Overview of Wind Power Forecasting Methods in India

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Ankit Narula studies the Wind Forecasting Methods and discusses the current challenges for Indian Wind Developers in this area.

It was once shown in the movie Swades an outlandish way to predicting weather where one Bholu can do it with just a fleeting look in the sky. It was centuries ago when human started to understand weather and soon after ways to model it so as to predicts it. It was dated in 320 BC at the time of Aristotle – an inquisitive poly mathematician –that he started observing atmospheric kinematics and wrote his first manuscript on this subject – Meteorologica –conferring to the phenomenon. The Odyssey continued with invention of instruments to measure state of atmosphere dated in 16th and 17th century, until late first half of the 20th century when computers were evolved and fast forwarded the development of weather forecasting, leading to a change in paradigm of knowledge.

Introduction

From the energy angle, predicting the speed of wind that blow next moment and the duration till when sun will shine became essential with an enlarging of renewable energy sector that totally dependent on nature and was largely sporadic.

In case of wind energy it was particularly significant to predict the wind resource in advance, which is due to rapidly increasing diffusion of wind power into the electricity grids compared to other renewable energy sources.

Traditionally, the grid operators are habituated with the supply side of the load, the source of electricity, dispatchability, reserves, and balancing the whole system. However with the approach of wind energy and other renewable source of energy – a form of dispersed generation – due to their intermittency, has mystified the grid operation during power planning like scheduling, dispatching and distribution of the power, which are amongst a variety of other problem.

Wind resource although is highly uncertain due to its stochastic nature, but it can be predicted, however with a significant error. Yet with evolving methodologies and models, wind forecasting can be produced upto satisfactory accuracy, out to several days ahead by massive supercomputers which are fed by weather data from array of weather stations, satellite data (like NECP/NCAR) and online wind data sent out by advancing SCADA systems.

Wind Power Forecasting

Wind speed forecast isn't new; it was a part of weather forecasting for many decades where it was being used for ship navigation, air traffic control, satellite launch etc. However, wind power forecasting recently have come into the picture with the arrival of wind industry.

Predicting wind speed and wind power are just not similar activities due to elements of wind turbine, grid availability etc. are required to be embedded into a model which correlate these two to provide forecasting results. Wind power forecasting, in countries (Denmark, Germany, United States) with strict grid regulations has put in place the forecasting mechanism and introduced penalty while obligating WEGs to supply the wind power forecasted.

Forecast Horizon T+12 hrs

Wind power forecasting is generally based on required forecasting horizon– long term (days ahead or seasonal) or a short term (hour ahead) forecast. Loosely there are

Physical method

A Numerical Weather Prediction (NWP) model is commonly used physical method which produces forecasting of weather elements – represented by equations of physics – through the use of numerical methods. NWP model typically run two or four times a day using updated meteorological information. These models are generally operated by national weather services' due to a complex nature of work and requirement of large resources. However, few profit making companies like ASW Truewind have invested and developed their own NWP model.

Statistical method

In this method relationship between wind speed prediction and measured power output from the wind farm is derived to predict the wind power. It generally does not use the power curve of the wind turbine and do not consider the local meteorology.

These models are self-calibrate in nature and inherit any changes occurring in roughness or wind resource to provide an advance forecast. However, the major shortcoming of this method is that it needs a large amount of validated and correct data to perform modelling.

two methods to do forecasting, based on the horizon of forecast required, namely

- Physical Method (numerical based approach) and
- Statistical Method (see previous page).

Forecast can also be produced based on other criterions like real time dispatch decision making, subsequently hour commitment, market trading, scheduling of committed unit, where a numerical forecasts can be blended with statistical forecast, multi parameter statistical auto regressive technique etc. to obtain the requisite results.

It was notional that short term forecast generally contain a low error percentage as compared to the long horizon forecast; however, it has been seen in few cases, as reported by Garrad Hassan, that comparing the different forecast horizons shows a greater difference in the small errors than the extreme errors. This is indicative of the fact that even when forecasting at very short forecast horizon it is still possible to get extreme errors, for example only slightly over or under predicting the wind speed close to high wind speed shut down could cause large errors in the power prediction (fig.1).

One important procedure performed before actual forecasting is training and testing of the wind power model. In this, the historical wind speed forecast is fed into the wind power model to produce generation forecast. After which, real time wind speed values are fed to produce real time forecast power. The validation of the results from the test is performed to check proper training and performance of the power model.

The systematic error caused due to transfer of actual generation data from the WTG SCADA system to the forecasting station and due to loss of data caused by a range of reasons amongst which grid unavailability is a major one, the model automatically tune itself by taking either the latest value of the generation or power value from the large data used to tuning the power model (fig. 2).

