The Need for a Pan India OFFSHORE WIND RESOURCE ATLAS

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India is currently the country with the fifth-largest onshore wind industry. As of March 2015, the total installed generation capacity of the onshore wind sector was as high as 23.4 GW. While this sector has gained significant visibility through large-scale deployments in the past decade, the offshore wind sector has also started getting some recognition amongst investors and policy makers. With the recent announcement of National Offshore Wind Energy Policy (approved by the Cabinet), significant research and development, and commercial activities are expected in this emerging sector.

Offshore wind tends to blow faster and steadier as compared to onshore wind. With a 7,600-km coastline, India could become an attractive hub for offshore wind investors in the coming years. Before embarking on setting up large-scale offshore wind farms, can the country benefit from an offshore wind atlas that reveals the high offshore wind potential zones?

Wind Resource Measurement and its Evolution

Wind resource assessment can be considered as one of the crucial activities in the development, siting, operation and maintenance of a wind farm. For successful execution of a project, developers look for high quality wind measurement data in order to determine the wind potential across a range of sites. As stated by Hasager in an Energy and Environment article, "Obtaining higher certainty on the potential wind power may reduce the financial investment risk and cost". According to TKI Wind op Zee (the Dutch offshore wind sector policy), a 1 per cent decrease in plant load factor corresponds to an increase in levellised cost of electricity by 1 per cent.

In early 1990s, the popular wind measurement techniques were satellite image-based wind resource mapping and anemometers. Innovative measurement techniques, including remote-sensing techniques have gained cognizance in recent years. Developers usually examine detailed satellite maps (e.g. QuickSCAT images) for pre-feasibility assessments, to estimate the energy production capability of a site. QuickSCAT images from satellite-borne systems provide measurements of near-surface winds over large regions of different grid resolution. These data sets provide enough evidence to indicate the existence of wind resource potential for possible exploitation. However, they have to be validated against wind speeds measured by masts with mounted anemometers to better determine the potential at a selected site. Sometimes, additional sensors are also mounted to measure parameters like humidity, pressure and temperature.

The Ministry of New and Renewable Energy, Government of India, has collaborated with the National Institute of Wind Energy (NIWE) to install dedicated masts for gathering long-term wind resource data from across the country. Currently, there are around 790-800 installed masts; but, as of March 2015, only 151 of these are operational. A majority of the operational wind measurement sites are distributed in Maharashtra (28), erstwhile Andhra Pradesh (28), Karnataka (24), Tamil Nadu (18) and Gujarat (13); the rest are in other States and Union Territories.

According to an article by the World Wind Energy Association, "Data has to be recorded for at least 12 months without gaps" for evaluating the wind potential at a site. Data collected over long durations help in better forecasting the wind energy generation potential of a site. Further, data captured on a seasonal, daily, and hourly basis provides developers/utilities a better perspective about the impact of wind power on system operation and transmission evacuation availability.

Tuticorin Port, one of the 12 major ports in India. Photo courtesy: FOWIND

The European offshore experience shows that measuring wind resource profiles of offshore sites vis-à-vis onshore sites differs significantly. In the case of offshore wind sites, it is structurally and economically not feasible to install multiple wind measuring masts in the sea. Instead, Light Detection and Ranging (LiDAR) equipment, a remote sensing technique, is becoming more popular in offshore wind assessments. LiDAR devices are able to provide relatively better wind profile data, as these can capture a wider area by surveying multiple turbine location points and at different hub heights. In addition to wind speed and wind direction, parameters such as hub-height turbulence intensity, temperature, air density and relative humidity are recorded as well. Although a LiDAR is a costly piece of equipment, it provides several benefits in terms of remote and real-time access to data, portability, and ability to function in rough marine conditions.

India's Status and Way Ahead

Wind resource maps serve to inform decision makers about the potential sites where wind farm development could be encouraged. The United States and Canada have a comprehensive national wind energy atlas, which primarily indicates wind speed across different hub heights, seasons, geographical distribution and topography. The *Indian Wind Atlas* published by NIWE estimates India's onshore wind power potential to be 49 GW at 50m hub height. A more recent study incorporates wind potential estimate at 80m hub height and anticipates a potential of 102 GW.

FOWIND, a consortium (led by the Global Wind Energy Council) working on India's first offshore wind assessment project, has identified potential zones off the coast of Tamil Nadu and Gujarat. The project reveals suitable zones that possess the desired wind speeds and water depths for possible offshore wind farm development.

Creation of a similar unified pan-India atlas depicting the offshore wind landscape will be an important step for exploring the offshore wind potential. To begin with, anemometer data from near-shore masts, observations from LiDAR campaigns and satellite remote sensing can be collated for developing preliminary offshore wind resource maps. In the FOWIND project, as a next step, India's first offshore measurement campaign using LiDAR is going to be conducted at selected sites off the coast of Gujarat and Tamil Nadu. Data generated from this campaign will be used by the government and other industry stakeholders for planning offshore development activities at these sites. Going forward, data assimilated from future LiDAR campaigns at various sites across coastal regions along with these maps could help build a comprehensive nation-wide offshore wind atlas.