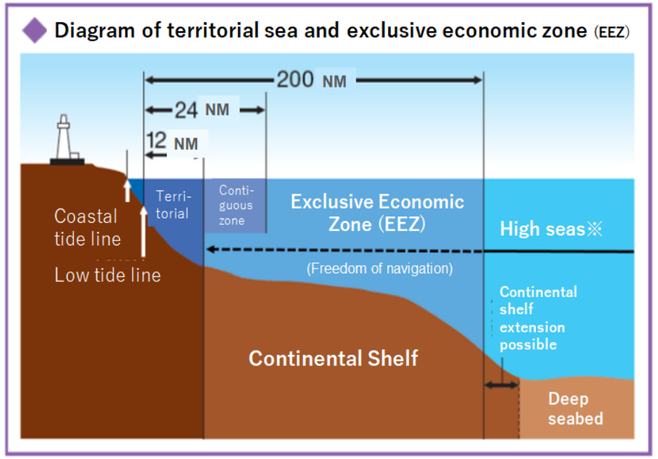
1. https://appwdc1.infoc.nedo.go.jp/Nedo_Webgis/index.html
2. https://www2.env.go.jp/eiadb/ebidbs/
3. https://www.msil.go.jp/msil/htm/topwindow.html

2． Japan's Potential-1

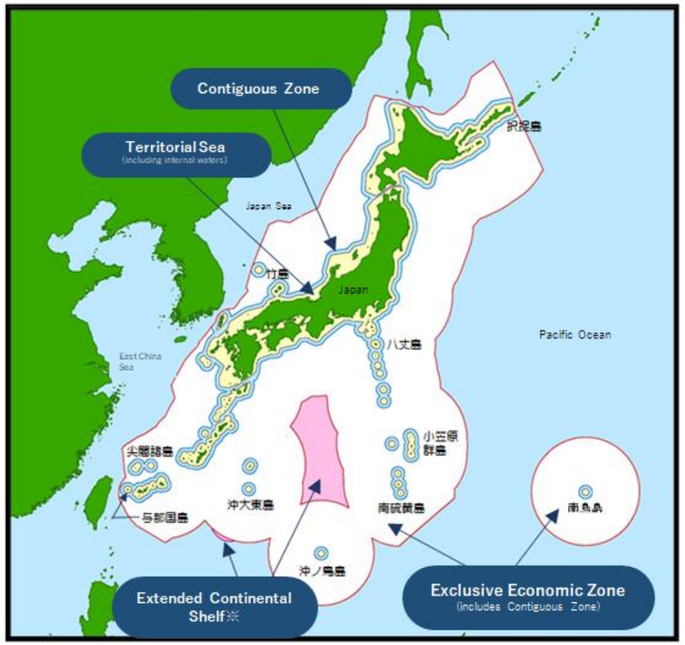
- Annual average wind speed, water depth and sea surface area
  - **Average annual wind speed**
    - With wind speed reduced from 8.0 m/s or more to 7.5 m/s or more, the capacity factor decreases, but the potential increases by about 2.0 times and the number of suitable areas also increases.
  - **Water depth**
    - With water depth increased from less than 200m to less than 300m, the potential increases by about 1.3 times, but the construction and installation costs increase due to longer mooring cables, etc.
  - **Sea surface area**
    - With the area expanded from "territorial sea + Contiguous Zone (CZ) in EEZ" to the entire EEZ, the potential of the deeper water area increases by about 1.3 times and the construction and installation costs increase due to the increased distance from shore, etc.
  - **Conclusion**
    - Considering business feasibility, the basic conditions for fixed-bottom are set as: 7.5m/s or more, territorial sea only. Floating: 8.0m/s or more, "territorial sea plus CZ," and water depth of 50m or more but less than 200m. Details shown in the following slides.



Source: Renewable Energy Institute.
(For a wind turbine with unit swept area of 3.0m²/kW *1)



Unit：GW	Fixed-bottom Water depth：less than 50m			Floating - 1 Water depth：50m or more, less than 100m			Floating - 2 Water depth：50m or more, less than 200m			Floating -3 Water depth：50m or more, less than 300m		
	Territorial Sea	Territorial Sea + Contiguous Zone	Territorial Sea + EEZ	Territorial Sea	Territorial Sea + Contiguous Zone	Territorial Sea + EEZ	Territorial Sea	Territorial Sea + Contiguous Zone	Territorial Sea + EEZ	Territorial Sea	Territorial Sea + Contiguous Zone	Territorial Sea + EEZ
Annual average wind speed 7.5m/s or higher	176	180	180	351	377	381	747	1,066	1,281	897	1,321	1,621
Annual average wind speed 8.0m/s or higher	81	85	85	165	180	184	381	542	733	470	690	952
Annual average wind speed 8.5m/s or higher	24	26	26	50	58	61	127	178	229	160	236	300



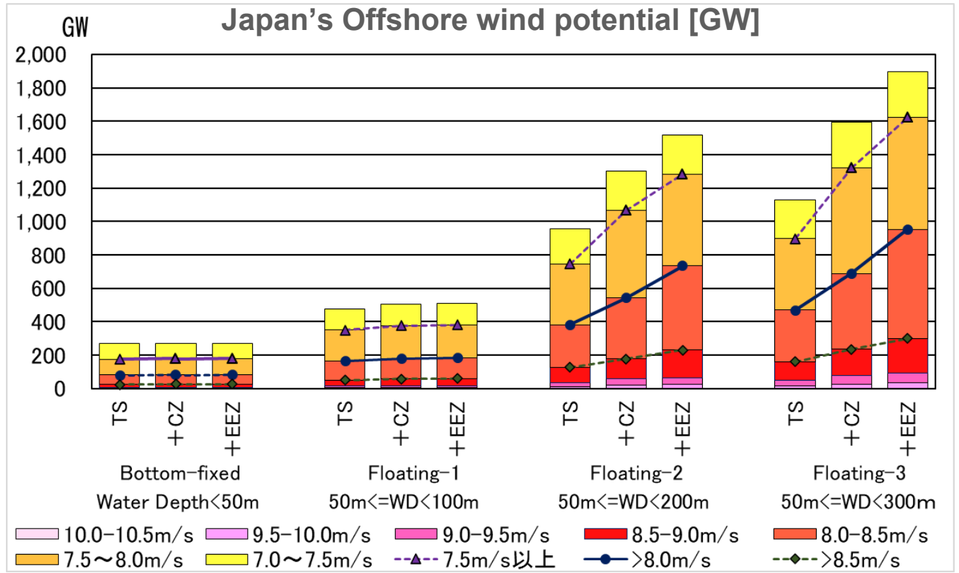
*1 Theoretical capacity factor: CF with the power curve of wind turbines and the occurrence distribution of wind speed assumed to be the Rayleigh distribution. Estimated real CF: About 90% of the theoretical CF, with outages due to periodic inspections of wind turbines and other factors, as well as different distributions of wind speed occurrence assumed. %

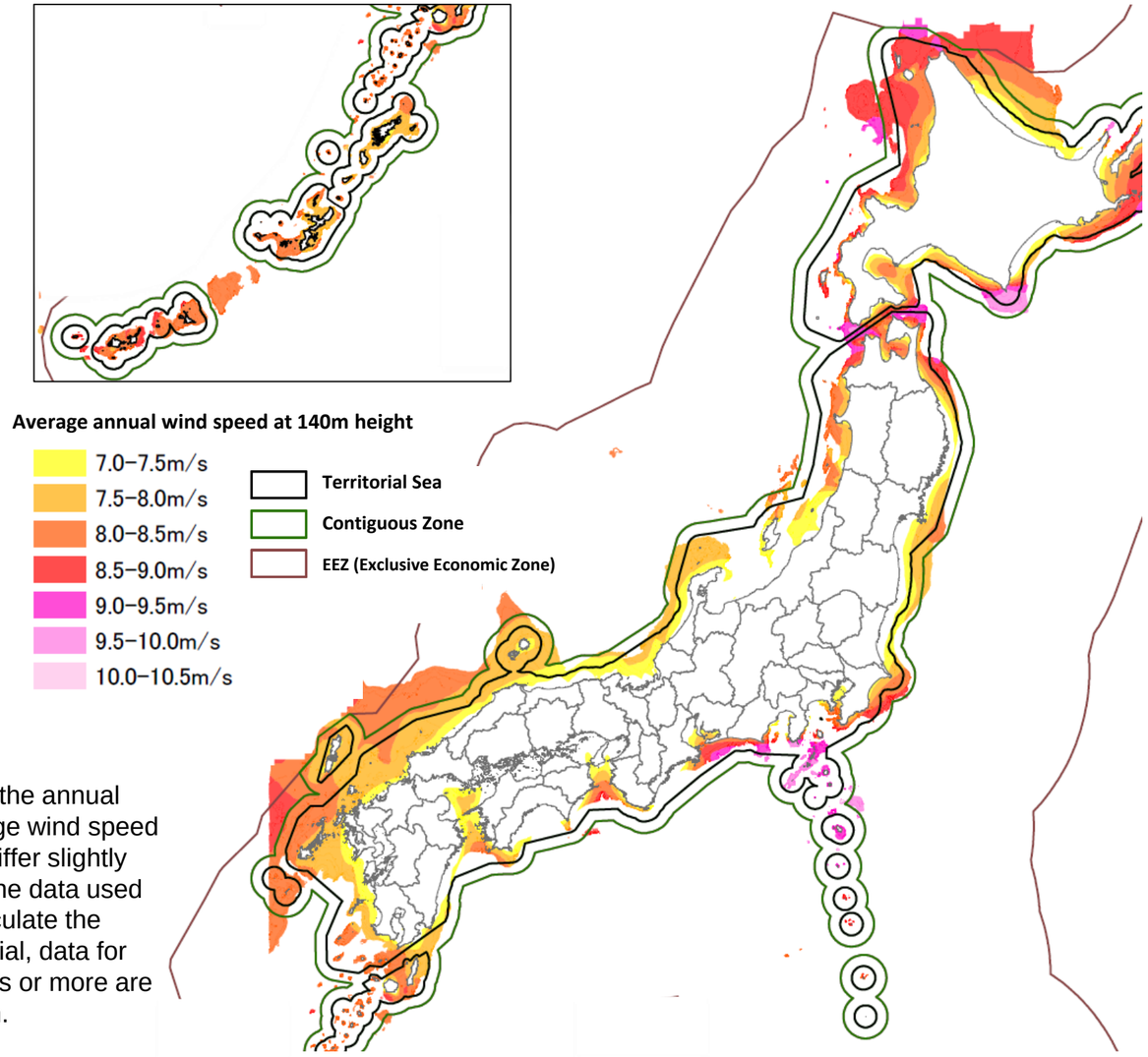
Source: Japan Coast Guard, Jurisdictional marine zone information

2． Japan's Potential-2

Fixed-bottom & floating offshore (See following slides for details of parts in red)

- Fixed-bottom: Water depth less than 50m
  - Wind speed 7.5m/s or more, territorial sea only : 176GW（100%）
  - Wind speed 7.5m/s or more, territorial sea + CZ: 180GW（104%）
  - Wind speed 7.5m/s or more, territorial sea + EEZ: 180GW（104%）
- Floating-1: Water depth 50m or more, less than 100m
  - Wind speed 8.0m/s or more, territorial sea only: 165GW（ 92%）
  - Wind speed 8.0m/s or more, territorial sea+ CZ : 180GW（100%）
  - Wind speed 8.0m/s or more, territorial sea + EEZ:184GW（102%）
- Floating-2: Water depth 50m or more, less than 200m
  - Wind speed 8.0m/s or more, territorial sea only : 381GW（ 70%）
  - Wind speed 8.0m/s or more, territorial sea+ CZ : 542GW（100%）
  - Wind speed 8.0m/s or more, territorial sea + EEZ : 733GW（135%）
- Floating-3: Water depth 50m or more, less than 300m
  - Wind speed 8.0m/s or more, territorial sea only : 470GW（ 68%）
  - Wind speed 8.0m/s or more, territorial sea+ CZ : 690GW（100%）
  - Wind speed of 8.0m/s or more, territorial sea + EEZ : 952GW（138%）





