

Day-ahead output forecasting OWEZ

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NoordzeeWind



Motivation

- Monitoring and Evaluation Programme NSW-MEP
 - * Organised learning by measurement and evaluation
- Task 1.7.2 “Short-term Output Prediction”
 - * Sub-contracted to ECN by NoordzeeWind
- Objectives:
 - * To produce daily overviews of measured and forecasted power, as well as imbalance energy and imbalance cost
 - * To assess
 - (i) The value of wind power forecasting on project basis, and
 - (ii) The use of such forecasts at events like storms

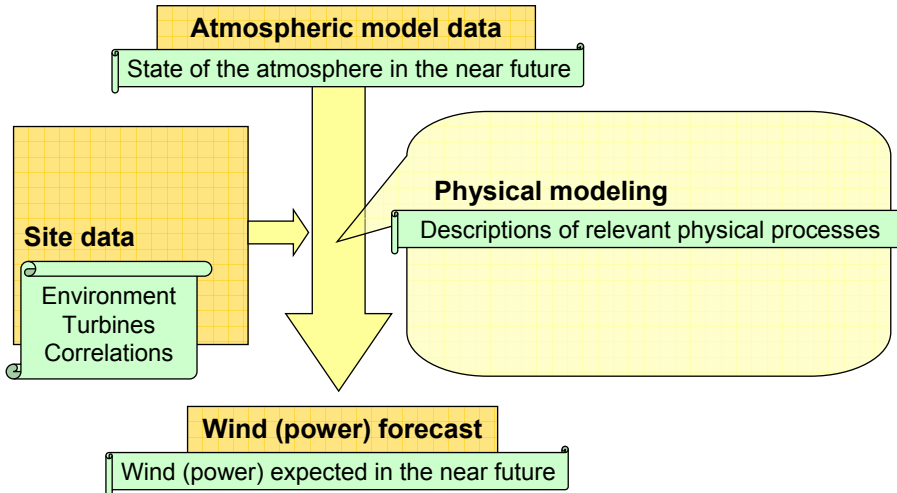
Summary

- OWEZ is better of with imbalance payments
- Optimized day-ahead forecasts are the more economic
- At a day-ahead notice:
 - * Predictability of exceedances is low
 - * Predictability of extremes is poor
 - * Some evidence for the ability to serve as an early warning

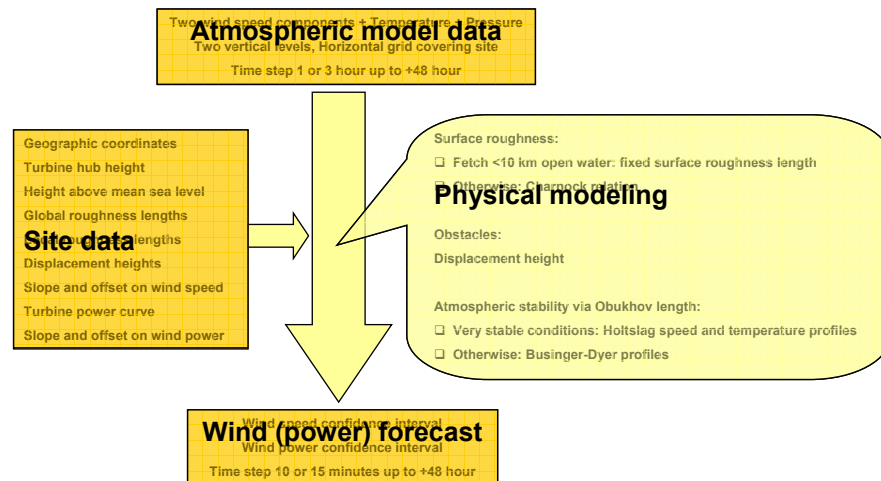
Outline

- Methodology
 - * Forecasting method
 - * Offshore Windfarm Egmond aan Zee
 - * Imbalance system
- Experience
 - * Forecast optimization
 - * Economic value of forecasting
 - * Predictability of exceedances and extremes

