ReNew POWER

Improving The Effeciency Of Our Wind Turbine

ReD

DIGITIZE . OPTIMIZE . MONETIZE

Used Case Diary
Vol 1

About The Initiative

Wind Turbine Generators (WTGs) capture the Kinetic Energy of wind and convert it to Electrical Energy. This conversion takes place in stages, with large rotating blades converting wind energy into rotation of drive train consisting of Gear Box and Generator, which in turn converts this motion into Electricity. While Wind energy is renewable in nature and does not cost, energy can be lost in the conversion process. This initiative is about identifying such losses and focusing on improvement areas to achieve maximum efficiency of each turbine with reference to turbine specific design power curve for each 10 min interval. This use case impacts all our sites as there is always scope for improving efficiency.

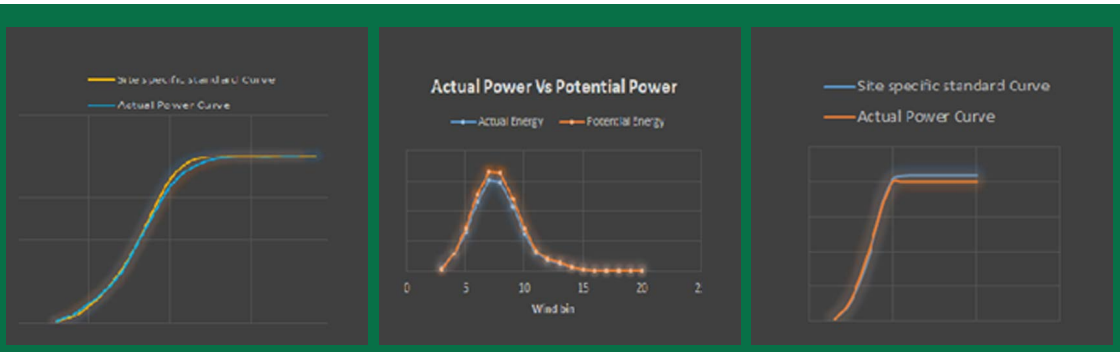
Key Persons involved:

A team consisting of experts drawn from various disciplines was involved in working on this use case.

