



Energy research Centre of the Netherlands

# **Will it blow?**

## **Short to mid-term wind power forecasting**

**A.J. Brand**

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ECN-M--11-081



Energy research Centre of the Netherlands

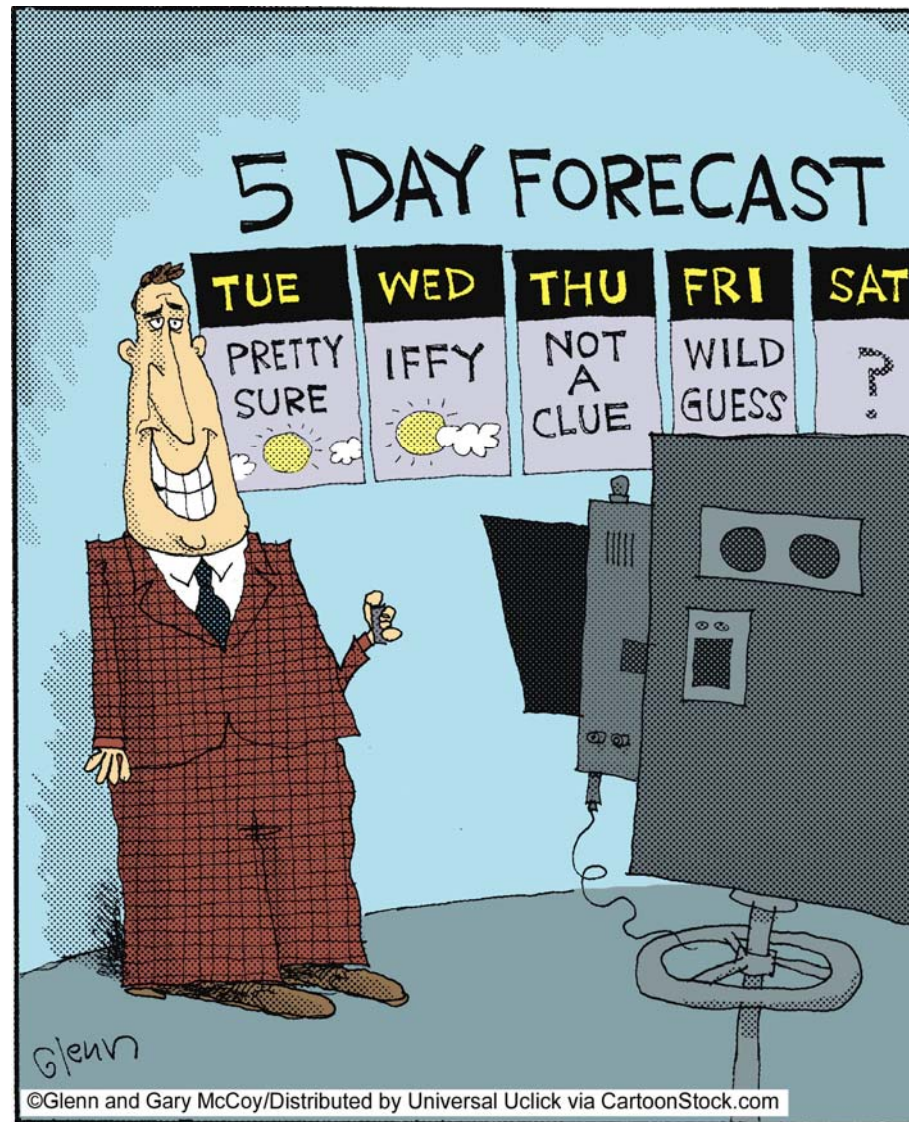
# Will it blow?

## Short to mid-term wind power forecasting

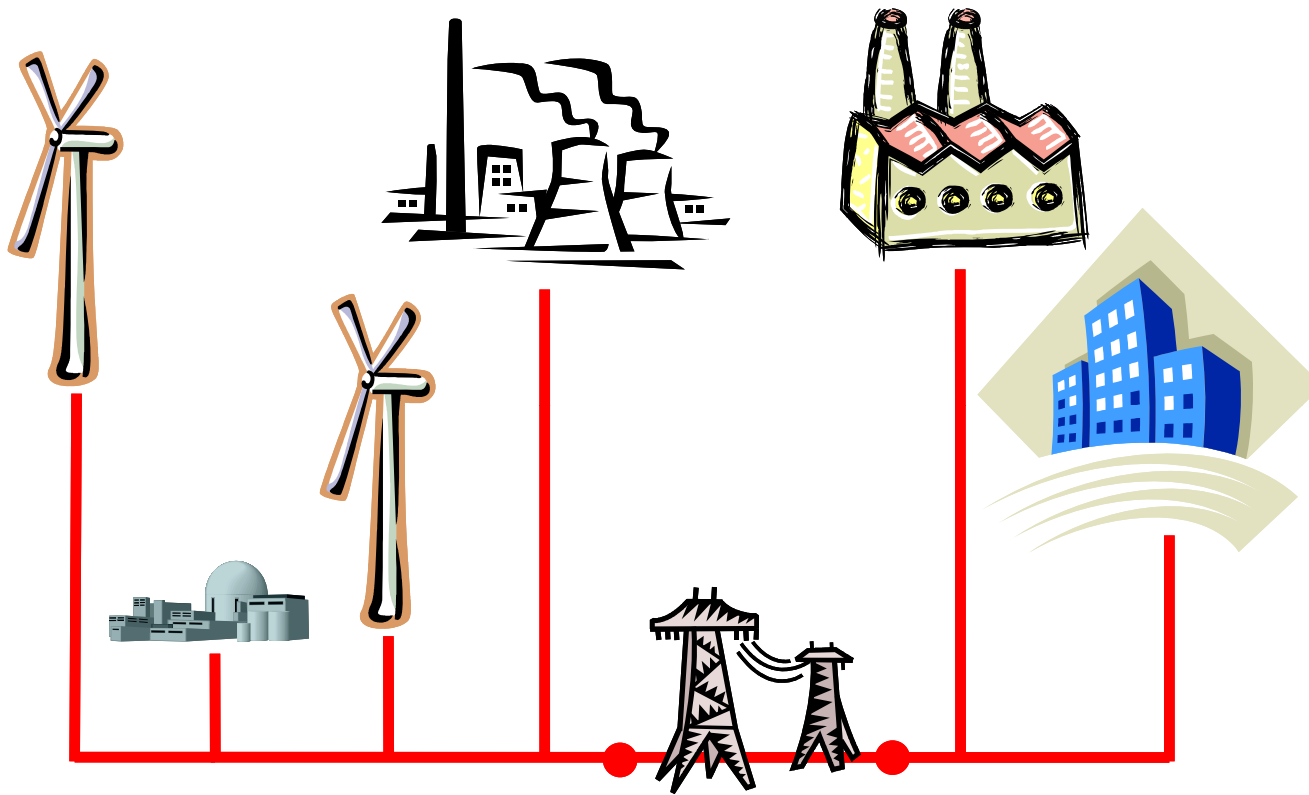
Arno J. Brand

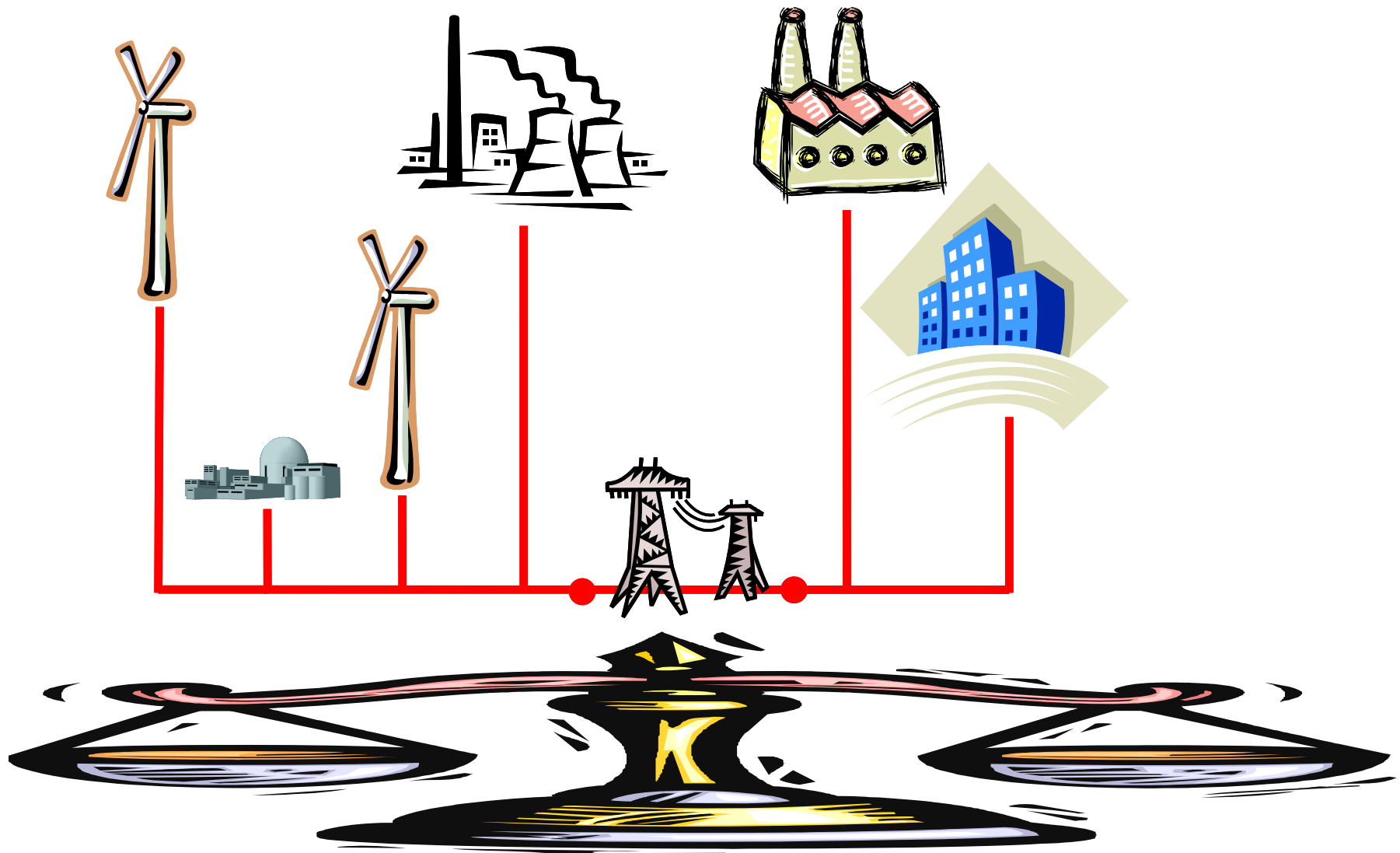
ECN Wind Energy

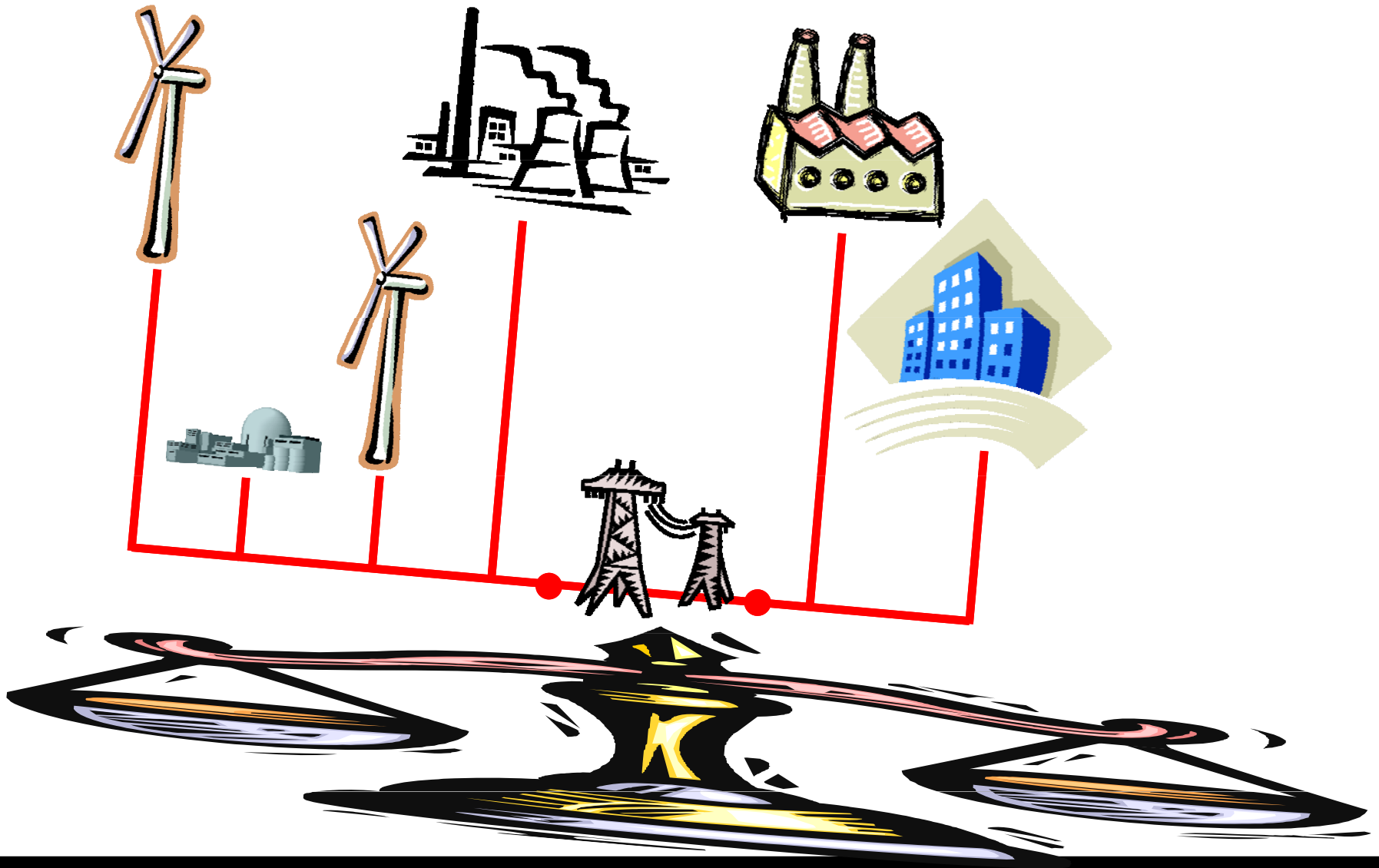


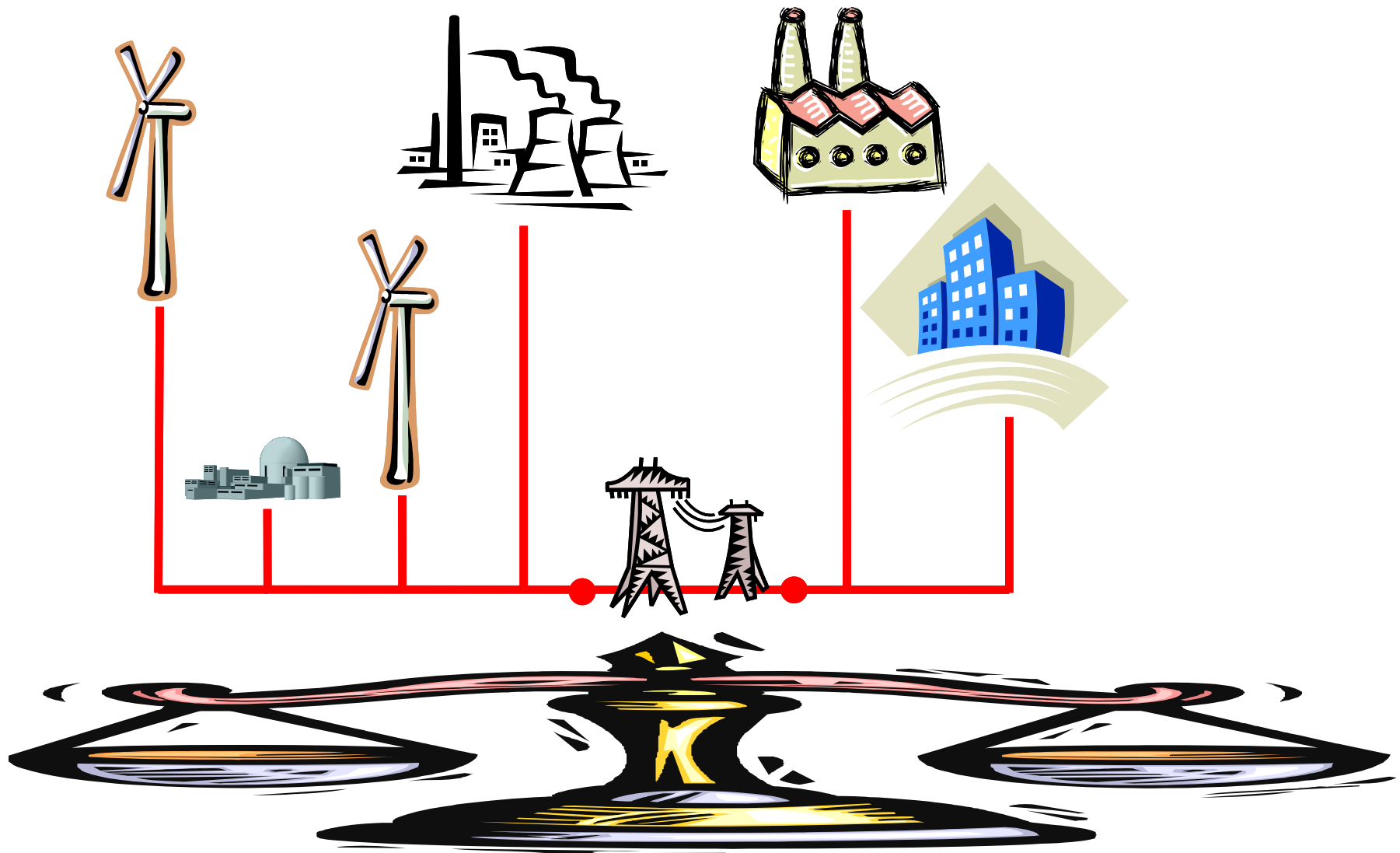


- ❑ Motivation
- ❑ Requirements
- ❑ Techniques
- ❑ Domains
- ❑ Uncertainty
- ❑ Extremes
- ❑ Experience

