When is lifetime extension worthwhile?

Assessments and analyses for lifetime extension of wind turbines

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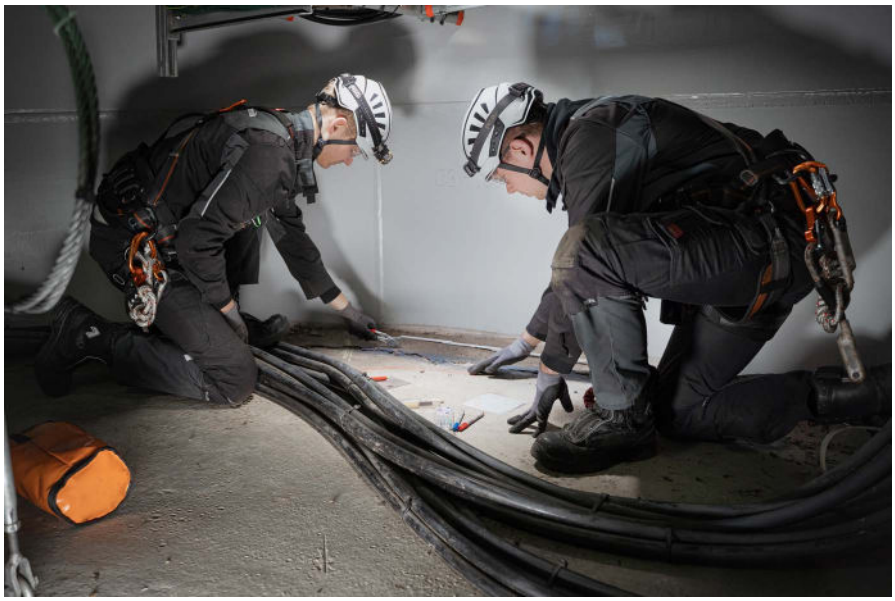
There's a sizeable wave rolling in towards the wind energy industry: this year, in Europe alone, more than ten percent of installed capacity will be reaching its 20th year of operation, and by 2025, the figure will be almost 30 percent. To keep them running or not, this is the question faced by more and more operators who are thinking about lifetime extensions for their turbines that go beyond the end of their 20-year design life.

With the constant annual growth in the number of renewable energy systems installed worldwide, there comes an increase in the average age of turbines in operation. Taking technical development into account, this now includes turbines up to the performance area of one or two megawatts, which are gradually coming to the end of their design life.

For many of these turbines, experience shows that they can continue being operated safely and economically, even after they reach the end of their planned service life. There are several possible options: repowering, lifetime extension, sale or even dismantling the entire turbine.

However, the possibilities arising beyond that point call for specific examination of each individual wind turbine. An important tool for identifying the various connection options is the evaluation and verification of the lifetime extension of the wind turbine concerned.



Assessment and evaluation using standardised methods

In order for the lifetime of the wind turbine concerned to be extended, the legal and commercial requirements need to be checked, along with the technical condition of the turbine. In addition to the suitability of the turbine type and location, the technical condition is a basic requirement for possible lifetime extension of the wind turbine.

A lifetime extension assessment does more than provide information about the potential for lifetime extension. It also helps to safeguard further contracts, as it provides a planning basis for lease right, maintenance and power purchase contracts.

In principle, the evaluation and verification of possible lifetime extension consists of an analytical and a practical aspect. While the analytical part examines the suitability of the respective wind turbine type for a specific location beyond the end of design life, the practical part examines the technical condition of the turbine and whether it is sufficient for lifetime extension beyond the planned service life.

The lifetime extension assessment always requires a country-specific approach, since there are differences in the necessary framework conditions and procedures, depending on the national legislation.