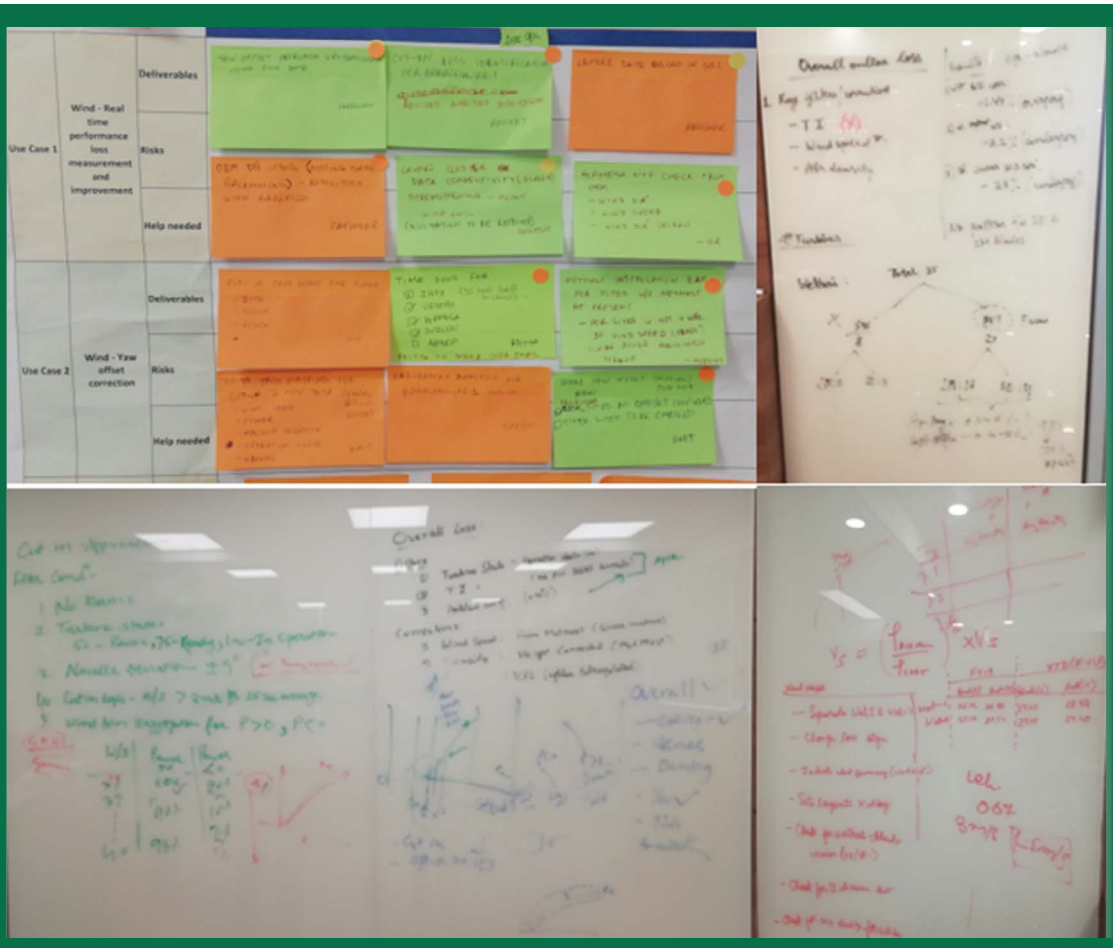
- **Amit Gandhi** (Electronic Engineer with ~12 years of experience in Renewables) as Use case owner
- **Ravinder Singh** (E&C Engineer with ~12 years of experience in Renewables) as Project Manager
- **Neeraj Yadav** from WRA was co-use case owner. He helped us in building the methodology and resolving wind resource related queries
- **Aysurya Sagar** and **Aditya Ramanathan** from RPDC were in charge of data analysis for various test and trials to understand the operational behaviour of different turbine models and how their components impact performance. They also helped in getting required data from Bazefield and OEM to create an automated pipeline for all the sites through API/ FTP.
- **Vir Singh** from Engineering team, with expertise in turbine designs was also involved as co-use case owner. He helped us source technical details from each of the OEMs for each model. Vir is helping us in conducting various trials on turbines to identify the root cause of under-performances in turbines.
- **Aditya Ramanathan** from SCADA is helping us obtain required historical and current data for each of the sites, besides assisting in identifying and correcting the data tags used for the use case pipeline building.

Implementation Team:

- **Prakash Vora** (Electrical Engineer with ~18 years of experience in Renewables) is leading implementation of the Overall use case across the portfolio.
- **Knayha Mongha** and **Snehal** is assisting in gathering and maintaining the Implementation status data and further reporting to leReRadership team.



Bin-wise actual power comparison with reference to calculated design power at 10 min interval