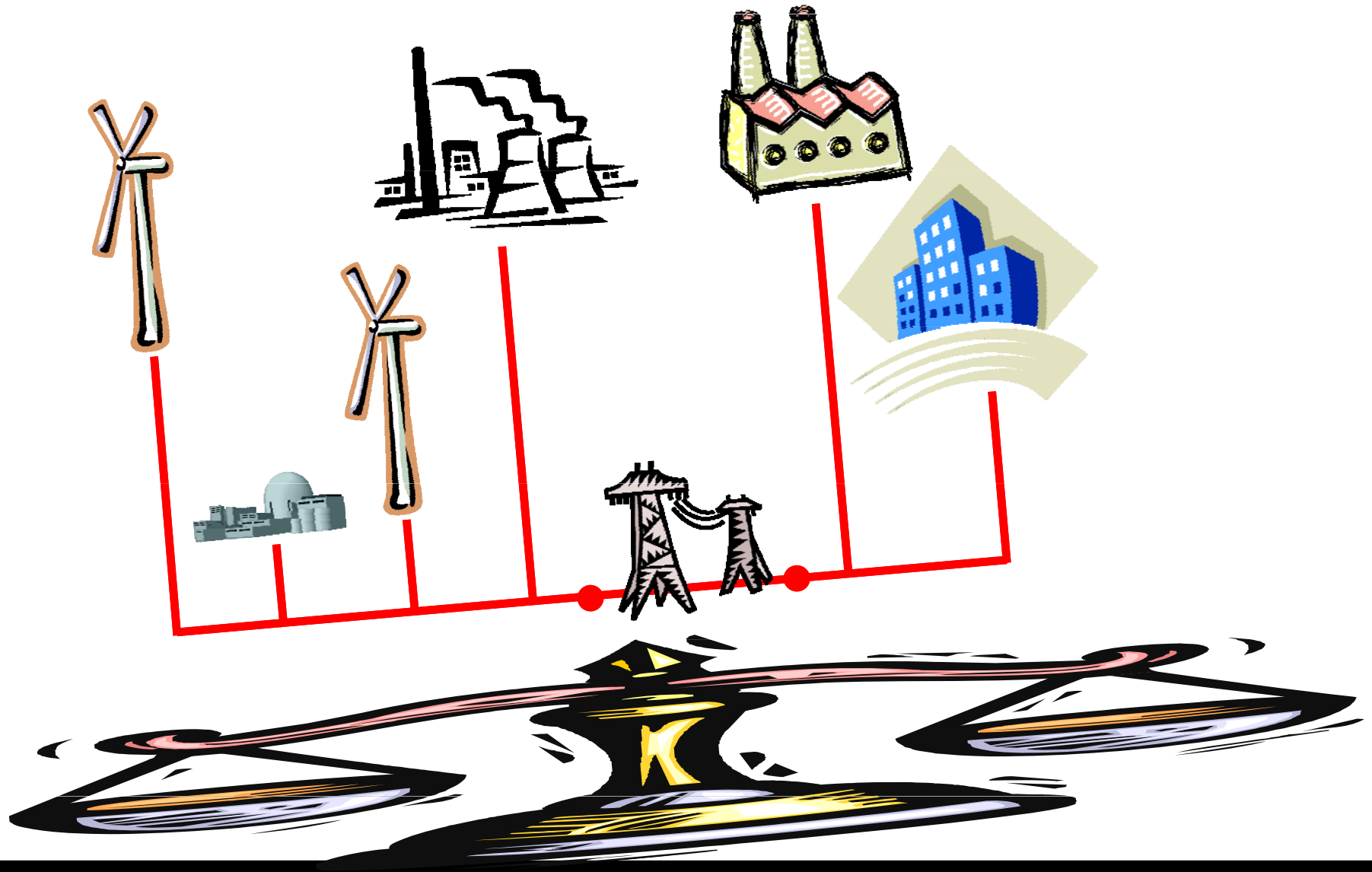


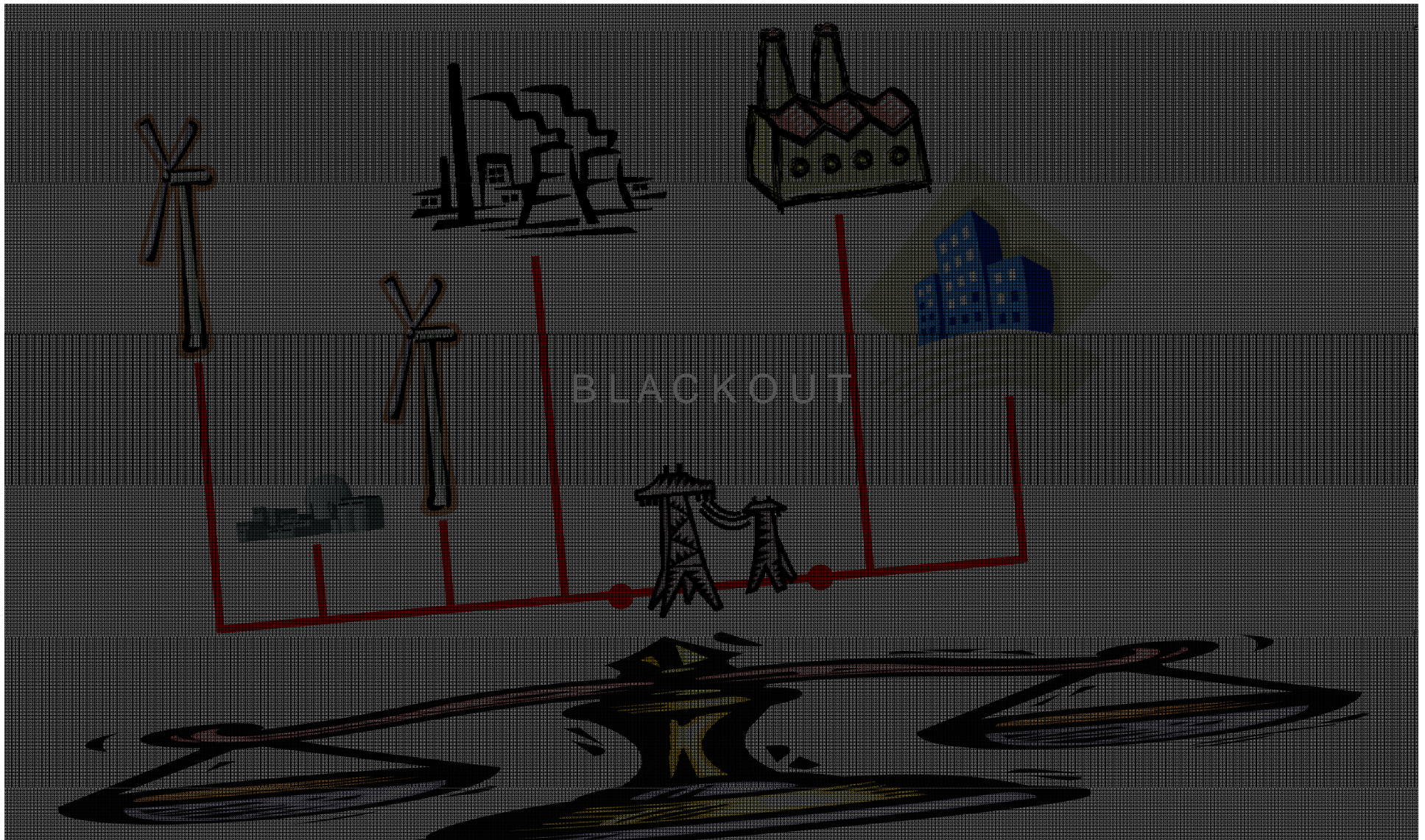


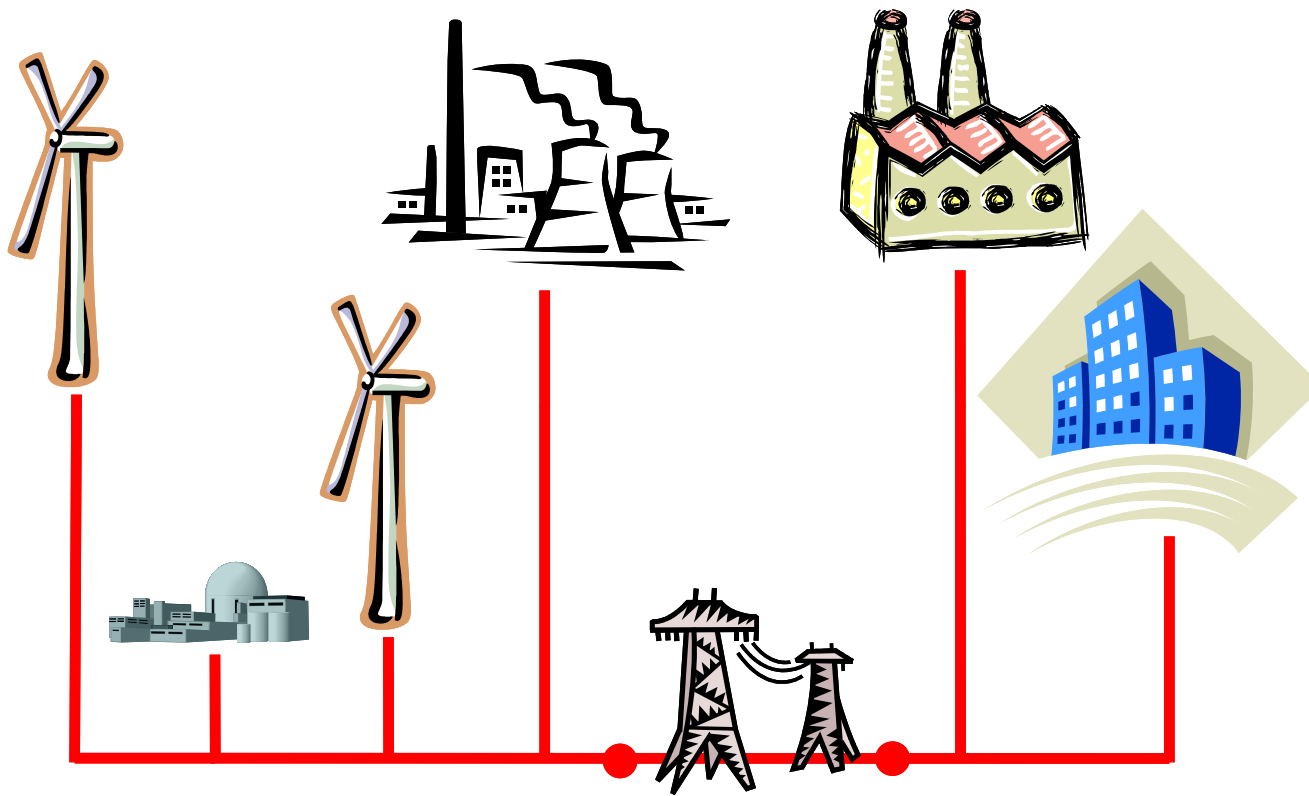












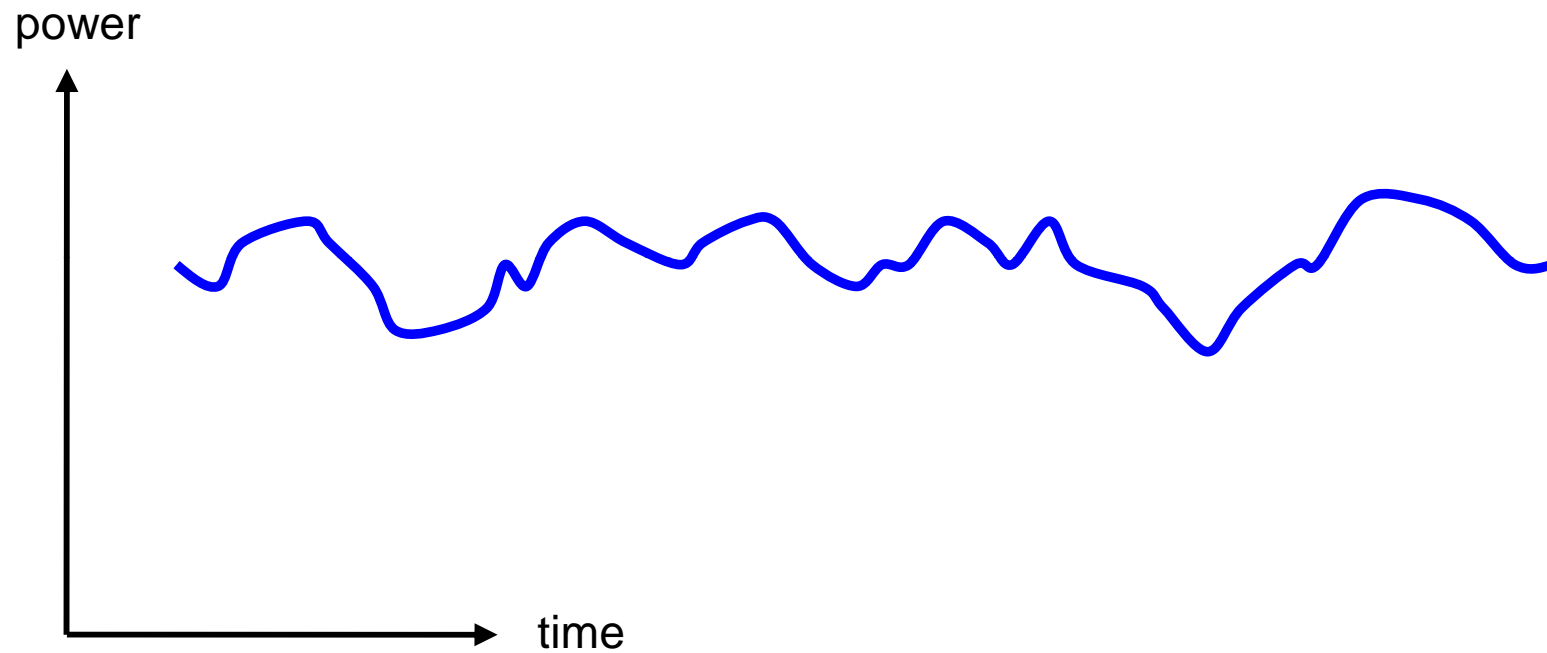
**Balance must be maintained in the grid**

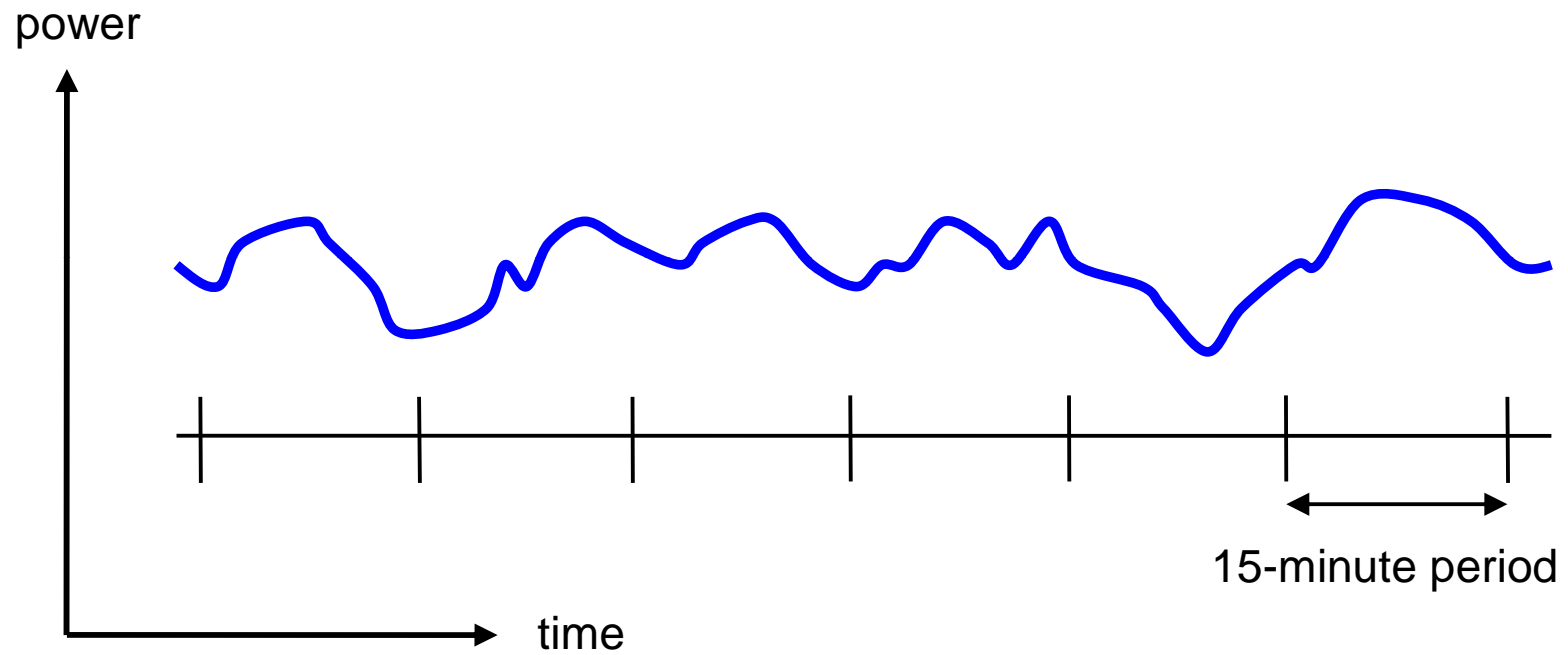
Ultra short-term forecasting    Next minutes    Next hours

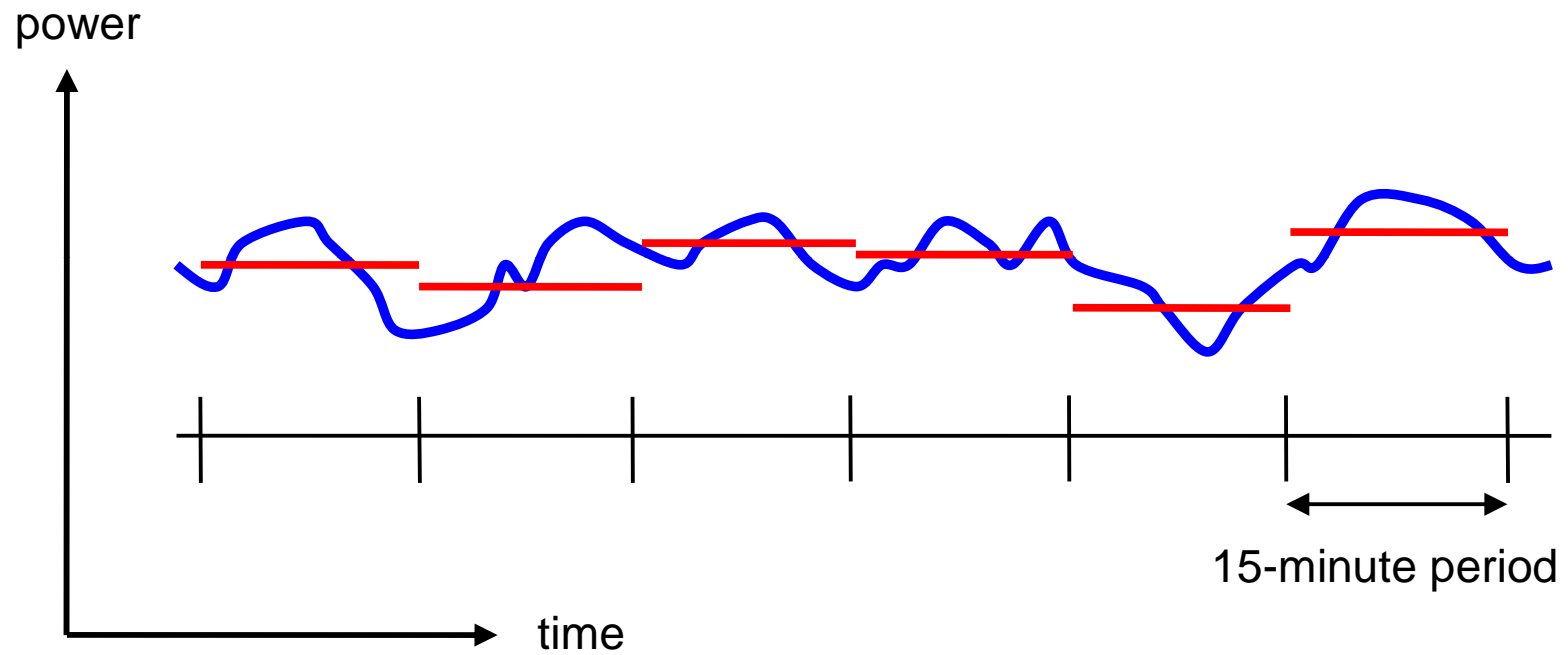
Short-term forecasting    Intra day    Day ahead

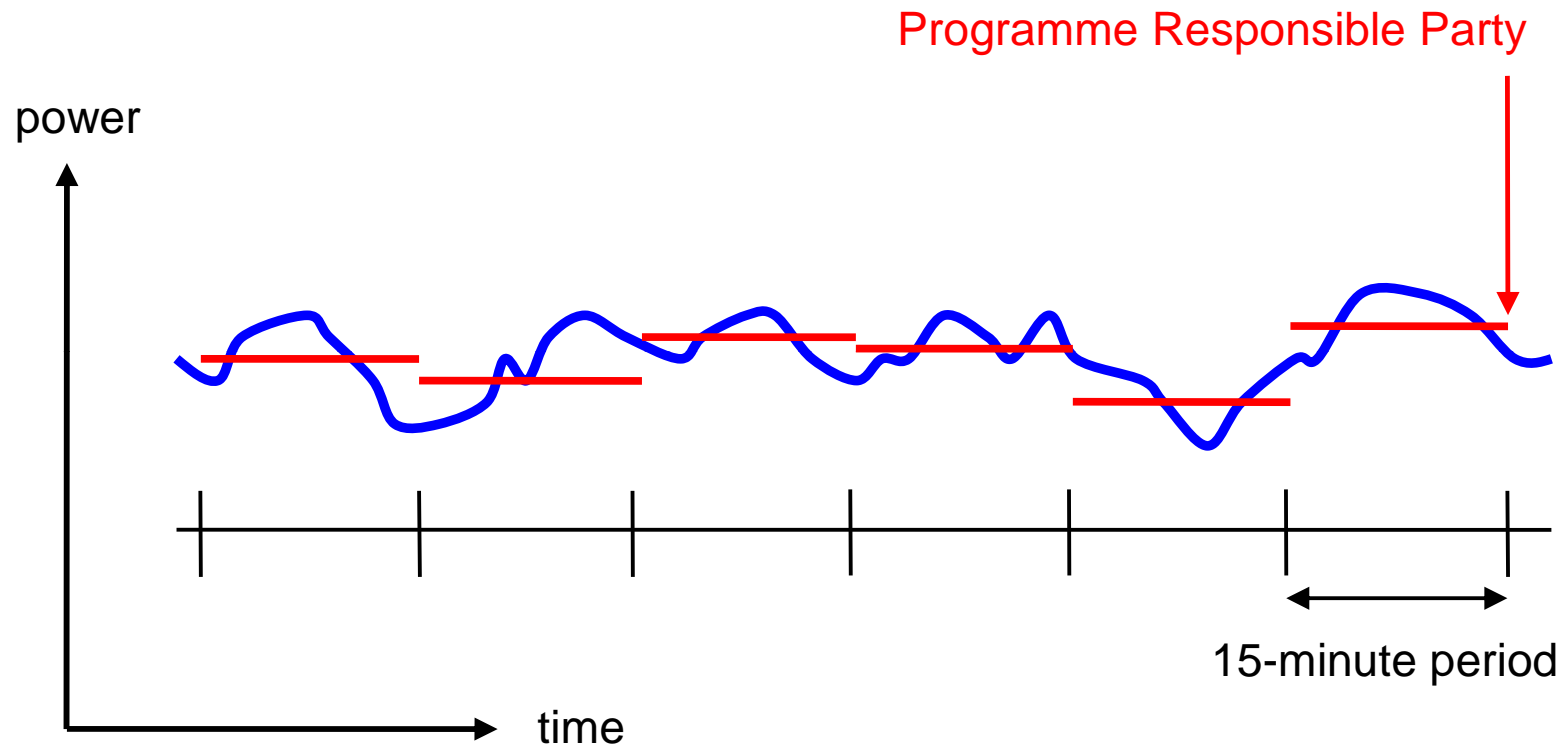
Medium-term forecasting    Five-day    Month

