

# An Assessment of Offshore Wind Energy Potential Using Mesoscale Model and GIS

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## Object

A large portion of wind energy potential in Japan is located at northern part, where demand is low and the grids are weak. On the other hand, in the supply area of Tokyo Electric Power Company (TEPCO), which supply one third of the national total demand, less wind potential is located and little land is left for wind farm.

This study aims to investigate the offshore wind energy potential around the supply area of TEPCO, annual demand of which is 282TWh/year.

The assessment of offshore wind climate was carried out by mesoscale model with horizontal resolution of 2km and geographical information system (GIS) was used to assess the available wind energy potential concerning economical and social criteria.

The supply area of TEPCO and the computational domain for mesoscale model



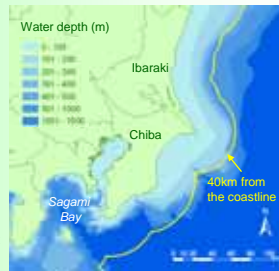
## Geographical Information System

To clarify the area available for wind energy, a GIS software, ArcInfo and the geographic data provided by Marine Information Research Center of Japan Hydrographic Association and Ministry of Land, Infrastructure and Transport were used. The criteria to determine the available area can be classified into economical and social criteria. Economical criteria might be changed with the progress of technology, while social criteria is strongly affected by political decision and the area related to social criteria was excluded from wind energy exploitation in this study.

### Economical criteria

Water depth	Not more than 20m for bottom-mounted foundations Not more than 500m for floating foundations
Distance from the coastline	Not more than 40km because of transmission line and maintenance

- At the east offshore of Chiba and Ibaraki including the offing of Choshi, water depth is relatively shallow.
- At Sagami Bay, seabed is very steep and even within 40km from the coastline, water depth exceeds 1500m at some sites.



Economic criteria considered in this study

### Social criteria

Fishery rights area	No energy will be exploited
National parks	No energy will be exploited
Distance from the coastline	Not less than 10km from the coastline because of landscape reason
Ports	No energy will be exploited

- Ports and national parks have relatively small area.
- On the other hand, fishery rights are established at most of the coastline.
- Landscape is also a dominant factor to determine the available area

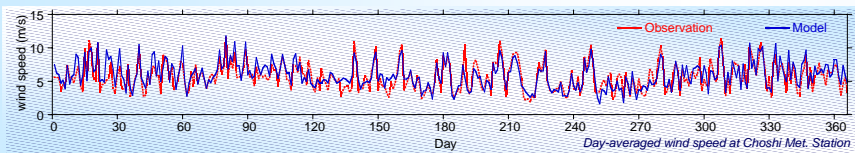
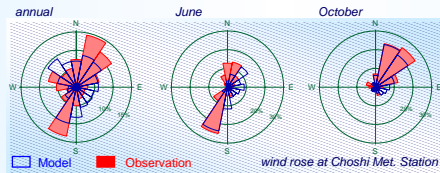


Social criteria considered in this study

## Mesoscale Model

- To investigate the spatial distribution of offshore wind climate, simulation by RAMS (Regional Atmospheric Modeling System) was carried out for the year 2000.
- A grid with horizontal resolution of 2km (Grid 2) was set to cover the offshore area around TEPCO supply area.
- To take the effect of surrounding mountain area into account, grid 1 with horizontal resolution of 8km was set around grid 2.
- ECMWF analysis data was used as boundary and initial condition.

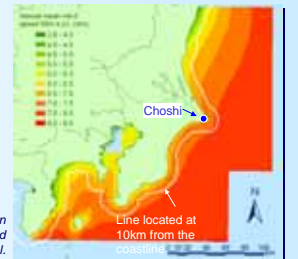
### Verification



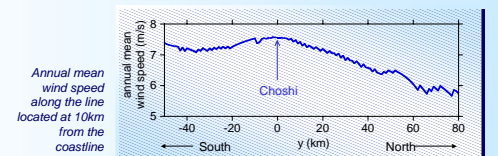
- Prediction error of annual mean wind speed by mesoscale model at Choshi meteorological station is 4.8%.
- Day averaged wind speed predicted by the model also shows good agreement with the observation.
- Seasonal variation in prevailing wind direction can be seen. In June, the wind direction is mainly SSW, while prevailing wind direction in October is NNE and NE.
- This variation is also well simulated by the mesoscale model.

### Annual mean wind speed

- Annual mean wind speed offshore Choshi is 7.5m/s while at northern site, it decreases to 5.7m/s although the distance from the coastline is same. This is because Choshi is located at the tip of a cape,



annual mean wind speed at 60m a.s.l.

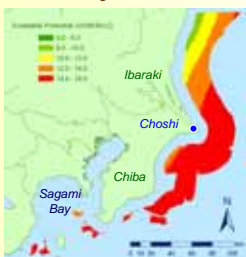


Annual mean wind speed along the line located at 10km from the coastline

## Available Potential

### Distribution of available potential

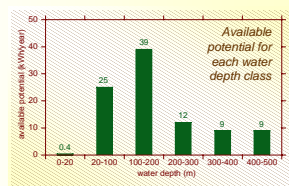
Concerning all the economical and social criteria, available potential was estimated assuming to settle 2MW wind turbines with rotor diameter of 80m and hub height of 60m.



Available potential per square kilometers

### Available potential for each water depth class

- If bottom mounted foundation, which is common in Europe, is used, only 0.4TWh/year of energy will be exploited, which accounts for only 0.1% of the annual demand of TEPCO.
- More than half of the available potential is located in the area where water depth is between 20 and 200m.
- Thus, floating foundation should be developed to exploit offshore wind energy in this area.



- Most of the available potential is located at the east offshore of Chiba and Ibaraki especially at the offing of Choshi while available area is limited around Sagami Bay because of the sea bed topography.
- Considering all the economical and social criteria, the total available energy potential in this area is 94TWh/year, accounting for 32% of the annual demand of TEPCO.

## Conclusion

Offshore wind energy potential in the supply area of Tokyo Electric Power Company (TEPCO) was investigated by using mesoscale model and geographical information system (GIS). Following results were obtained.

- Predicted annual mean wind speed, day averaged wind speed and wind direction show good agreement with observation. The prediction error of annual mean wind speed was 4.8%.
- Annual mean wind speed offshore Choshi is 7.5m/s while at northern site, it decreases to 5.7m/s although the distance from the coastline is same. This is because Choshi is located at the tip of a cape,
- Concerning all the economical and social criteria, the available potential becomes 94TWh/year, accounting for 32% of the annual demand of TEPCO.
- If bottom mounted foundation is used, 0.4TWh/year of energy will be exploited, which accounts for only 0.1% of the annual demand of TEPCO.