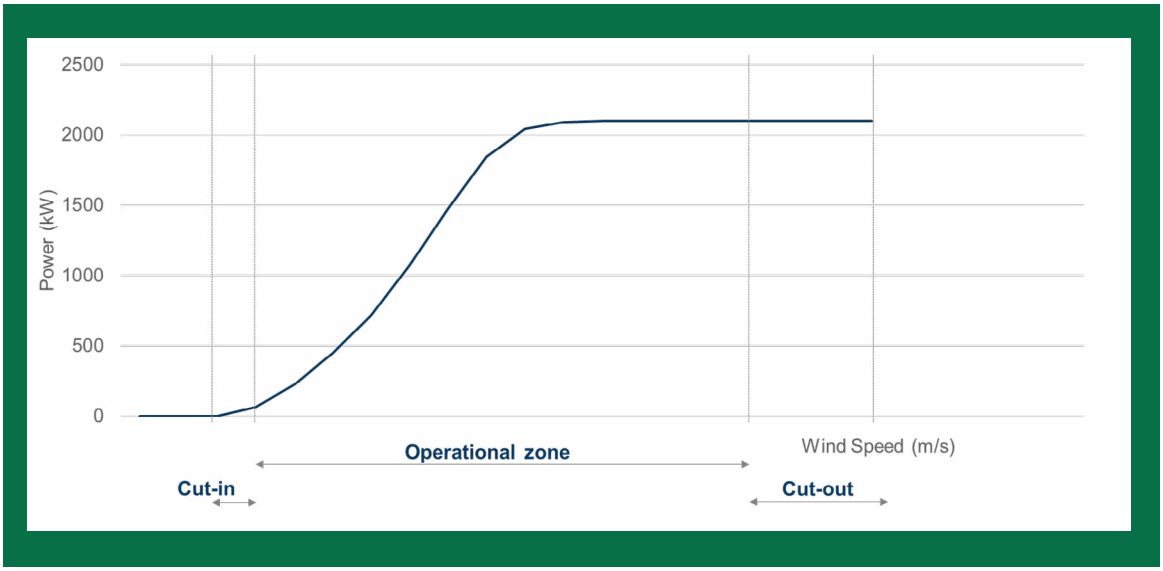


Daily Check-in activity chart to assign task (upper left) and various problem solving sessions for Use case (bottom)

The Use Case

At ReNew, since beginning we have laid stress on LPF i.e. Lost production factor, which is expression of potential energy that could not be captured. We have been focused on discovering ways and means to identify and minimise the losses. During the digitization journey, we learnt that it is important to focus on yield, which expresses actual energy expressed as % of potential energy. Improvement in yield will automatically result in reduction of LPF. That is how the Overall use case idea came into being under the ReD. initiative.

The methodology adopted for this use case is to measure the actual power curve with respect to the dynamic design power curve of individual turbine based on actual ambient temp., air density and other variables. The Power curve is further bifurcated in different zones like Cut-in zone, Operational zone and Cut-out zone.



The operational zone is further sub-grouped to various sub-use cases like De-rating, Pitch optimization, Knee point losses, Yaw Misalignment, Max-rating, etc.

Impact on organization

The initiative has proved to be a great success in terms of data-driven understanding of turbine behaviour, analysing impact of environmental factors on turbine performance and generation of actionable ideas / action plan for yield and/ revenue optimization. The data driven insights enable us to pin point what action to take where and what is the expected outcome. Once an action is taken, it allows us to measure impact also. All this is in real time, allowing for quick changes. I am confident that with this use case we will be able to deliver tangible value to business and build a strong technical knowledge hub at ReNew which is data-driven.

Before ReNew initiated its digital program, performance analysis was carried out using traditional approaches, such as simple power curve analysis without applying data filters, correction factor as per OEM / IEC recommendation and that too on fortnightly basis, so sometimes there were delays in identification of underperformance of assets.

With this initiative, one can perform the Power curve analysis on daily basis as per OEM recommendations, share and exchange information with OEM on frequent basis and have them attended to. Some of the OEMs have learnt and benefitted from our exchange, and have promised to evaluate if these learnings can be replicated across their fleet.

Key Success Factors

- The number one success factor is cross functional collaboration between Asset Management, Engineering, Wind Resource Assessment, Implementation and the IT team.
- Second factor is the agile and strategic approach adopted for day to day progress. We conducted daily check-ins where we reviewed the previous day's progress along with action plan for next 2 days or so, which helped us in achieving quick results.
- Weekly / fortnightly reviews by leadership team helped us in refining our methodologies adopted for data consideration like high frequency vs 10 min data, model building, impact measurement, etc.

