Nowcasting Meteorological Readings for Wind Energy Prediction
A. Torres, J. Prada, J.R. Dorronsoro
Departamento de Ingeniería Informática, Universidad Autónoma de Madrid

Abstract

- Frequent forecast updates are needed for efficient wind energy integration
- NWP based predictions have a built in delay of at least 4-6 hours and even larger if assimilation is taken into account
- Near real time information is thus needed for hourly forecast updates
- We explore here the use of synoptic station readings to nowcast short term wind energy
- We show that readings do indeed help to improve short term energy prediction but with two possible limitations
  - The independence between concrete station sites and overall wind energy production
  - The need of more comprehensive spatial and temporal station covering

Objectives

- Meteorology based renewable energy forecasting is usually done at two different time horizons:
  - Short-term forecasting: from 1 to 6-12 hours ahead and
  - Medium term forecasting: from 6-12 to 72-96 hours ahead.
- Energy forecasts derived from NWP inputs give clearly the best medium term performance
- However, currently NWP updates are given at most every 6 hours and even in the best conditions NWP has at least a 4-6 hours delay
- Thus, alternative data sources are needed for short-term forecasting
- Here we explore nowcasting from meteorological readings with two main objectives:
  - Explore the availability of real time weather measurements and their relevance for short term wind energy forecasts
  - Build and test short term prediction models that combine real time measurements with NWP day-ahead based energy predictions

Data and Models

Data
- Primary data sources: 265 synoptic stations from the network of the Agencia Española de Meteorología (AEMET) retrieved during a year from its website [1]
  - Using wind (V) and gust (G) speeds, temperature (T) and pressure (P) and if fully available, they would yield hourly values of 4 x 265 = 1,060 dimensional patterns
  - But web based readings have missing value gaps that, while relatively small for a given station, may invalidate a large number of hourly patterns
- We have thus filtered the initial set of stations finally arriving to 48 stations that combined yield a total of 5,680 hourly patterns (locations can be seen in adjacent figure)

Models
- We build two Support Vector Regression (SVR) models [3, 4] to predict at hour h energy values at horizons h+1, ..., h+9 using
  - In model 1: ECMWF forecasts at hour h+k, k=1, ..., 9
  - In model 2: station readings at hour h plus ECMWF forecasts at hour h+k
- Model 1 is built over 9,721 hourly values from 20/11/2012 to 31/12/2013
- Model 2 is built over 5,680 hourly values from the same period
- We select SVR parameters by 5-fold cross-validation
- For testing we divide the data sets in 12 equally sized consecutive subsets and use 11 subsets for training models 1 and 2 and rotate the remaining one for testing

Results

- The table below shows the errors of models 1 and 2 plus those of a simple persistence model given as a reference

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<th>H+1</th>
<th>H+2</th>
<th>H+3</th>
<th>H+4</th>
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<th>H+6</th>
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- Model 1’s error corresponds to day ahead predictions and is thus constant over all time horizons
- Model 2’s errors improve on persistence from h+4 on and are better than Model 1’s up to h+6
- Model 2’s errors are comparable to those achieved using ECMWF with surface wind over the entire peninsula [4] but higher than when 100m wind is used
- While low, the image below shows that the correlations between measured wind at hour h and wind energy at hour h+1 decrease slowly over time
- This hints to station readings being valuable for short term wind energy forecast updates

Conclusions

- Model 2 built with weather station readings improve on model 1 that only uses NWP forecasts for the 43 points closest to the 48 stations until h+6.
- Thus, when used in a nowcasting setting, real time weather measures can be used to improve on day ahead forecasts derived from NWP
- An important reason for this may be the slow decrease of speed-energy correlations
- Model 2 is not competitive with peninsula-wide models using 100m ECMWF day ahead forecasts, most likely because of the small number of stations
- Using full data from the entire synoptic station system offers a clear path for improvement in short term energy forecast updates

References


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