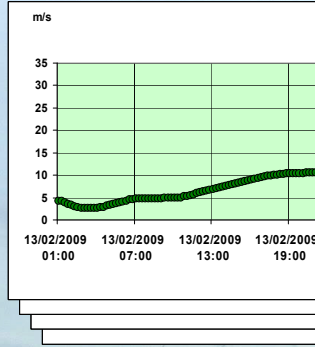
Forecasting method AVDE



Forecasting method AVDE

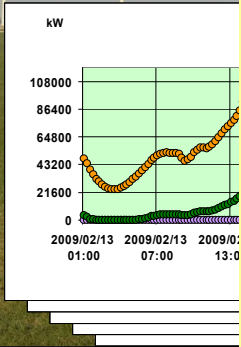


Wind speed forecasting mode of AVDE



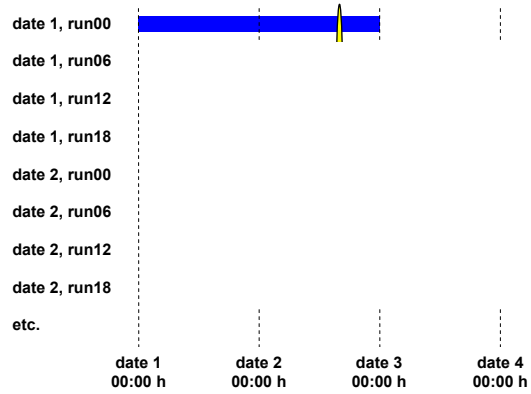
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					13/02/2009	01:00-01:15	3.6	1011.7	4.3	312.4	3.04	0.028
					13/02/2009	01:15-01:30	3.6	1011.5	4.2	310.2	0.75	0.021
					14/02/2009	00:00-00:15	4.0	1013.9	8.2	25.6	0.39	0.019
					14/02/2009	00:15-00:30	4.0	1014.0	8.0	26.1	0.36	0.018
					14/02/2009	00:30-00:45	3.9	1014.1	7.9	26.6	0.34	0.017
					14/02/2009	00:45-01:00	3.9	1014.1	7.7	27.1	0.31	0.017
					14/02/2009	01:00-01:15	3.9	1014.2	7.6	27.6	0.29	0.016
					14/02/2009	01:15-01:30	3.9	1014.2	7.5	28.0	0.27	0.016
					14/02/2009	22:30-22:45	4.9	1017.8	7.4	240.7	0.27	0.015
					14/02/2009	22:45-23:00	5.0	1017.7	7.7	240.3	0.29	0.015
					14/02/2009	23:00-23:15	5.0	1017.6	7.9	239.9	0.32	0.016
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Wind power forecasting mode of AVDE

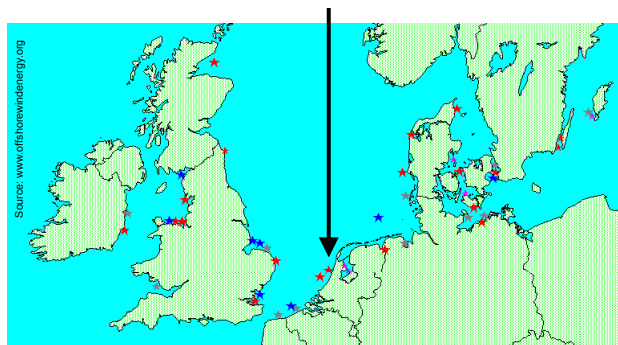


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										2009/02/14	00:00-00:15	1	33040.6	28058.0	72.1	101652.3	0.055	7.7	25.3	1.274
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										2009/02/14	01:15-01:30	6	24769.0	21096.1	1.8	93674.9	0.049	7.0	27.4	1.275
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										2009/02/15	00:45-00:00	4	53126.6	46431.3	2800.7	110339.2	0.051	9.2	236.3	1.271

Hierarchy of forecasts



Offshore Wind Farm Egmond aan Zee



Offshore Wind Farm Egmond aan Zee



Image © 2007 Aerodata International Surveys

Image NASA
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elev 0 m Streaming 100%