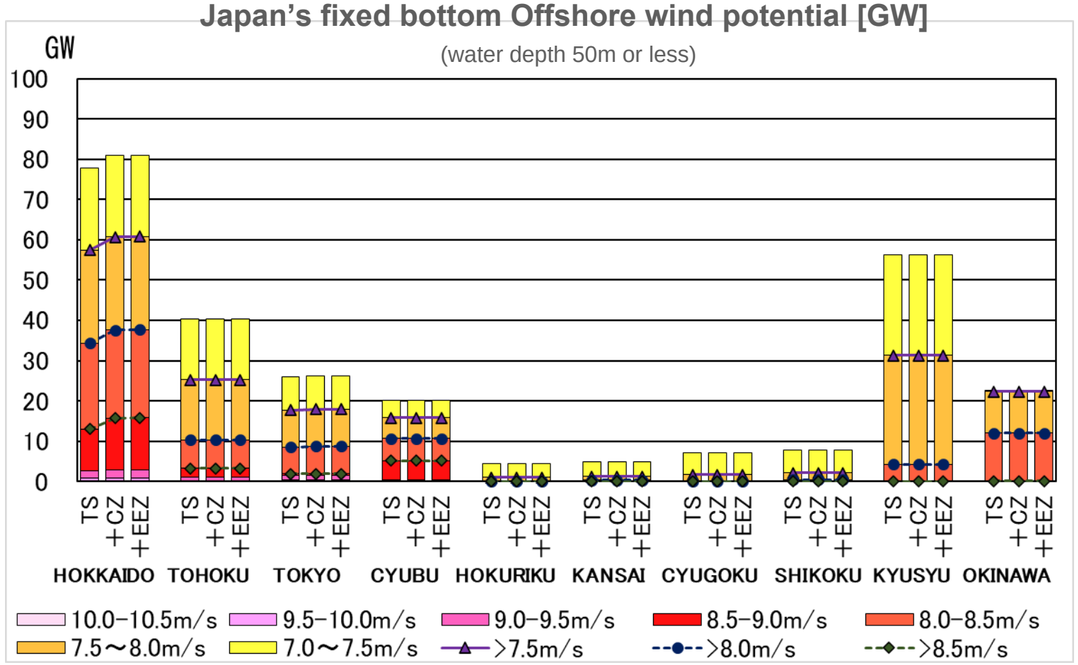
Since the annual average wind speed may differ slightly from the data used to calculate the potential, data for 7.0 m/s or more are shown.

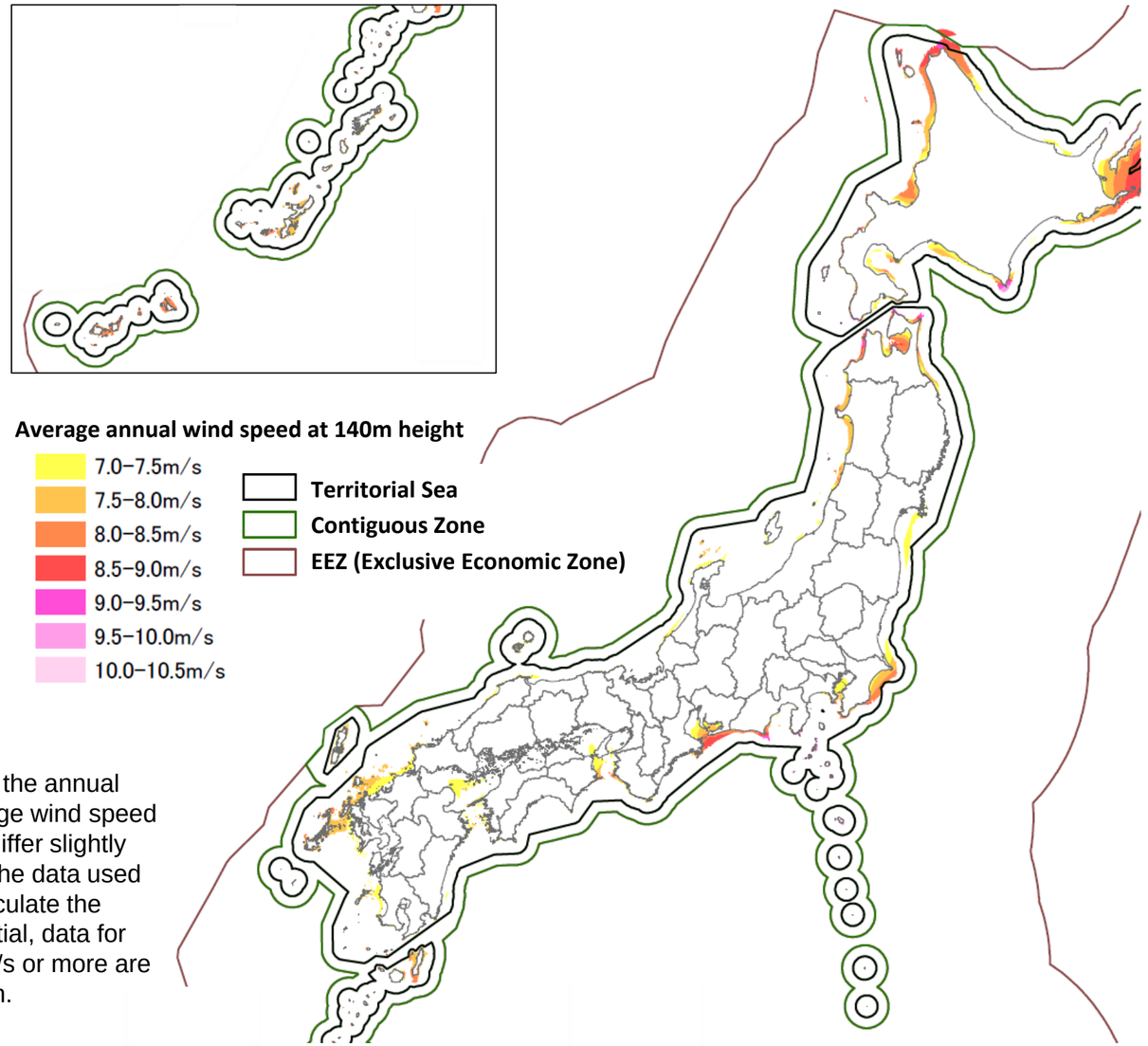
Source: Renewable Energy Institute (depth less than 300m)

3．Potential for 10 regional areas -1

Fixed-bottom offshore

- Water depth 50m or less, wind speed 7.5m/s or more
  Territorial Sea: 176GW（8.0m/s or more: 81GW）
  - Hokkaido: 57.5GW (8.0m/s or more: 34.4GW)
  - Tohoku: 25.3GW (8.0m/s or more: 10.4GW)
  - Tokyo: 17.7GW (8.0m/s or more: 8.6GW)
  - Chubu: 15.8GW (8.0m/s or more: 10.7GW)
  - Hokuriku: 1.0GW (8.0m/s or more: 0.0GW)
  - Kansai: 1.2GW (8.0m/s or more: 0.3GW)
  - Chugoku: 1.7GW (8.0m/s or more: 0.0GW)
  - Shikoku: 2.2GW (8.0m/s or more: 0.5GW)
  - Kyushu: 31.2GW (8.0m/s or more: 4.3GW)
  - Okinawa: 22.3GW (8.0m/s or more: 12.1GW)



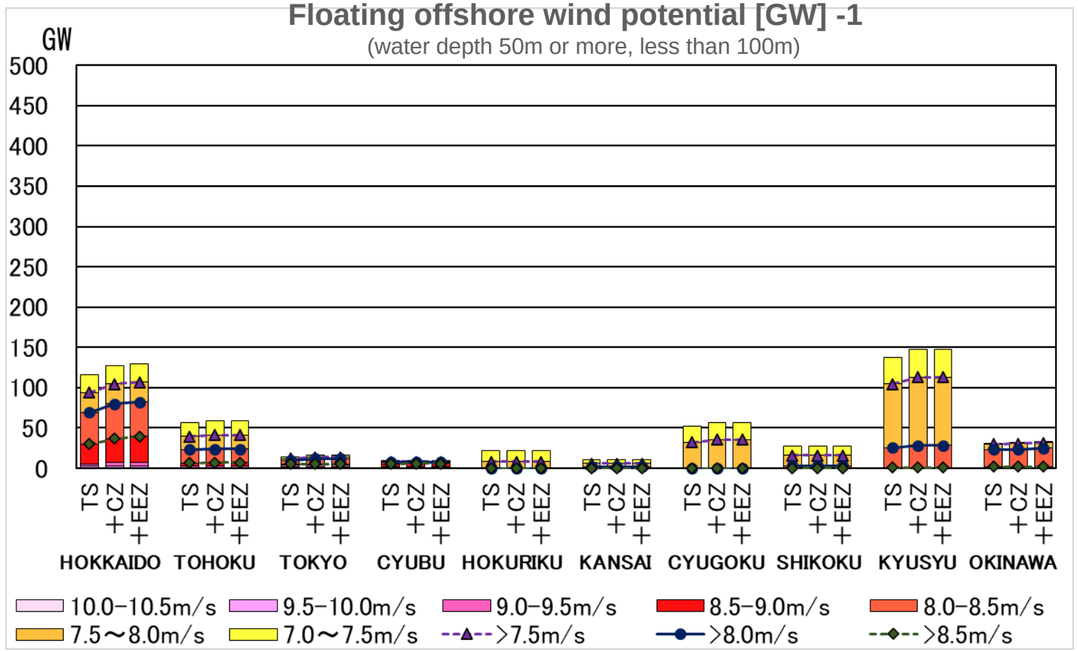


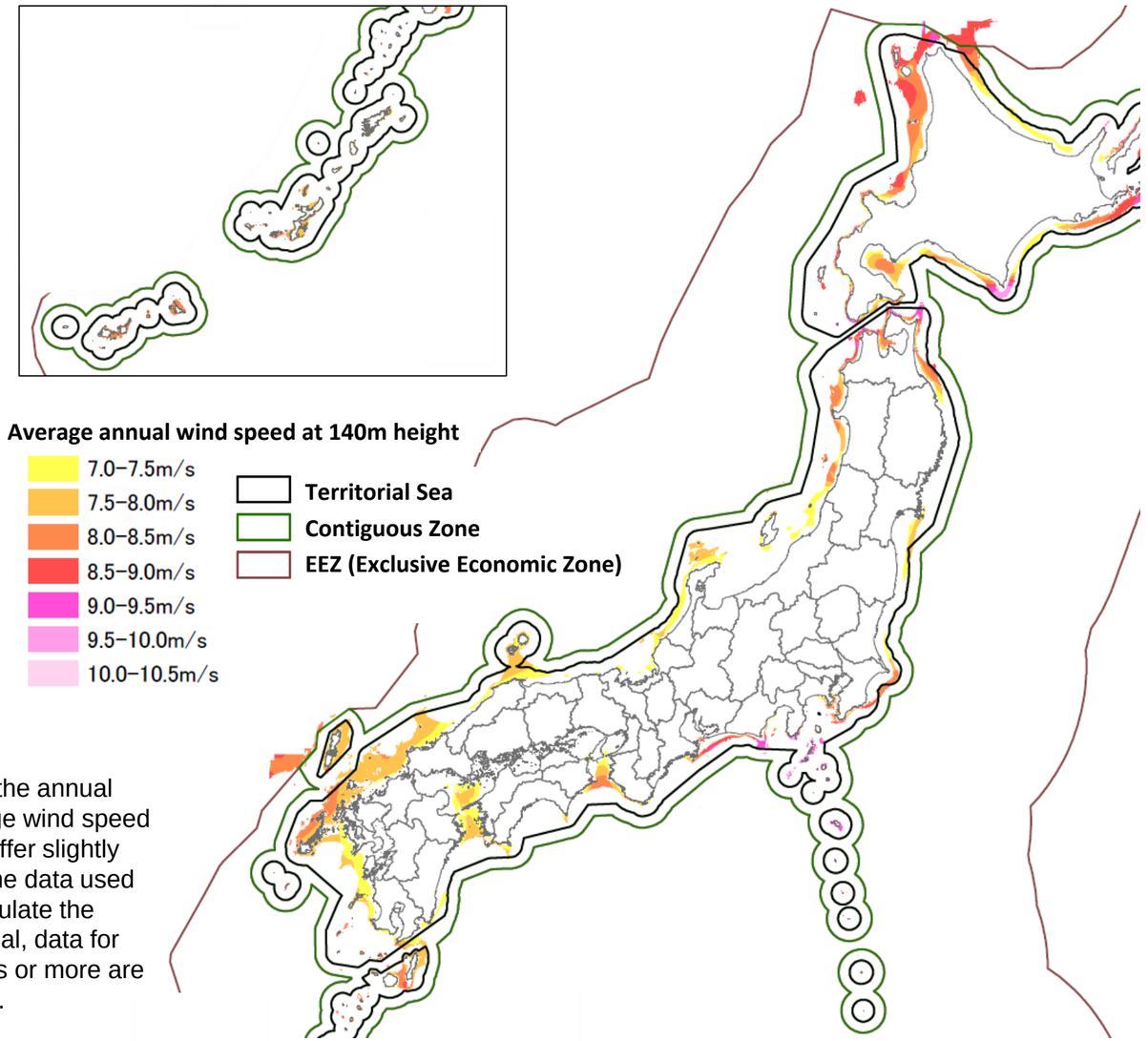
Since the annual average wind speed may differ slightly from the data used to calculate the potential, data for 7.0 m/s or more are shown.

