Optimized Wind and Solar Power Forecasts for India

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***Abstract*— India has very ambitious plans of increase of wind and solar generation for the upcoming years. In order to maintain or even improve the stability of the electrical grid, accurate forecasts of wind and solar power are an important building block for a sustainable future. Currently, many approaches are transferred from countries like Germany, Denmark, and the US in order to offer prediction services for Indian wind and solar power farms.**

Without doubt, this is a good starting point. Nevertheless, a lot of conditions are quite different from the situation in the mentioned countries. Climatological conditions like rainy season and high and low wind seasons must be taken into account during tuning of prediction models. Influences like haze, aerosols and soiling demand for extended solar power forecasting models. Quite strong thermal gradients in the atmosphere must be modelled differently from conditions in the moderate latitudes for predicting the power output from wind farms.

Finally, we will shed some light on the current Indian regulations with respect to forecasting and will propose some potential developments for the future.

Keywords- Solar forecasting, Wind forecasting, Day ahead, physical, statistical,intra-day, India

I. INTRODUCTION

II. SOLAR POWER PREDICTIONS

In India, the influence of haze and aerosols is much bigger than in regions like Europe and the US. This naturally has a significant influence on the irradiation which can be used by PV modules. In addition, the day-to-day variations of the so-called clear sky irradiation are much bigger than in countries with less aerosol impact. In order to gain excellent solar power forecasts for India in general, the tuning of clear sky models must be adapted. In addition, existing forecasts of aerosols are tested in order to improve the day-to-day forecasts quality even further.

A big advantage in India is the availability of an irradiation measuring network with high quality measurement stations (SRRA), which is operated by NIWE. More than 100 irradiation measurement stations are spread out over all states, so a proper analysis of the clear sky behavior in different climatic regions support model development, and the final tuning of these models. (see also [1,2])

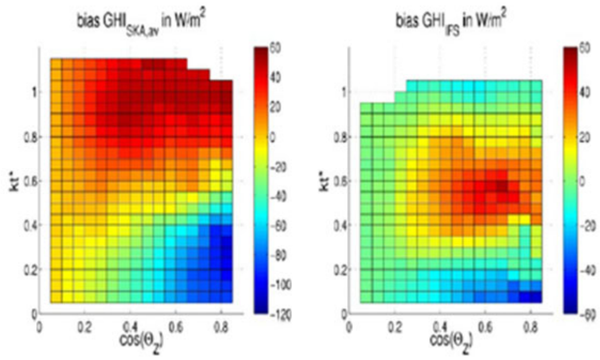

Figure 1: Figure 1: Representation of Binned irradiation bias as function of clear-sky index and cosine of zenith angle compared to SRRA data. [3]

Another big impact on PV production is the soiling of PV panels by dust and dirt. Model development and improvement is ongoing in at least two studies carried out by NIWE and the German company Suntrace, partially funded by the German giz.

With respect to very-short term predictions (30 minutes to 4 hours), an approach based on Indian weather satellite data is under development at NIWE and overspeed. (Figure 2 and Figure 3)

Figure 2: Insat 3D satellite. (source: isro.gov.in)

III. Wind power predictions

With respect to wind power predictions, there are mainly two points which must be taken into account in India.

Compared to countries at moderate latitudes, the influence of the thermal stratification of the atmosphere (i.e. the difference in temperature at different heights) is much bigger. This must be taken into account in the model chain by a more accurate model approach for these effects. As a follow up, this dependency on the atmospheric conditions leads to higher amplitude of daily patterns and extreme events/ramps of power production.

Today, most prediction systems work on an adaptive basis. This means that the tuning of models is updated permanently with the latest measurement data. This helps to take into account slow changes in conditions, like the transition from summer to fall to winter. In areas with Monsoon influences, this approach may lead to big forecast deviations at the beginning of the rainy season. The models then have been trained adaptively on low-wind data for up to 9 month, and the training for the high wind season may be poor. For that reason, the model training approaches must be optimized for the situation of high- and low-wind seasons. (Similar arguments hold for the training of solar power prediction models.

IV. Proposals for Future Regulations

Currently, the Indian regulations for the power sector demand a forecast for each single wind farm. This is not a bad approach, but the combination with penalties for forecast deviations on a single farm level limit the possibility of improving the prediction quality.

In general, forecast deviations of a single farm do no harm to the power system (of course, depending on the size of the farm; this doesn't hold for Gigawatt farms). For that reason, in most countries with high penetration from wind and solar, there is the possibility to deliver forecasts for a complete pool of wind and solar farm. The power production of the portfolio(s) is summed up by specialized companies called aggregators, similar to aggregators for pooling stations in some Indian states. Prediction products are then delivered on the aggregated levels.

