

# Restructuring Electricity Industry from the Viewpoint of Wind Power

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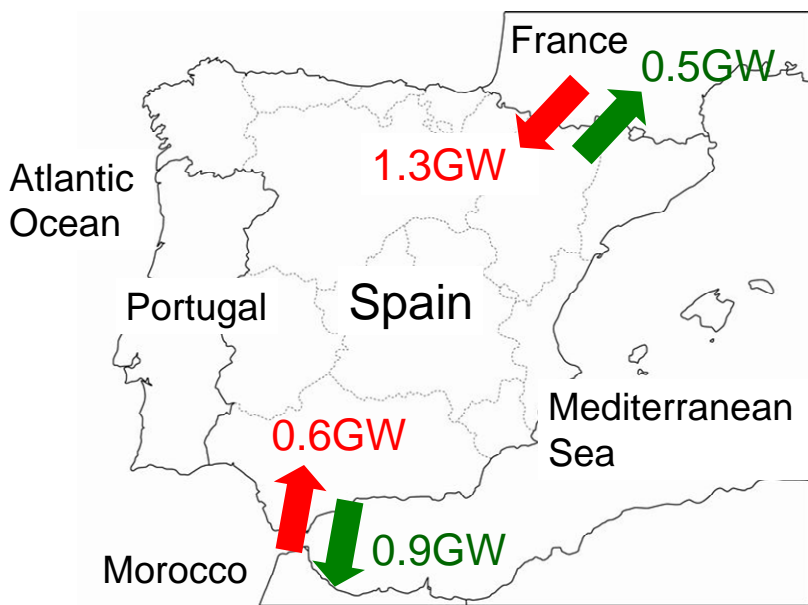
The University of Tokyo  
Prof. Takeshi ISHIHARA

# Questions

- Weak grid interconnection is said to be the obstacle for the high penetration of wind power in Japan, but is it true ?
- How 20% of wind power can be integrated to the grid ?
- What is the characteristic of the fluctuation of wind farm output ?
- What kind of regulatory framework is needed to increase wind penetration ?

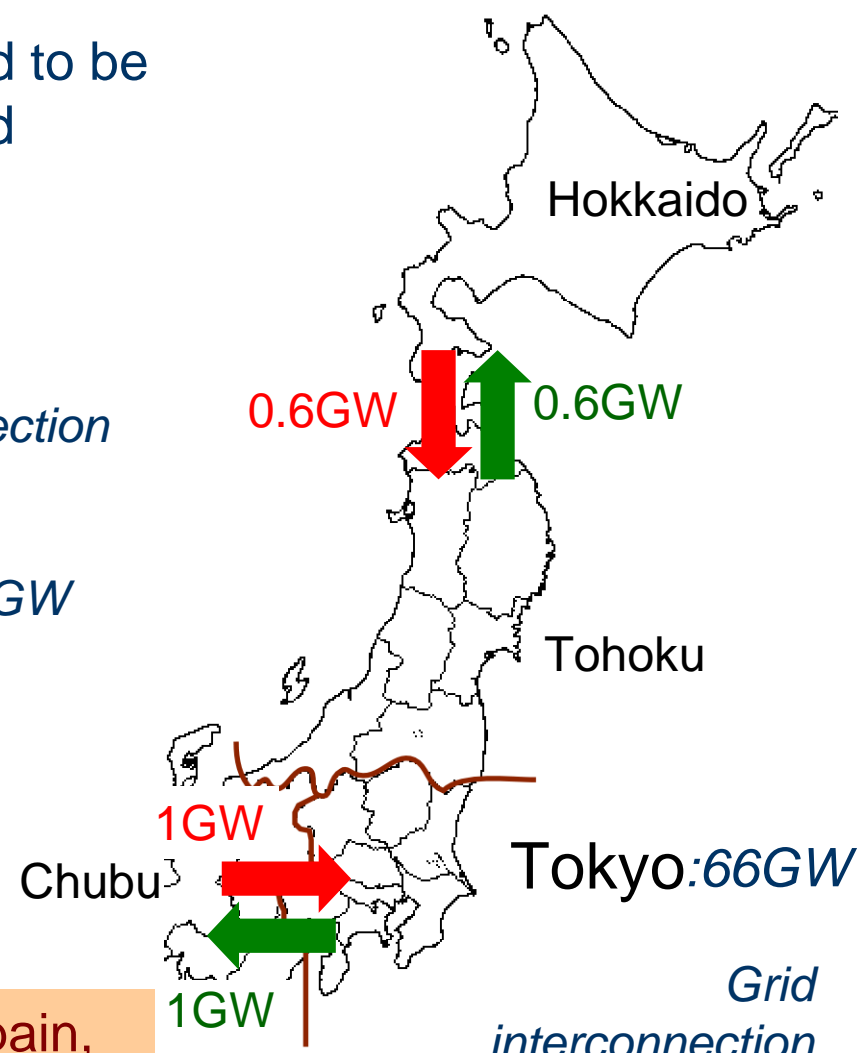
# Grid interconnection

In Japan, weak grid interconnection is said to be the obstacle for the grid integration of wind energy, but is it true ?