Long-term forecasting    Season    Year

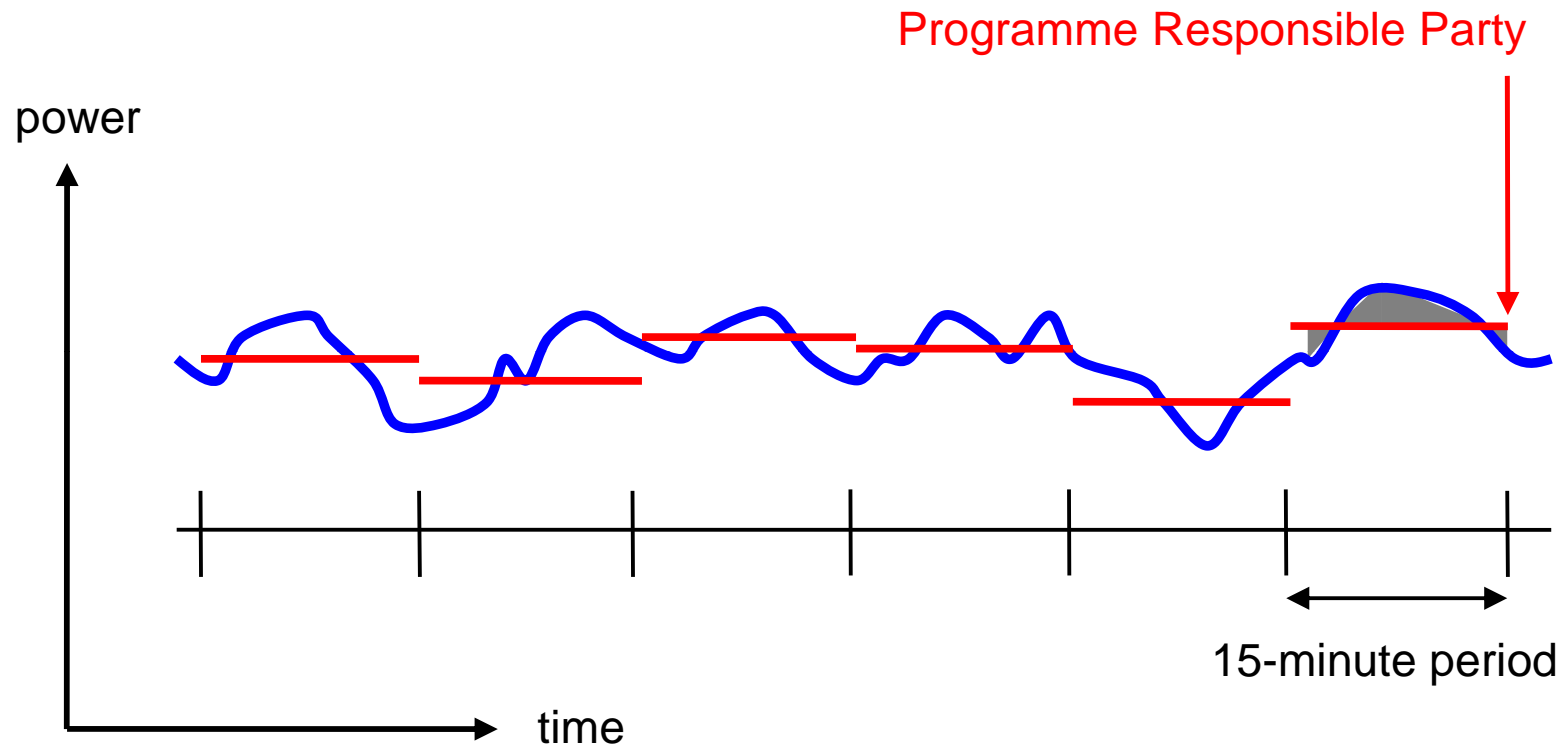


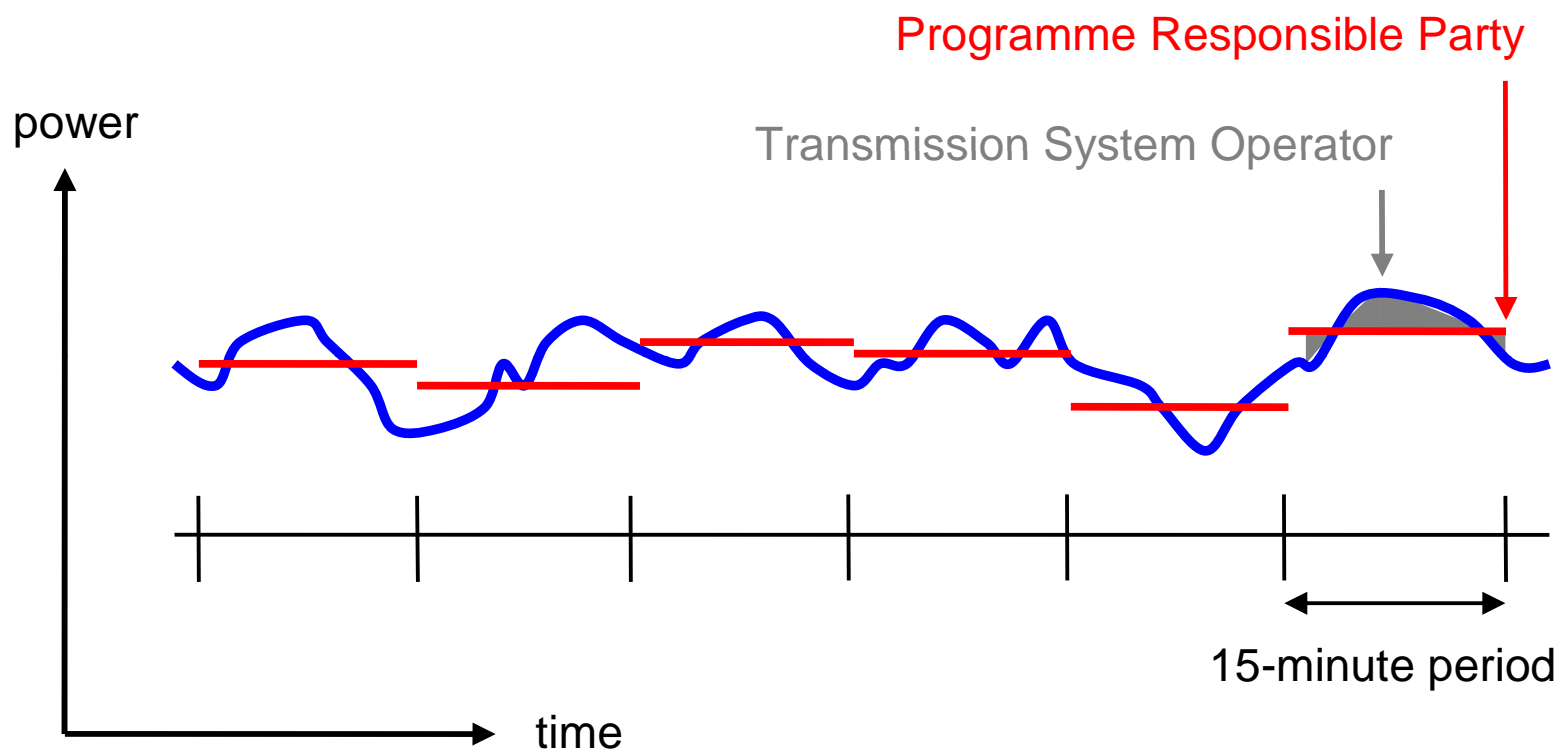




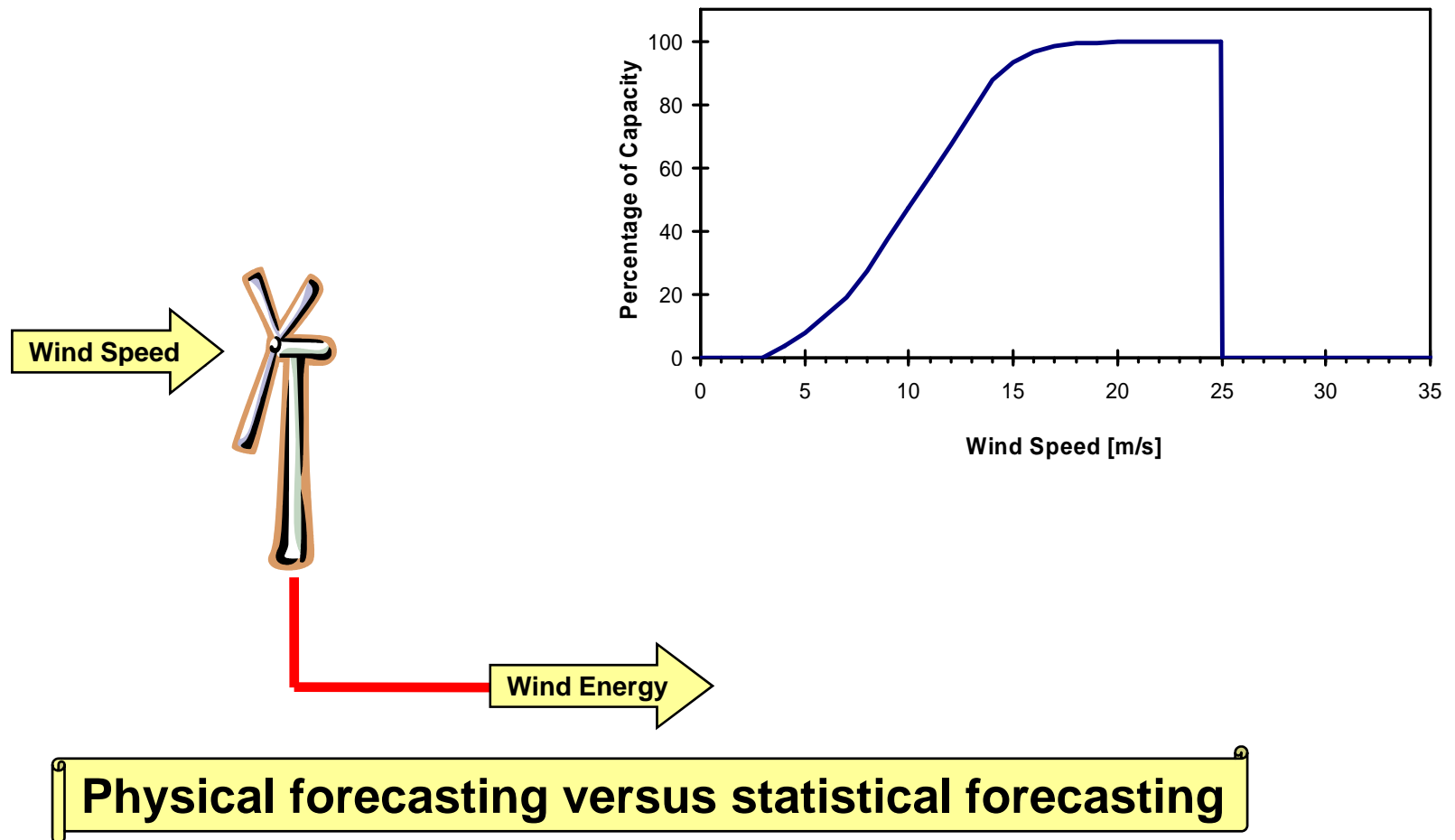


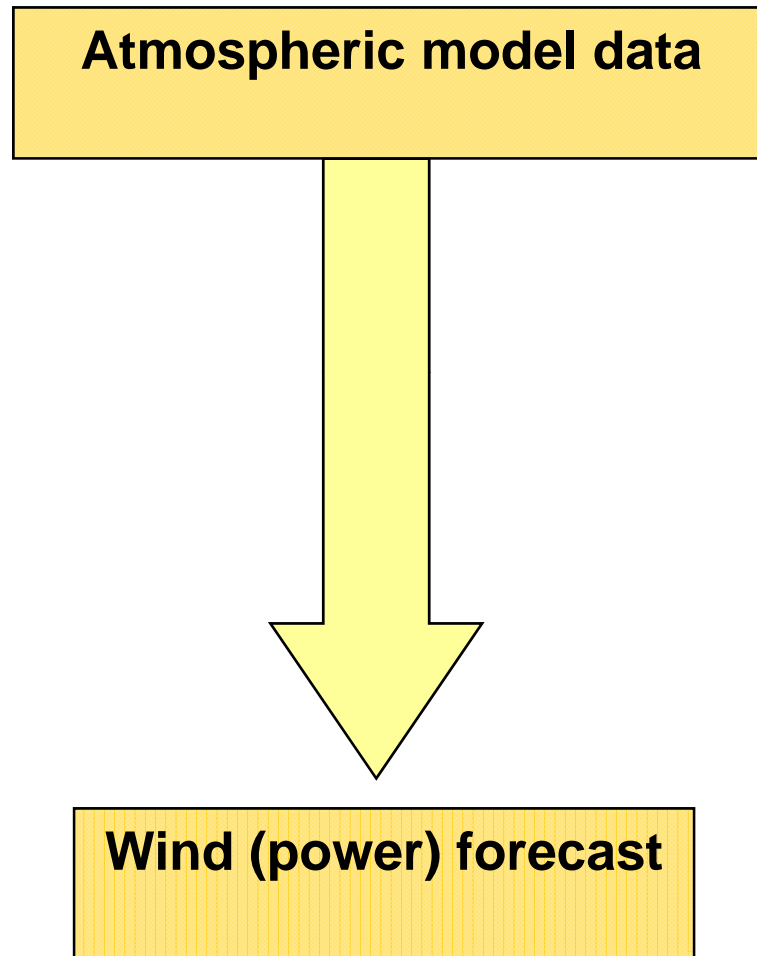


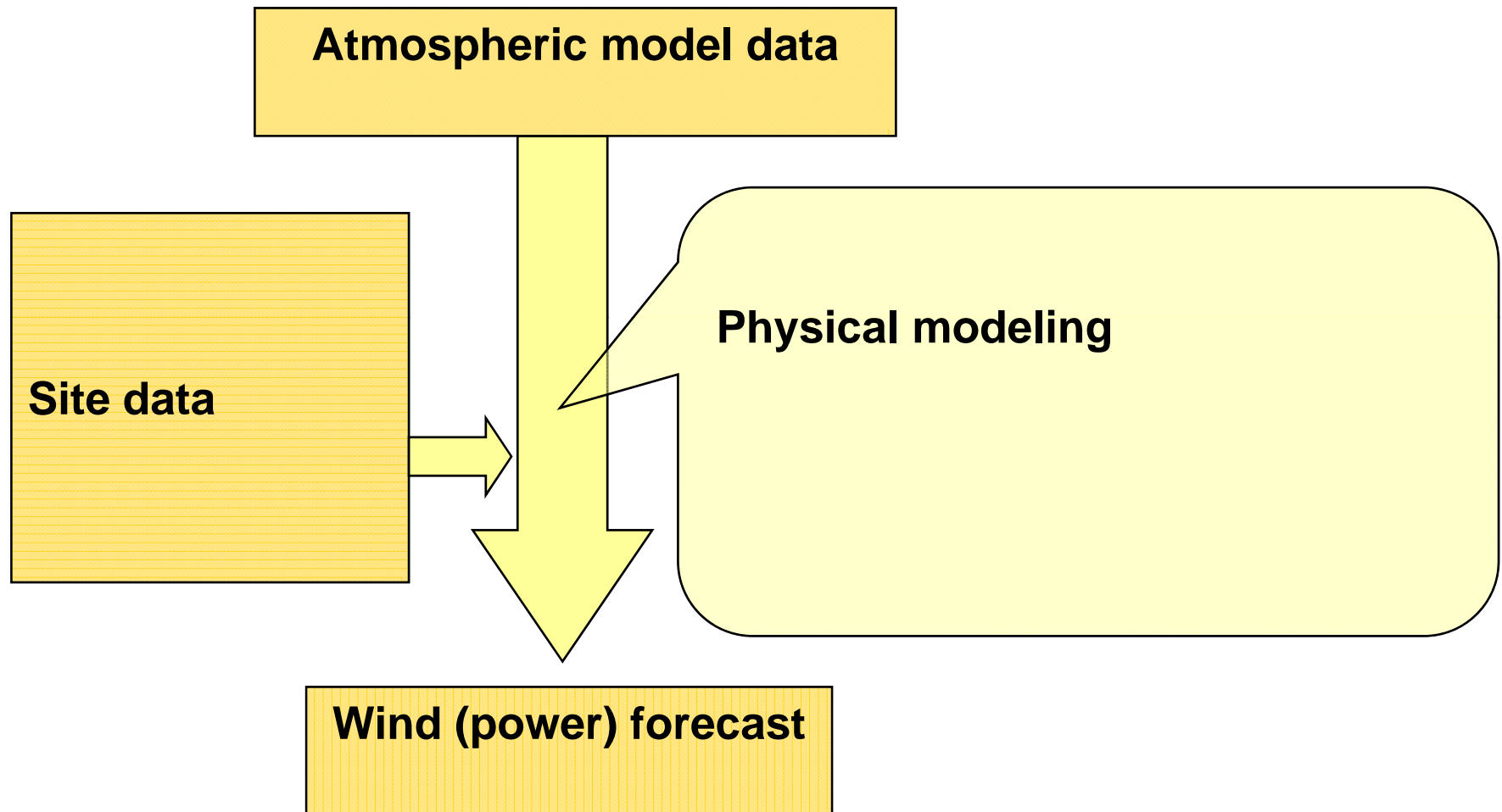


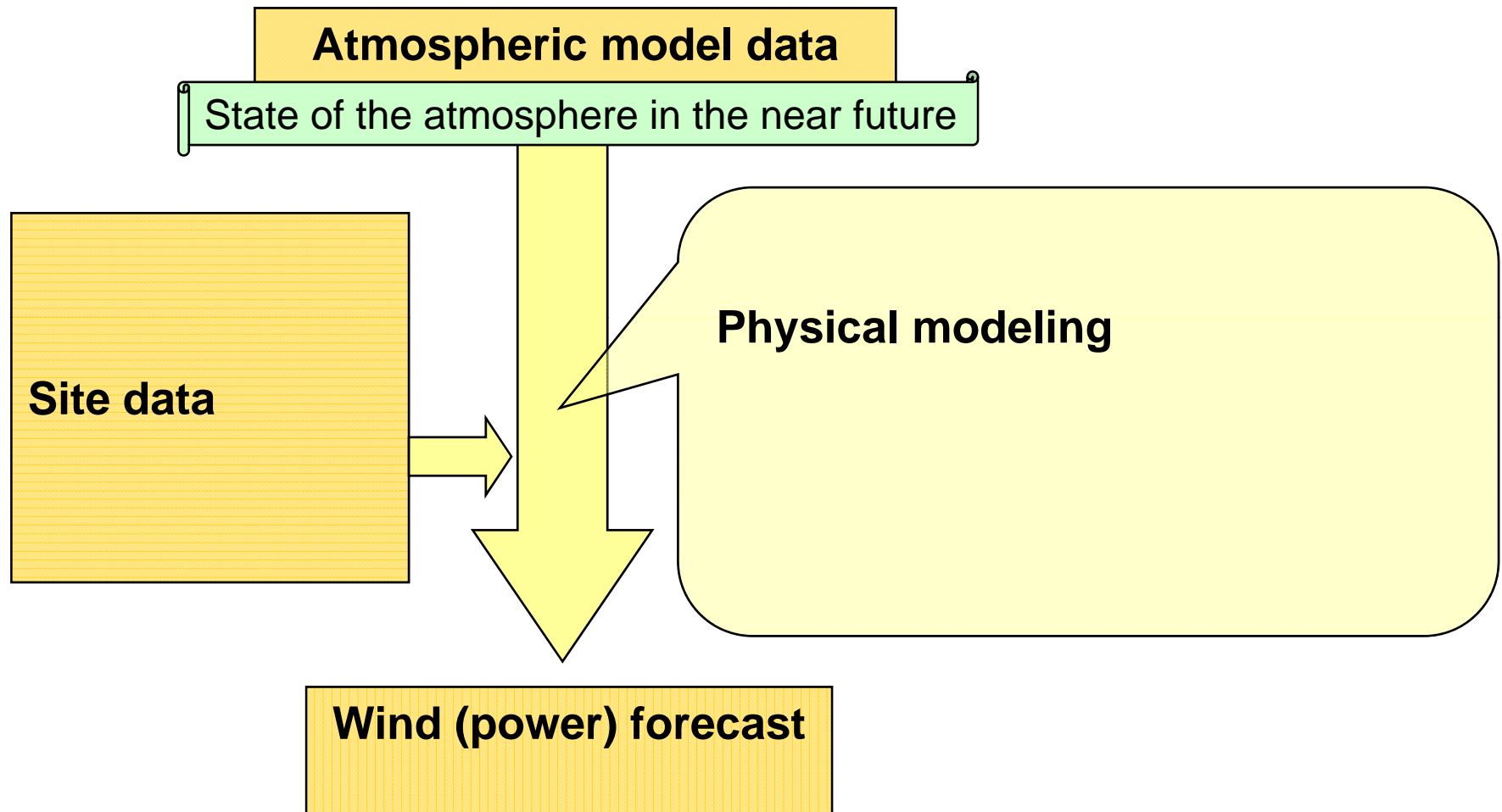


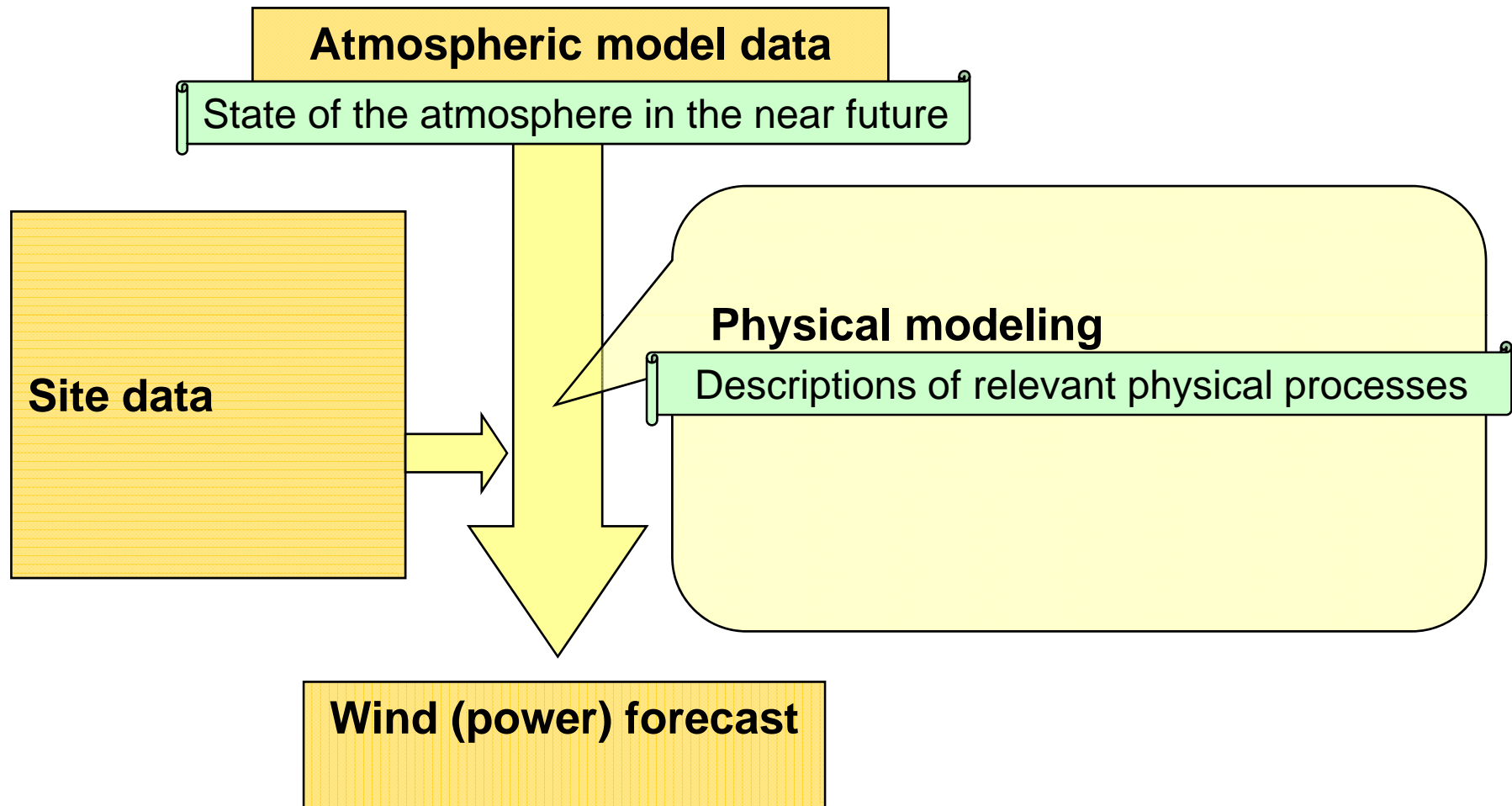
**Wind energy integration warrants wind power forecasts**

