Demo 4: Storm management

Detlefsen, Nina; Gøttig, Allan; Cutululis, Nicolaos Antonio; Sørensen, Poul Ejnar

Publication date:
2011

Document Version
Publisher's PDF, also known as Version of record

Twenties
Transmitting wind

DEMO4: STORM MANAGEMENT

Nina Detlefsen, Energinet.dk (demo leader)
Allan Gøttig, Energinet.dk
Nicolaos Cutululis, Risø DTU
Poul Sørensen, Risø DTU (presenter)

EWEA 2011 BRUSSELS
EUROPE'S PREMIER WIND ENERGY EVENT

SEVENTH FRAMEWORK PROGRAMME

EUROPEAN COMMISION

Demo 4 STORM MANAGEMENT (Leader: Energinet)

Main objective

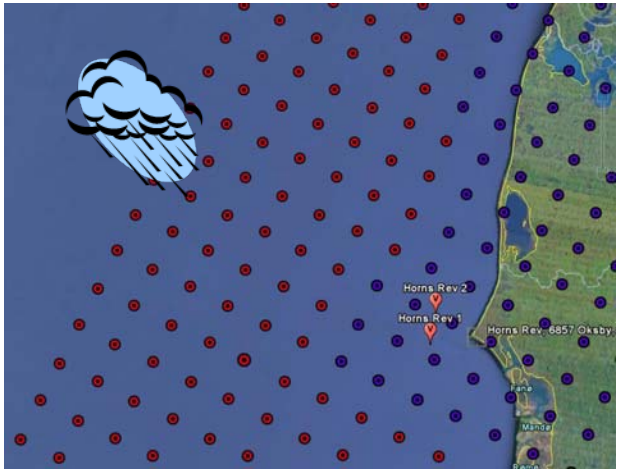
- Demonstrate shut down of wind farms under stormy conditions without jeopardizing safety of the system

Approach

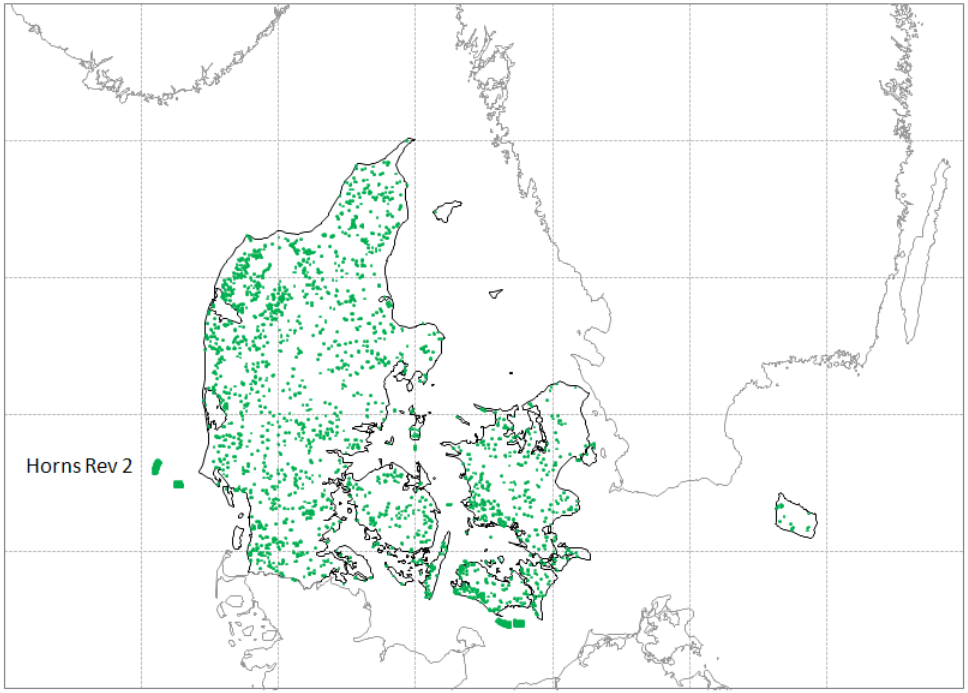
- Horns Rev 2 (200MW)
- Flexible turbine control
- Storm front forecasts
- Investigate cost of changed production associated with the planned down regulation
- Coordinate wind farm control with HVDC interconnector control and with hydro power plant operation