Source: Renewable Energy Institute (depth less than 50m)

3．Potential for 10 regional areas -2

- **Floating offshore-1** (mainly semi-sub-floating)
  - Water depth 50m or more, less than 100m, wind speed 8.0m/s or more
    Territorial Sea + CZ : 180GW (7.5m/s or more 377GW)
    - Hokkaido: 79.7GW (7.5m/s or more: 104.5GW)
    - Tohoku: 24.2GW (7.5m/s or more: 41.1GW)
    - Tokyo: 12.0GW (7.5m/s or more: 14.0GW)
    - Chubu: 7.6GW (7.5m/s or more: 8.1GW)
    - Hokuriku: 0.0GW (7.5m/s or more: 0.0GW)
    - Kansai: 2.2GW (7.5m/s or more: 6.0GW)
    - Chugoku: 0.0GW (7.5m/s or more: 35.6GW)
    - Shikoku: 3.0GW (7.5m/s or more: 16.1GW)
    - Kyushu: 28.3GW (7.5m/s or more: 112.8GW)
    - Okinawa: 23.6GW (7.5m/s or more: 30.4GW)





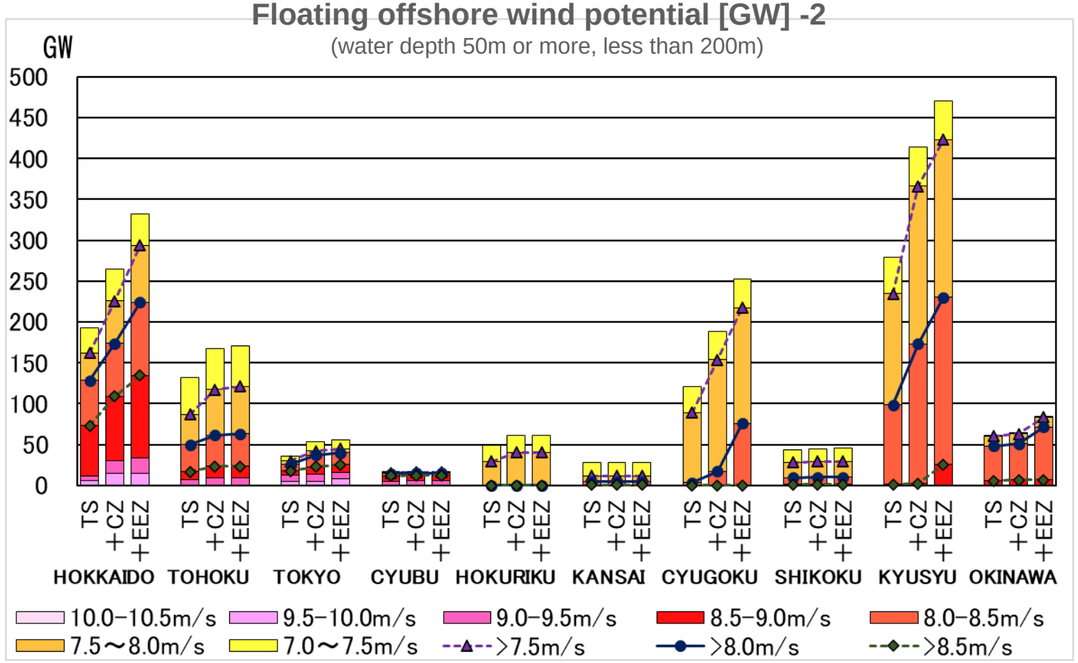
Since the annual average wind speed may differ slightly from the data used to calculate the potential, data for 7.0 m/s or more are shown.

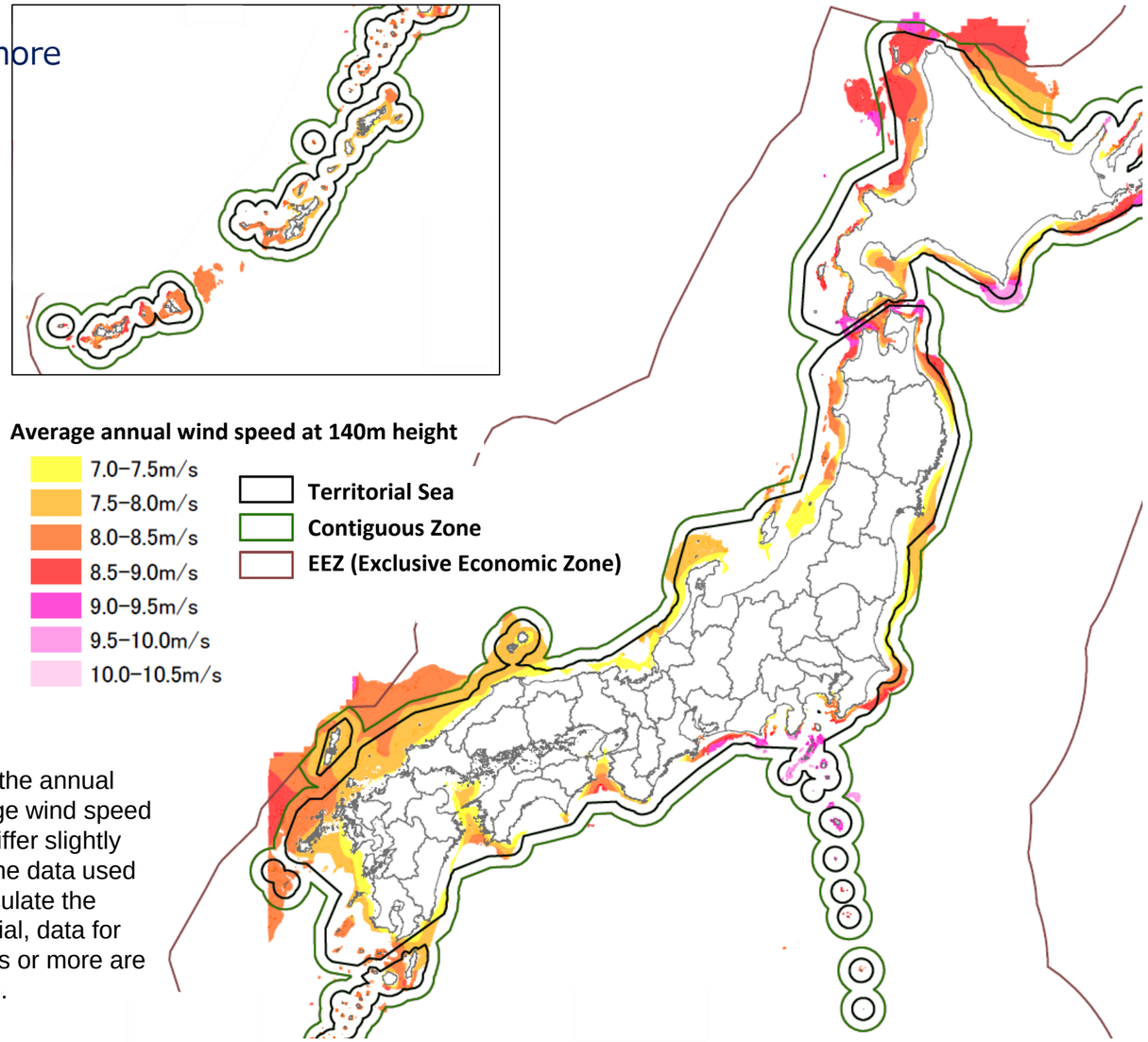
Source: Renewable Energy Institute (depth 50m or more, less than 100m))

3．Potential for 10 regional areas -3

Floating offshore-2

- Water depth 50m or more, less than 200m, wind speed 8.0m/s or more
  Territorial sea + CZ: 542GW (7.5m/s or more: 1,066GW)
  - Hokkaido: 173.5GW (7.5m/s or more: 225.9GW)
  - Tohoku: 61.4GW (7.5m/s or more: 117.1GW)
  - Tokyo: 37.2GW (7.5m/s or more : 42.2GW)
  - Chubu: 15.2GW (7.5m/s or more: 16.2GW)
  - Hokuriku: 0.0GW (7.5m/s or more: 40.2GW)
  - Kansai: 4.2GW (7.5m/s or more: 11.7GW)
  - Chugoku: 17.1GW (7.5m/s or more: 153.9GW)
  - Shikoku: 9.8GW (7.5m/s or more: 29.3GW)
  - Kyushu: 173.0GW (7.5m/s or more: 366.0GW)
  - Okinawa: 50.9GW (7.5m/s or more: 62.9GW)





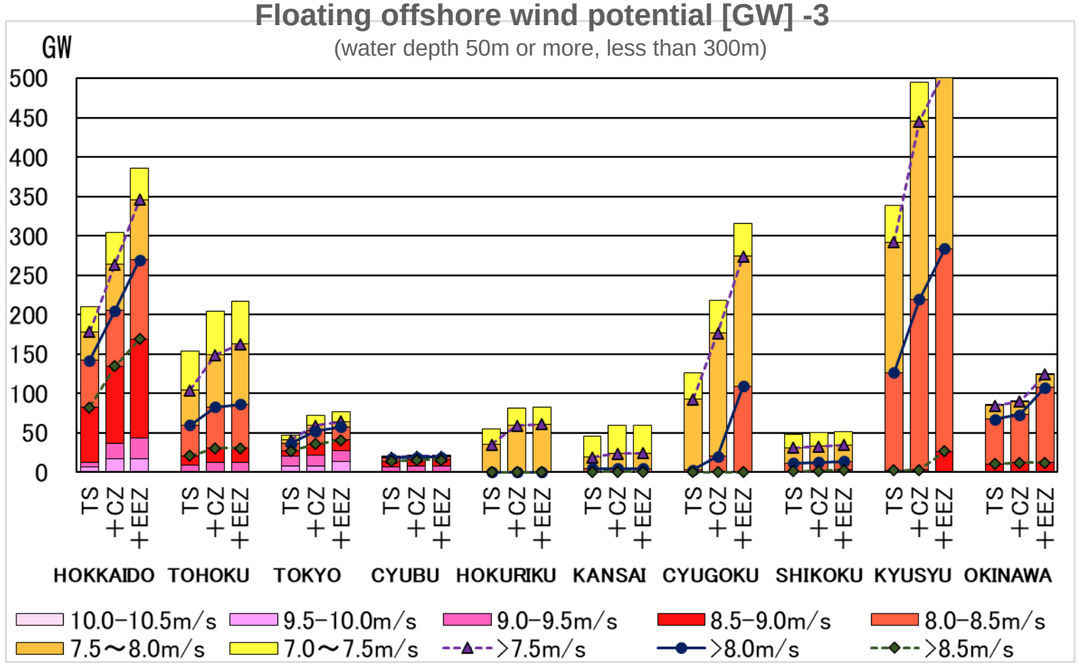
Since the annual average wind speed may differ slightly from the data used to calculate the potential, data for 7.0 m/s or more are shown.