Performance evaluation of the forecasted results is generally done using two principles---Normalized Mean Absolute Error (NMAE) and Normalized Root Mean Square Error (NRMSE). Normalization is done with generating capacity of the wind

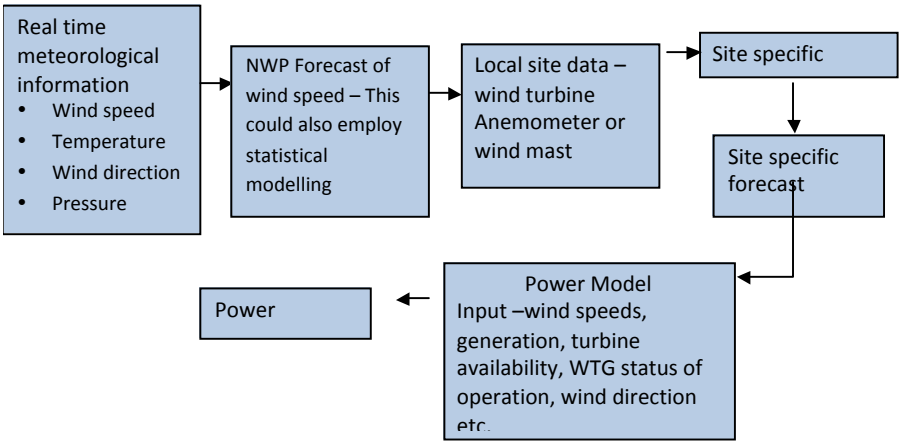

Fig.1

farm to calculate error in terms of per unit MW of installed capacity.

Wind Power Forecasting in India

The total installed capacity of wind energy in India is 17352 MW (as of March 2012); making India the 5th largest wind energy producer in the world. The annual capacity addition is growing at a rate of around 20 %.

In 2012, according to the Central Electricity Authority, 8% of India's power capacity is supplied by wind energy. The growing wind power is brining prosperity to the country and serving towards energy security, but at a cost of technical challenges.

Indian electricity grid condition wasn't really good until Electricity Act 2003 was enacted for development and betterment of this sector. To continually serve the purpose of keeping the electricity grid stabilized, CERC then enacted Indian Electricity Grid Codes (IEGC, 2010) in which scheduling of wind power (and solar) is made compulsory with effect from January 1, 2012 for wind farms where the sum of generation capacity (of all the WTGs) is more than 10 MW and all the wind turbines are connected to a common point of 33 kV. The wind turbine owners if not have signed the PPA till this date will come under this regulation.

According to this regulation the wind farm developers have to provide a day ahead forecast for next 24 hours in a block of 15 minutes. To safeguard the interest of wind farm developers, a relaxation ceiling of 70% accuracy was kept in such a way that if actual generation is under +/- 30% variation of the schedule, no Unscheduled Interchanges (UI) will be applicable. Over and above, Renewable Regulatory Fund (RRF) was also introduced for pooling UI accounts at the regional level for wind energy generators. This all has been done so as to manage the electricity well in advance before dispatching for distribution in such a way that the quality of electricity remains paramount.

Forecasting Related Issues specific to India

Forecasting across the world is provided

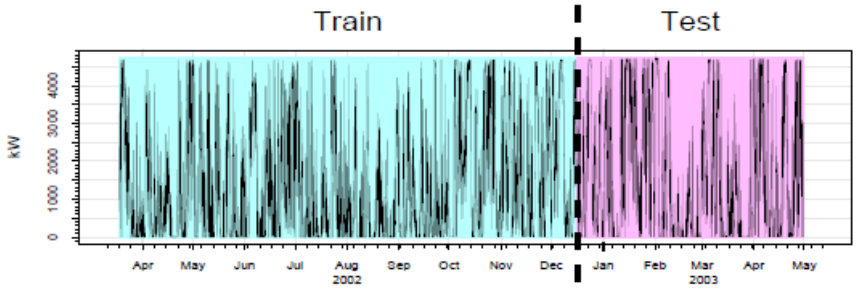

Fig.1

by many professional forecasting agencies and companies like Energy and Meteo GmbH (Previento), AWS Truewind (eWind), WEPROG, 3Tier, Garrad Hassan and partners Ltd., National Centre for Atmospheric Research, NCAR (generally with collaboration) , etc.

In India there are no native organizations which provide the prediction facility except few international organizations present in India like AWS Truewind, 3Tier etc. The concentration of error claimed by these companies across the range of countries where they have used their forecasting tool including India is between 20-30% of the capacity of wind farm, for different type of terrain features. To simply put, a better accuracy for a short forecast horizon for a day ahead in comparison to a long forecast horizon of 3 to 4 days ahead (in which forecasting error varies between 30-35%); however there are exceptions as mentioned earlier.

Another issue is related to the forecasting framework faced by regional LDC such as, according to IEGC regulation the wind power developers should start providing the schedule of power to the eight identified SLDC in the states where wind farms are installed. The current situations up till March 2012 was that only few farm developers like Gamesa and GFL in Gujarat have started forecasting and providing the schedule to regional SLDC on trial basis while others are working on acquiring and setting up of the requisite tools, instruments and data acquisition system in place to do forecasting and provide schedules to the SLDCs.

In fact many SLDCs are also not ready and do not have necessary tool and metering facilities (Availability Based Tariff (ABT) meters)to evaluate the forecast and schedule provided by wind developers.

Yet another issue is pooling of wind power at the substations developed by multiple wind farm developers; with either different contracted rates for sale of power or sale of power to a third party.

Then there are technical issues particularly related to Indian power sector; missing grid. This causes data loss during recording which is represented by zeros, blanks or some time with random values like -999. This essentially deteriorates the quality of forecast and thus causes dilemma during evaluating the results of the model.

There is a sheer need to resolve these issues one by one starting from first establishing the support structure and a proper framework while clearly defining the methodology of sharing responsibilities between different stakeholders and then facilitating wind energy generators to establish a proper system in place to forecast the power and then sharing it with the authorities.