Wind power

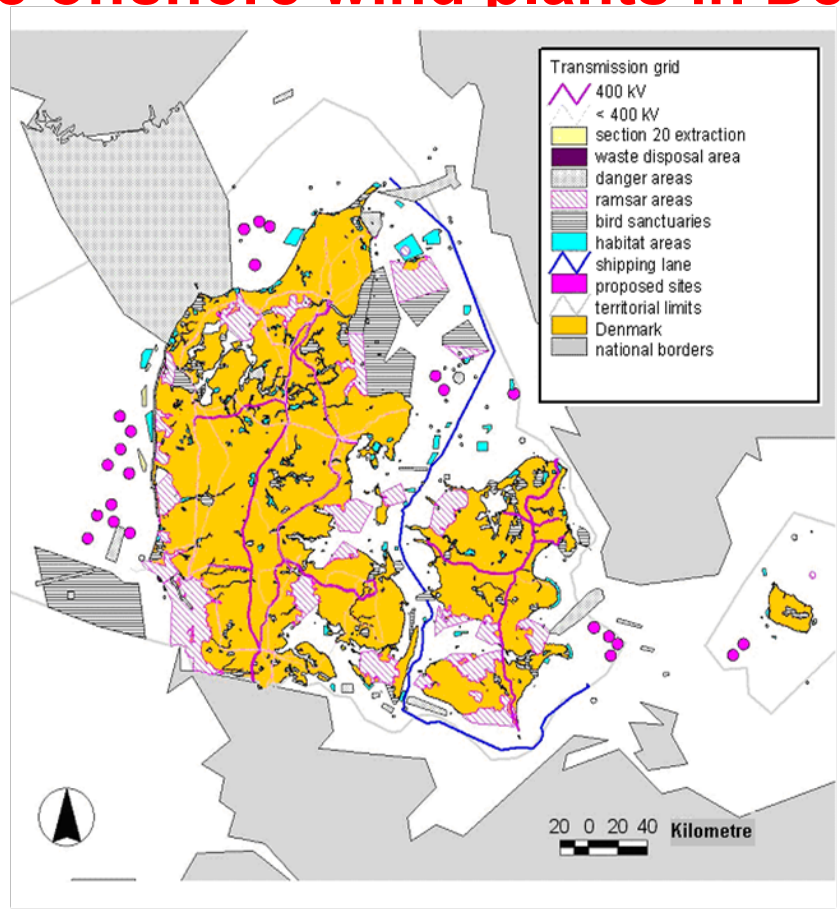
Hydro power



Present wind turbines in Denmark



Possible offshore wind plants in Denmark (23 x 200 MW)