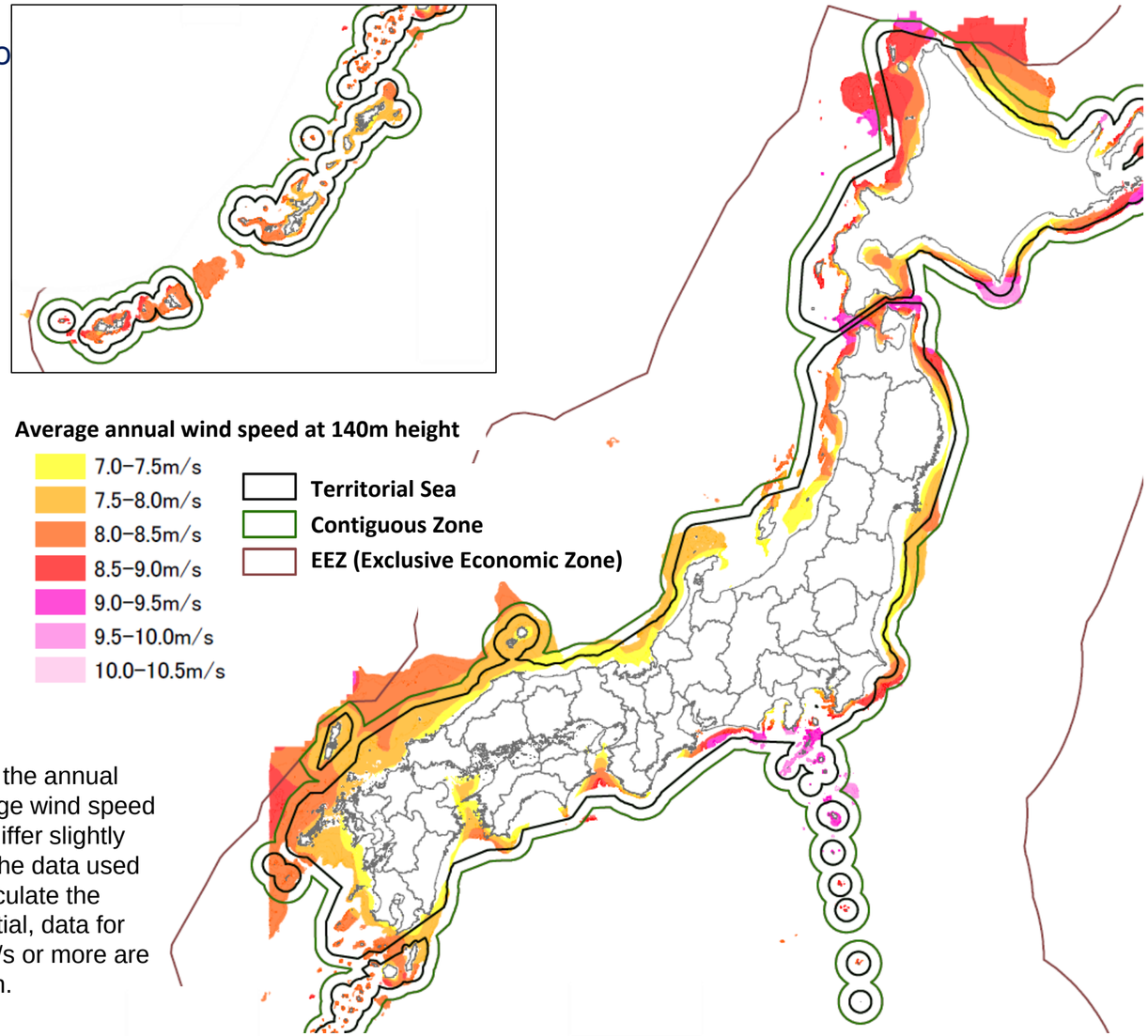
Source: Renewable Energy Institute (depth 50m or more, less than 200m)

3．Potential for 10 regional areas -4

Floating offshore-3

- Water depth 50m or more but less than 300m, wind speed 8.0m/s o
  Territorial sea + CZ: 690GW(7.5m/s or more: 263.9GW)
  - Hokkaido: 205.4GW (7.5m/s or more: 263.9GW)
  - Tohoku: 82.7GW (7.5m/s or more: 149.1GW)
  - Tokyo: 52.3GW (7.5m/s or more: 59.3GW)
  - Chubu: 19.2GW (7.5m/s or more: 20.5GW)
  - Hokuriku: 0.0GW (7.5m/s or more: 59.1GW)
  - Kansai: 4.9GW (7.5m/s or more: 23.8GW)
  - Chugoku: 20.3GW (7.5m/s or more: 176.3GW)
  - Shikoku: 12.7GW (7.5m/s or more: 33.2GW)
  - Kyushu: 219.3GW (7.5m/s or more: 445.1GW)
  - Okinawa: 73.2GW (7.5m/s or more: 90.0GW)



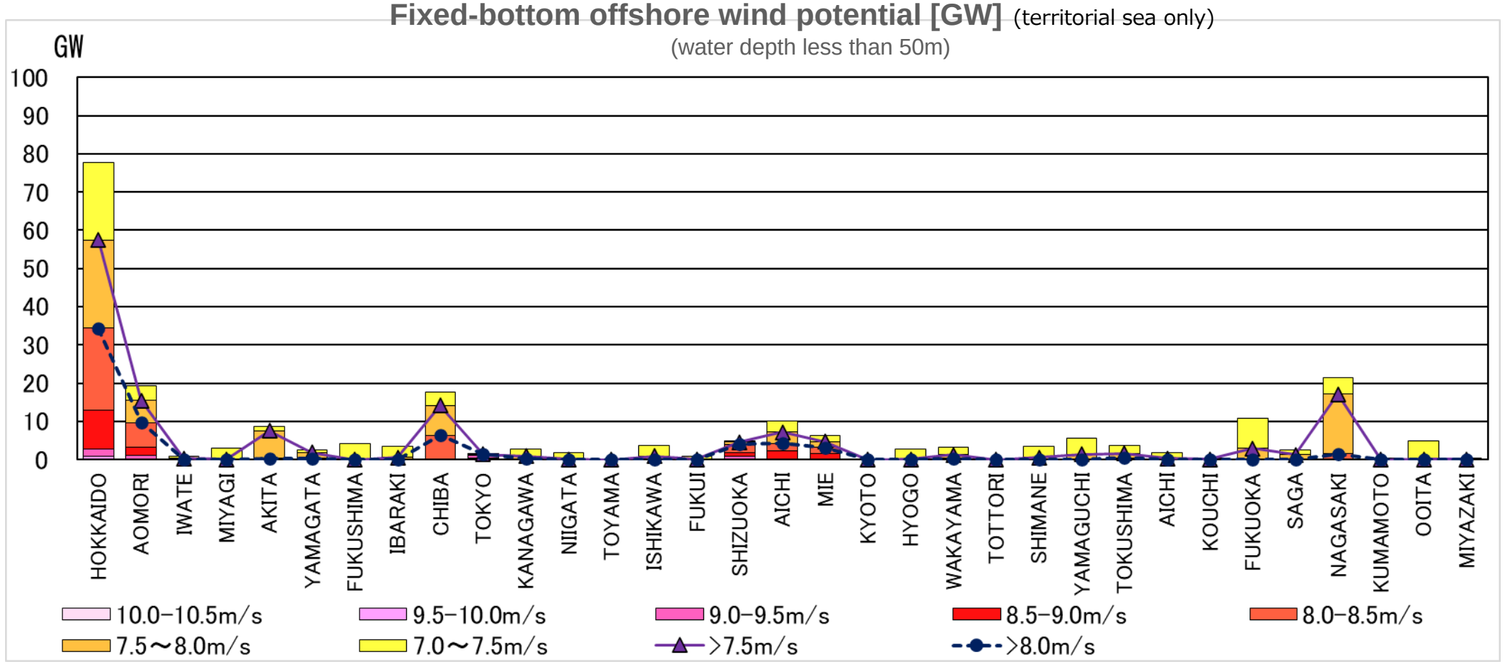


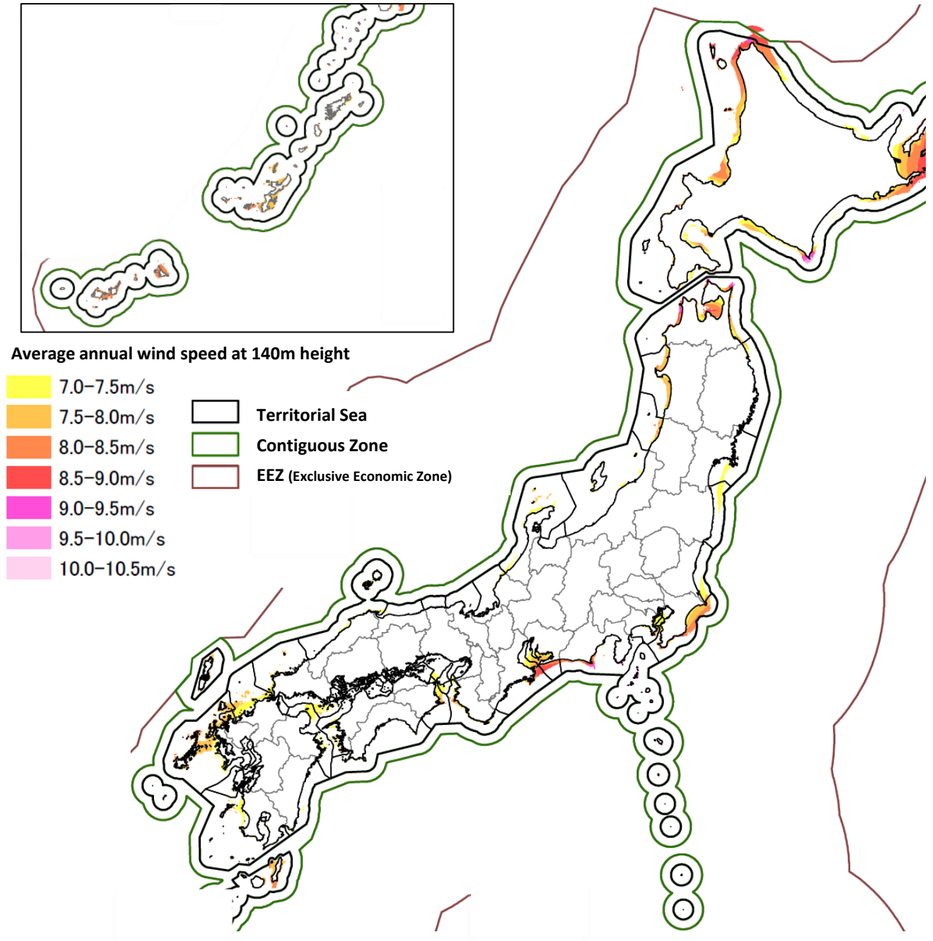
Since the annual average wind speed may differ slightly from the data used to calculate the potential, data for 7.0 m/s or more are shown.