This opens the opportunity to ask for higher prediction accuracy (due to smoothing effects), stimulates investments in better forecasts (like better FSPs and higher quality of measurement data, and is closer to the needs of the energy system operations.

Last, but not least, a good quality of the measured data from wind and solar farms is crucial for an excellent prediction process. The occurrence of mixed power readings in some states, combining wind, solar and load, leads to the application of quite complicated correction and upscaling methods with limited accuracy. One proposal for future regulations could be an incentive for delivering reliable data to the dispatch centers/REMCs for every single farm, including signals of current power production, downregulation set-points, and turbine or inverter availability.

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VI References

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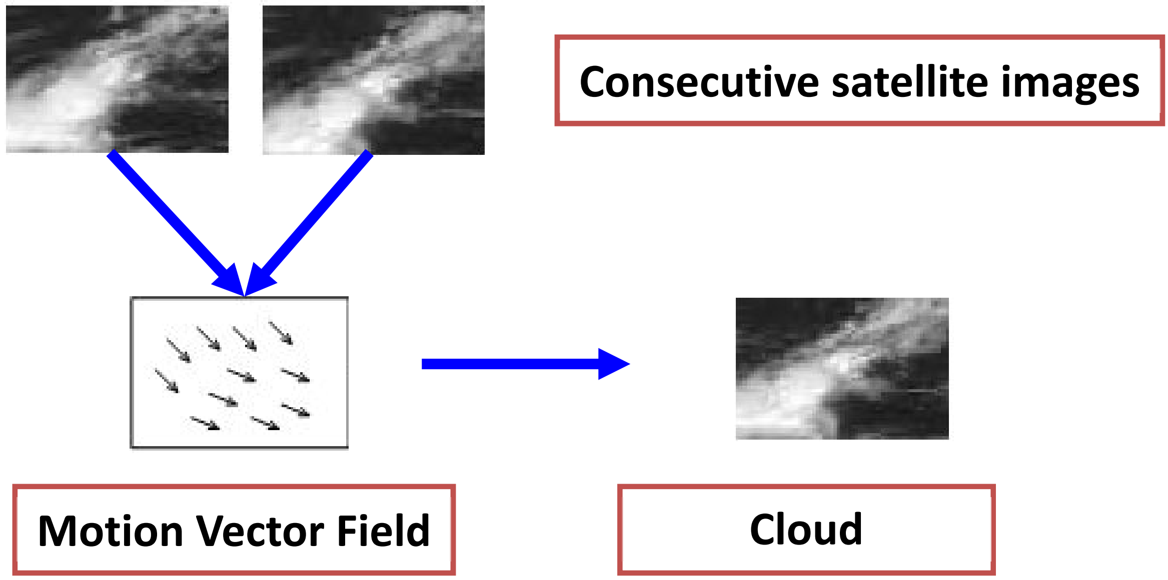

Figure 3: Principle of deriving solar power prediction from consecutive satellite images, producing cloud motion vectors, from which the irradiation forecast is derived.

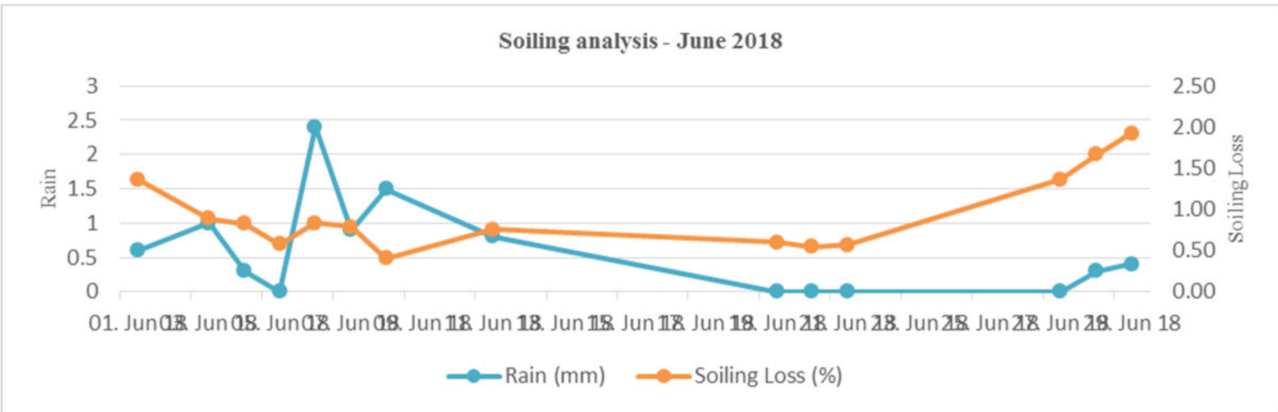

Figure 4: Soiling analysis at NIWE [1].