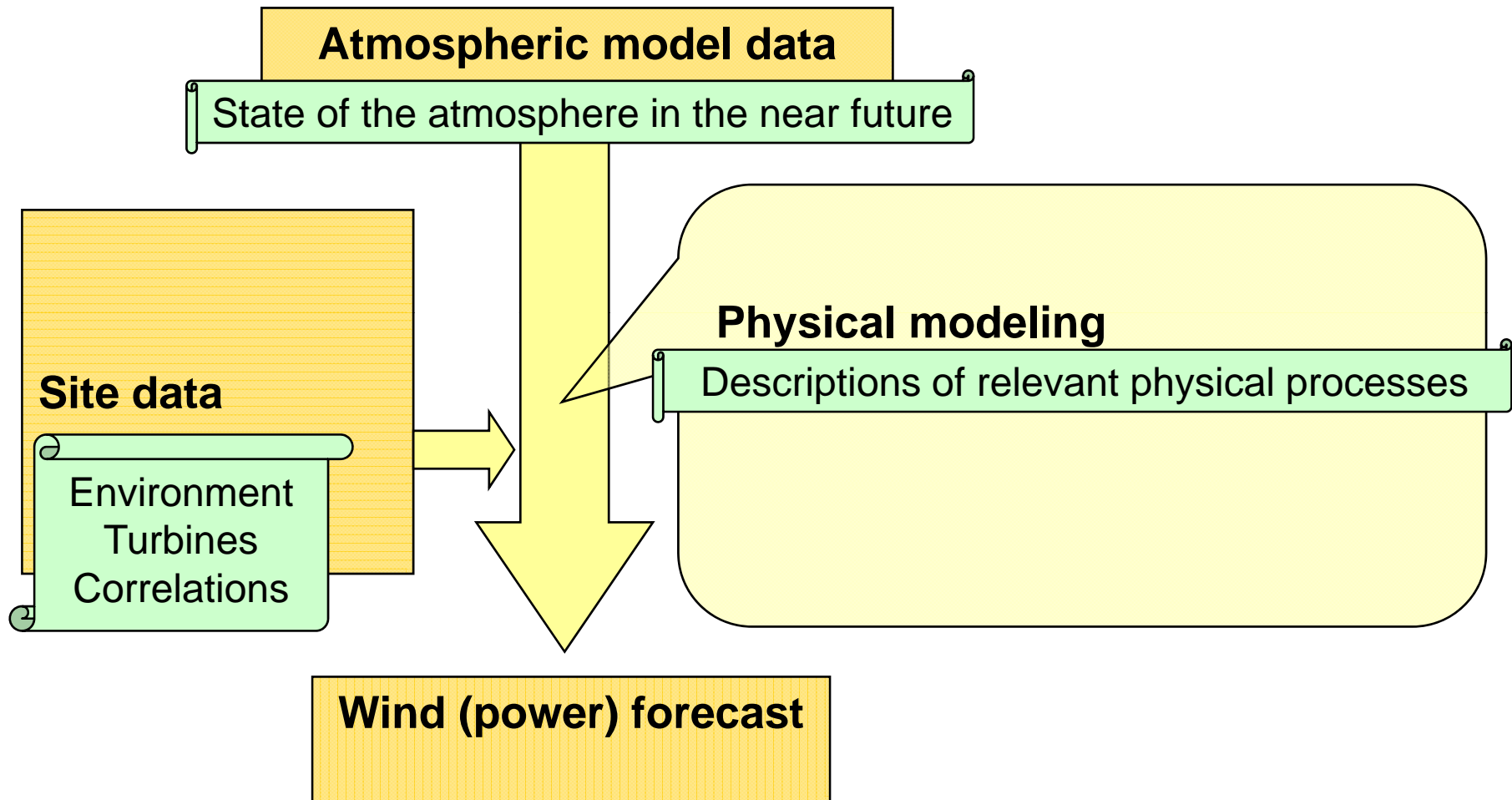




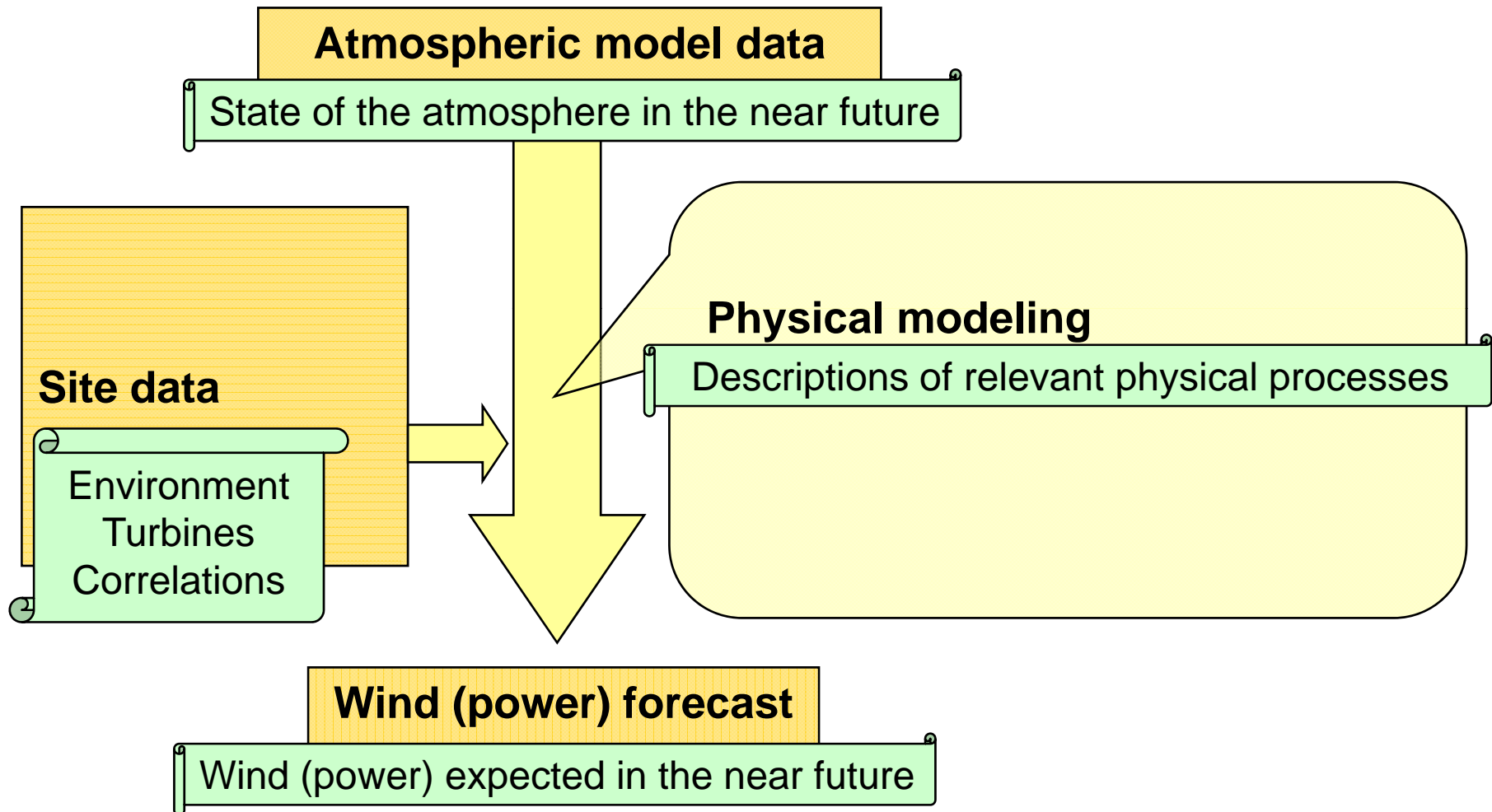


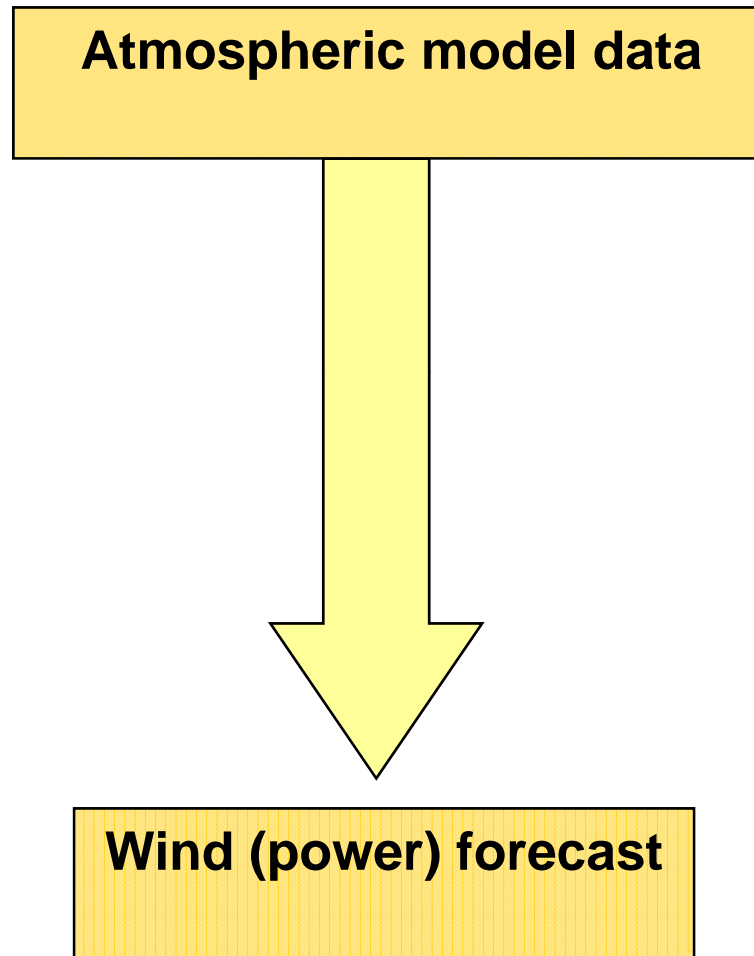


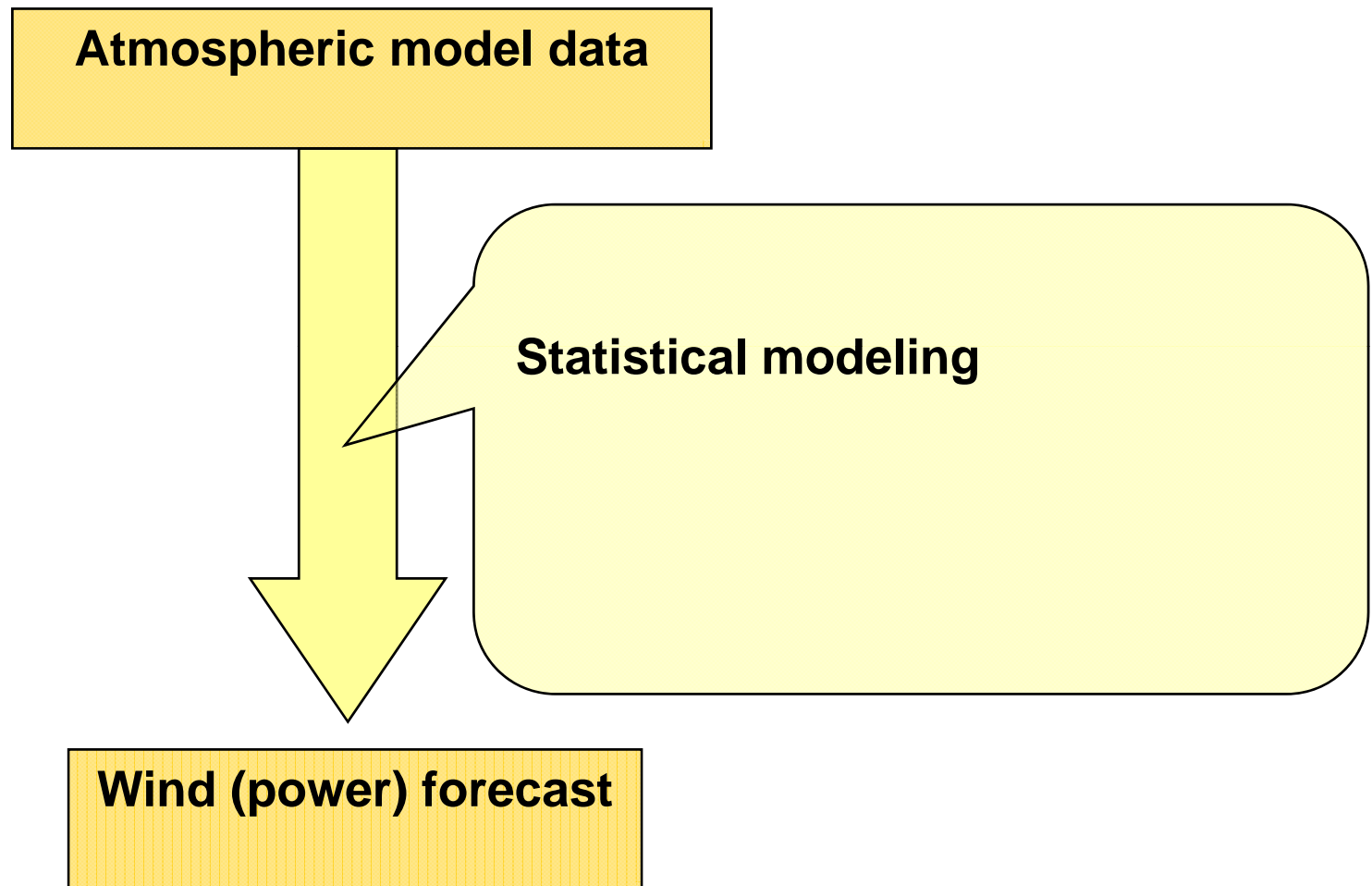


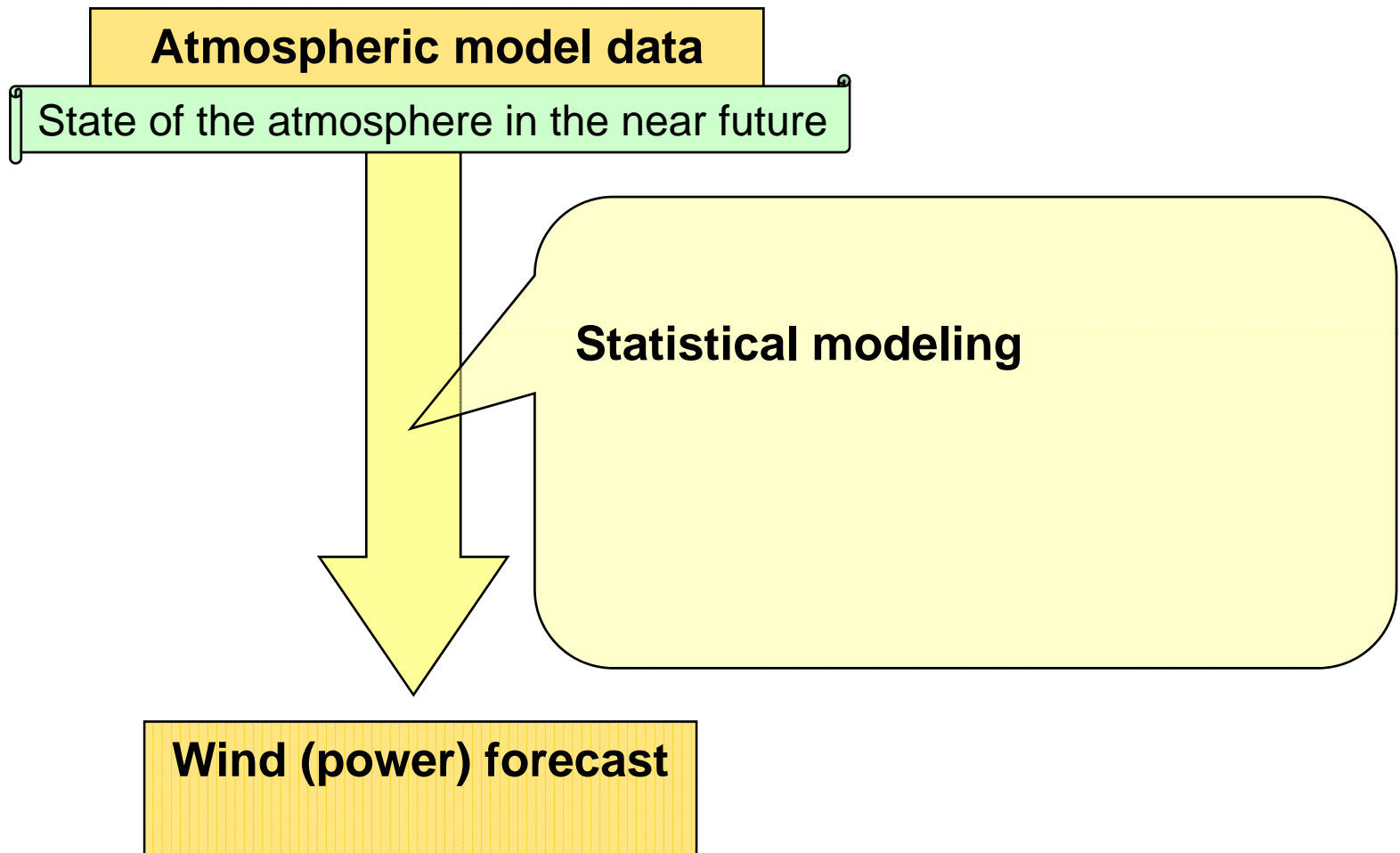


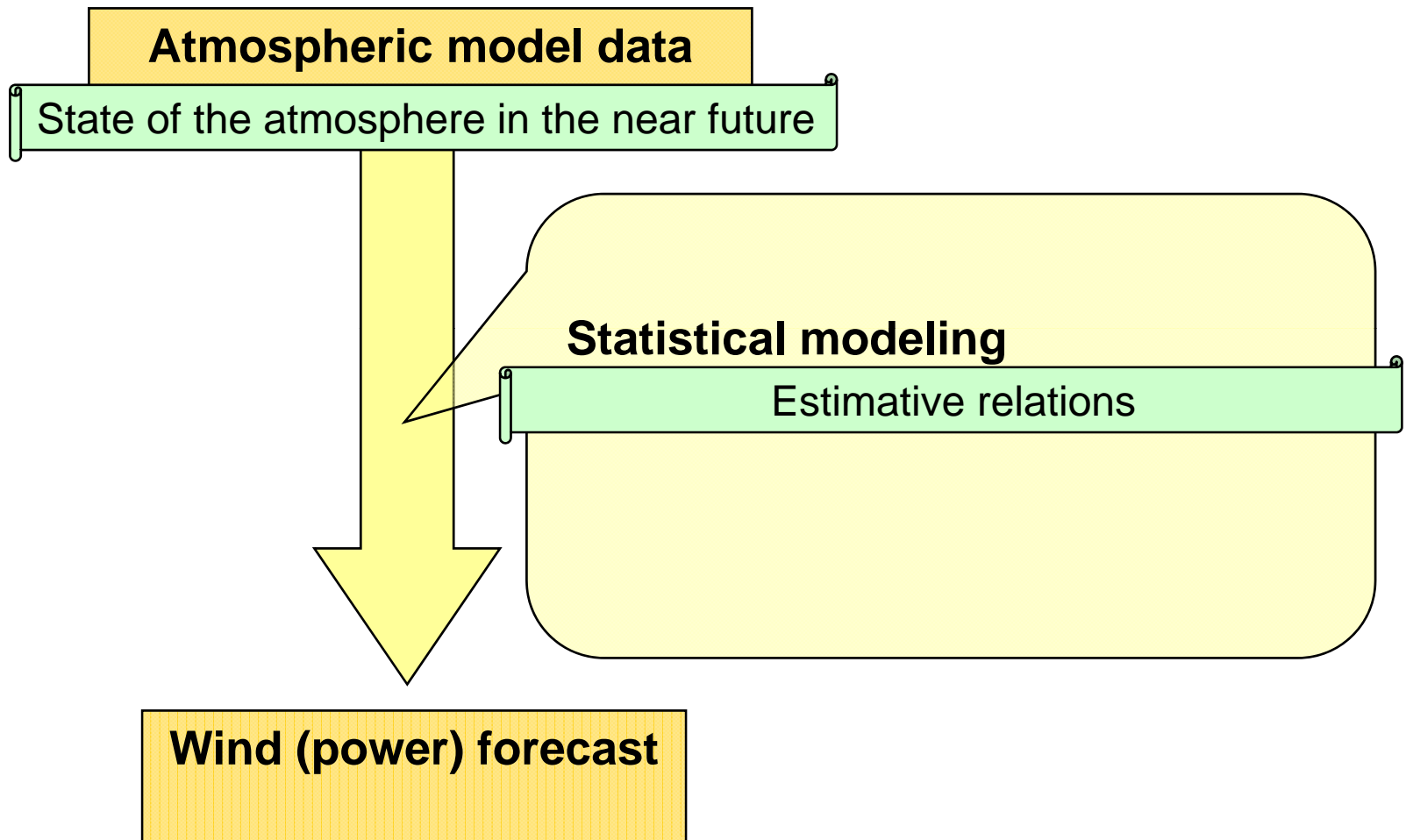


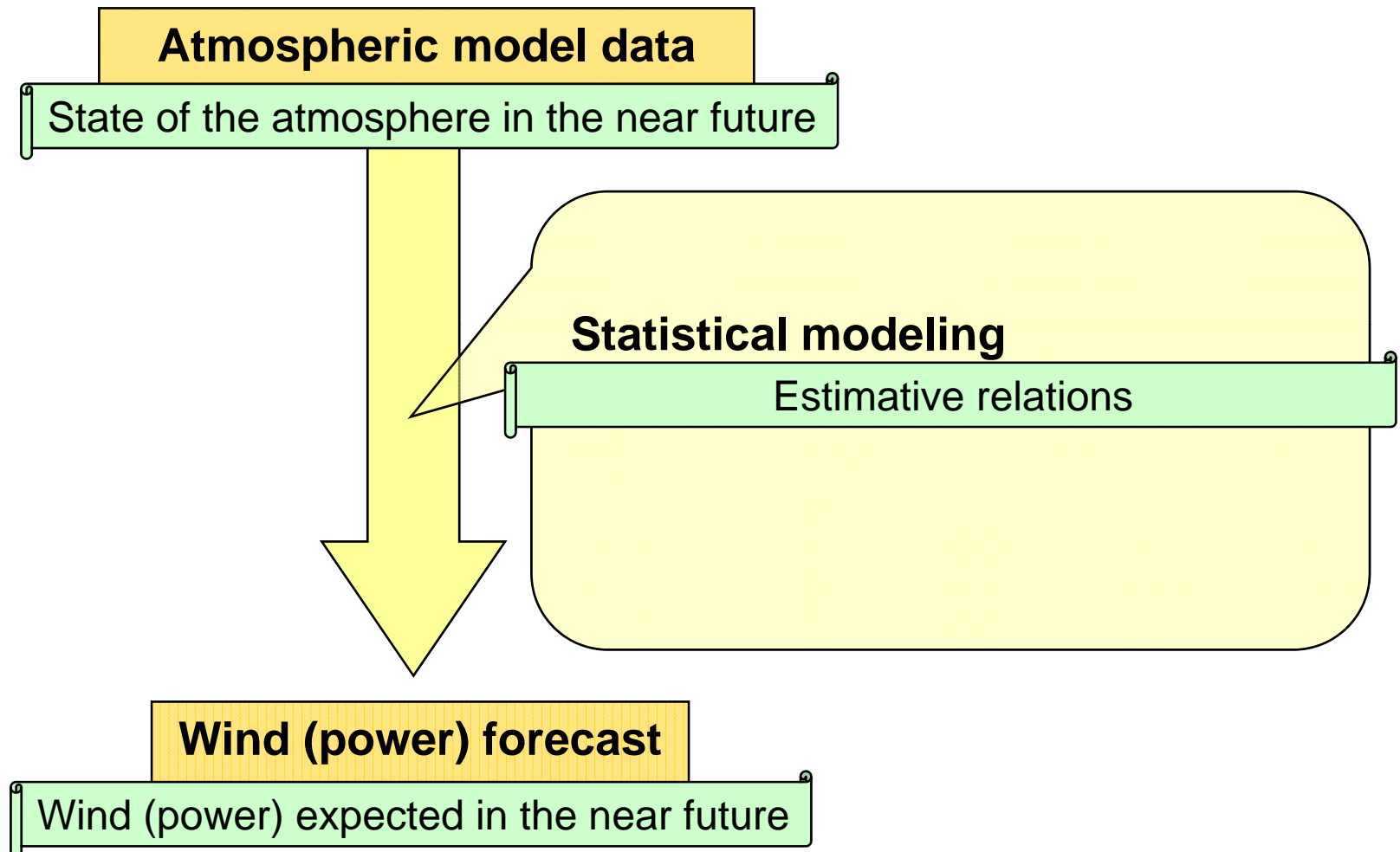


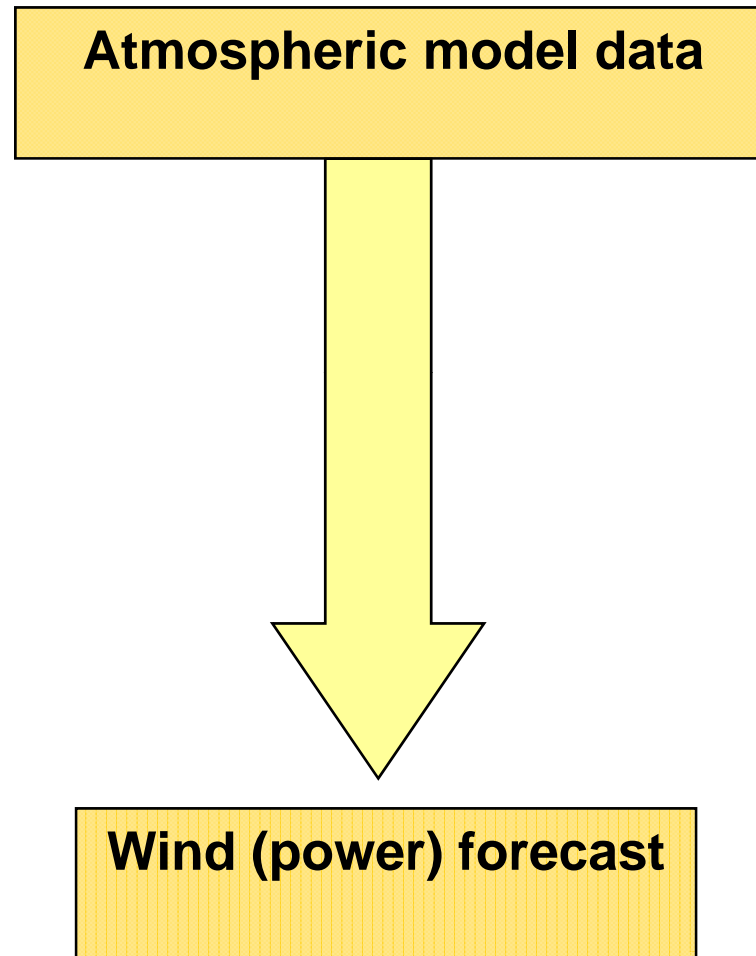






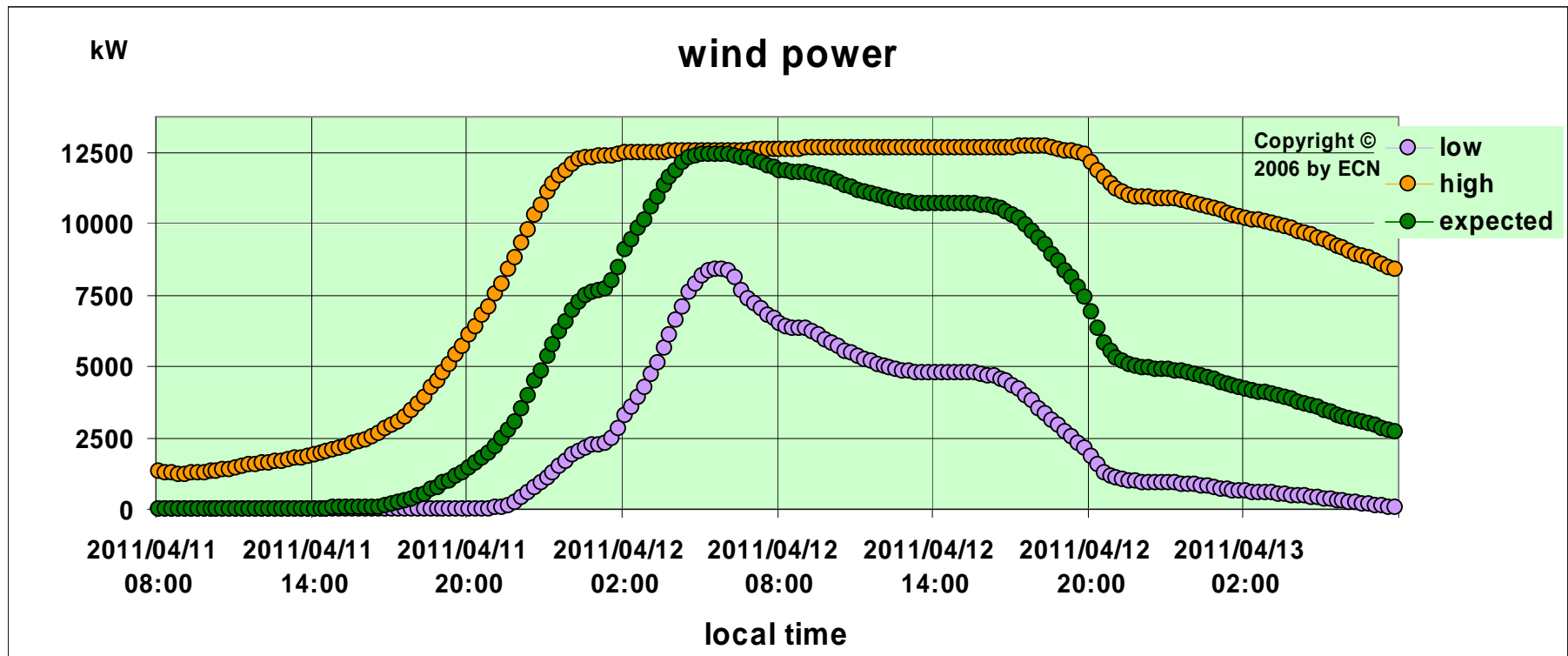


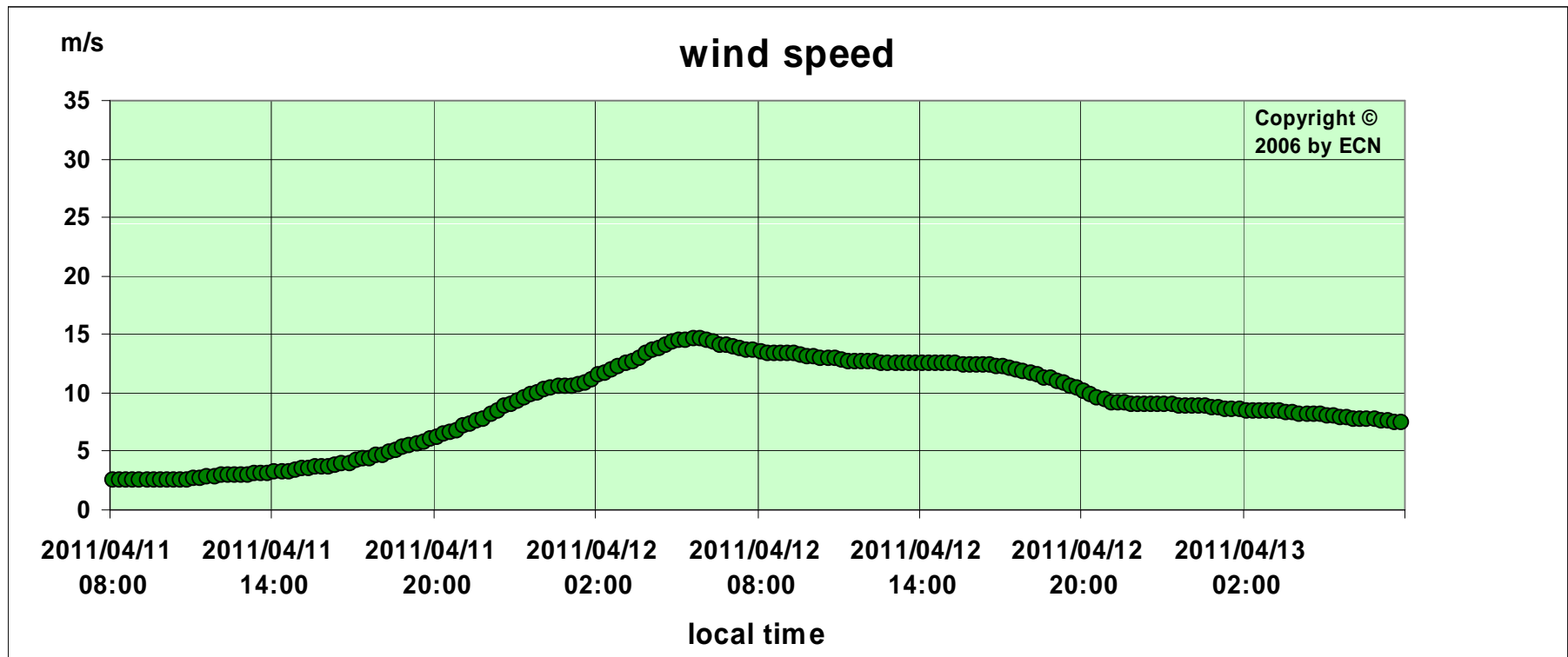


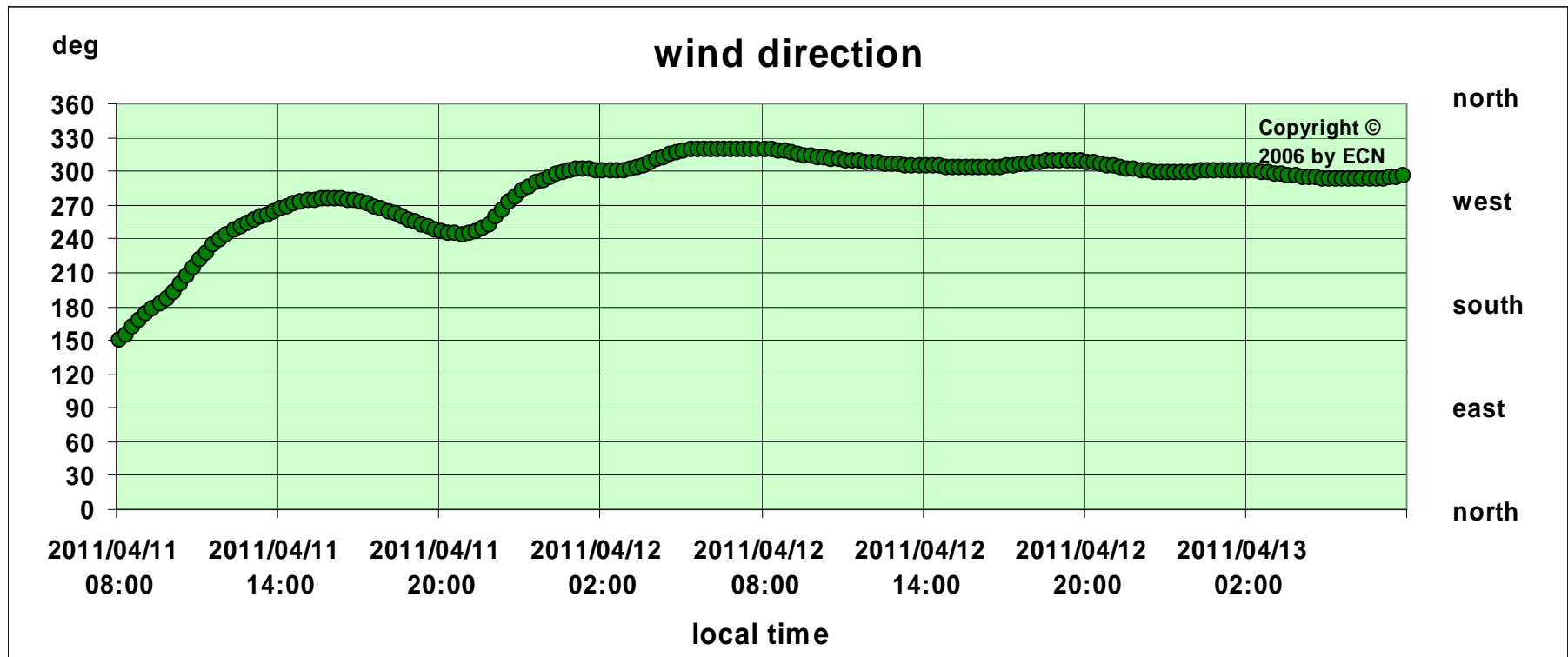


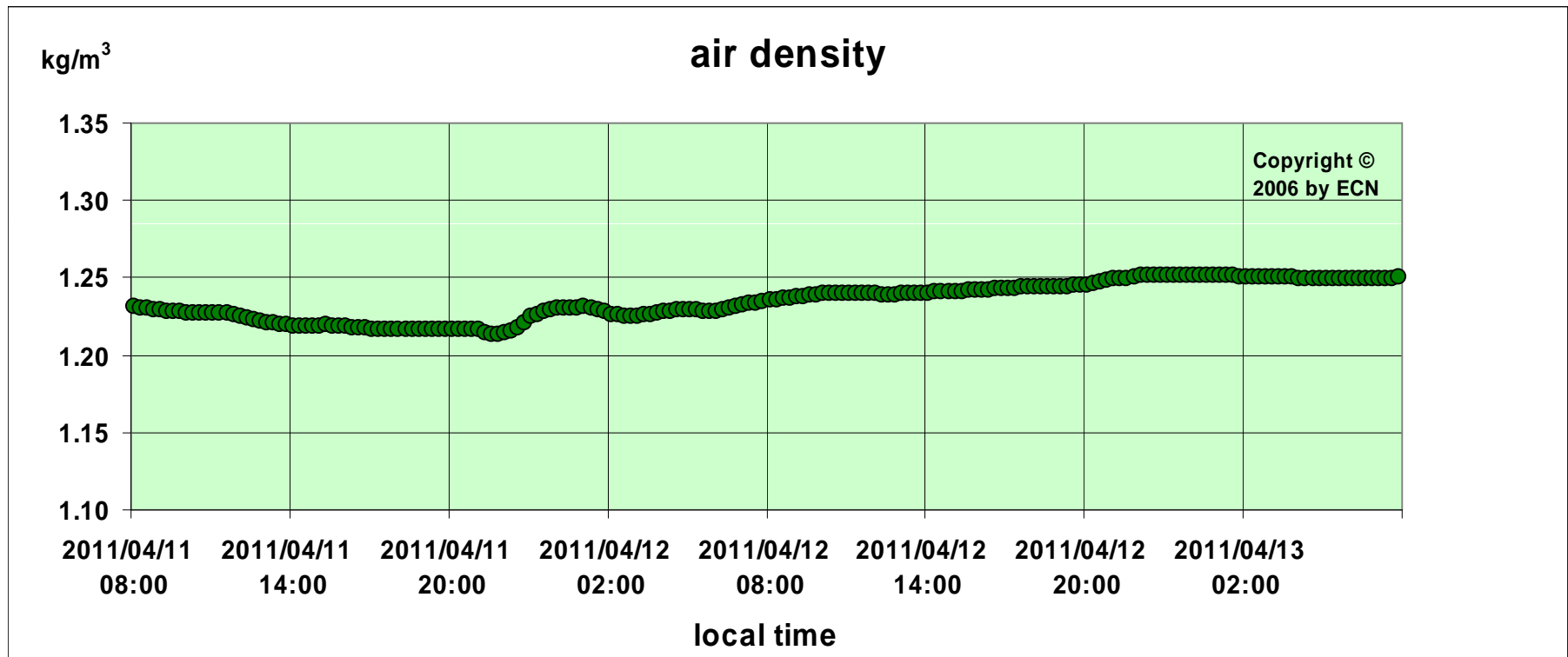
Prediktor Anemos WPPT  
GH Forecaster Ecofys  
3E Meteo Consult many more AVDE  
LocalPred eWind Forecasting Service  
Aeolis Forecasting Services HirPom  
Previento Regional Wind Power Prediction

