Wind Generation Forecasting at REE.
Situation in Spain

Introduction

- Renewable energies, wind and solar energy,...Is this new in Spain?
Installed capacity and demand coverage in Spain December 2015

Introduction

Installed capacity

- Wind: 22.6%
- Solar photovoltaic: 4.4%
- Coal: 10.4%
- Combined cycle: 24.7%
- Hydroelectric: 20.1%
- Nuclear: 7.5%
- Cogeneration: 6.6%
- Other renewable: 0.7%
- Solar thermoelectric: 2.3%
- Waste: 0.7%

Demand coverage

- Hydroelectric: 11.0%
- Nuclear: 21.8%
- Wind: 19.0%
- Waste: 0.8%
- Combined cycle: 10.1%
- Coal: 20.3%
- Cogeneration: 10.1%
- Solar photovoltaic: 3.1%
- Solar thermoelectric: 2.0%
- Other renewable: 1.8%
Installed wind power capacity evolution in Spain

Introduction
Historical record of wind generation

Introduction

<table>
<thead>
<tr>
<th>Wind Power Generation</th>
<th>Thursday 29/01/15</th>
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<tbody>
<tr>
<td>Power (MW)</td>
<td>17,553 (7:27 pm)</td>
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Demand coverage at the moment of maximum wind production (29/01/15 at 19:27 h)
Control Center of Renewable Energies (CECRE)

- Target: achieve a greater level of integration for renewable energy sources
- Real-time production supervision and control
System overview
Sipreolico

• SIPREOLICO forecasts are calculated for individual wind farms, up to 240 hours horizon
• Aggregated national hourly forecast by adding individual wind farms forecast.
• Prediction method: based on neural networks. (More than 800 NN)
• Probabilistic wind power forecast: confidence intervals
Essential input: meteorology

- Numerical Weather Prediction model
- Grid results: wind speed and direction forecast
Input Data: Real production measurements

- CECRE receives the telemeasures of all the wind/solar plants with an installed power > 1 MW:
  - ✓ 96% of wind installed power
  - ✓ 100% of CSP installed power
  - ✓ 70% of PV installed power

- These telemeasures are supplied as an input to our forecasting algorithms
Combination strategy

%Mean Absolute Error/Real Production.

Horizons (Hours)

%MAE Relative to Real Production. 2015

Combined
Forecast 1
Forecast 2
Forecast 3

Combined
Forecast 1
Forecast 2
Forecast 3
Evolution of wind power forecast errors

Error calculations

- SIPREOLICO has improved significantly in the last 8 years. Further improvements seem to be limited by weather prediction models.
Singular days: 09 may 2016

Price under 10 €/MWh

3000 MW

1500 MW
REE Wind Generation Forecasting System has been improved year by year since it was developed.

Main challenge: improving our forecast for days with a very high error

Wish list:

- Use of NWP with higher spatial resolution grid
- Increase the update frequency of the NWP (every 3 hours)
- Nowcasting: wind forecast including storm cells
Thank you