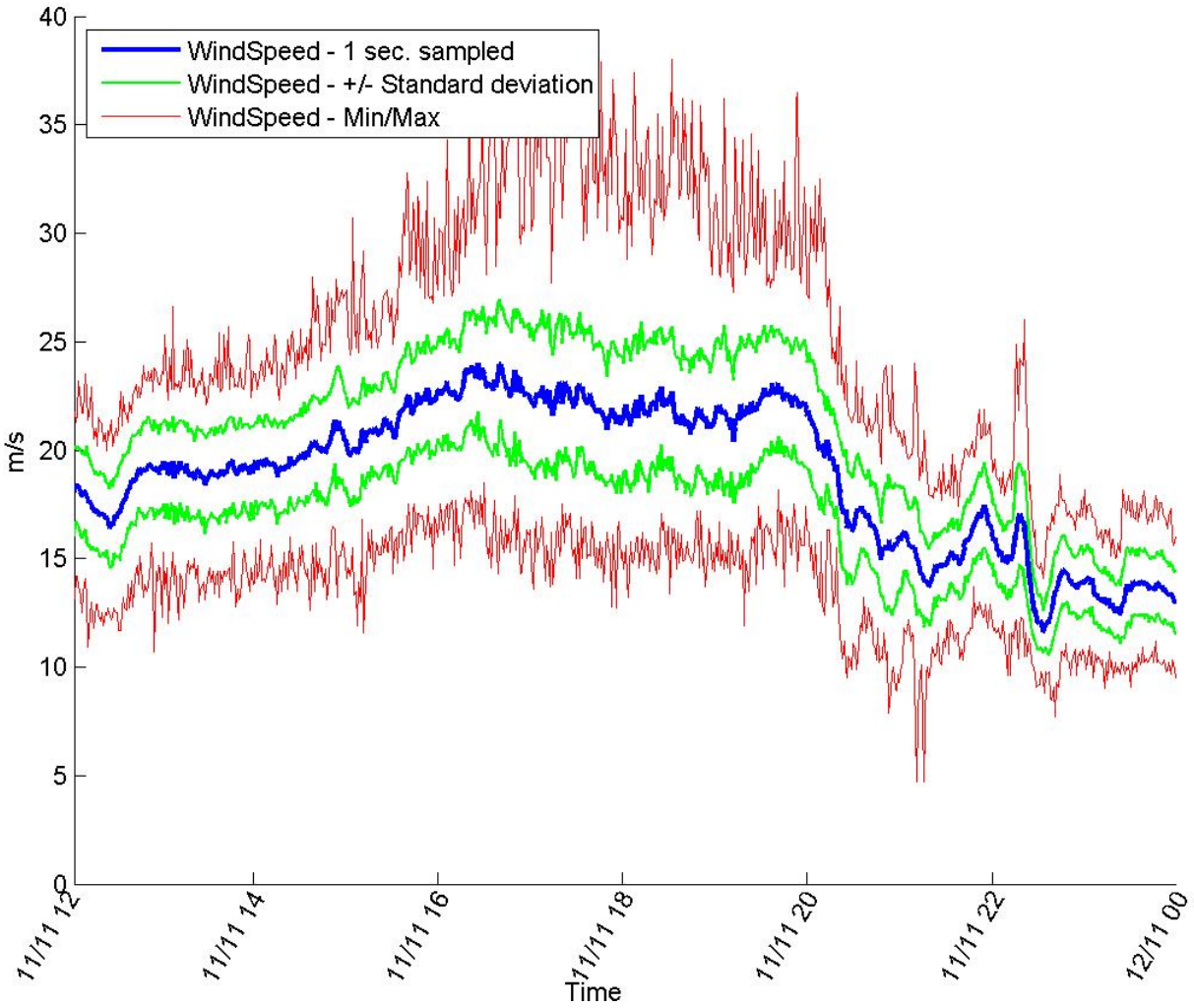
Strategies

- Two possible strategies:
  - Manual control
  - Automatic control

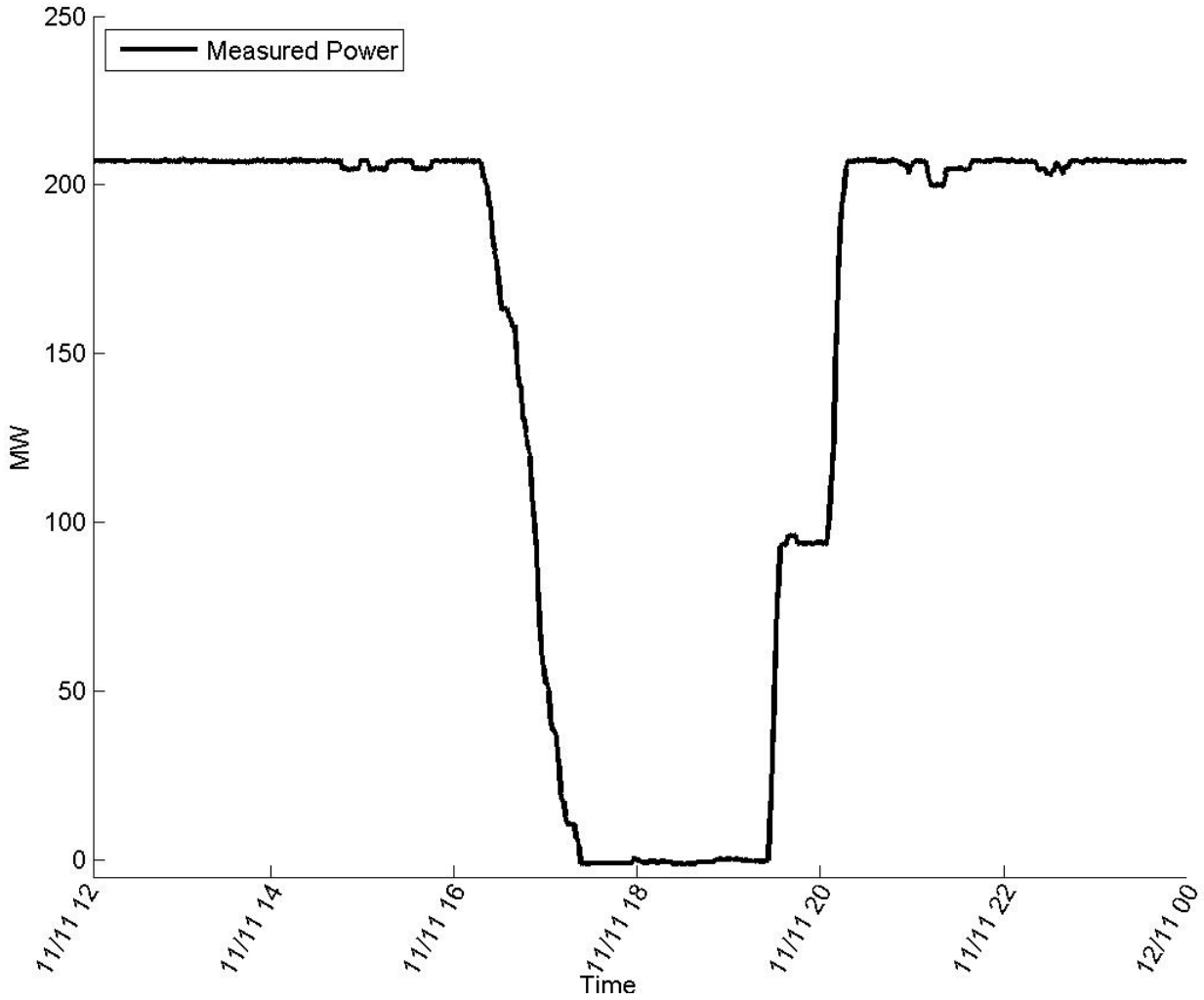
- Manual control involves:
  - Wind speed forecasting
  - Wind power forecasting
  - System imbalance forecasting
  - Regulating power

- Automatic control involves:
  - New controller in the turbines
  - Automatic imbalance control