Engagement & Contribution of Site Employees

Employee engagement process began right from the idea generation stage. Employees were communicated about this mission, and were invited to contribute ideas for improvement through face to face or on line workshops. From idea generation to refinement to implementation phase, designated site employees were nominated as Single Points of contact (SPOC) for their respective areas, and worked closely with the implementation team. SPOCs provided feedback on execution and challenges faced, if any. Thus, they acted as critical link between the site team and the development team through Implementation team resulting in a robust close loop process.

Impact on site operations

The most visible impact on site has been an increased motivation level of employees. Employees can see their ideas being accepted, refined and implemented across Wind Turbine Generator fleet, giving them sense of "belonging" and satisfaction of making a visible contribution.

Second most striking impact has been the way site team members have gradually adopted data driven decision making, rather than relying on method of elimination or repeating past set of actions. This has also made quickened rectification.

Third big change has been increase in interactions between experts and site service team, enhancing the latter's learning and knowledge.

Last, but not the least, the team now knows their machines better, and this reflects during their discussions with OEMs. The discussions are based on hard facts and data, and not on assumptions or personal opinions.

Overcoming Challenges

There were three main challenges faced for this initiative;

1. **Historical 1-year data gathering** along with all the required tags from various sources like Bazefield, OEM data, met mast data, etc. as per methodology developed and to check the data quality for its correctness. For e.g. **Bazefield** is having all the required tags at required frequency however, SAT was done after Oct- 19 for most of the sites. So, before that data was un-reliable. Second source was **OEM data** which is reliable data and made available by SCADA team, however, this data does not contain the Std. Deviation tag for wind speed and in absence of this model can't filter out the TI data (beyond range) as recommended by OEM. **To overcome this challenge**, we carried out manual analysis for those sites using a combination of Bazefield and OEM data and followed up with OEMs rigorously to integrate the additional required tags in their data also. Now, we are creating automatic data structure for OEM data as well to automate the complete process.
2. To define Impact measurement methodology. Initially we thought impact measurement is an easy task by simply deducting the before and after performance % between design and actual power. However, while defining the methodology working team realised that performance is also varying from turbine to turbine due to various environment factors like air density, ambient. temperature, in flow angle to turbine, wind sector, etc. So, to nullify the environmental influence on the performance gain /loss after action, we needed a different approach. Multiple analysis was done to create clusters between rectified and non-rectified turbines based on topology, through data driven statistical method i.e. k-means clustering using different input/ output parameters of turbines like wind speed, active power, ambient temperature, wind sector, air density, etc. To arrive at the final methodology, we took almost 2 months of intensive analysis wherein we conducted multiple brainstorming and problem solving sessions within the working and leadership team. Finally, we struck upon an idea to make clusters based on 1-year month on month historical performance between the turbines using the statistical correlation and volatility ratio between the reference and rectified turbine. This has worked well for impact measurement.
3. There were execution difficulties at site, arising out of restrictions in movement due to outbreak of **Covid19 pandemic** and precautionary lockdowns imposed by Governments. Both ReNew and OEM worked real hard to keep their team safe, healthy and well looked after, obtain necessary travel permissions and ensure all safety guidelines were complied with.

Next Steps

The next steps for this use case are;

1. Continued refinement of model using feedback from various stake holders
2. Complete level 1 basic actions like Wind sensor alignment, Blade calibrations, basic parameter settings, etc. for Phase-2 and Phase-3 turbines
3. To initiate level 2 checks like De-rating checks, Blade inspection & cleaning, Inflow angle checks, Blade calibration using laser alignment, etc. for those turbines where we didn't get the deviation in level-1 basic checks
4. Release of integrated Power BI dashboard for Performance check, Implementation status and Impact measurement for Overall use case
5. Development of various sub-use cases model and results for Pitch, De-rating, Yaw Misalignment, etc.

ReD working team visit at Lahori wind site

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