Analytical part calculates load reserves through simulation

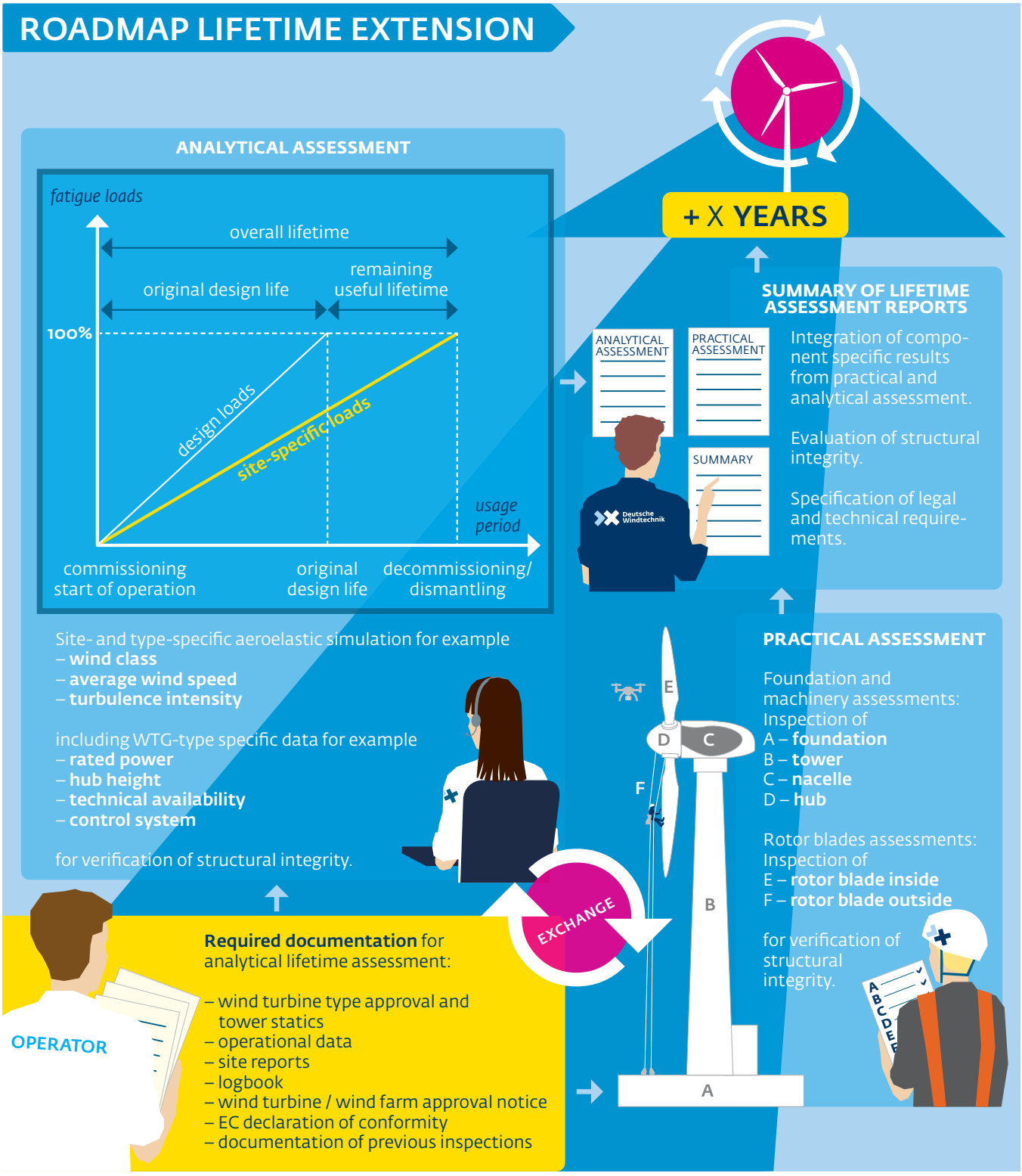
Wind turbines are dynamic systems, and as such, they are subject to different types of loads: dead loads, such as inertial and gravitational loads, but also aerodynamic loads that result from operational, extreme and ambient wind conditions. In the analytical part, load effect is determined by means of a load comparison: what is the potential of the individual structural components and how have they already been stressed with regard to the respective site loads?

In the calculation, fatigue loads are primarily simulated using software-based methods and are compared with the design conditions of the respective turbine type and the historical location data. This analysis is a crucial point as it allows calculation of material reserves and remaining useful life in years and months.

Among other things, the result of the analytical verification depends on the individual documentation status of the respective wind turbine. Good availability of documents and operational data reduces uncertainties in simulations and calculations, which then has an effect on the number of additional operating years within the remaining useful life.

List of documents required for a lifetime extension assessment:

- Wind turbine type approval and tower statics (certification documents including all appendices)
- Operational data (SCADA data: wind speed, wind direction distribution, yield data)
- Site reports (wind reports, yield reports, turbulence intensity certificates)
- Logbook (maintenance-related actions on large components)
- Wind turbine / wind farm approval notice (DE: Building permit / operating permit)
- Declaration of conformity by the manufacturer (EC declaration of conformity, CE marking)
- Documentation of previous inspections / assessments



In addition to the complexity of the terrain, consideration must also be given to neighbouring wind turbines, existing infrastructure and effects within the wind farm, with regard to the respective IEC classification (IEC 61400-1: design requirements). In order to ensure efficient verification, it is essential to include turbulent wind fields, wind shear, gusts and wake effects in the calculation. In the case of larger wind farms, there is also the option of switching to a clustering model in which the individual wind turbines are grouped in a site-specific manner.

