16/05/2023

Impact of Climate Change on Wind Energy Production – First Draft

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The Renewable Energy Independent Power Producers Procurement Programme (REIPPPP) has paved the way for the adoption of renewable energy including wind energy to form a base of power in SA. Since the completion of the REIPPPP wind projects from 2012 onwards, constant wind data has been captured from the operating plants which has informed the further development and improvement to the WASA map. These maps and meteorological data are incorporated into the simulation software in order to inform the annual yield of a theoretical wind plant during the design process.

Wind energy by its very nature is dependent on weather cycles and general climatic conditions. During the development of wind plants, a key factor in the design and financial modelling will look at the amount of energy generated over a period of time. A wind simulation is required in order for the financial modelling to take place which will use the amount of energy generated and correlate that to a potential payback model which thus determines the overall tariff of the plant. Wind plants are heavily dependent on their production in order to determine whether they will be profitable and the biggest driver of the energy production is average wind speed. The Wind Atlas of South Africa (WASA 4) map provides an overview of the average wind speed across South Africa according to historical data which has been collected by met masts and from existing wind farms.

Historically, the measurement campaigns run by most developers (together with the WASA data) has been of good quality and has been relied upon as a key input in the financial models. Interannual variability can be high and may not typically be captured in short term records. This is one of the key reasons why long0term correction is done as part of the yield assessment process. Due to the maturation of the wind industry over the past decade, there has not been any major concerns regarding the accuracy of the data however the impact of climate change on the data going forward is unknown.

The main source of information for the availability of wind resources is the Wind Atlas of South Africa or WASA map. This map has been created in phases from 2009 with the latest version, WASA 4, being launched at Windaba 2022. There are no current plans for a timeline for regular updates to the map to occur and has largely been relied on to be updated on an ad-hoc basis.

Engagements with research institutions have implied that there may be a link between the movement of the El Nino and La Nina (ENLN) weather systems and wind production. There are limited studies available on the effect of ENLN on the wind production in Southern Africa. There is some evidence that ISO (ENLN) and IOD (Indian Ocean Dipole) which are 2 of the well-known climate studies which have linked to windspeeds in Southern Africa. IPPs have not yet seen any correlation between the ENLN and wind production although there was a marked difference in wind energy production in the 2023 calendar year.

Regarding the tools used to measure the meteorological data, there are 2 main types of data acquisition methods being Met masts and LiDar. Met masts require to be calibrated against other long term datasets in order to calibrate the period that the met mast data was collected to a much longer timeframe. Challenges are more related to generating representative timeseries at an hourly

level as opposed to annual generation since annual generation is well understood and modelled for the most part.

LiDAR is not currently well accepted by lenders as the primary form of data collection however is accepted as an additional tool to correlate to the met mast data in order to improve accuracy. LiDAR is gaining in popularity and the view is that it will play a much bigger role in future wind data collection campaigns.

The existing software used by developers already incorporate variability in wind production as part of their software suite. In the short term, without any significant changes in weather systems, the accuracy of the simulation data will likely be maintained.

One of the major impacts of climate change will be the financial impact of lost production. There is not currently sufficient information to draw a definitive conclusion on this. IPPs have reported generally meeting their performance targets, with the exception of 2022. Underperformance against the base case can be caused by overoptimistic interpretation of pre-construction met mast data. Generally, interannual variability is more of an issue than climate change for the lifetime of a wind project.

There has not been any significant downturn in performance to jeopardize the development of new wind projects nor to cause real concerns to the long term adherence to the their respective PPA's. There is limited evidence of a small downward trend at a few meteorological stations, in the order of 0.0002m/s/year hence in the grand scheme of a 20 year project, this will not be significant.

Wind energy will remain a key energy source for the future and it is yet to be reliably quantified how climate change will affect the availability of wind resources in South Africa.

More research is required to determine whether climate change will have a significant effect on wind resources. In the current circumstances, the low production for 2022 could be due to a low wind cycle with anecdotal evidence from some IPPs indicating that March and April 2023 have produced wind resources exceeding expectations once again.