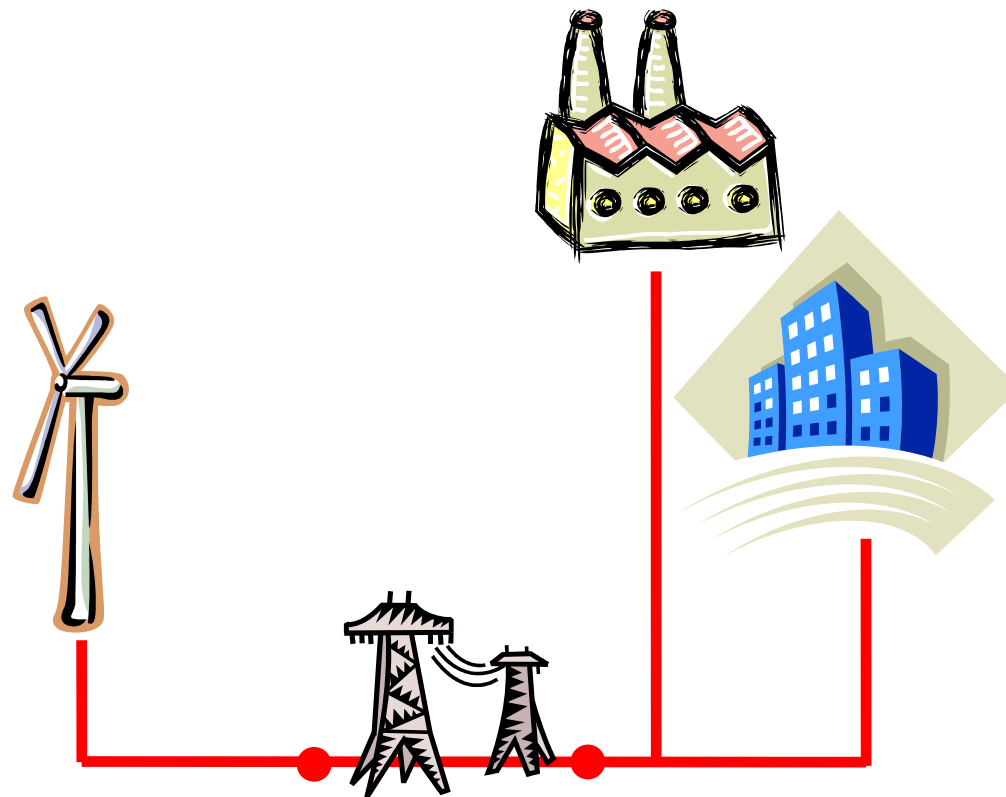




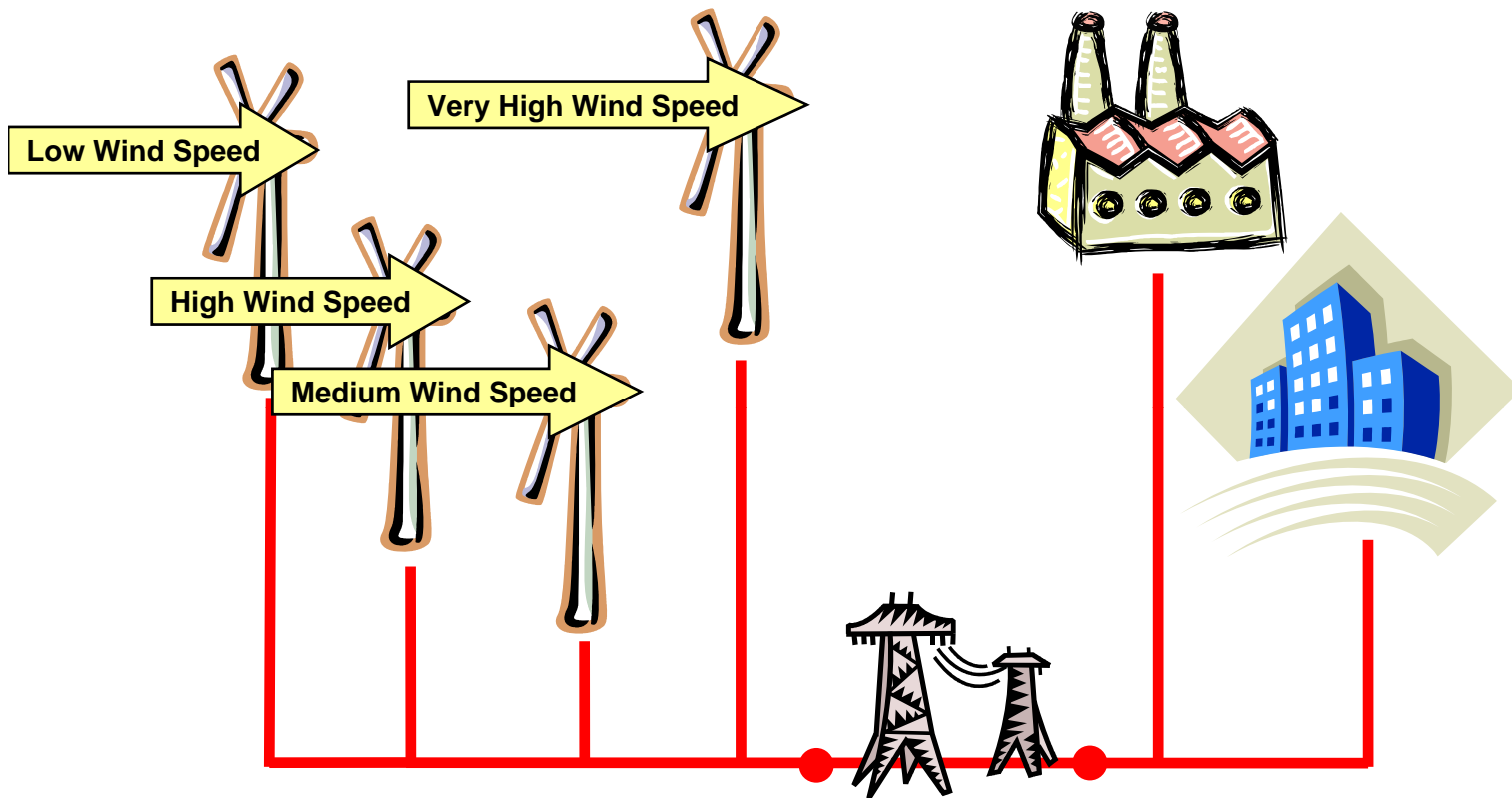




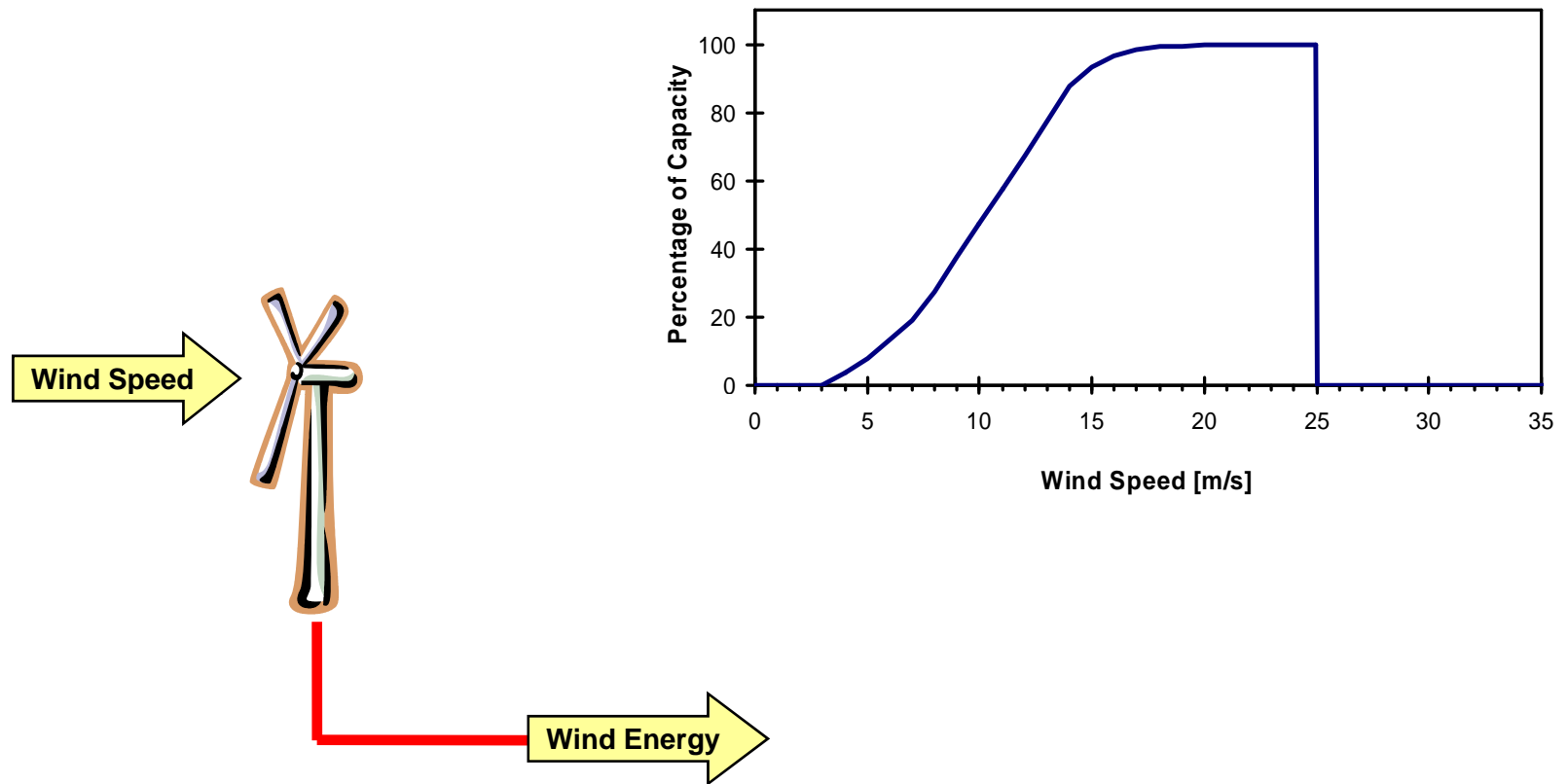


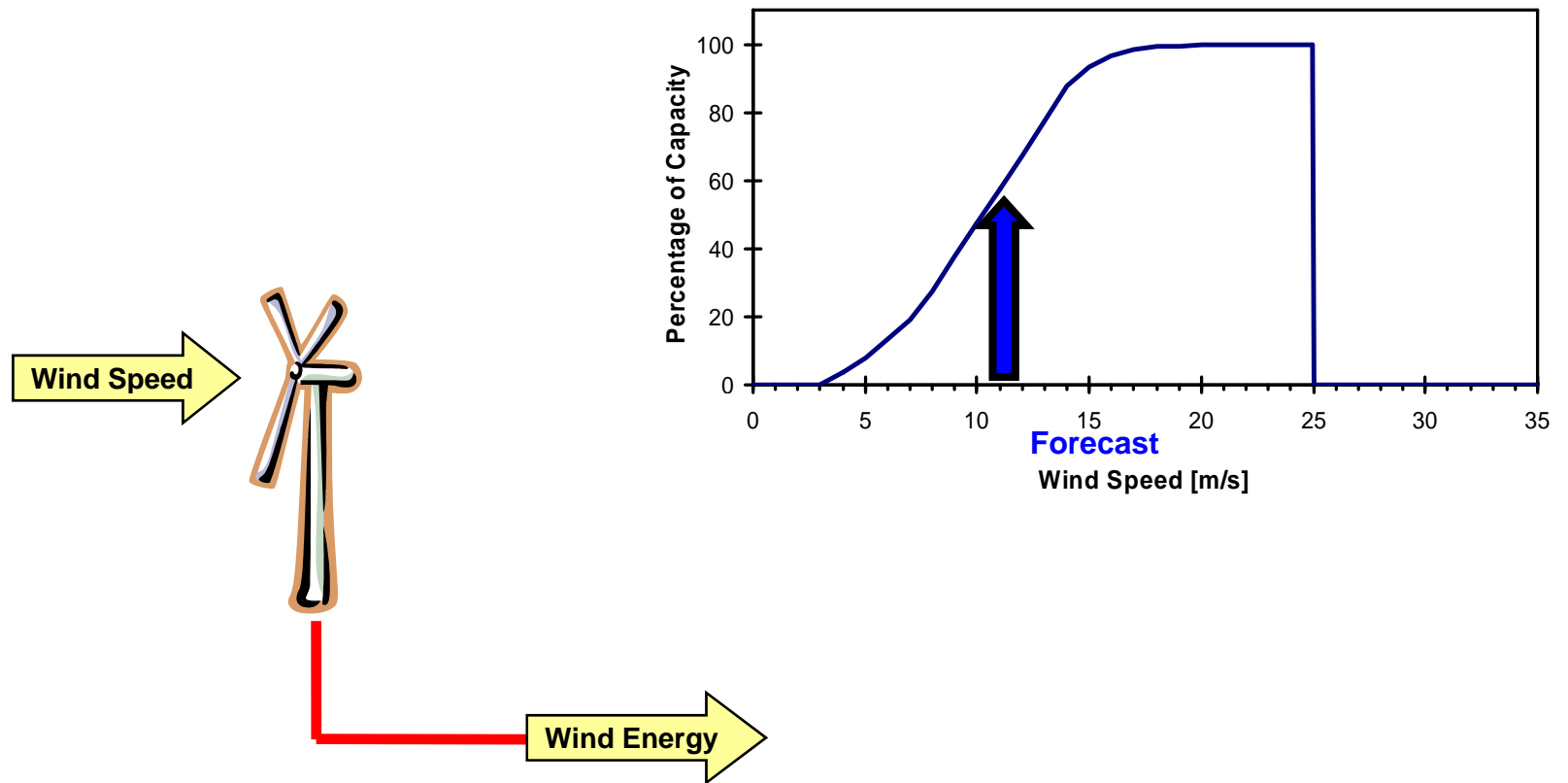


**Energy from a single wind turbine fluctuates considerably**

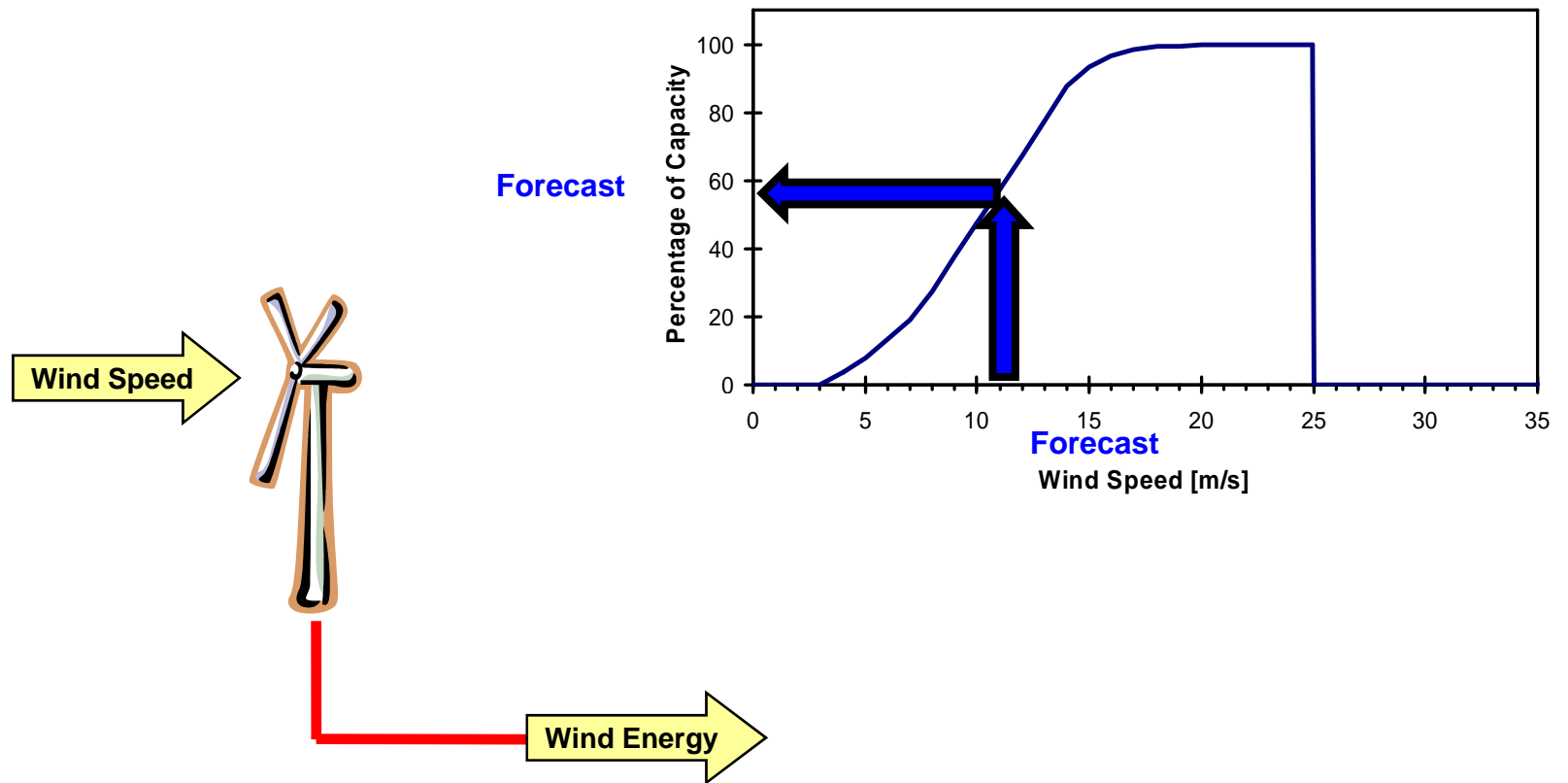


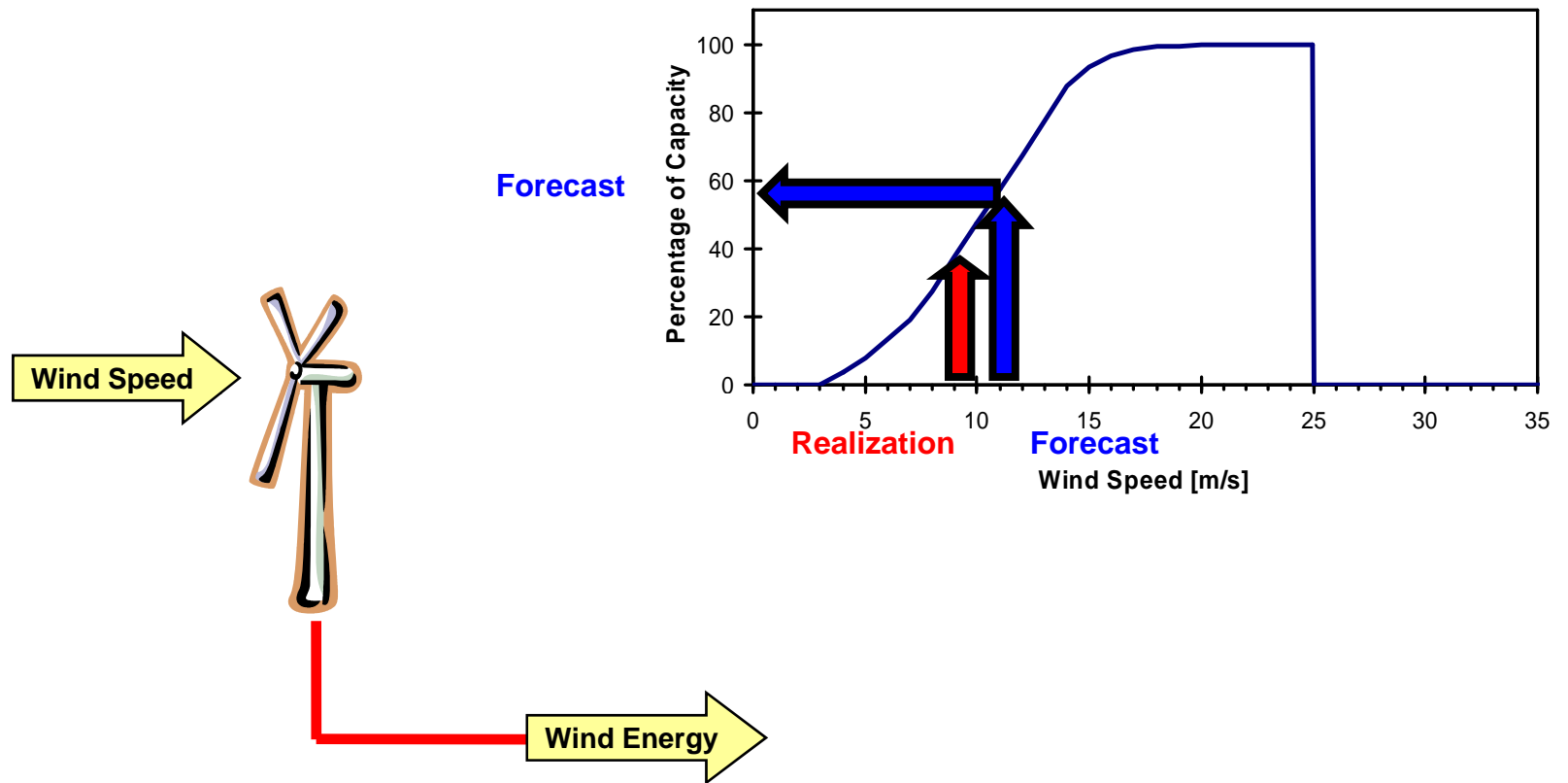
**Dispersion of wind turbines smooths fluctuations**