Source: Renewable Energy Institute (depth 50m or more, less than 300m)

4． Potential by Prefecture (territorial sea only) -1

- Fixed-bottom offshore
  - Water depth less than 50 m, wind speed more than 7.5 m/s
    Territorial sea only: 176 GW (8.0 m/s or more: 81 GW)
    - Hokkaido: 57.5 GW (8.0 m/s or more: 34.4 GW)
    - Okinawa: 22.3 GW (8.0 m/s or more: 12.1 GW)
    - Nagasaki: 17.1 GW (8.0 m/s or more: 1.5 GW)
    - Aomori: 15.4 GW (8.0 m/s or more: 9.6 GW)
    - Chiba: 14.1 GW (8.0 m/s or more: 6.3 GW)
    - Kagoshima: 9.8 GW (8.0 m/s or more: 2.9 GW)
    - Akita: 7.5 GW (8.0 m/s or more: 0.4 GW)
    - Aichi: 7.2 GW (8.0 m/s or more: 4.2 GW)
    - Mie: 4.7 GW (8.0 m/s or more: 3.1 GW)
    - Shizuoka: 4.6 GW (8.0 m/s or more: 4.0 GW)





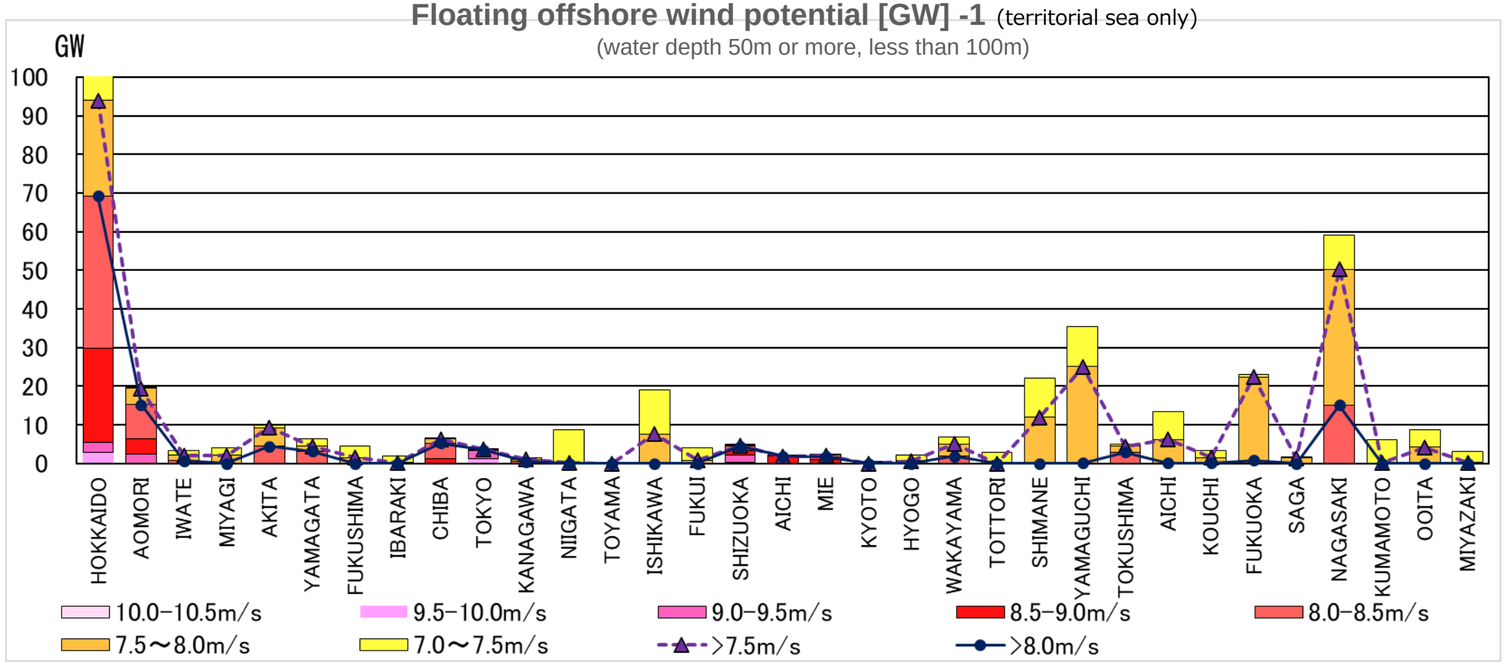
Since the annual average wind speed may differ slightly from the data used to calculate the potential, data for 7.0 m/s or more are shown.

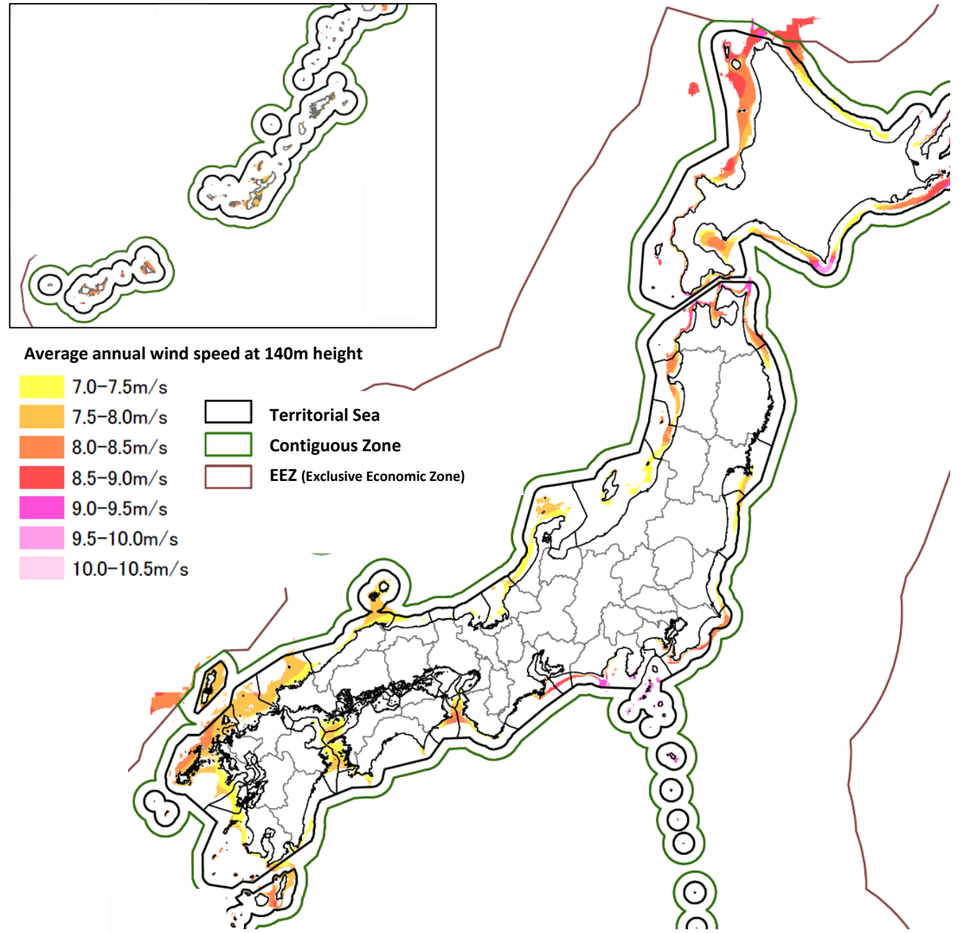
35 of the 39 Prefectures with coasts, excluding the 4 Prefectures with zero potential of 7.0 m/s or more

4． Potential by Prefecture (territorial sea only) -2

Floating offshore-1 (mainly semi-sub-floating)

- Water depth 50m or more, less than 100m, wind speed 8.0m/s or more
  Territorial sea only: 165 GW (7.5 m/s or more, 351 GW)
  - Hokkaido: 69.2 GW (7.5 m/s or more:94.0 GW)
  - Okinawa: 23.5 GW (7.5 m/s or more:30.0 GW)
  - Aomori: 15.2 GW (7.5 m/s or more:19.5 GW)
  - Nagasaki: 15.1 GW (7.5 m/s or more:50.2 GW)
  - Kagoshima: 9.7 GW (7.5 m/s or more:25.0 GW)
  - Chiba: 5.3 GW (7.5 m/s or more: 6.4 GW)
  - Akita: 4.5 GW (7.5 m/s or more: 9.2 GW)
  - Shizuoka: 4.5 GW (7.5 m/s or more: 4.7 GW)
  - Tokyo: 3.6 GW (7.5 m/s or more: 3.6 GW)
  - Yamagata: 3.1 GW (7.5 m/s or more: 4.5 GW)



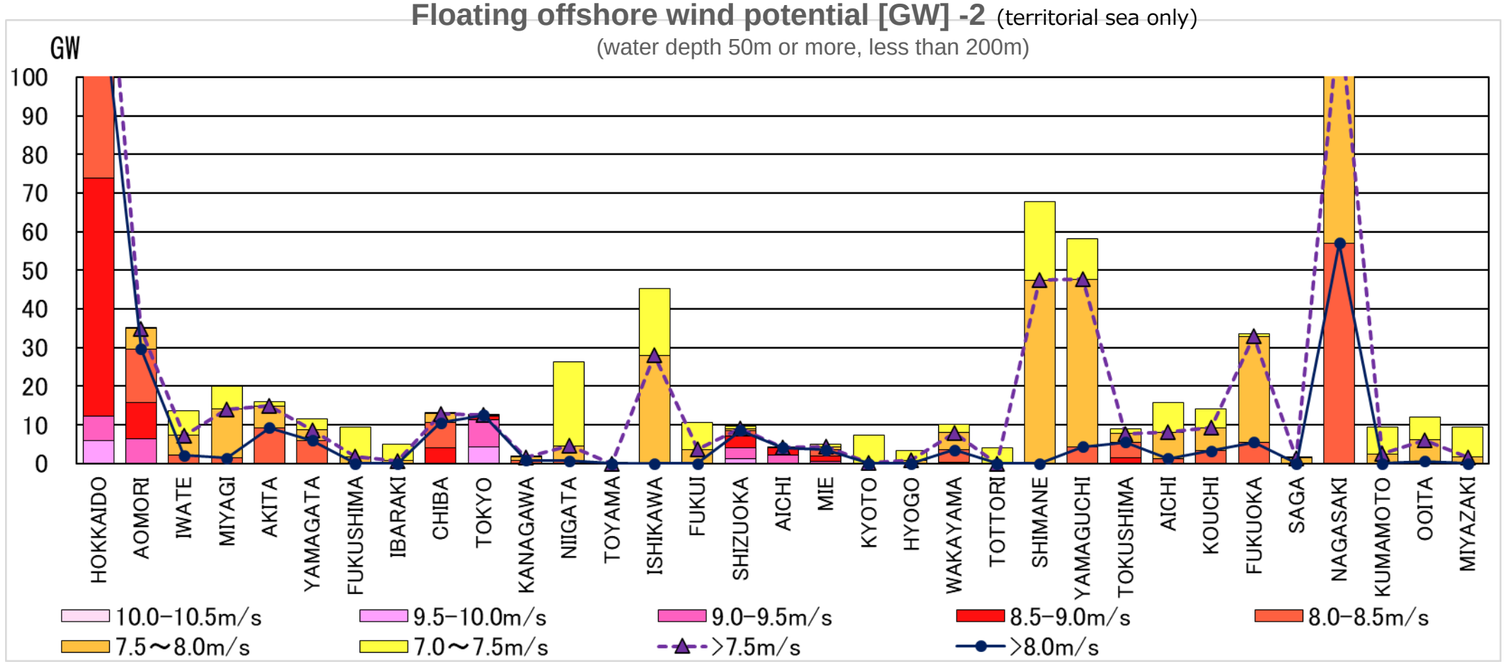


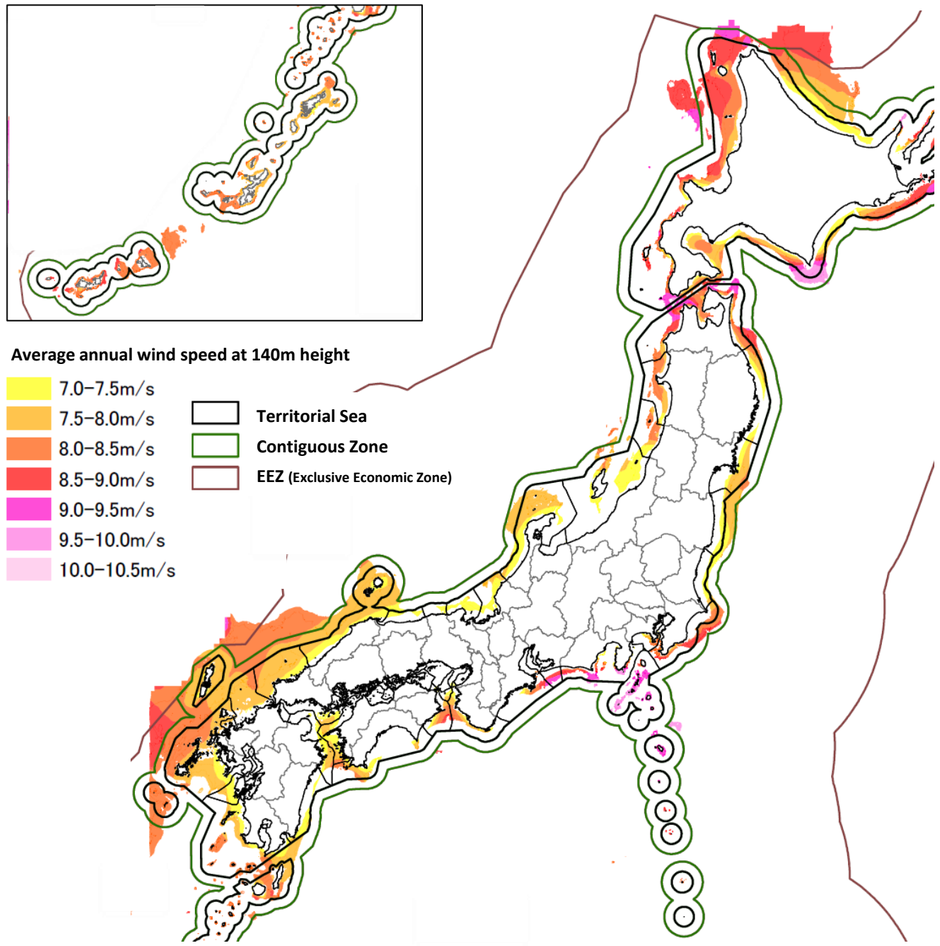
Since the annual average wind speed may differ slightly from the data used to calculate the potential, data for 7.0 m/s or more are shown.