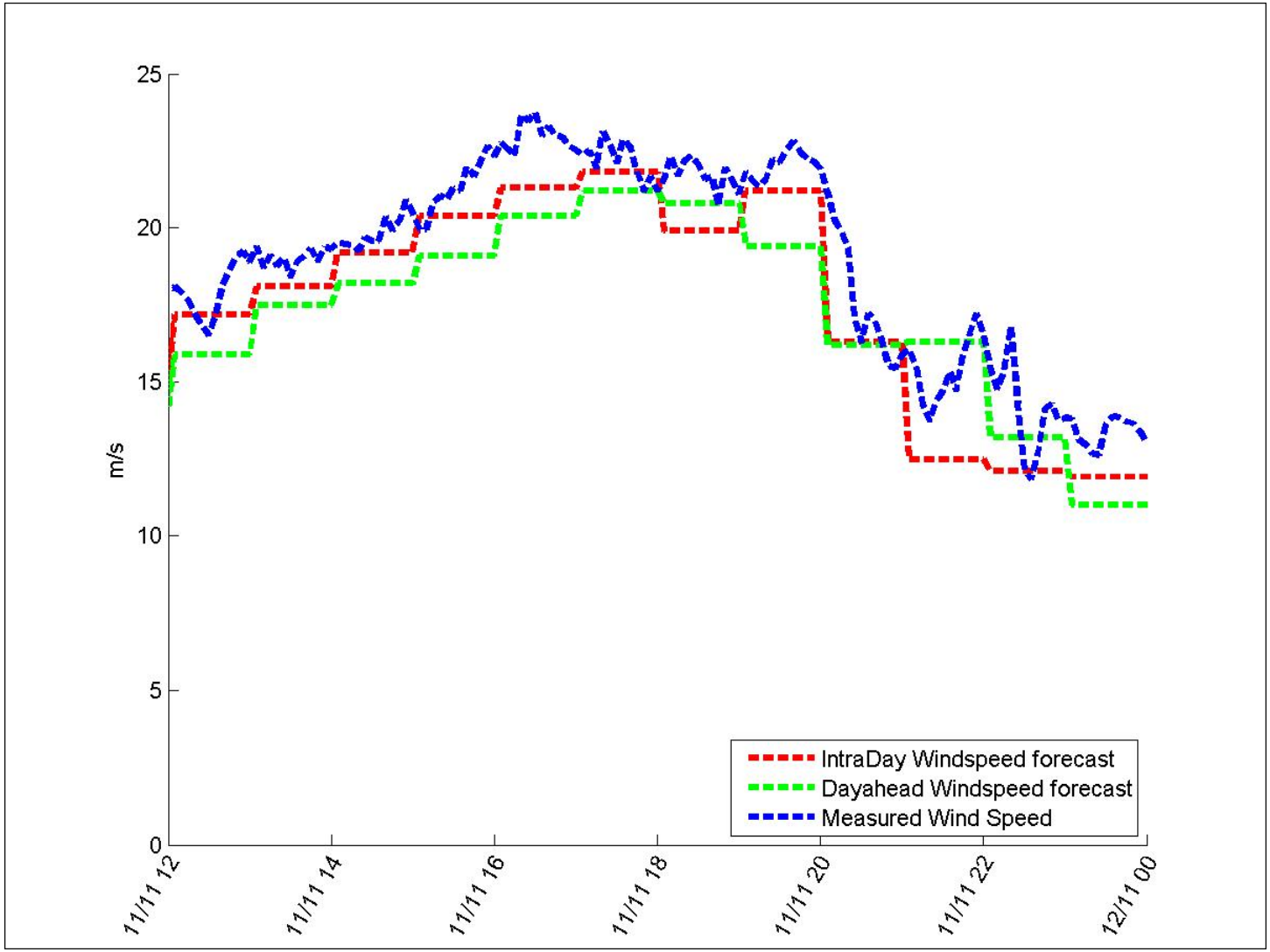
Wind speed – statistics of 91 wind turbines