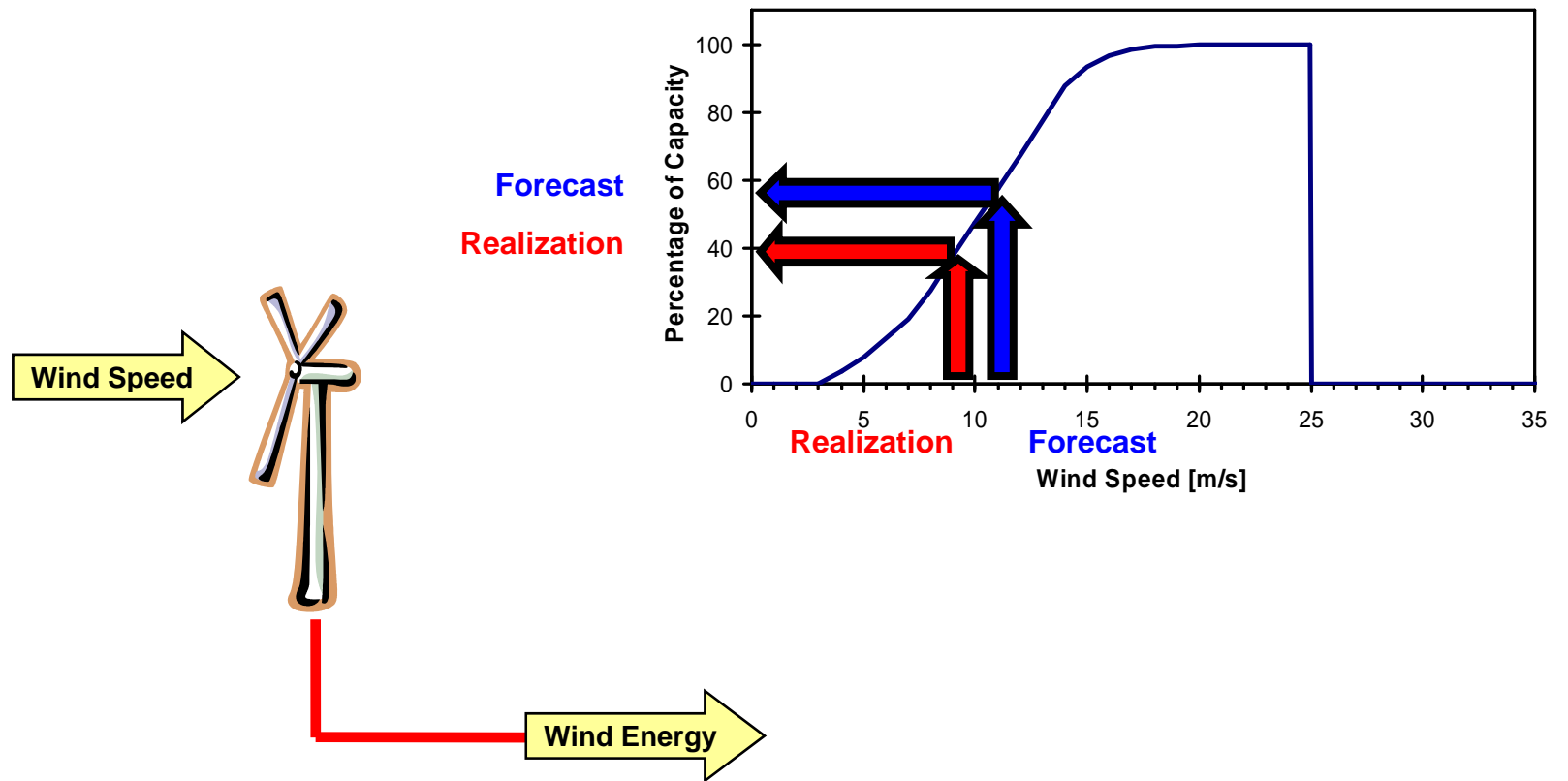


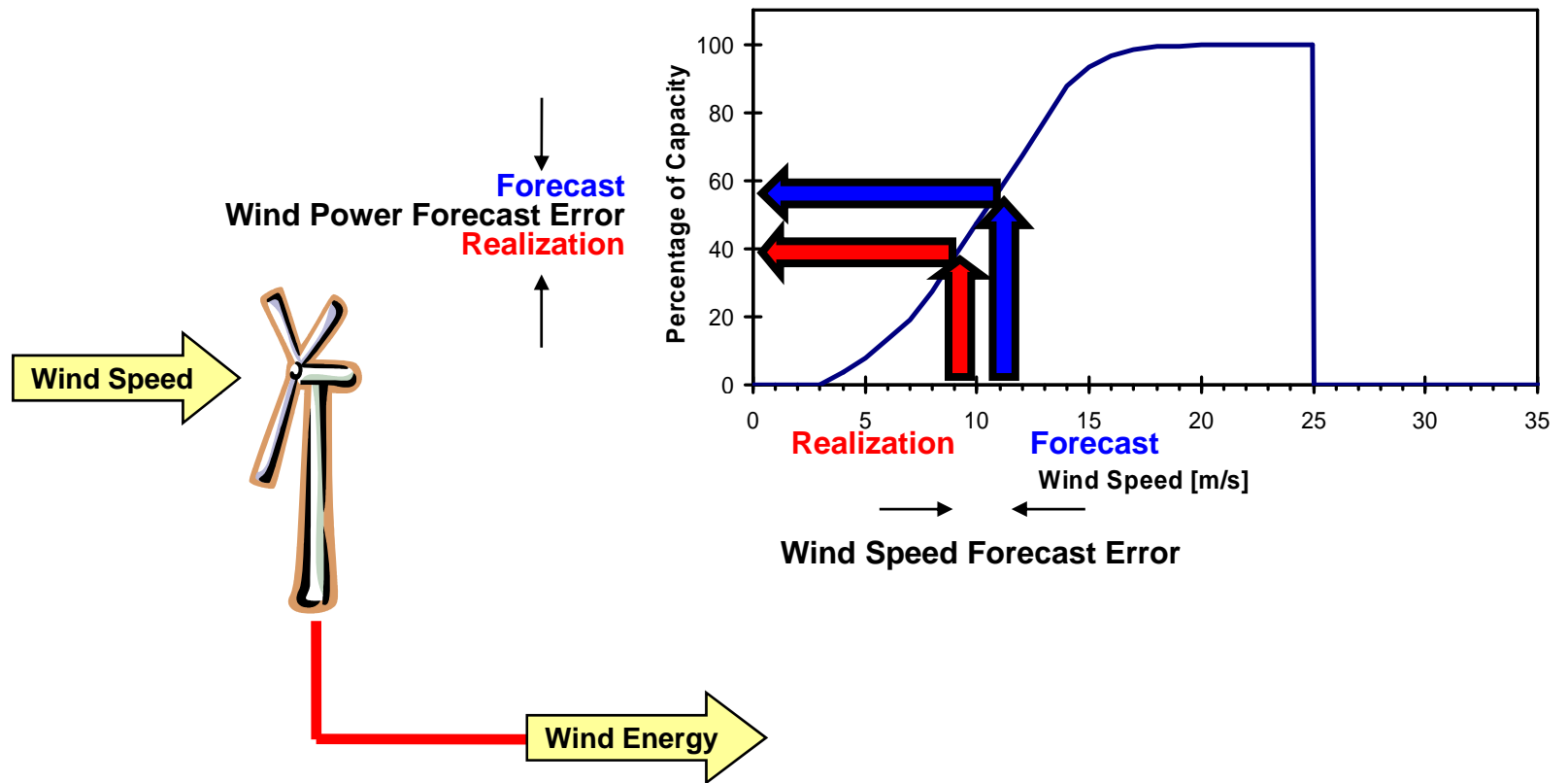


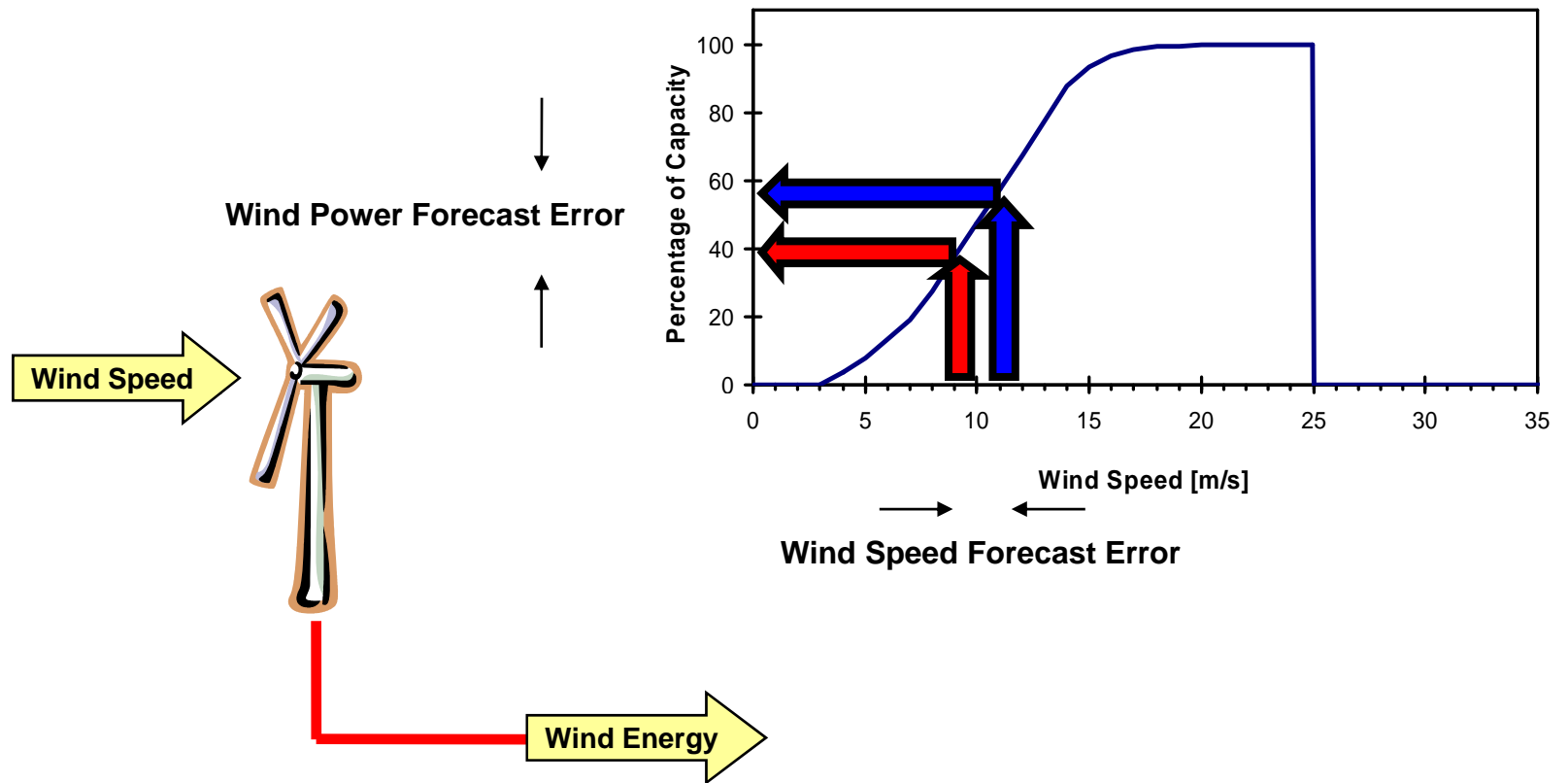


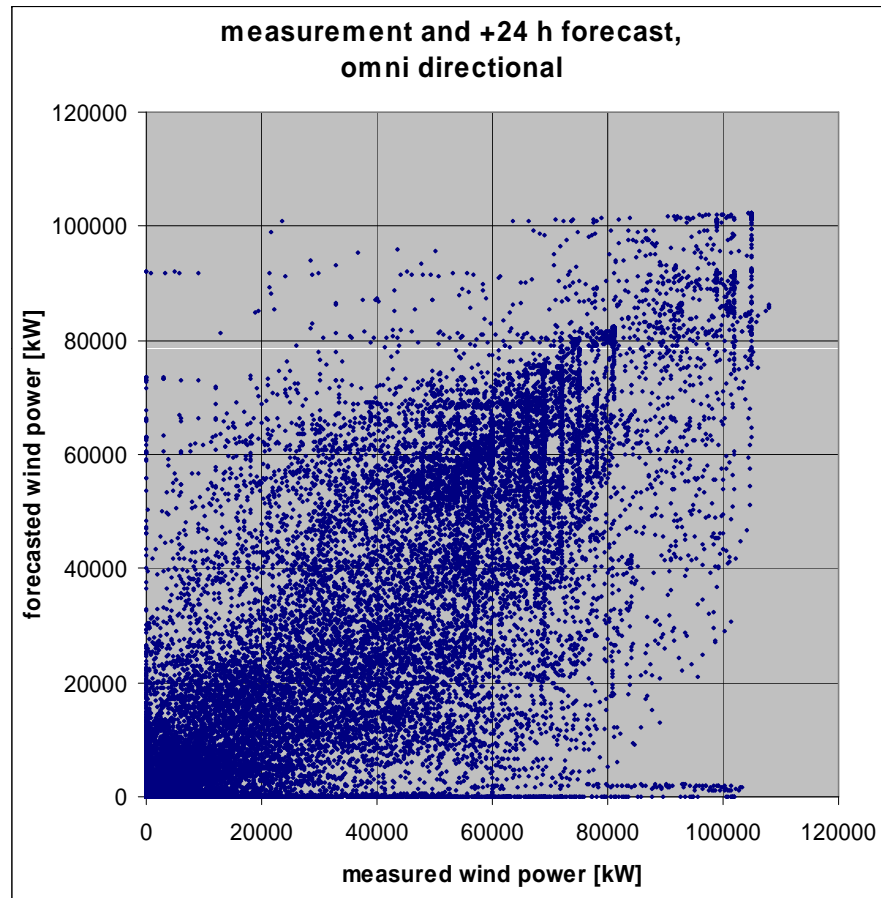


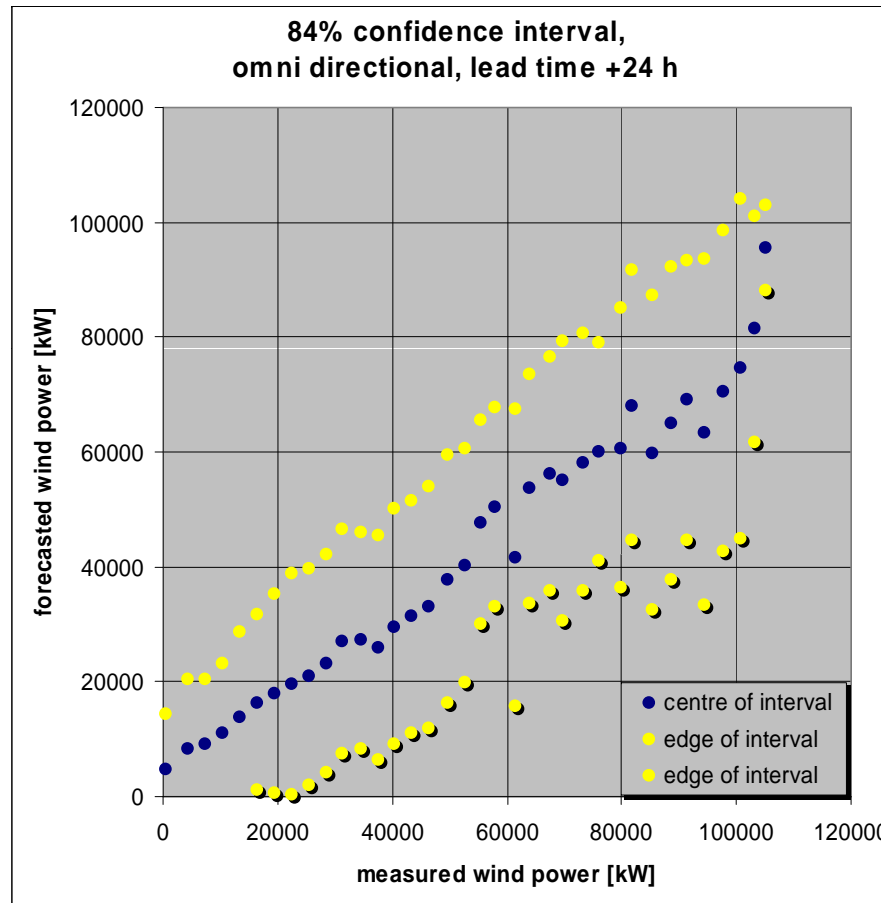


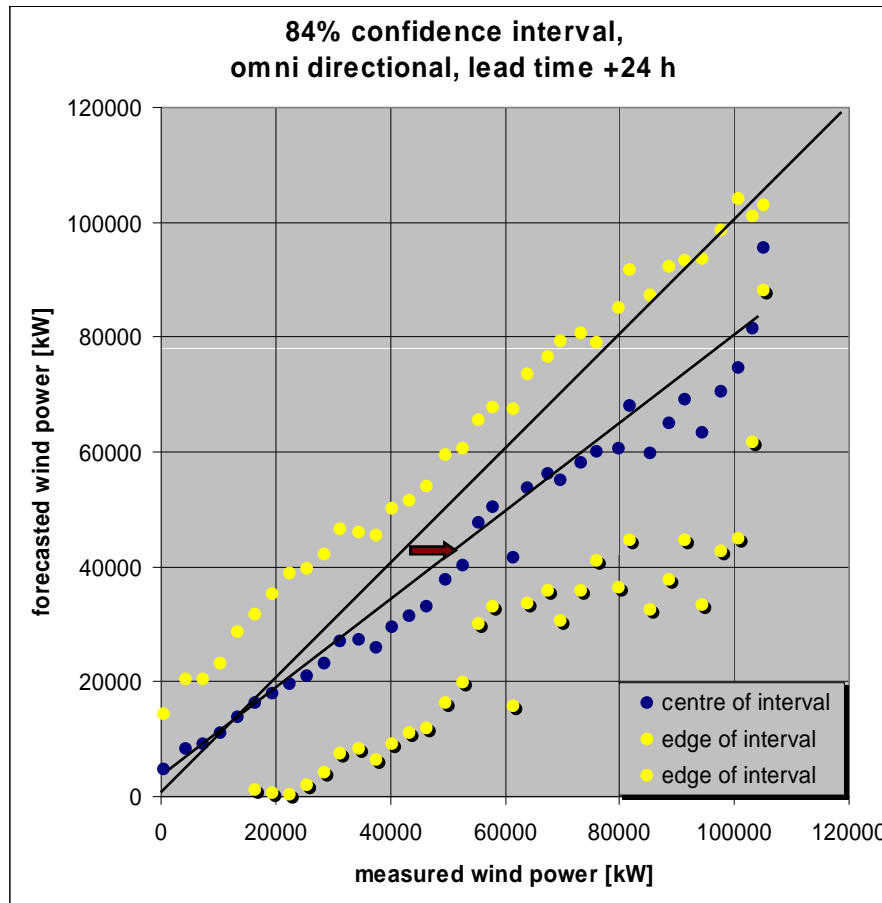






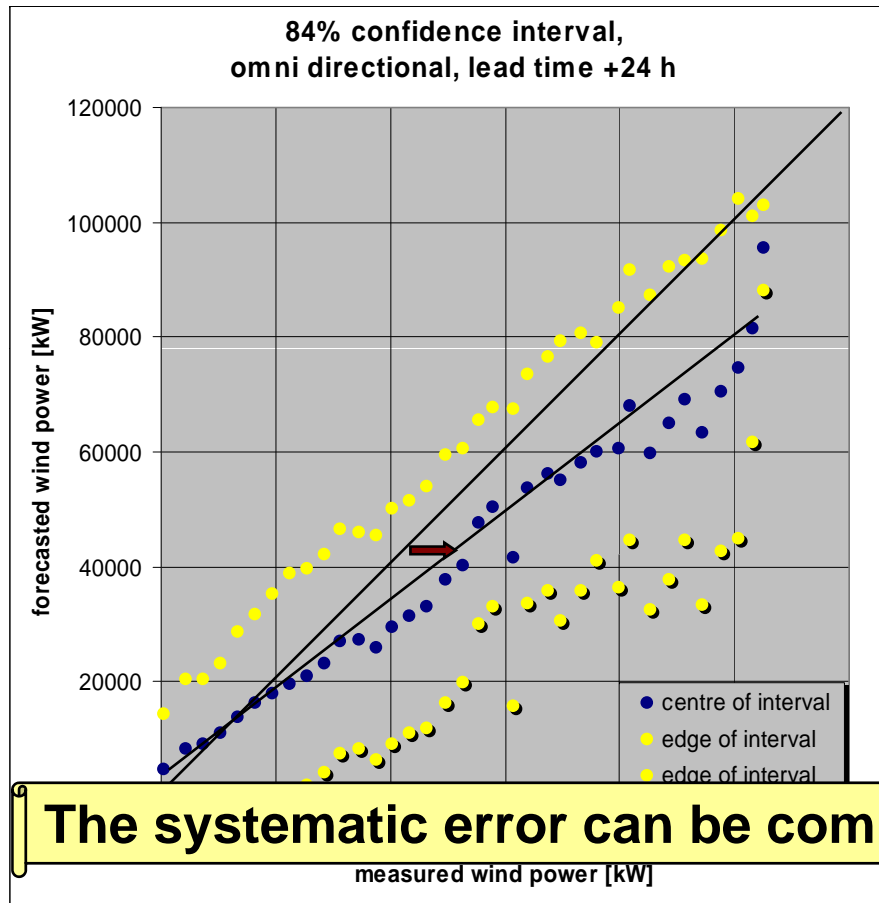




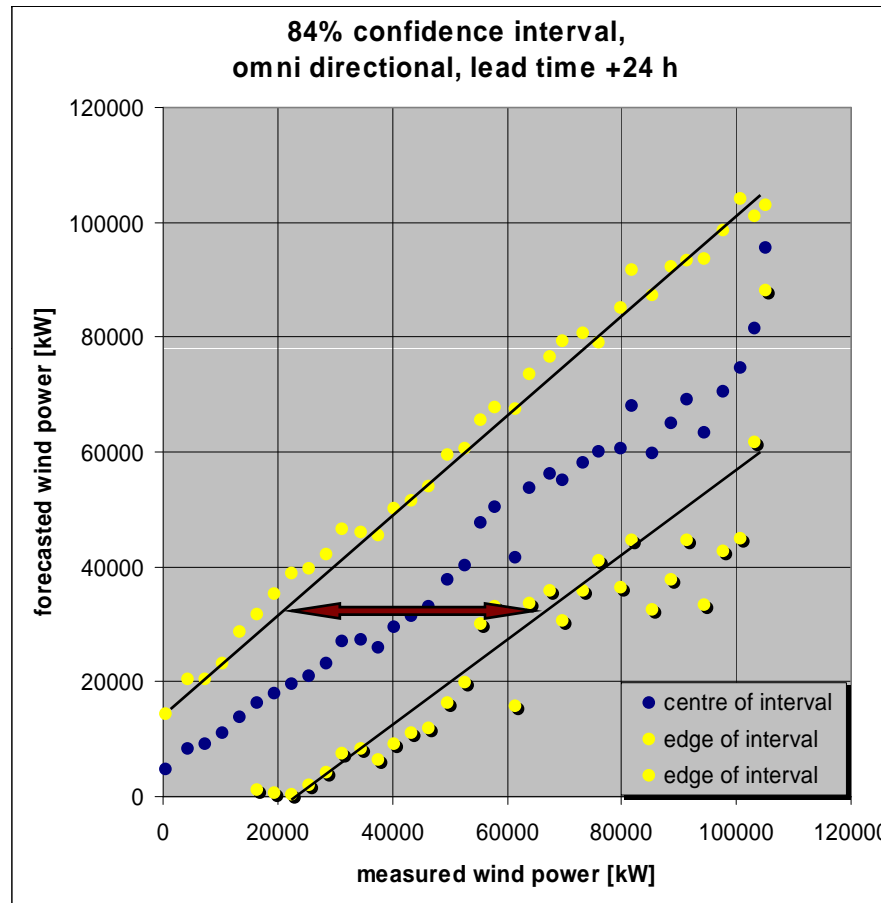


Systematic error

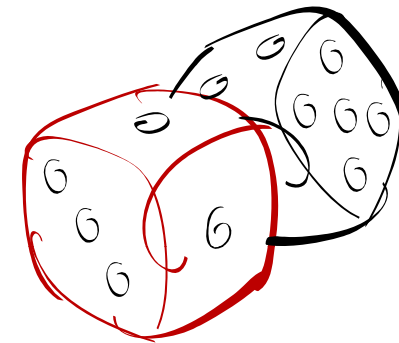
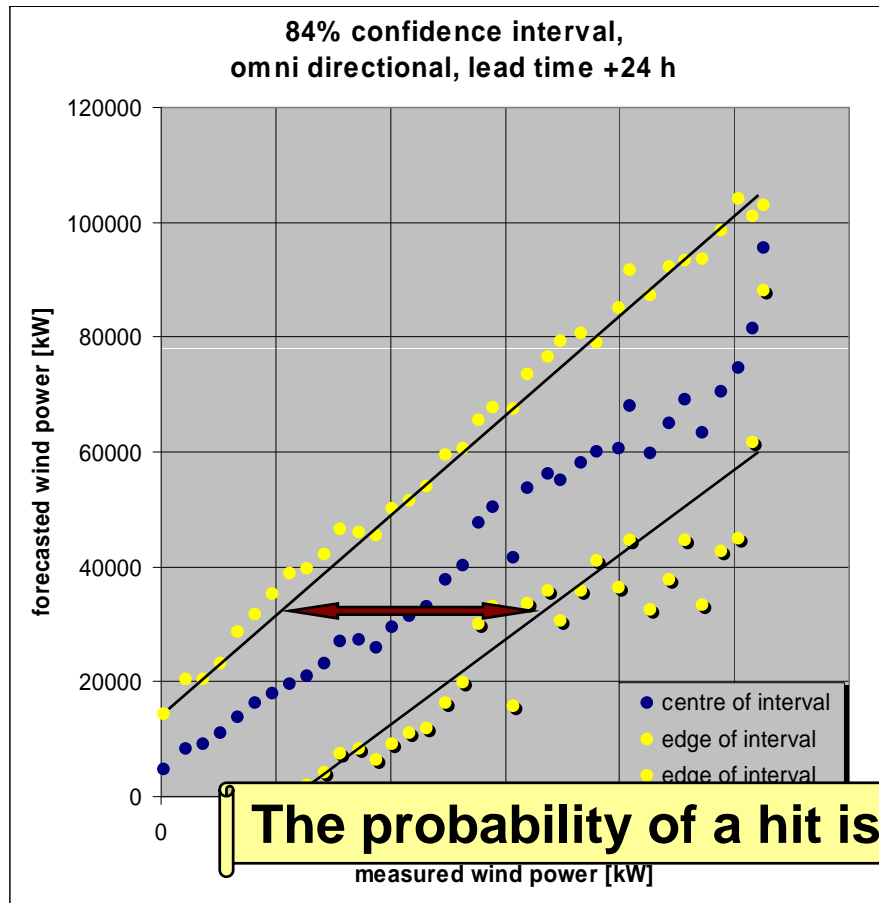