35 of the 39 Prefectures with coasts, excluding the 4 Prefectures with zero potential of 7.0 m/s or more

4． Potential by Prefecture (territorial sea only) -3

- Floating offshore -2
  - Water depth 50m or more, less than 200m, wind speed 8.0m/s or more
    Territorial sea only: 381 GW (7.5 m/s or more: 747 GW)
    - Hokkaido: 128.9 GW (7.5 m/s or more: 162.9 GW)
    - Nagasaki: 57.0 GW (7.5 m/s or more: 116.1 GW)
    - Okinawa: 48.7 GW (7.5 m/s or more: 60.7 GW)
    - Kagoshima: 33.6 GW (7.5 m/s or more: 71.0 GW)
    - Aomori: 29.6 GW (7.5 m/s or more: 6.3 GW)
    - Tokyo: 12.6 GW (7.5 m/s or more: 4.9 GW)
    - Chiba: 10.6 GW (7.5 m/s or more: 12.8 GW)
    - Akita: 9.3 GW (7.5 m/s or more: 14.8 GW)
    - Shizuoka: 8.5 GW (7.5 m/s or more: 9.0 GW)
    - Yamagata: 5.9 GW (7.5 m/s or more: 8.6 GW)





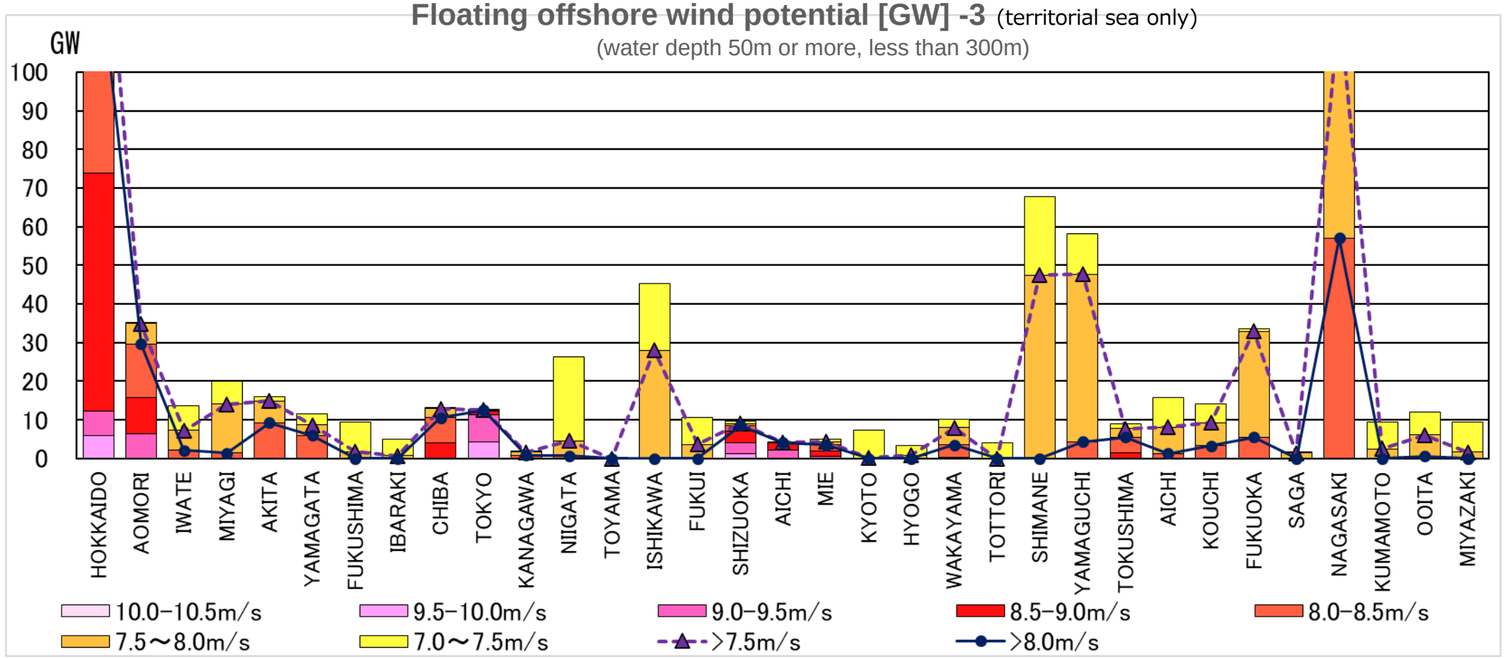
Since the annual average wind speed may differ slightly from the data used to calculate the potential, data for 7.0 m/s or more are shown.

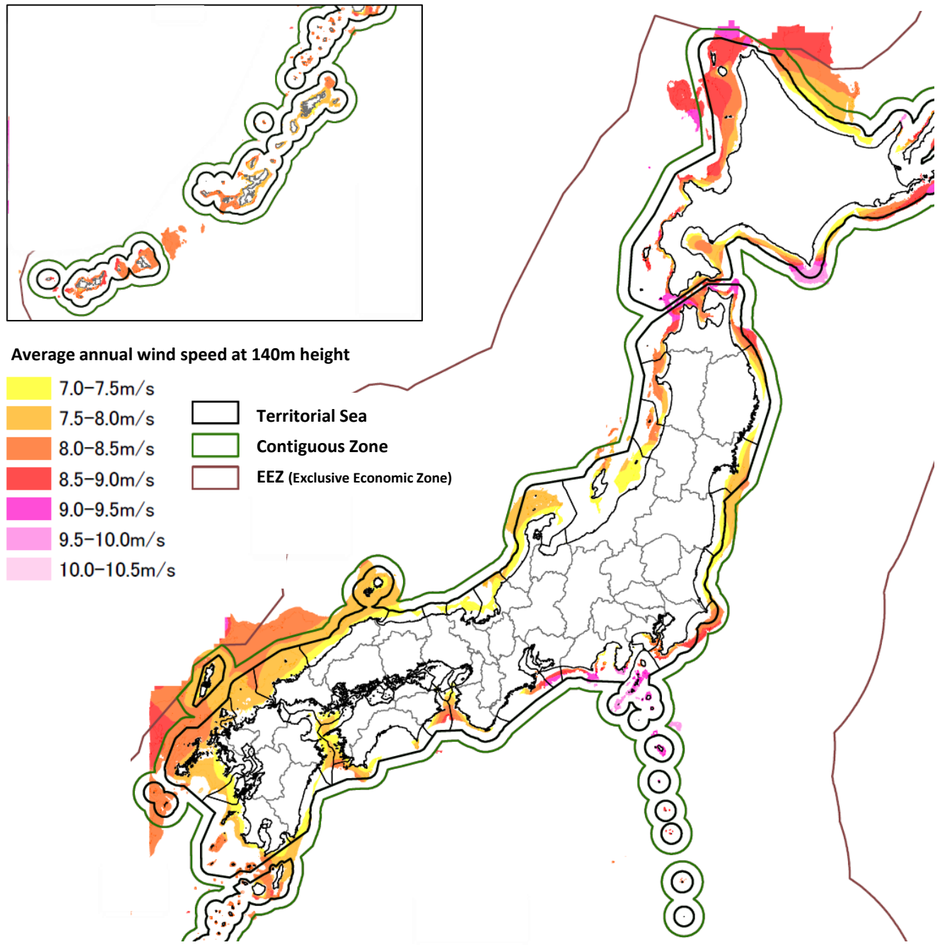
35 of the 39 Prefectures with coasts, excluding the 4 Prefectures with zero potential of 7.0 m/s or more

4． Potential by Prefecture (territorial sea only) -4

Floating offshore -3

- Water depth 50m or more, less than 300m, wind speed 8.0m/s or more
  Territorial sea only: 470 GW (7.5 m/s or more: 897 GW)
  - Hokkaido: 143.2 GW (7.5 m/s or more: 179.3 GW)
  - Okinawa: 68.8 GW (7.5 m/s or more: 85.7 GW)
  - Nagasaki: 65.4 GW (7.5 m/s or more: 134.9 GW)
  - Kagoshima: 52.3 GW (7.5 m/s or more: 107.3 GW)
  - Aomori: 35.2 GW (7.5 m/s or more: 40.8 GW)
  - Tokyo: 20.8 GW (7.5 m/s or more: 20.8 GW)
  - Chiba: 12.1 GW (7.5 m/s or more: 14.3 GW)
  - Akita: 11.8 GW (7.5 m/s or more: 17.6 GW)
  - Shizuoka: 10.9 GW (7.5 m/s or more: 11.6 GW)
  - Yamagata: 7.2GW (7.5 m/s or more: 10.6 GW)



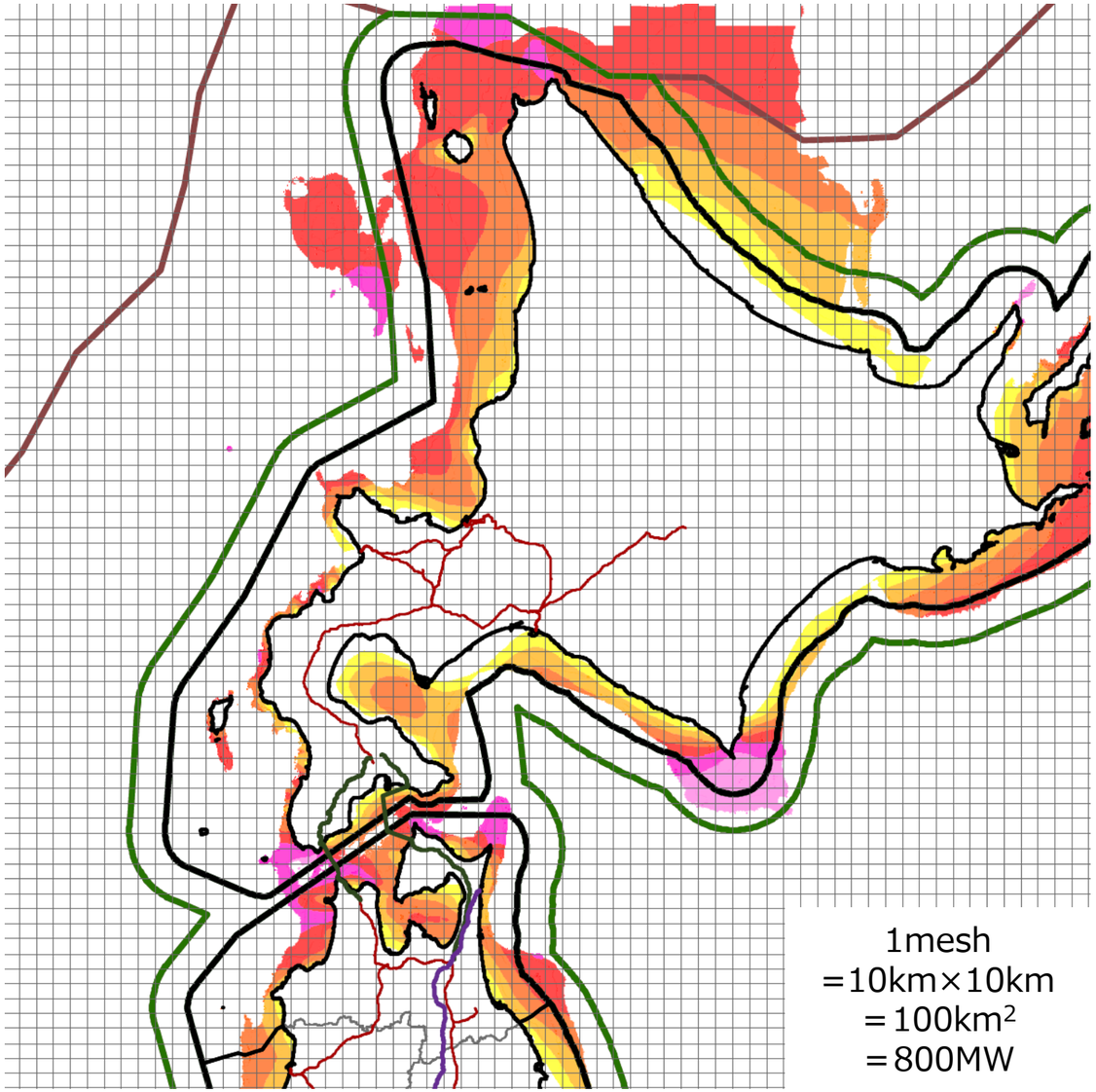


Since the annual average wind speed may differ slightly from the data used to calculate the potential, data for 7.0 m/s or more are shown.