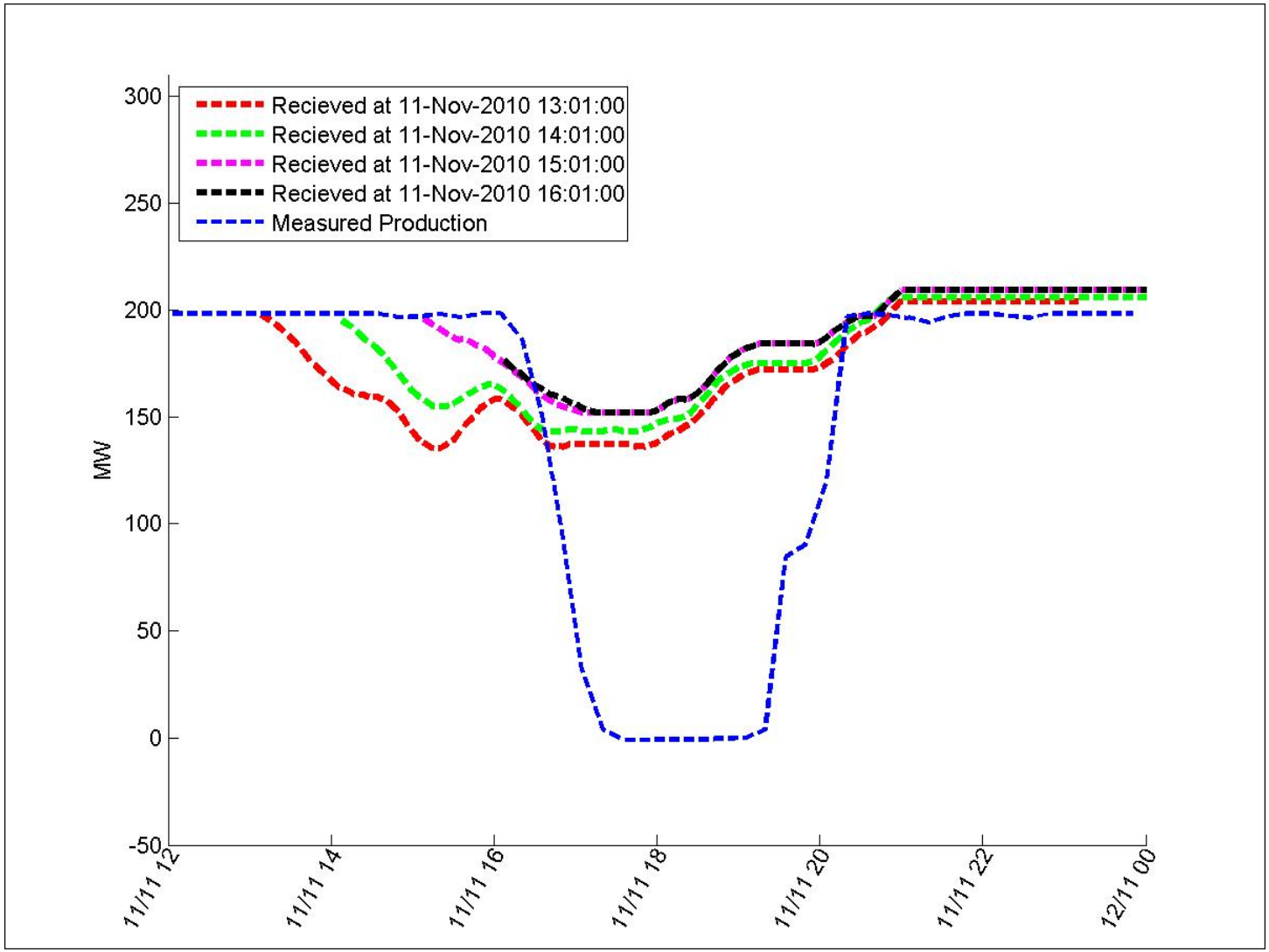
Wind power


Measured Power
250
200
150
100
50
0
MW
11/11 12
11/11 14
11/11 16
11/11 18
11/11 20
11/11 22
12/11 00
Time

Wind speed forecast

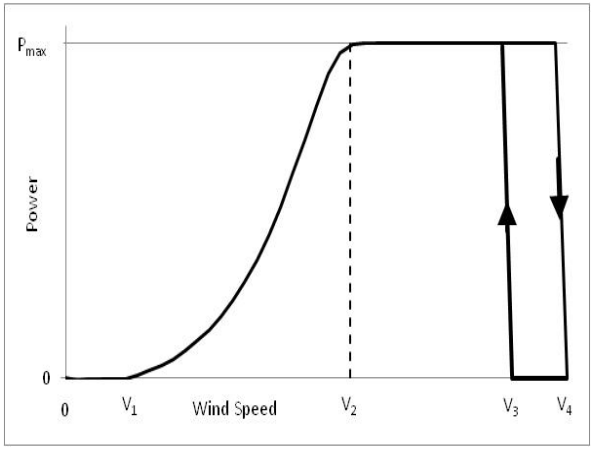


Wind power forecast



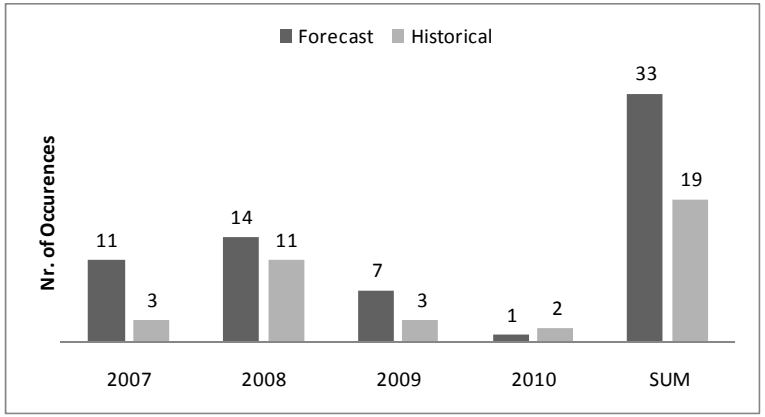
Definition of Extreme Wind Period (EWP)

