RENEWABLE ENERGY FORECASTING METHODOLOGY IN INDIA: A REVIEW

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Abstract: ***Forecasting is a vital and cost- effective means for integrating Variable Renewable Energy (VRE) resources such as wind and solar into power systems. Renewable Energy forecasting affects a variety of scheme operations including scheduling, dispatch, real-time balancing, and reserve necessities. By integrating VRE forecasts into system operations, power system operators can anticipate up-and down-ramps in VRE generation in order to cost-effectively balance load and generation in intra-day and day- ahead scheduling. This process leads to reduce fuel costs, improve system reliability, and minimize curtailment of renewable resources. Factors that affect forecast performance comprise forecast time-horizon, local weather conditions (which influence variability in VRE resources), geographic scope, data availability (e.g., plant size, location, components), and data quality (e.g., consistency, accuracy, resolution). The precision of VRE forecasts usually increases at shorter time intervals. However, frequent forecasts are only functional when their time-steps match the time intervals in which system operators can make actionable decisions. Scientists and Engineers can curtail forecast errors by customizing their methodology to account for local situation and system operator needs. This paper reviews the Forecasting Methodology that Indian government and Non government institutes have adopted.***

Index Terms: Variable Renewable Energy (VRE), Wind Energy, Solar Energy, Forecasting.

Abbreviation:

VRE	Variable Renewable Energy
NWP	Numerical Weather Prediction
HPCS	High Performance computing System
GFS	Global Forecast System
NIWE	National Institute of Wind Energy
IMD	India Metrological Department
NCEP	National Centre for Environmental Prediction
WRF	Weather Research & Forecasting
NCAR	National Centre for Atmospheric Research
RLDC	Regional Load Dispatch Centre
REMC	Renewable Energy Management Centre

I. INTRODUCTION

Growing Renewable Energy (RE) means a greater advance in variability of supply, a relatively newer experience for grids where demand was the usual changeable and supply was tightly controlled, or 'dispatchable'. One cannot have power over the presence of wind or sun, but one at least needs to predict it well, so that the rest of the grid can plan its output accordingly. This is one of several key aspects of making RE grid integration cheaper and more scalable. Otherwise, as RE penetration grows, its challenges for the rest of the grid will increase [1].

II. FORECASTING METHODS IN GENERAL:

In general, forecasting methods fall into two categories. **Physical methods** input weather data (e.g., temperature, pressure, surface roughness, and obstacles) into numerical weather prediction (NWP) models to create terrain- specific weather conditions, which can then be converted to energy production. **Statistical methods** use historic and real-time generation data to statistically correct results derived from NWP models. Persistence forecasting is a simple statistical method that assumes existing generation levels will stay unaffected in the very near future. Persistence forecasts are often used as a benchmark or reference model to evaluate more advanced methods [2].

Centralized VRE forecasting is widely considered a best-practice move toward for economic dispatch. Administered by the balancing authority or system operator, centralized forecasts provide system-wide forecasts for all VRE generators within a balancing area. Decentralized VRE forecasting, administered by individual plant operators, provides plant-level information to help inform system operators of possible transmission blocking due to a single plant's output [2].

Dependence on a single forecasting methodology for centralized forecasts can increase the risk of systematic bias. A common way to get better centralized forecasts is through ensemble forecasting, whereby practitioners combine and aggregate the results from different forecasts formed by multiple forecast providers or methods.

Integrating VRE forecasts into energy and market management systems improves the efficiency of system operations at various timescales. Day-ahead forecasts provide hourly power values for three to six days ahead. They are used in the scheduling process to help avoid costs and inefficiencies due to needless starts and stops of thermal generators. Daily basis forecasts usually provide power values with common time steps (i.e., every ten minutes) up to six hours ahead and that is used in real-time dispatch and market-clearing decisions. Slope forecasting, useful for escalating grid reliability, identifies the peril and possible for rapid and sustained change in power output within a specific time interval. Forecasts for distributed PV can be integrated with load forecasting to obtain net load forecasts, increasing the visibility of demand-side variability.

III. RE forecasting in India:

Source: Ministry of New & Renewable Energy, Govt. of India

The current boost in variable wind and solar power generation, future projections of higher share of RE in the total generation assortment and associated challenges of grid management make wind and solar power forecasting an obligatory task for the Indian electricity grid. Owing to higher penetration of variable wind and solar resources, appropriate balancing actions are becoming increasingly complex [3].