*Grid interconnection in Spain*

*Spain :64GW*



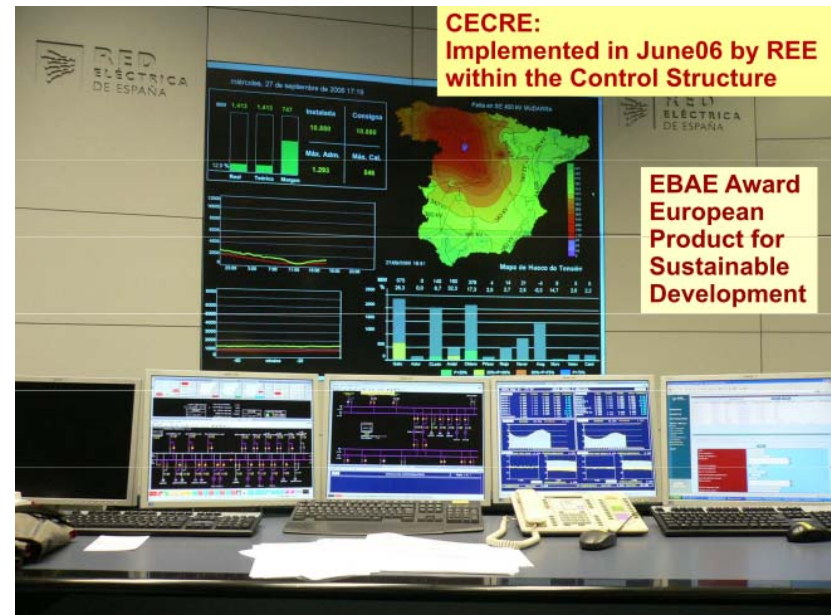
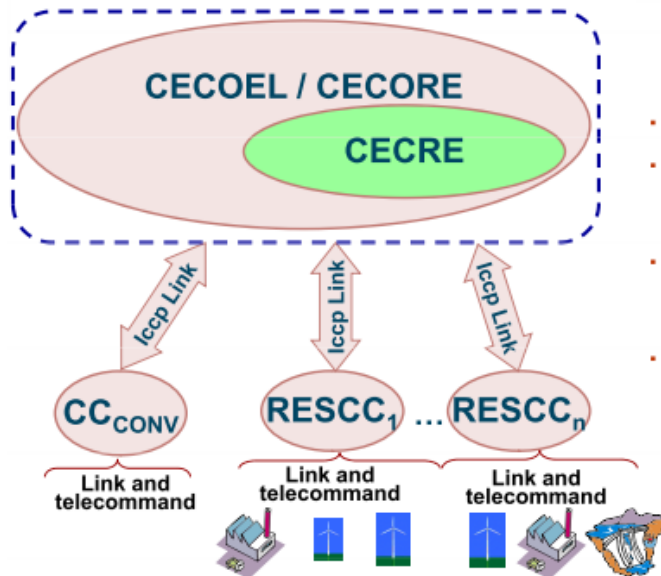
*Grid interconnection in East Japan  
50Hz area*

The situation in East Japan is similar to Spain, they have high penetration of wind power, 20% of installed capacity.

# Forecasting and Control of wind power

How 20% of wind power is integrated to the grid in Spain?

- Wind farm owners have to provide wind power forecasting and wind farms are under control of grid operator.
- Grid operators perform dynamic simulation of the grid using forecast data and control the maximum output from wind farms.