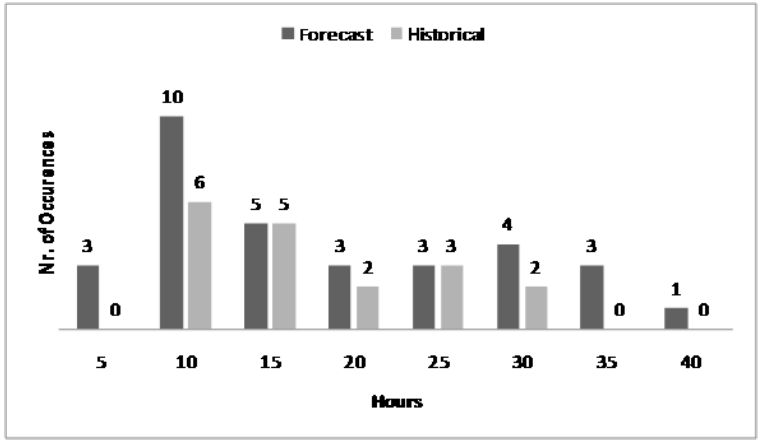
- **Wind speeds:**
  - **v_1: cut-in wind speed**
  - **v_2: rated wind speed**
  - **v_4: cut-out wind speed**
  - **v_3: high wind reconnection wind speed**
- **EWP for single turbine**
  - **Starts when $v > v_4$** (typically 25 m/s)
  - **Ends when $v < v_3$** (typically 20 m/s)
- **EWP for wind power plant (wind farm)**
  - **Starts when half of wind turbines are cut-out** (typically at wind farm average 22.5 m/s)
  - **Stops when half of wind turbines are re-connected** (typically at wind farm average 18 m/s)



Statistics of Extreme Wind Periods (EWPs)

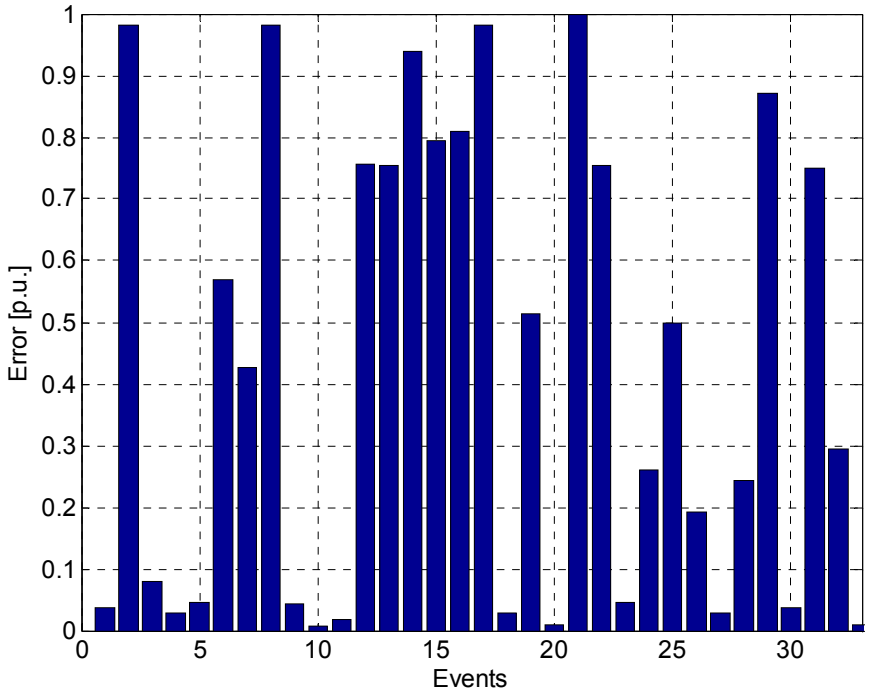
- Ideally, purpose is to compare actual and forecasted wind speeds
- Difficult to provide sufficiently long period of data
- Forecasts are from Energinet.dk
- Historical data would ideally be measurements, but are re-analysis performed with Weather Research and Forecasting (WRF)-model
- Grahps show 100m height (10m data much better agreement, but less relevant)





KPI: worst case forecast error

- **Maximum absolute power prediction error for each Extreme Wind Period (EWP)**



Conclusions

- New turbine controller will be developed
- Improved actions based on wind power forecasts will be developed
- Potential of Norwegian Hydro
- Impact from storm in Danish (UCTE) and Nordic system
- Correlation of storms in the regions will be assessed

THANK YOU FOR YOUR ATTENTION