The challenges which are addressed by the Scientists of National Institute of Wind Energy (NIWE), Government of India and other Technical Institutes are given below [3]:

- Necessary measures for grid stabilization
- Implementation of appropriate forecasting techniques and balancing capabilities
- Establishment of an effective control infrastructure.

India has adopted a Work package which comprises of following four tasks:

- Analysis of wind and solar power forecasting infrastructure and requirements
- Proposal for establishment of Renewable Energy Management Centers
- Balancing capability enhancement
- Overall strategy and roadmap

The existing systems and practices on wind, solar and load forecasting in all the Indian states have been reviewed and potential development has been recognized. Forecasting practices which are successfully operating globally -and specifically in Germany are presented and analyzed with respect to their applicability for the selected Indian states. On this basis, a recommended framework for the implementation of a sophisticated forecasting system for wind and solar electricity generation is described. This framework includes both, the forecasting techniques (software, data, etc.) needed for obtaining relevant information, and the infrastructure necessary for the generation and communication of this information [4].

A Study had been conducted by the GIZ-Germany [5], University of Oldenburg, Germany, Ernst and Young, India office in 2015 at the state Gujarat, Andhra Pradesh, Himachal Pradesh, Karnataka, Rajasthan and Tamilnadu and the scientists did not find any matured Wind Solar Forecasting methodology.

In Tamil Nadu, Spanish RE forecast provider [5] Vortex has started the operation of a wind power forecast system in cooperation with the National Institute of Wind Energy (NIWE) on behalf of the Indian Wind Power Association.

Since 2009, the India Meteorological Department (IMD) operates a High Performance Computing System (HPCS) and is running a version of the Global Forecast System GFS T574/L64. This high resolution global forecast model and the corresponding assimilation system are adopted

from the National Centre for Environmental Prediction (NCEP), USA. The spectral model has a horizontal resolution over ~ 22 km and runs twice a day (00 UTC and 12 UTC). In addition to this, the meso-scale forecast system WRF (Weather Research and Forecasting) is being operated twice in a day, at 27 km, 9 km and 3 km horizontal resolutions for forecasting up to 3 days using initial and boundary conditions from the GFS-574/L64 model. At ten other regional centers, very high resolution mesoscale models (WRF at 3 km resolution) are operational [5].

For wind and solar power forecasting the most significant forecasting model is the regional mesoscale analysis system -WRF supported by the National Center for Atmospheric Research (NCAR) but developed as an open source model by several US research entities.

In March 2015, Central Electricity Regulatory Commission (CERC) [3] published its proposed 'Framework for Forecasting, Scheduling & Imbalance Handling for Wind & Solar Generating Stations at Inter-State Level' according to which RE forecasting needs to be done both by the RE power producer and the concerned RLDC. While the forecast by the RLDC would be done with the objective of securing grid operation, the forecast by the RE power producer would be plant-centric and form the basis of scheduling. The RE power producer may choose to utilize its own forecast or the regional forecast given by the concerned RLDC (via its REMC).

Not many research papers are also available to use as reference for the Wind-Solar power performance. Madhuchandrika et.al [6] studied the impact of changing climatic parameters like temperatures and humidity on the performance of Solar PV.

IV. CONCLUSION:

At this point it is necessary to distinguish between technically motivated needs and economically desired mechanisms. That is, if market mechanisms are excluded, there is generally no need for plant specific (i.e., single-site) forecasts and forecast information is necessary only on control area level (responsibility of RLDC). This is because at the RLDC level, grid stability, security of supply, etc. are potentially affected by the availability of high-quality forecasts.

Site-specific forecasting does not contribute to improvements of overall forecast quality on the more important regional level. This is because site-specific forecasting uses post -processing techniques that are adapted (or tuned) to the specific single site case. Therefore, much effort is spent on the optimization of site-specific forecasts without any benefit for the regional level. This leads to a misallocation of personnel and financial resources.

V. RECOMMENDATION:

For the establishment of forecast systems as integral ports of the Renewable Energy Management Centers the following recommendations are made:

- Forecasting should be concentrated on the regional level. Regional forecasting results in significantly lower uncertainties due to spatial smoothing effects.
- There is no need for single site forecasting–except for economic reasons given by the market mechanisms.
- Forecasting by both, the RE power producer and the concerned RLDC as is proposed in the recent Framework for Forecasting, Scheduling & Imbalance Handling for Wind & Solar Generating Stations at Inter-State Level 'is not recommended.
- RE forecasting needs to be accompanied by a load forecasting scheme of at least the same accuracy. This should take into account the regional differences in load structure.
- Standardized processes for forecast evaluation should be implemented. An Evaluation Handbook should be considered as an option.

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