Power Consistency Warranty: Closing the Gap between Availability and Power Curve Warranty

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Summary

Modern wind turbines are operated increasingly often with reduced or limited power output, what can lead to significant production losses. Such production losses are often not covered by availability warranties or power curve warranties. A new type of warranty, called Power Consistency Warranty has been designed in the frame of advice or negotiations on turbine supply or maintenance agreements. This warranty covers losses due to obvious power reductions or power limitations in the responsibility of the contractor, so far such losses are not covered by other warranties. The relevant production losses are assessed on the basis of external data sources like production data of adjacent wind turbines, wind measurements or nacelle anemometer data. As it is difficult and sometimes even impossible for the contractor to avoid extraordinary power reductions completely, a threshold value for allowed production losses is suggested. This threshold value can be combined with the threshold for the allowed unavailability given in the availability warranty, i.e. the combined losses due to extraordinary power reductions and turbine unavailability shall not exceed a certain value. Consequently, compensation payments for losses due to extraordinary power reductions are suggested being integrated in the compensation for turbine unavailability, i.e. the percentage turbine availability is suggested being reduced by the percentage production loss due to extraordinary power reductions.

1 Introduction

Wind turbine supply or maintenance agreements normally contain a warranty of the technical availability and of the power curve of the wind turbines. The warranty of the technical availability is intended to compensate unreasonable losses of the energy production caused by turbine standstills in the responsibility of the contractor, while the warranty of the power curve is intended to compensate energy losses due a lack of ability of the turbine to produce the warranted power output when the turbine is available. A gap arises as production losses due to improper operating modes are hardly covered by these two warranties. Such losses can be of significant magnitude and are often not expected by turbine owners. The proposed Power Consistency Warranty closes this gap.

2 Problem

It is relatively often observed that wind turbines are put to operating modes with reduced or limited power output by the contractor for some time without agreement of the owner. Typical examples of such events of extraordinary power reductions are illustrated in Figure 1, Figure 2 and Figure 3. Table 1 lists events of extraordinary power reductions, which are typically in the responsibility of the contractor.

Many of these events happen unintended, e.g. the turbine is put accidently in an unwanted operating mode by the contractor (e.g. due to lack of information of service teams), while sometimes the non-ideal operating mode is applied on purpose by the contractor (e.g. for reducing mechanical loads).

Anyway, the wind turbine counts as technically available at such events, as power is produced, i.e. the energy production losses attributed to the reduced or limited power output are not covered by the warranty of the technical availability. The production losses are often also not covered by the power cure warranty, because the warranted power curve is normally verified only in a very limited operating period with a length of a few months and only for exemplary wind turbines of the wind farm.

The respective events are observed mostly at modern wind turbines, where smart control systems offer more room for adjustments than at former, simpler turbine types.

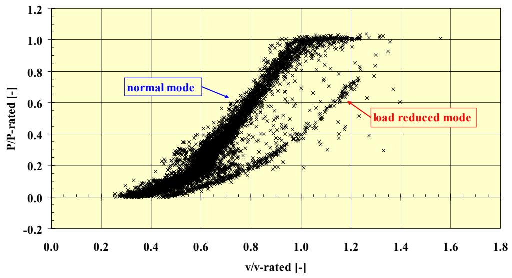

Figure 1: Example of power curve significantly suffering from automatic load control. Losses due to events of load control are mostly not covered by power curve tests aiming to verify warranted power curves, neither are they covered by availability warranties.

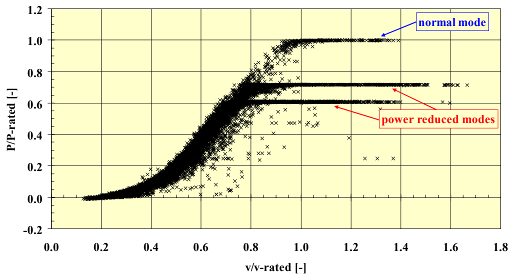

Figure 2: Example of unintended power reductions. As these events usually do not appear at power curve tests aiming to verify warranted power curves and as the turbine is available, the attributed losses are neither covered by power curve warranties, nor by availability warranties.