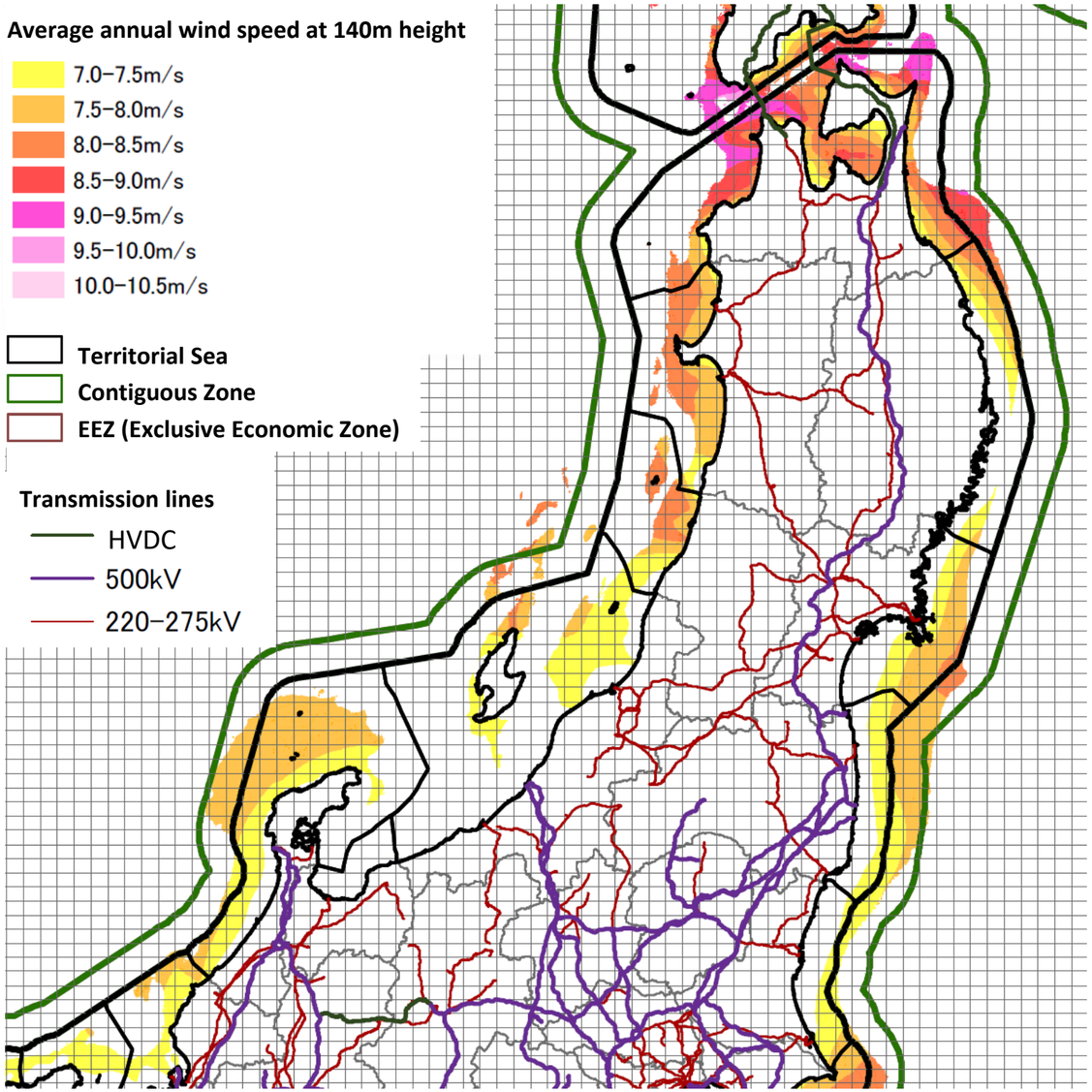
35 of the 39 Prefectures with coasts, excluding the 4 Prefectures with zero potential of 7.0 m/s or more

5． Wind map (water depth less than 200m) and transmission lines - 1

- New **local transmission lines** are needed to accommodate the locations suitable for GW-class offshore wind
- New **inter-regional transmission lines** are needed to ensure a stable power supply（smoothing effect utilization）



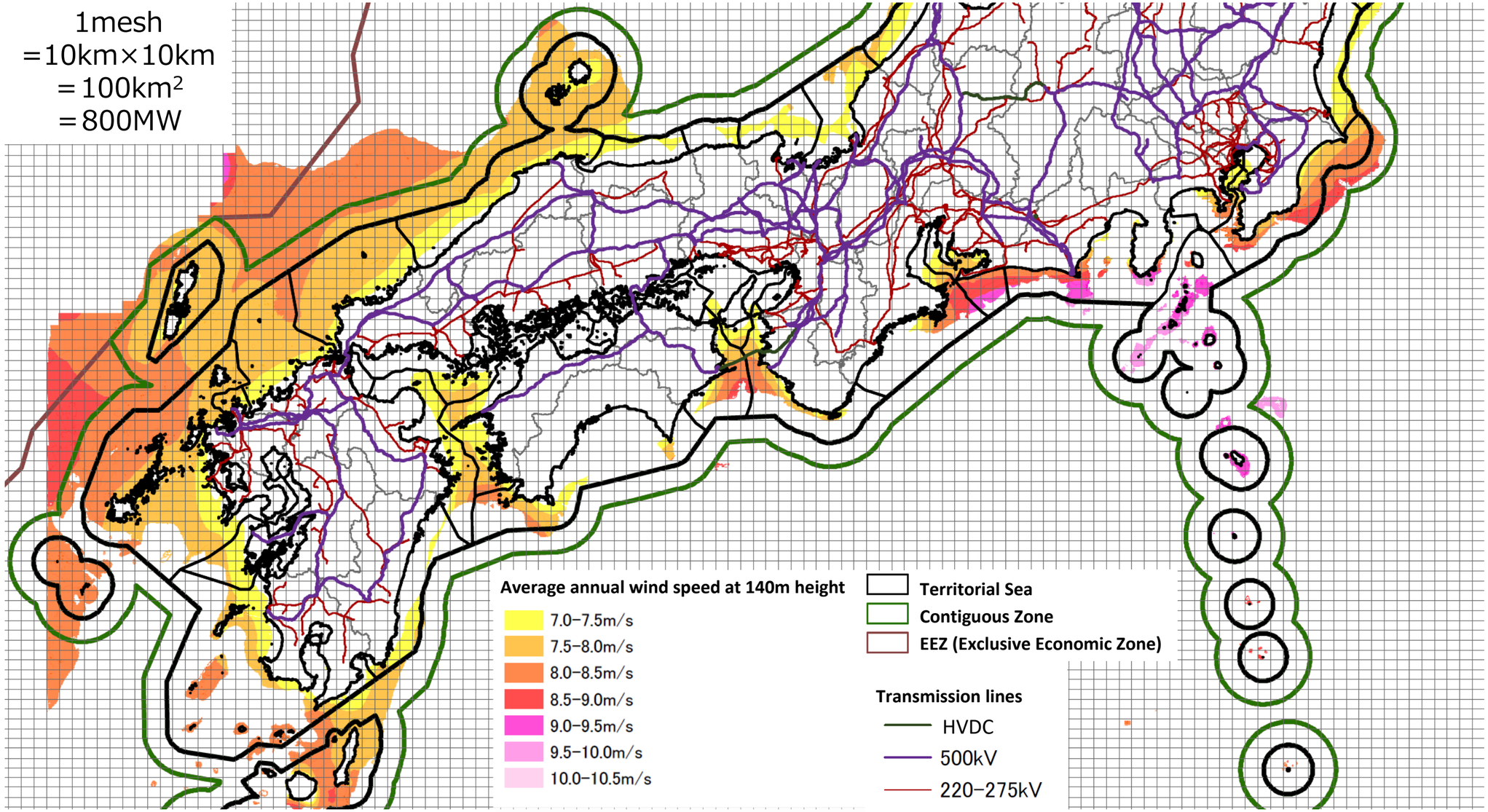
1mesh
=10km×10km
=100km^2
=800MW



Source: Renewable Energy Institute (Water depth less than 200m)）

5． Wind map (water depth less than 200m) and transmission lines - 2

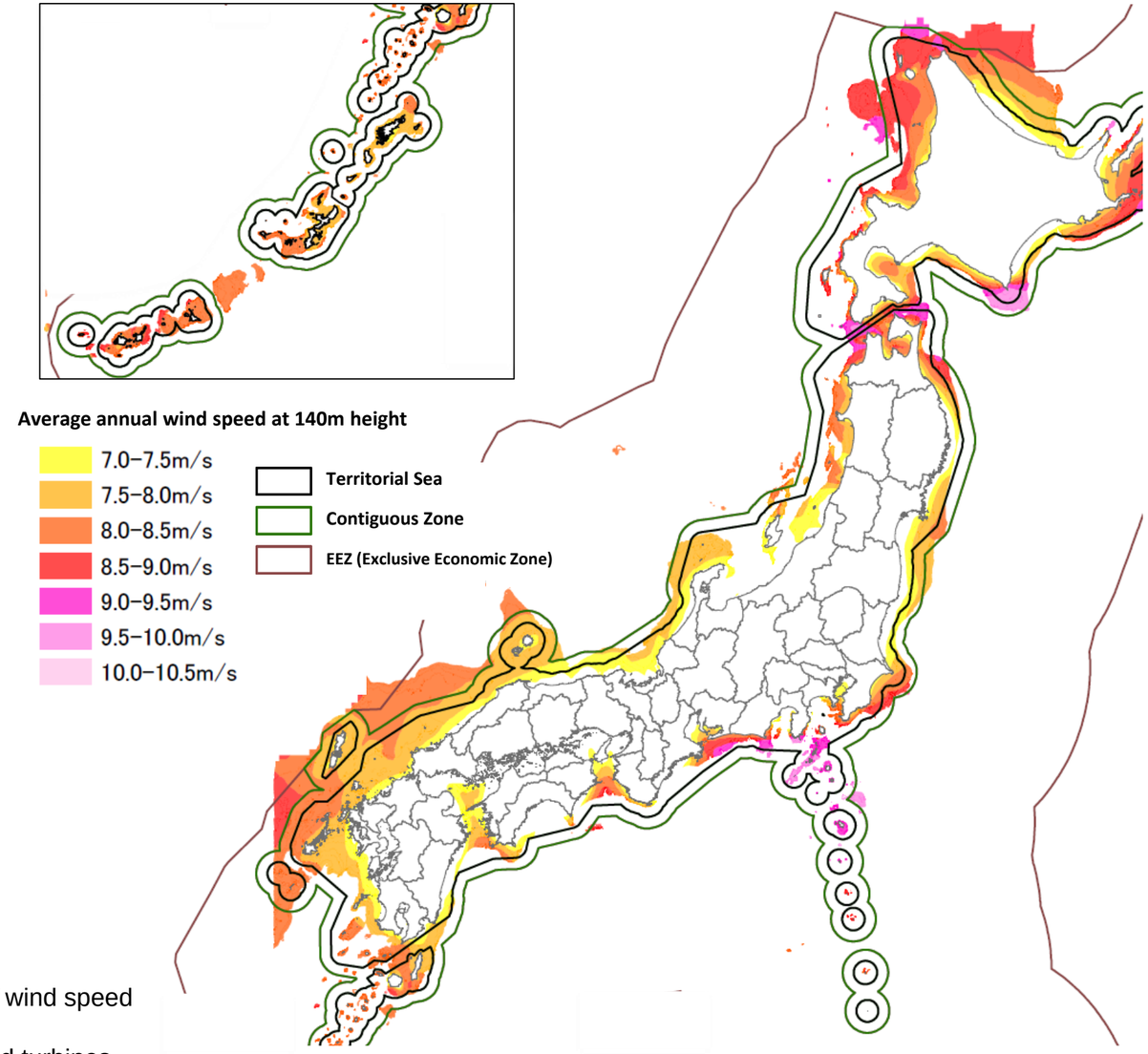
- New **local transmission lines** are needed to accommodate the locations suitable for GW-class offshore wind
- New **inter-regional transmission lines** are needed to ensure a stable power supply（smoothing effect utilization）