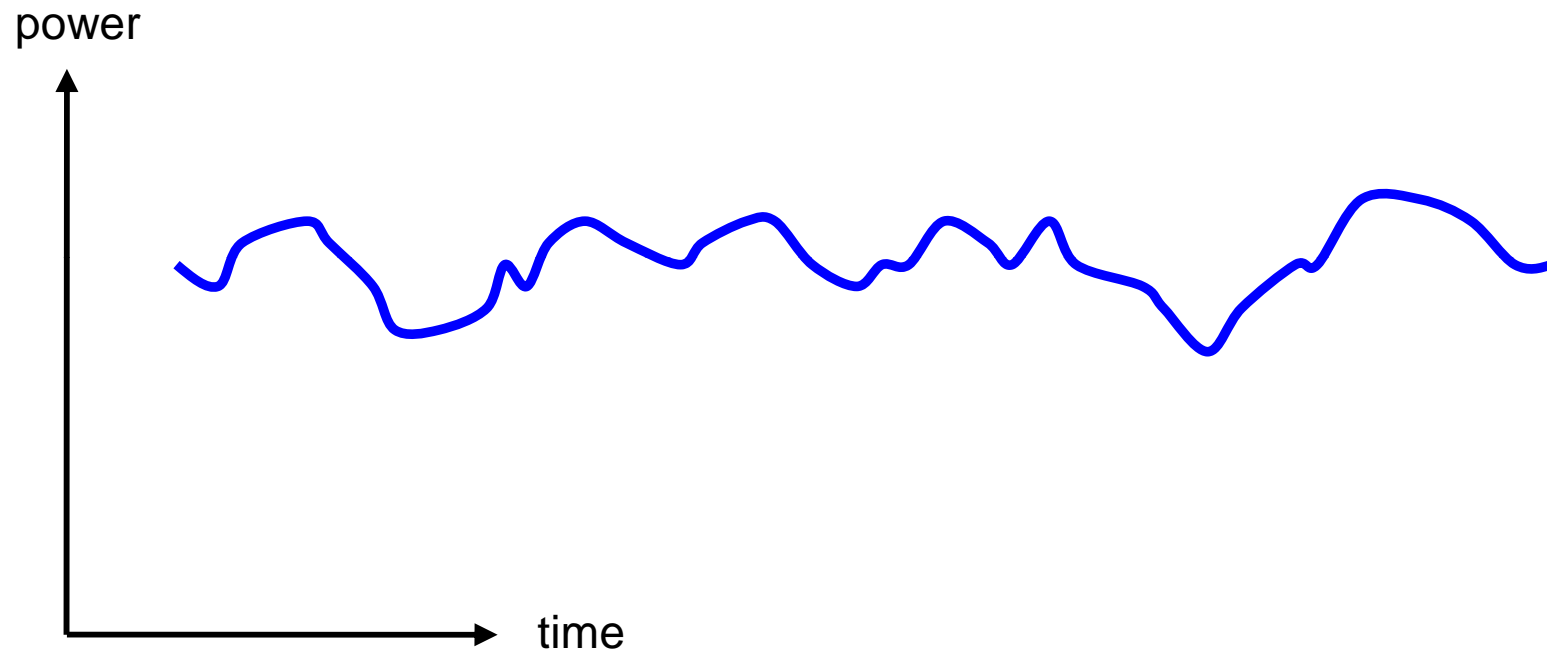
Systematic error



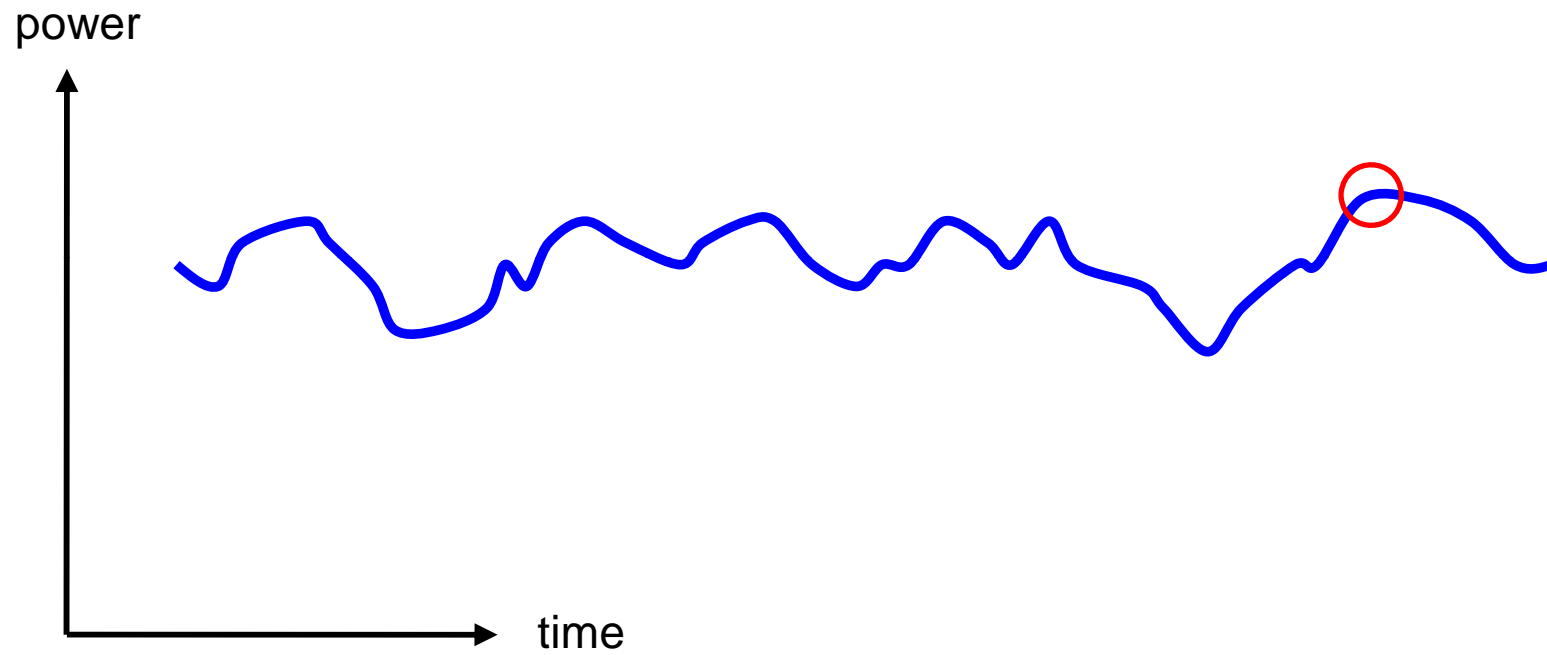
Random error

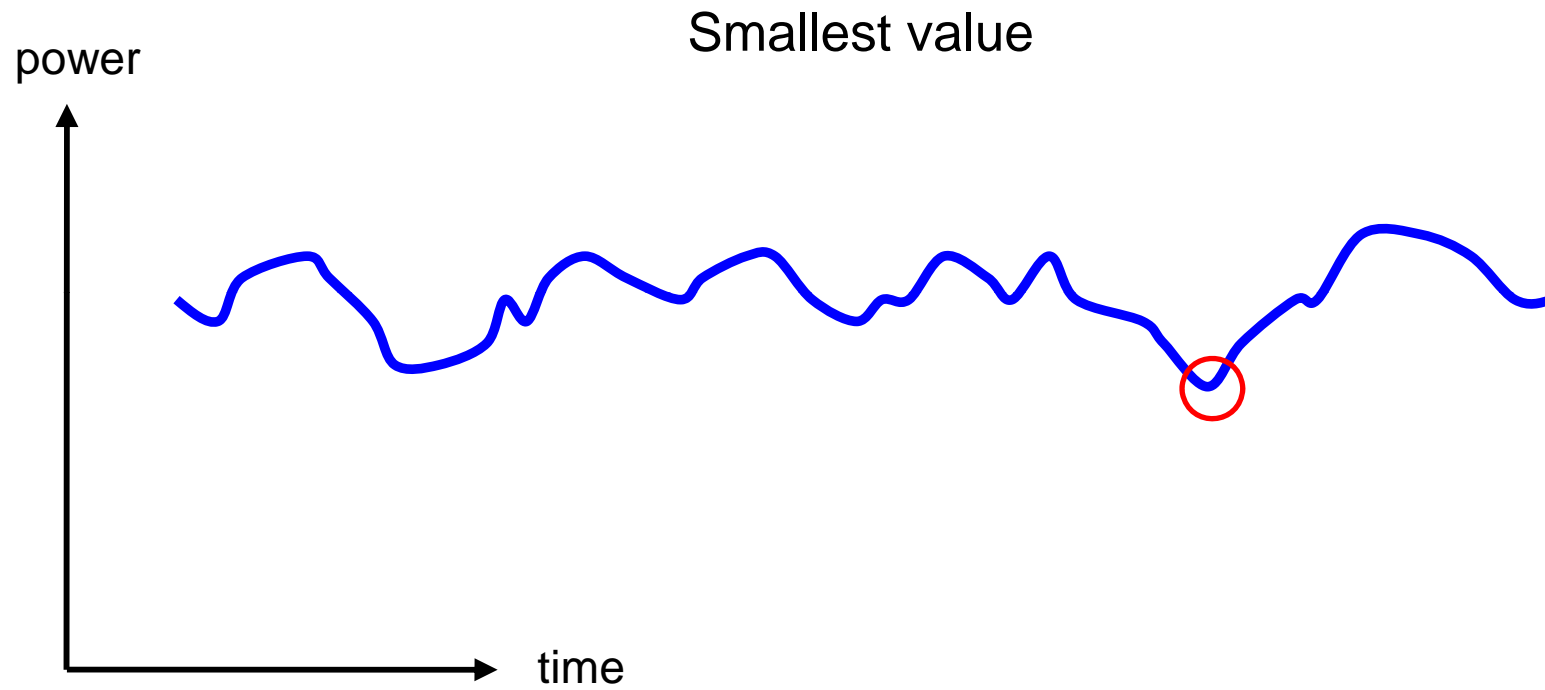


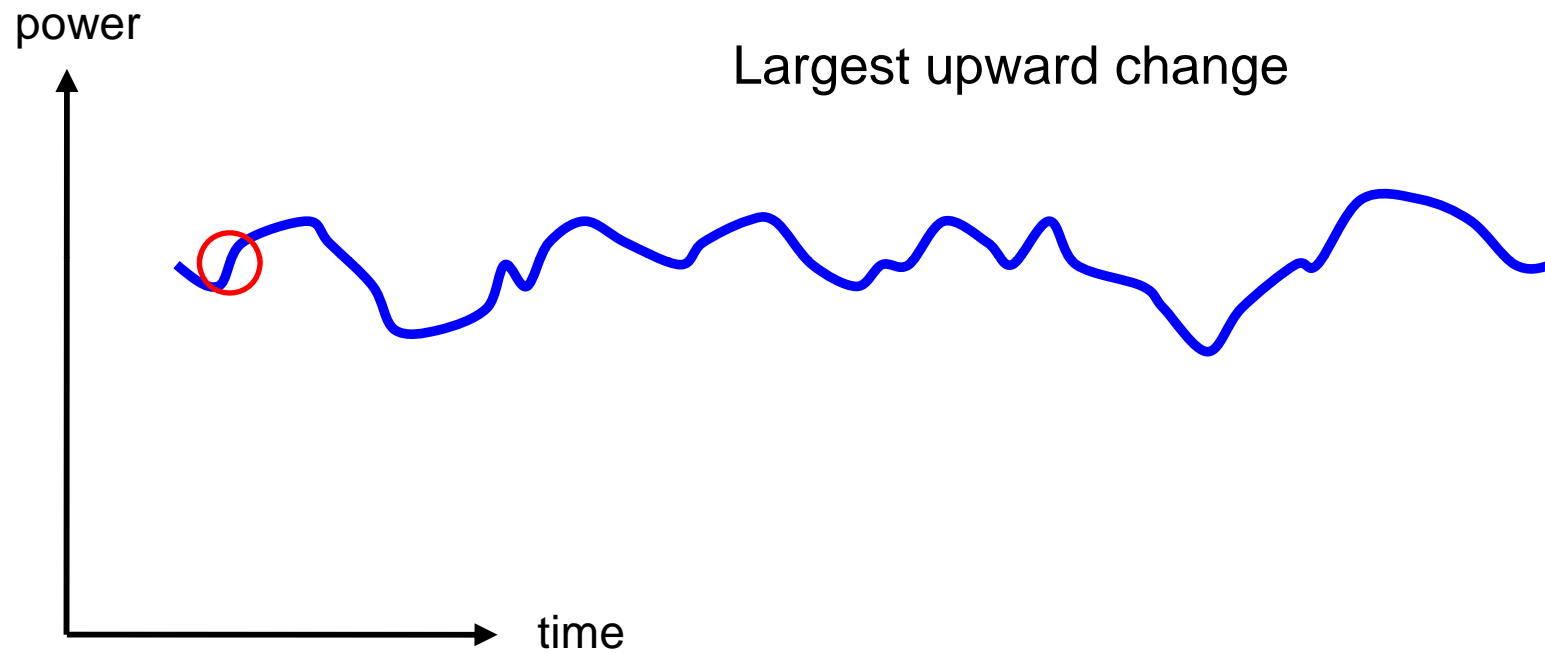
Random error

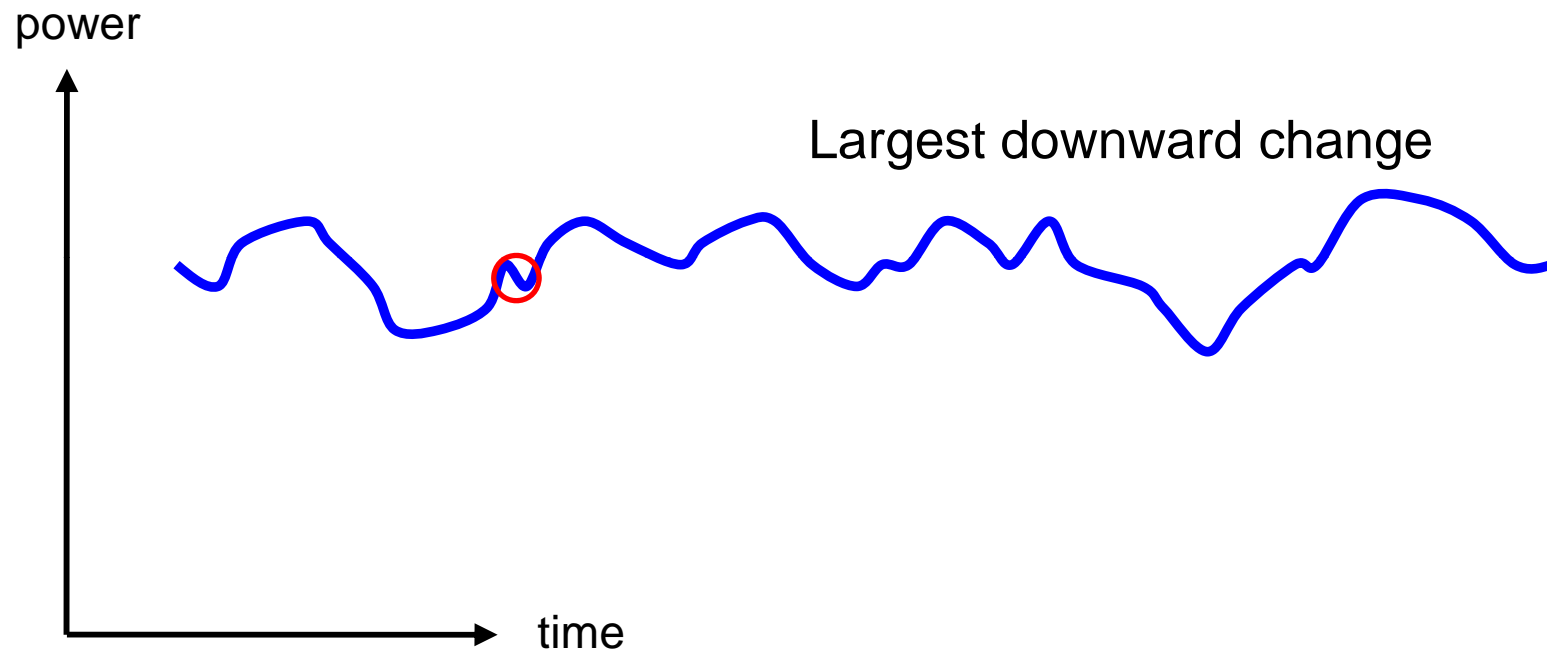


Largest value

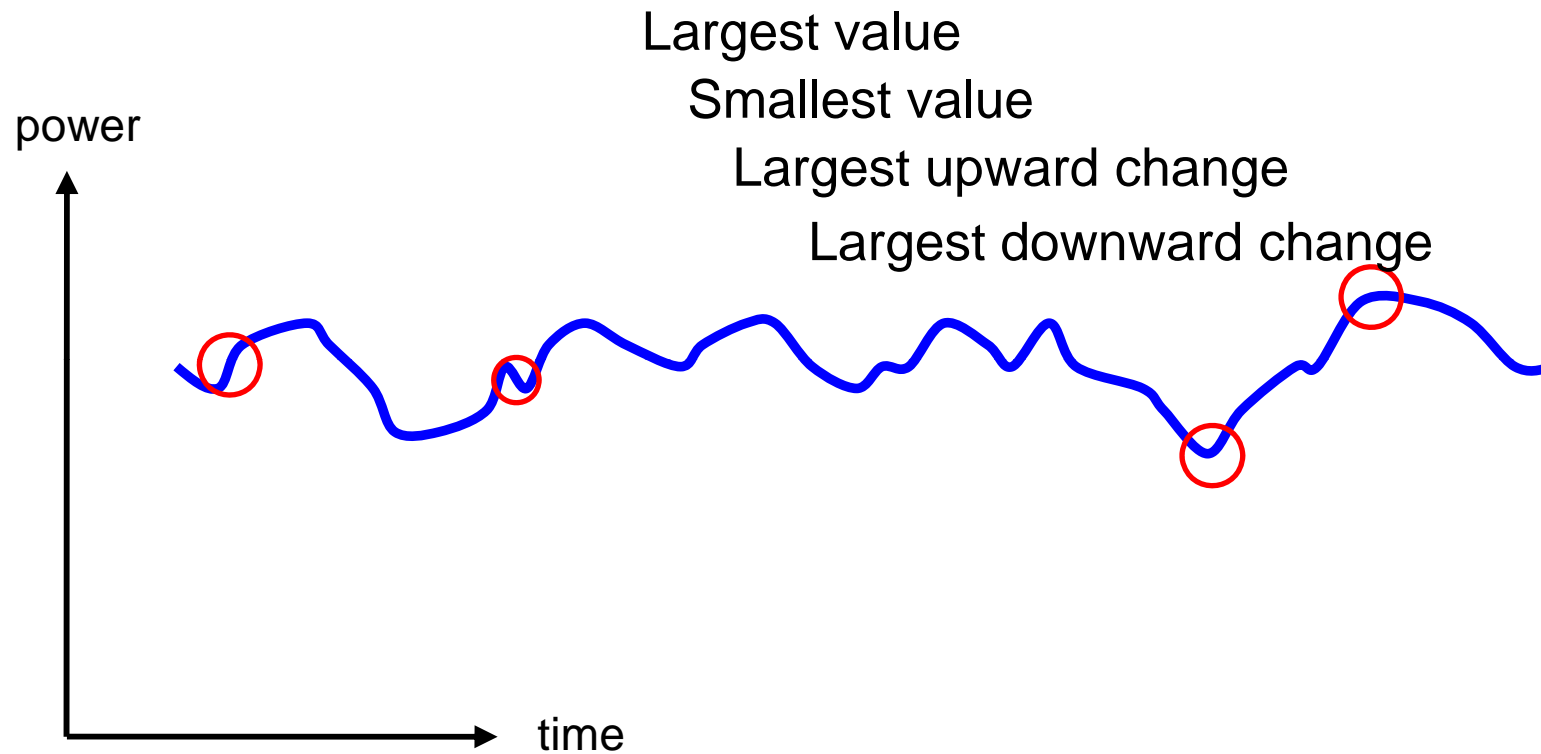




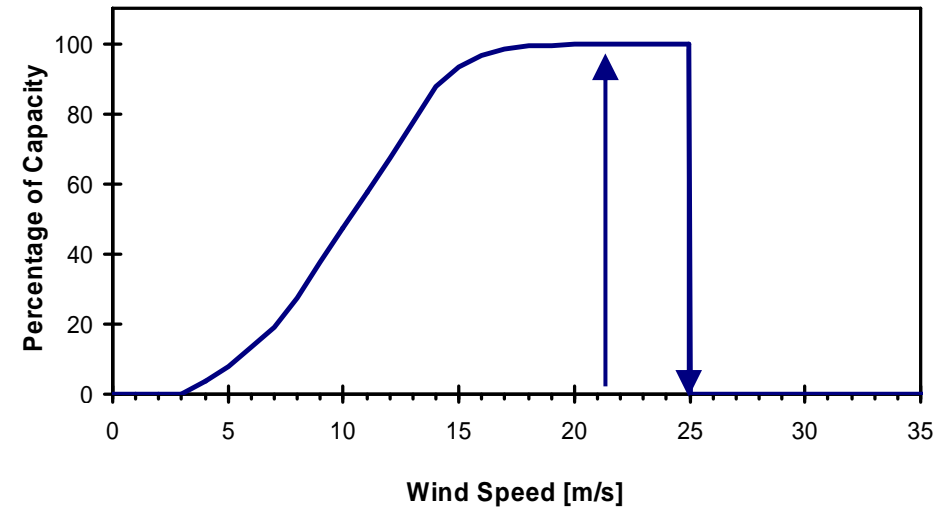


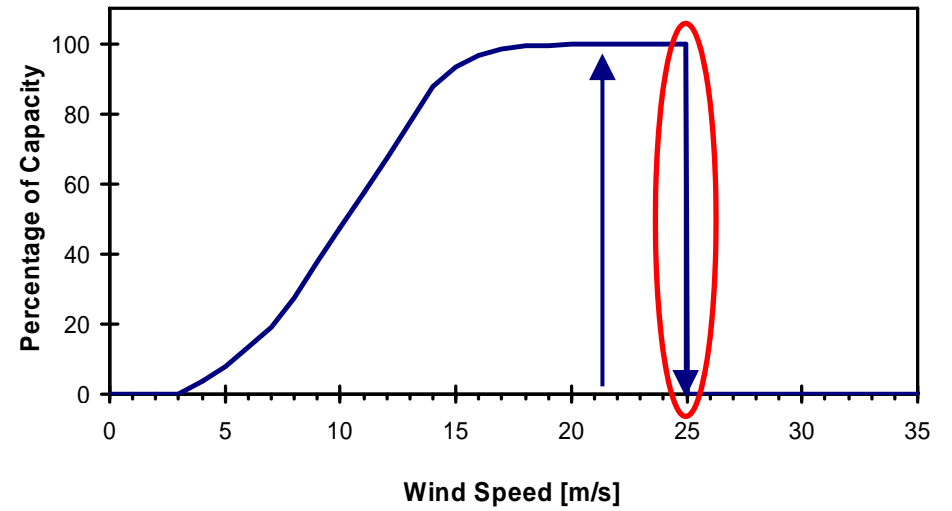




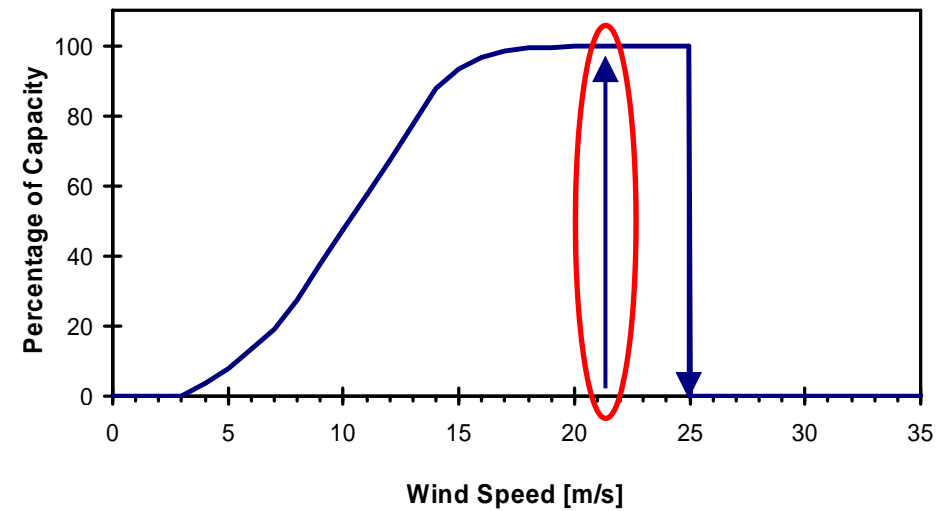


**Extremes are hard to predict**

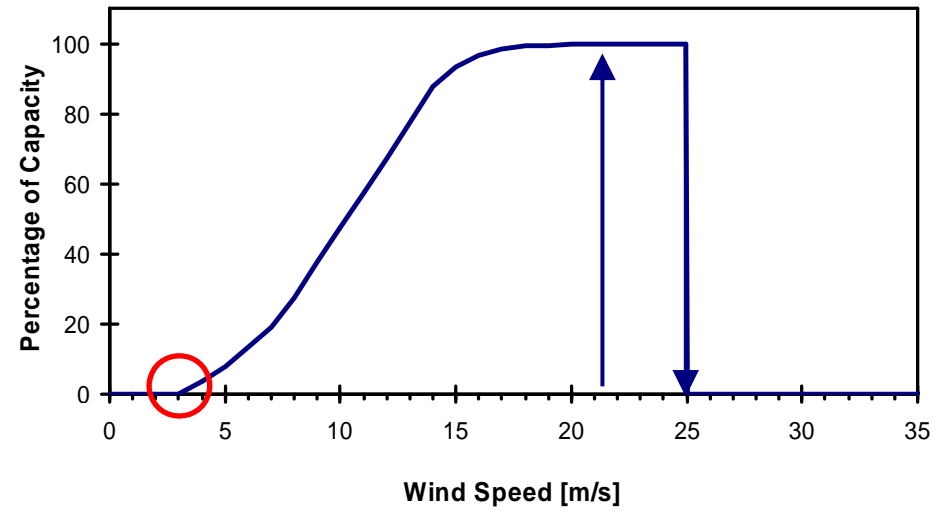