Eye alt 29.76 km

Motivation & Outline - Methodology - Experience - Summary

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Imbalance system

- Programme imbalance
- Imbalance energy: $E_{imb} = \Delta E = E_{mea} - E_{frc} = c (P_{mea} - P_{frc}) = c \Delta P$
- Surplus energy: $E_{sur} = E_{imb}$ if $E_{imb} > 0 \Leftrightarrow \Delta P > 0$
- Shortage energy: $E_{sho} = E_{imb}$ if $E_{imb} < 0 \Leftrightarrow \Delta P < 0$

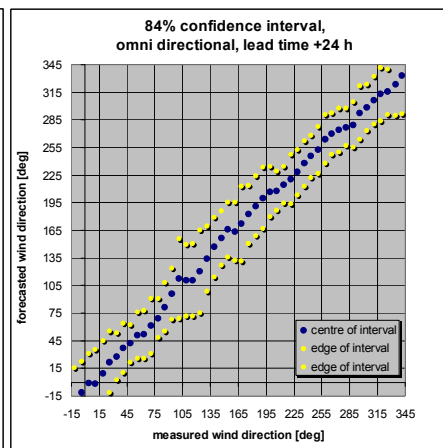
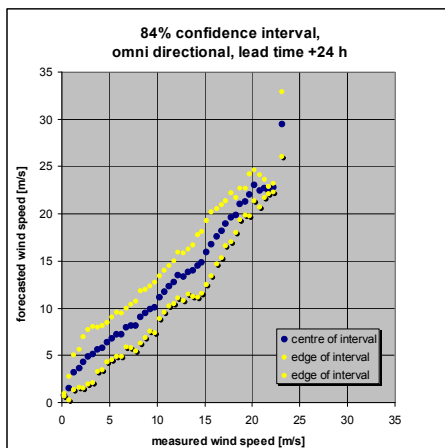
Forecast optimization

- ❑ Systematic forecasts errors
- ❑ Optimized wind speed forecast

$$* W_{\text{frc,opt}} = a_w W_{\text{frc,AVDE}} + b_w \quad \text{if } 4 \leq W_{\text{frc,AVDE}} \leq 20 \text{ m/s}$$

$$* W_{\text{frc,opt}} = (a_w + 0.25b_w) W_{\text{frc,AVDE}} \quad \text{if } 0 \leq W_{\text{frc,AVDE}} \leq 4 \text{ m/s}$$

Forecast optimization



Economic value of forecasting

- Imbalance fee = $0.11 p_{APX} E_{mea}$
- Imbalance payment = $p_{ext} E_{sho} - p_{fin} E_{sur}$

Economic value of forecasting

- Imbalance fee
- Imbalance payment

Predictability of exceedances and extremes

- Exceedances
 - * $24.5 \text{ m/s} < \text{wind speed} \leq 28.5 \text{ m/s}$
 - * $28.5 \text{ m/s} < \text{wind speed} \leq 32.6 \text{ m/s}$
 - * $\text{wind speed} > 32.6 \text{ m/s}$

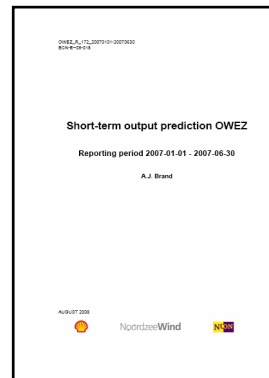
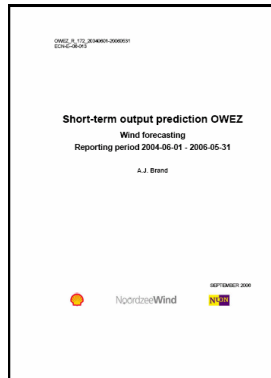
- Extremes
 - * Smallest resp. largest value
 - * Largest downward resp. upward change

Predictability of exceedances and extremes

- Predictability of exceedances: Low

- Predictability of extremes: Poor

- Early-warning ability: Some evidence



Public reports available from NoordzeeWind

Summary

- OWEZ is better off with imbalance payments
- Optimized day-ahead forecasts are the more economic
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