Source: Renewable Energy Institute (Water depth less than 200m)

6. Capacity factor [%] and annual electricity generation [TWh]

- Since strong wind areas move, area dispersion is necessary for a stable power supply.
  - Fixed-bottom: Water depth less than 50m
    Territorial sea only, wind speed 7.5 m/s or more
    - When each wind speed area is developed at the same ratio
      Average theoretical capacity factor: 44.5%
      Estimated actual capacity factor: 40.1%
    - When 50GW (less than 30% of potential) is developed: 175.6TWh
  - Floating-2: Water depth 50m or more, less than 200m
    Territorial sea + CZ, wind speed 8.0m/s or more
    - When each wind speed area is developed at the same ratio
      Average theoretical capacity factor: 47.8%
      Estimated actual capacity factor: 43.0%
    - When 100GW (less than 20% of potential) is developed: 376.9TWh
  - Floating-3 : Water depth of 50m or more, less than 300m
    Only in territorial sea + CZ, wind speed of 8.0m/s or more
    - When each wind speed area is developed at the same ratio
      Average theoretical capacity factor: 47.9%
      Estimated actual capacity factor: 43.1%
    - When 100GW (less than 15% of potential) is developed: 377.5TWh
  - Total power generation in Japan in 2022: 1,008TWh*1



Source:: REI (Water depth less than 300m)

- Theoretical capacity factor: CF when the power curve of wind turbines and the occurrence distribution of wind speed are assumed to be the Rayleigh distribution.
- Actual capacity factor: About 90% of the theoretical CF, when outages due to periodic inspections of wind turbines and other factors, as well as different distributions of wind speed occurrence are assumed.

*1 METI/ANRE "Total Energy Statistics"

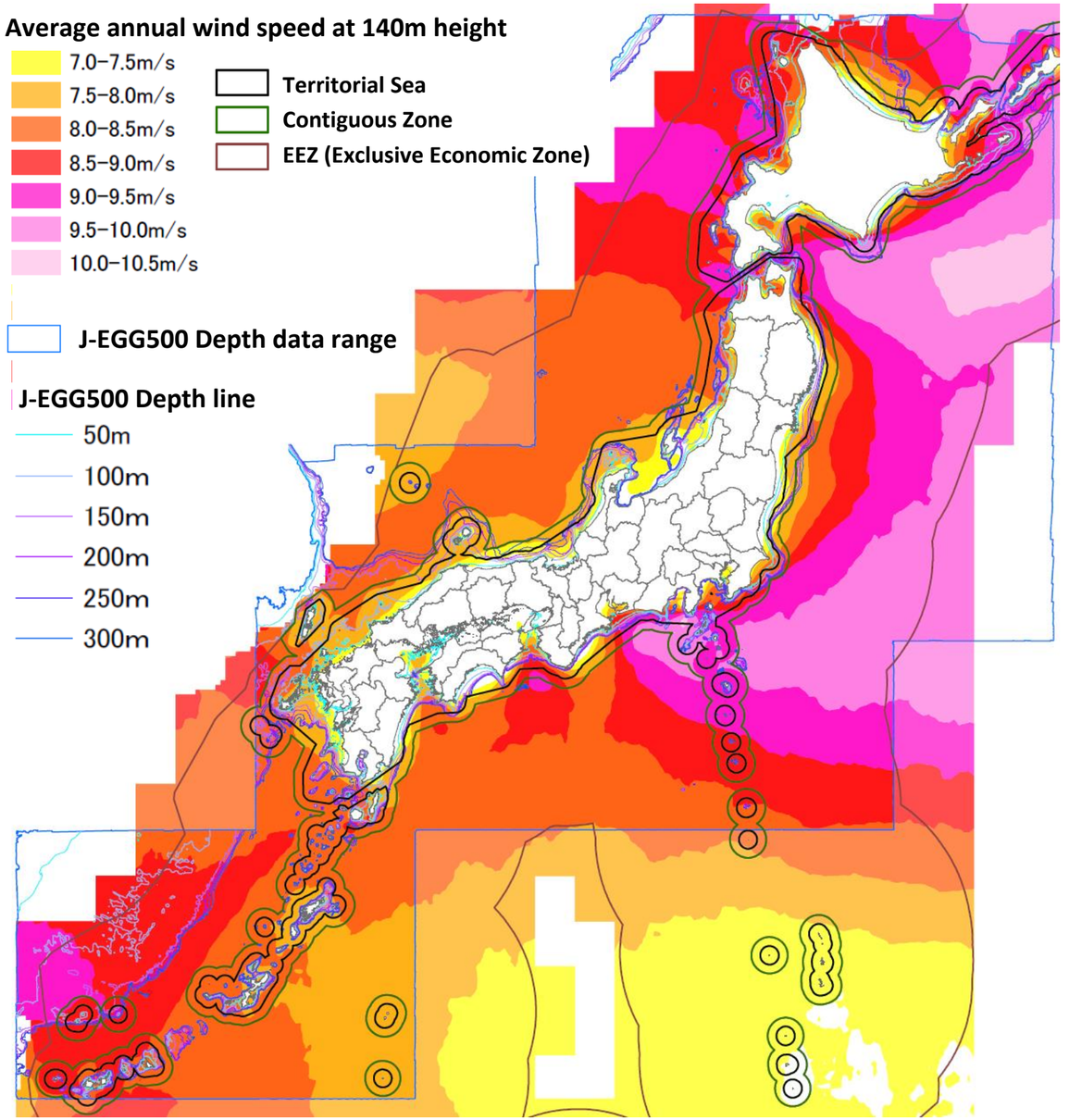
7．Assumptions for potential calculations -1

Potential calculation range

- Only for sea areas where both wind and water depth data are publicly available
  - Wind condition data and water depth data are available in different ranges
- Water depth range limited to less than 300m at 50m pitch
  - Construction costs increase as water depth increases
- Only for sea areas with feasibility assumed
  - Sea areas where feasibility is assumed to be difficult, such as those with water depths of 1,000m or more found on the power transmission route from the offshore wind power construction site to land, are excluded.
  - Difficulty in laying submarine power lines or increased construction costs
- Limited to sea area within the Exclusive Economic Zone (EEZ)
  - Excluding sea areas where the boundary with a foreign country has not yet been demarcated

Area classification

- General Electricity Transmission and Distribution Utilities' regional service areas (10)
  - GIS data created independently based on the electricity supply status on land and remote islands are applied.
- Prefectures (39 of them with coasts)
  - Original GIS data created based on the Open Street Map[1] are applied.



1 https://www.openstreetmap.org/#map=6/34.815/135.045

Source: Based on NEDO NeoWinds, water depth data range, 250m and 300m depth lines, territorial sea classification are added.

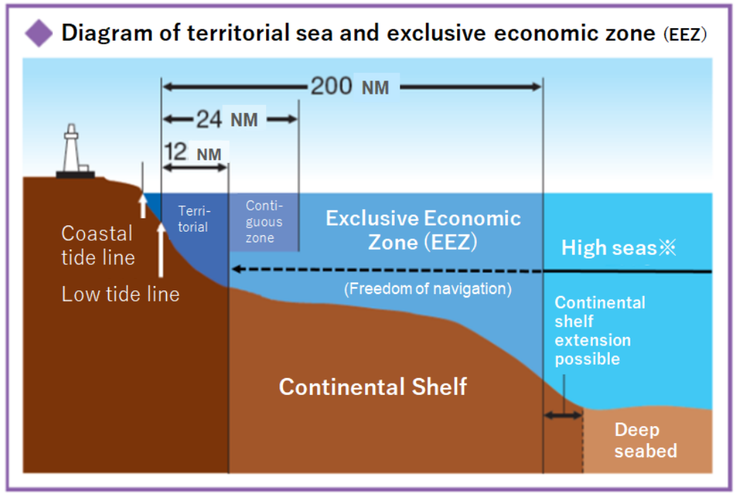
7．Assumptions for potential calculations -2

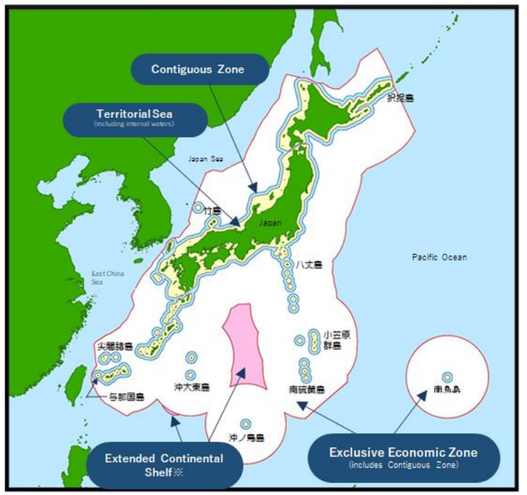
Wind conditions and water depth

- Wind conditions: Data for the sea level height of 140 m in NeoWinds[1] published by the New Energy and Industrial Technology Development Organization (NEDO) are applied.
- Water depth: 500m mesh water depth data from J-EGG500[2] published by the Japan Oceanographic Data Center (JODC) are applied.

Territorial sea and EEZ

- GIS data for territorial sea and EEZ (including CZ) were created independently based on the Japan Coast Guard's Jurisdictional marine zones information[3] and applied.



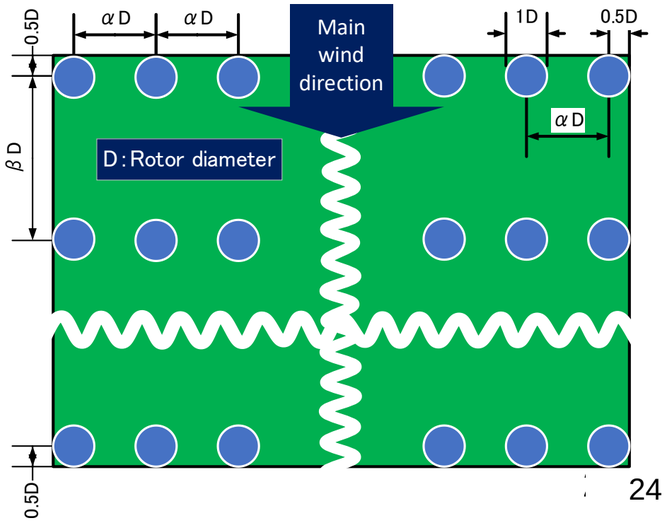


Wind turbines assumed

- Wind turbines with a unit swept area of3.0m²/kW are assumed.
  - 10MW machine: Rotor diameter (D) 196m
  - 15MW machine: Rotor diameter (D) 240m
  - 20MW machine: Rotor diameter (D) 277m

Installed capacity that can be built in 100km²

- 800 MW/100 km² is applied. The general wind turbine configuration to be applied when there is a prevailing wind direction is: 3D in the orthogonal direction to the main wind direction, and 10D in the main wind direction. Adding the margin for securing the route, etc., it becomes: 4D in the orthogonal direction to the main wind direction, and 10D in the main wind direction. In addition, with 1GW wind farms in mind, 10 rows in the main wind direction are also taken into account, resulting in the above value.



1. https://appwdc1.infoc.nedo.go.jp/Nedo_Webgis/index.html
2. https://www.jodc.go.jp/jodcweb/JDOSS/infoJEGG.html
3. https://www1.kaiho.mlit.go.jp/ryokai/ryokai.html

Source：
Above figure: Japan Coast Guard, Jurisdictional marine zone information
Bottom figure: Created by Renewable Energy Institute

［Analysis Report］

Japan's Offshore Wind Power Potential

Territorial Sea and Exclusive Economic Zone

December 2023

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