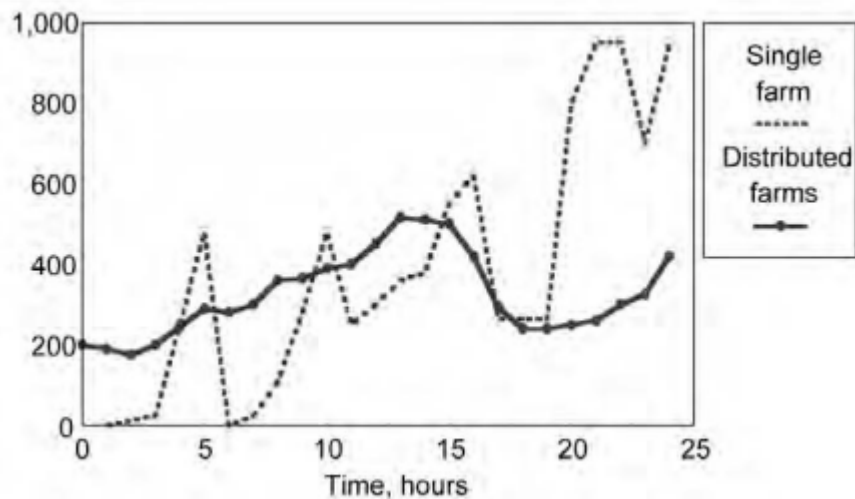


Integrated operation of the electrical system is needed

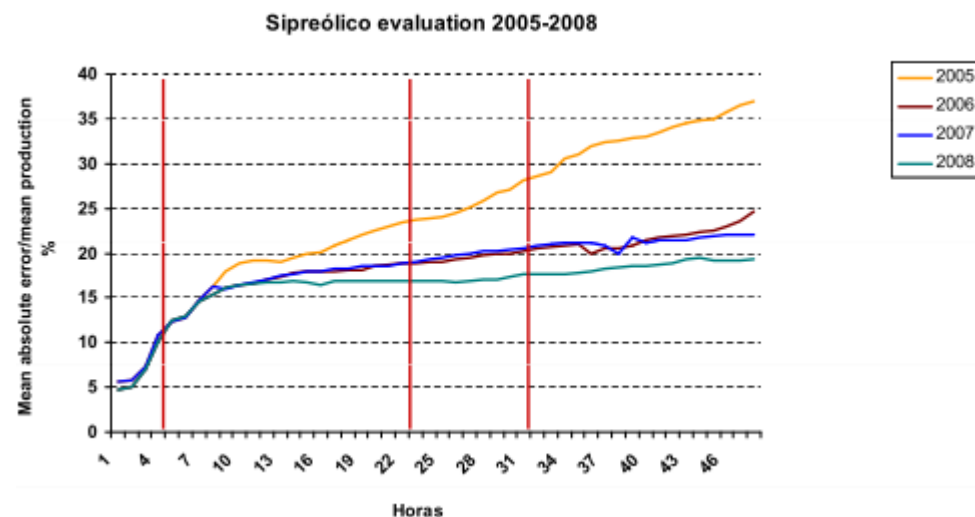
# characteristic of wind power

What is the characteristic of the wind farm output ?

- The output is smoothed out as the number of wind farm increases.
- The forecasting error decreases as the number of wind farm increases.



Smoothing effect of wind power



Improvement of forecasting method

The fluctuation of wind power decreases as the wind energy penetration increases and can be predicted

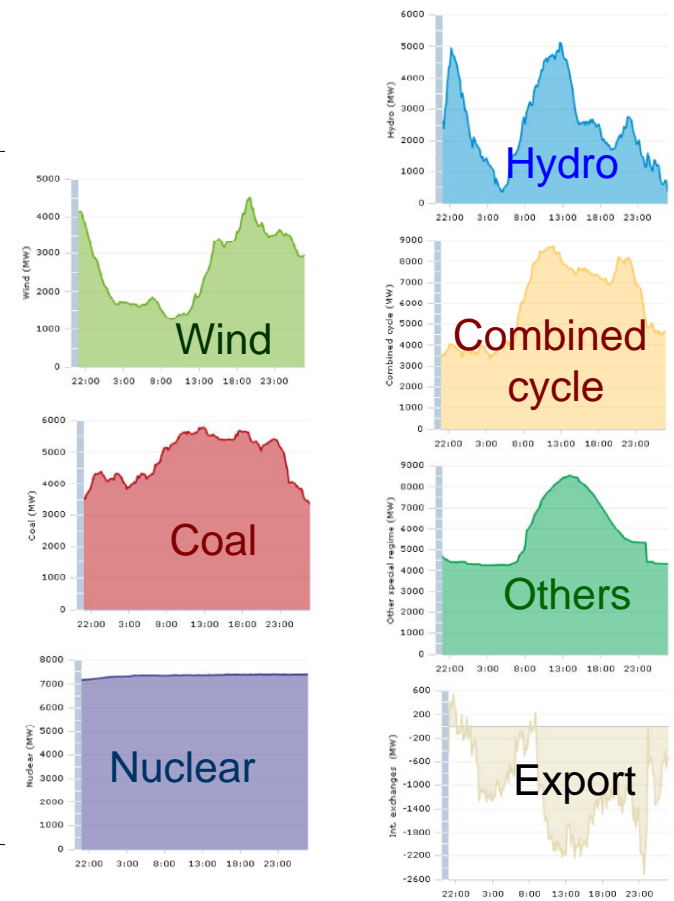
# Regulatory framework for wind integration

What kind of regulatory framework is needed to increase wind penetration ?

— Forecast — Measured  
— Planned



$$= \Sigma$$

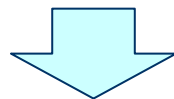


Output from several power sources

Power source can be divided into base load and balancing power and wind power shall be considered as base load and prioritized.

# Summary

- The situation in East Japan is similar to Spain, having high penetration of wind energy, 20% of installed capacity.
- Integrated operation of the electrical system is needed, considering dynamic simulation of the grid using wind power forecasting data and control of the maximum output from wind farms.
- The fluctuation of wind power decreases as the wind penetration increases and wind power can be predicted well as demand prediction.
- Wind power shall be considered as base load and prioritized.



Electrical system and regulatory framework in Japan should be restructured for the high penetration of wind power.



Thank you for your attention !

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