The wind turbines are classified into load groups, with each group represented by the wind turbine that is subject to the greatest stress within the group. As a result, structural stability is still verified by calculation, but at the same time, simulation cost is reduced. This is useful, for example, for bridging the period until repowering, and it reduces the overall budget.

How many years will my turbine be given?

PE-20+ app calculates initial propensity for lifetime extension

Documentation for older turbines is not always complete, and reconstructing missing documents can cause a lot of work. For this reason, Deutsche Windtechnik has brought a well-known partner, PE Concepts GmbH, on board for the analytical part of the lifetime extension assessment.

The engineering firm is active in developing wind turbines as well as towers and foundations, and is a proven specialist in the field of turbine and load simulation, as well as measurement technology. PE Concept has developed the 'PE-20+' app, which is used to calculate individual propensity for lifetime extension, after entering a few framework conditions: www.pec.com/de/produkte/pe-20-app

Practical part checks wind turbine technology on-site

Wind turbines are machines, and as with all machines, individual parts and components are subject to wear and ageing effects. In the practical part, the entire wind turbine, from the foundation to the tips of the blades, is subjected to a technical inspection. During this step, the experts at the Deutsche Windtechnik inspection body (according to DIN EN ISO/IEC 17020) examine the structures meticulously: in addition to the structural stability and structural integrity of the wind turbine as a whole, any type-specific weak points of the respective turbine type are also checked. In this condition-oriented inspection, the respective international standards are taken into account and all structural components are checked to determine whether they have defects with regard to tightness, wear and tear, corrosion, lubrication condition and possible crack formation.

Furthermore, the scope of the on-site inspection includes a check of the turbine documentation stored in the wind turbine, and all work and safety-related certificates are also checked. It is useful that the inspection of the technical condition of the rotor blades be supplemented by a lightning protection measurement to ensure that the system is protected against the effects of lightning even after the end of its design life. Optionally, the technical inspection can also be supplemented by a gearbox video endoscopy, which also provides planning security with regard to gearbox condition.

Guidance for cost-effective lifetime extension: the lifetime assessment report

The information obtained from the analytical and practical parts is incorporated into an overall summary report, which not only provides statements about maintenance-related actions and requirements, but ultimately also shows the service life of the limiting wind turbine components. With the information obtained, the operator is able to further consider the remaining useful life of the wind turbine.

The above-mentioned inspection elements require some time. The ideal time for this is the last regular year of the design life. However, it is also possible to carry out the analytical part in advance, in order to check whether lifetime extension is possible and to obtain information about the medium-term budget planning required for this purpose. Experience has shown that, in most cases, it is possible to extend turbine operation significantly by means of small, inexpensive repair and maintenance actions. It can be seen that, in particular, those operators who value the technical condition of the turbine during the operating period, will have clear advantages concerning available usage reserves. They can play a much more active role in lifetime extension.

How to find an appropriate individual strategy for lifetime extension

Eike Feder, Project Management & Business Support at Deutsche Windtechnik, is a specialist for the profitable operation of old wind turbines. Here are some questions and answers he has had with operators.

Q: Mr. Feder, what information does the operator need in order to develop the most efficient strategy for lifetime extension?

EF: From a technical point of view, an operator needs to consider what investments are required in order to embark on lifetime extension. An accredited expert must first determine how good the structural stability is by inspecting the foundation, tower, rotor, nacelle and drive train. The expert must analyse which follow-up investments in structural stability are needed in the course of lifetime extension. The amount of data submitted for expert assessment is very important. In particular, this includes the yield data, wind speeds and availability of the wind turbine over the entire service life.

Q: To what extent does the technical report on lifetime extension result in subsequent costs for the operator with regard to lifetime extension?

EF: The lifetime assessment report provides the wind turbine operator with a good technical overview of the turbines. In any case, the requirements for maintaining structural stability must always be taken into account. Furthermore, depending on the strategy for lifetime extension, the operator can take preventive maintenance actions and therefore increase the lifetime extension period. This calls for close coordination with the sales side.

Q: What opportunities arise for financial optimisation at the end of the planned period of operation?

EF: For the turbine operator, the revenue situation is changing, which indicates a need to minimise operating costs and live with lower returns. This requires every factor to be tackled, especially leasing, management, maintenance or insurance. The degree of potential for savings in these areas must be examined in each individual case. As well as minimising operating costs, however, it is also important to develop a good power purchase strategy. This can be very diverse and requires a certain market overview. We provide our contract customers with comprehensive support to help them find the right one for them.

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