Extraordinary Power Reductions (Examples)
automatic load reduction due to vibrations
automatic load reduction due to extreme temperatures
power reduction due to (partial) malfunction of turbine component, e.g. power converters, cooling fans
noise reduced operation, e.g. due to breech of warranty of sound power level
power reduction due to grid conditions, when grid conditions within agreed specifications
power reduction due to changes of the WT settings
power reduction due to improper functioning of the WT control system
power reduction implemented for no reason

Table 1: Typical events of extraordinary power reductions in the responsibility of the contractor

Figure 3: Different arrangements of anemometers/vanes on nacelles observed in the same wind farm leading to massive production losses covered neither by exemplary power curve tests nor by the availability warranty

3 Concept of Power Consistency Warranty

3.1 Definition of Events of Extraordinary Power Reductions

An event of power reduction / power limitation is defined as event of extraordinary power production being relevant for the Power Consistency Warranty if all of the following conditions are fulfilled:

- An obvious power reduction is present.
- Contractor is responsible for the power reduction.
- The power reduction is not covered by a power curve test intended to verify the fulfilment of a power curve warranty.
- The turbine is operational / available.

3.2 Assessment of Losses due to Extraordinary Power Reductions

Production losses due to extraordinary power reductions can normally be assessed best on the basis of the following data sources:

- energy production of adjacent turbines, which are not subject to extraordinary power reductions, e.g. by means of the relative power curve analysis described in reference [1],
- reference wind measurements available at the wind farm,
- local wind data as available from weather forecasts, production forecasts or reanalysis wind data,
- nacelle anemometer data.

The exact procedure and the basis for the assessment of the relevant production losses must be kept open in the warranty, as different types of extraordinary power reductions may require the application of different methods. In general, the assessment of production losses due to extraordinary power reductions requires significant experience with techniques to correlate different data sources like wind turbine production data and external wind data sources, what is seen as a weak point of the warranty. On the other hand, the application of such methods is already common practice in the wind energy industry for assessing production losses in insurance cases.

3.3 Criteria of Fulfilment of the Warranty

It is hardly possible for contractors to avoid losses due to extraordinary power reductions completely, i.e. the warranty should provide the contractor some allowance of such production losses.

It is suggested to sum up the production losses due to extraordinary power reductions for the same reference periods for which also the turbine availability according to an availability warranty is assessed. It is further proposed to calculate the relative production loss due to extraordinary power reductions in such a reference period as follows:

$$E_{rel.loss} = \frac{E_{loss}}{E_{true} + E_{loss}}$$

where

$E_{rel.loss}$: relative production loss due to extraordinary power reductions in a reference period

E_{loss}: production loss due to extraordinary power reductions in a reference period

E_{true}: true energy production in a reference period

The turbine availability in a reference period as defined in the availability warranty should be reduced by the relative production loss due to extraordinary power reductions:

$$A_{reduced} = A - E_{rel.loss} \quad (1)$$

where

$A_{reduced}$: reduced availability

A: availability according to the definition of the availability warranty

The Power Consistency Warranty as well as the availability warranty is then suggested being fulfilled if:

$$A_{reduced} \geq A_{warranted}$$

where

$A_{warranted}$: warranted availability

This regulation provides the contractor the possibility to compensate production losses due to extraordinary power reductions by an availability above the warranty level. However, a breech of the warranty is given if the sum of unavailability and percentage losses due to extraordinary power reductions exceeds the allowance of unavailability as provided by the availability warranty.

3.4 Compensation

Compensation of losses due to extraordinary power reductions is proposed being integrated in the compensation of availability losses according to the availability warranty by applying the reduced availability defined in equation (1), i.e. the difference of the reduced and warranted availability is compensated.

4 Conclusions

- The Power Consistency Warranty closes the gap between availability warranties and power curve warranties. By that, it contributes significantly to a better balance of expected and true energy yields of wind farms.
- The Power Consistency Warranty is especially well suited for the integration in long-term full service agreements.
- The Power Consistency Warranty is a useful tool to encourage the contractor to take better care for proper turbine settings over the entire warranty period and not only during power curve tests.
- The Power Consistency Warranty has been successfully negotiated.

5 Reference

[1] Albers A.; Relative and Integral Wind Turbine Power Performance Evaluation, proceedings of EWEC 2004, London