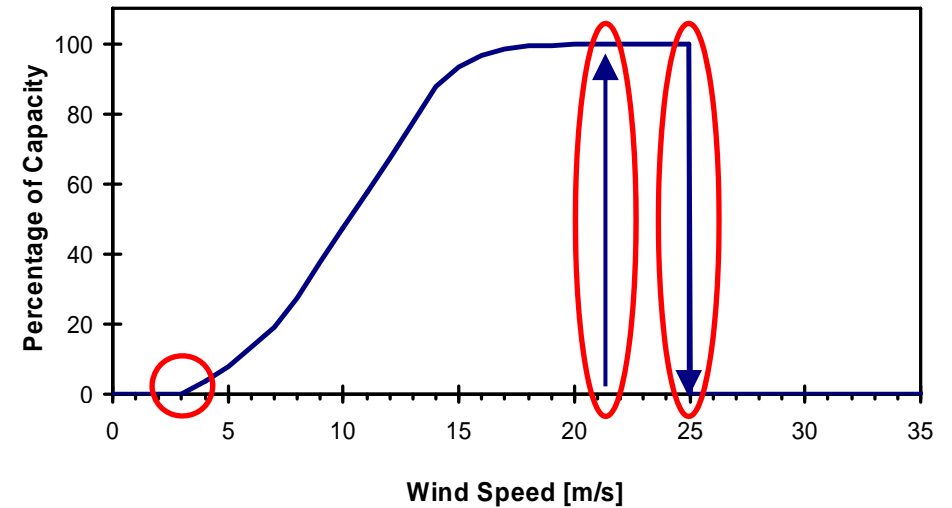
High-wind-speed cut-out



High-wind-speed cut-in



Low-wind-speed cut-in

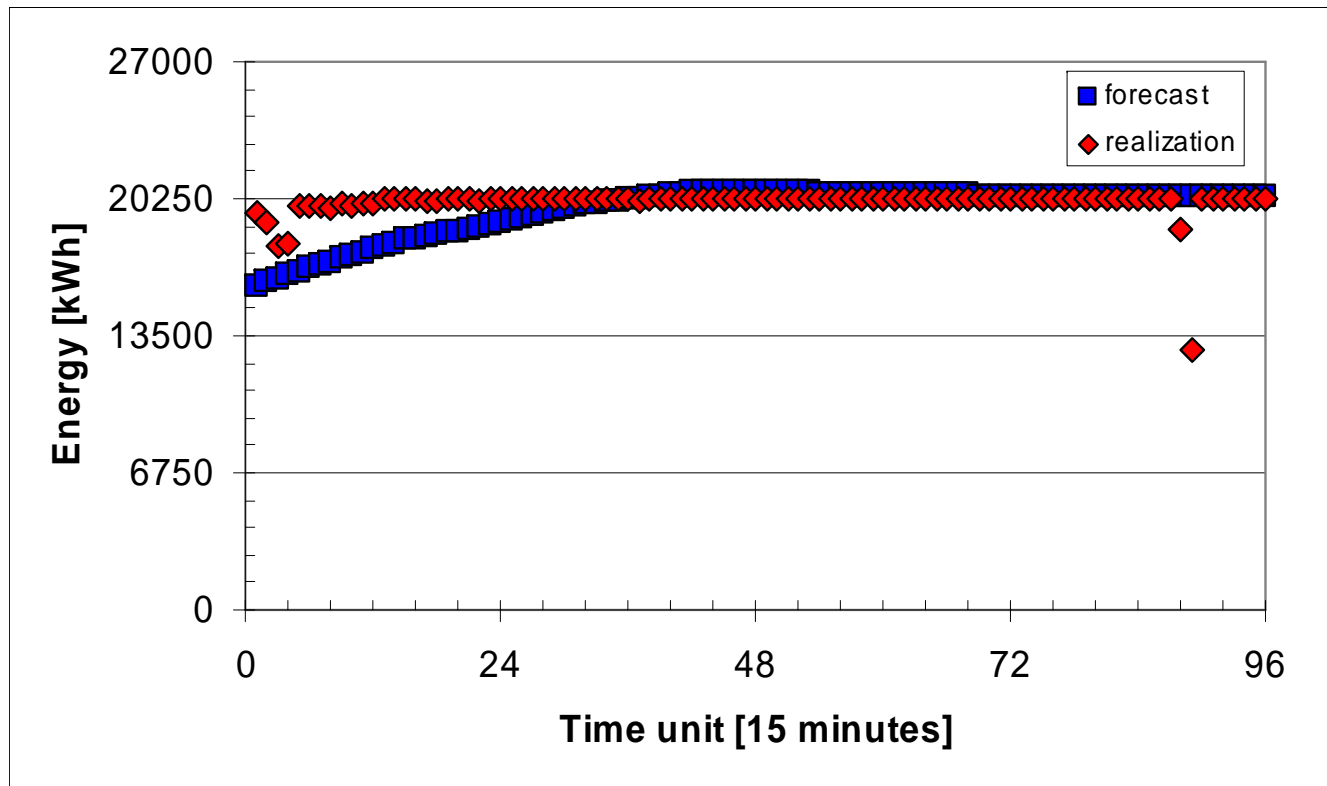


High-wind-speed cut-out

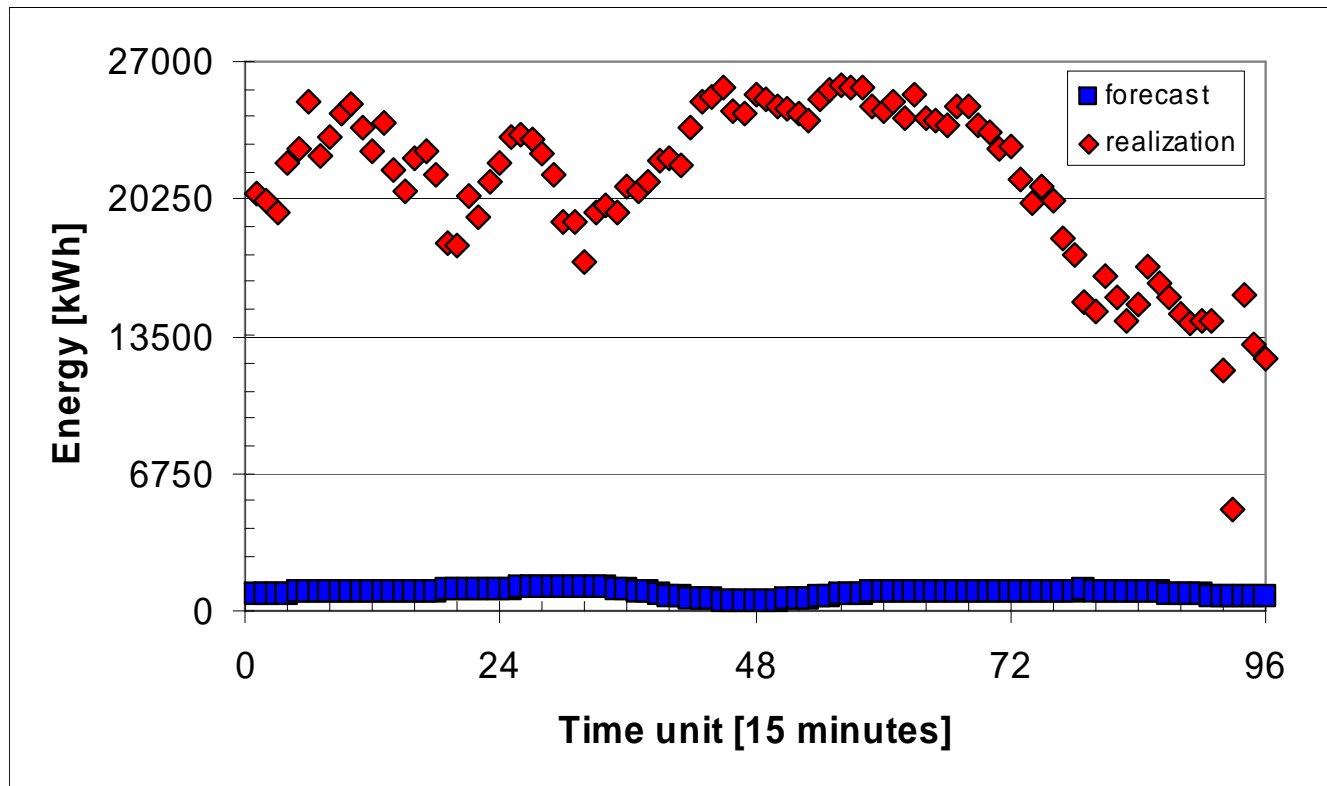
High-wind-speed cut-in

Low-wind-speed cut-in

**Extreme events are hard to predict**

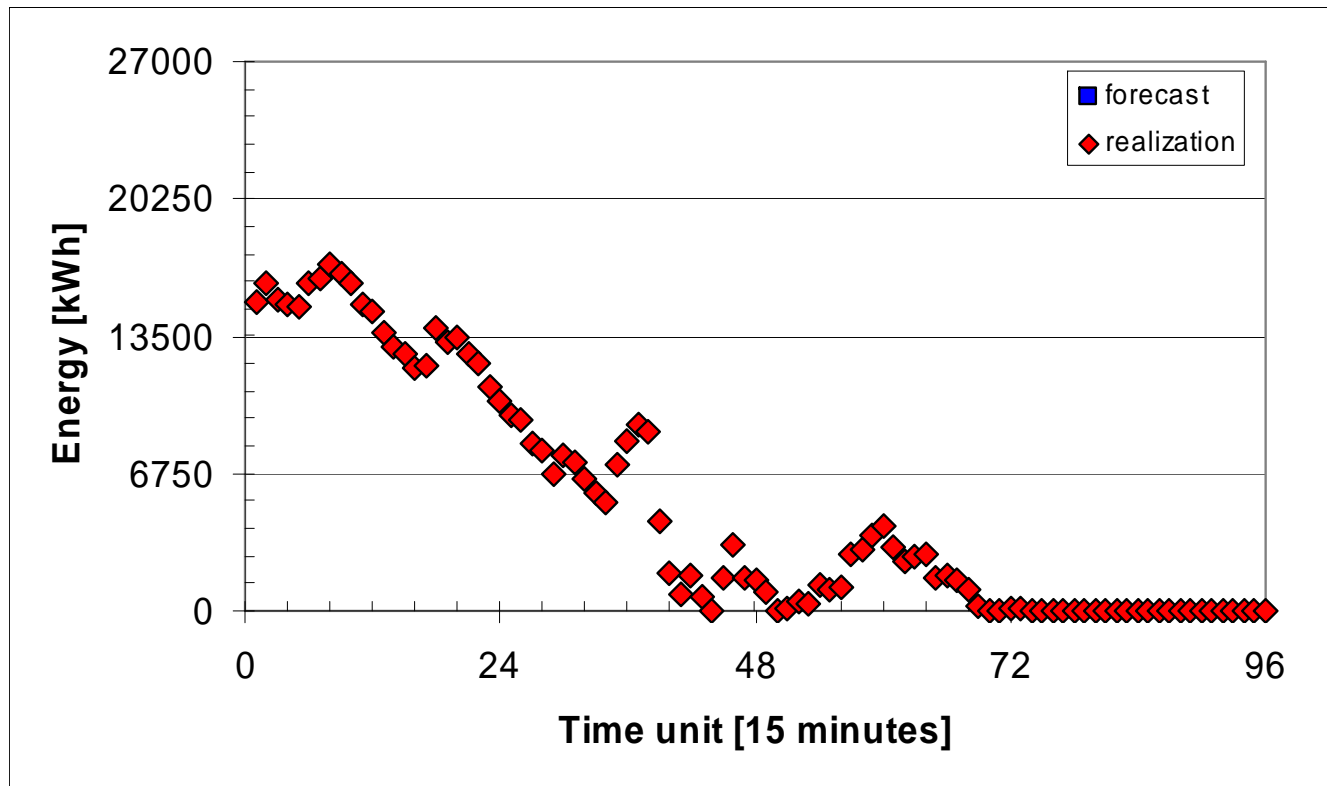


**The good**

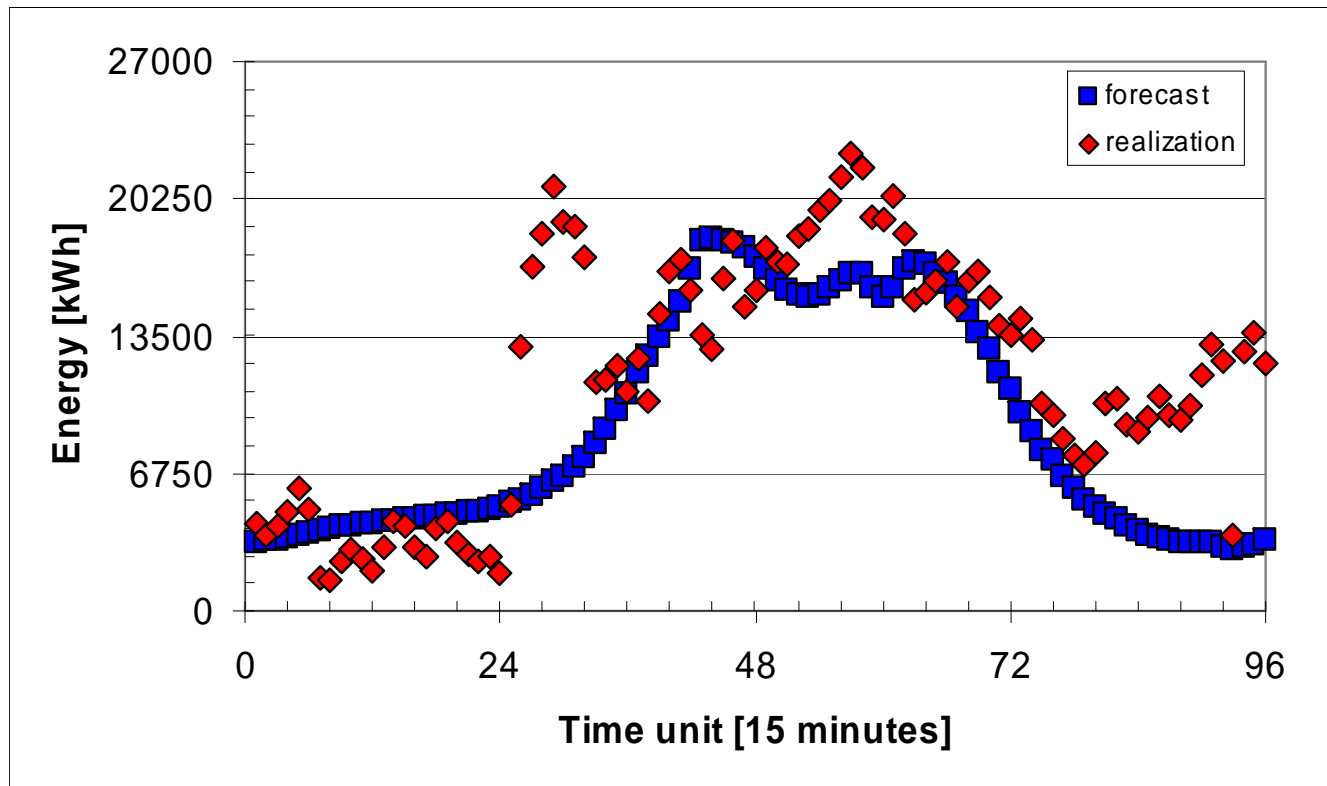


**The bad**





The ugly





Arno J. Brand

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