

ERG Lifetime Extension Process

Sandy Knowe Wind Farm is owned and operated by ERG Group. ERG Group is a major independent operator of clean energy from renewable sources, operating in nine countries at European level. ERG is the leading wind power operator in Italy, and among the top ten in Europe, with over 2 GW of wind farms in operation. ERG contributes to decarbonisation while facilitating a fair and inclusive energy transition as guided by ERG's Environmental, Social and Governance strategy which has been developed in line with the United Nation's Sustainable Development Goals.

Maintenance Strategy from Commissioning

The selection of a turbine for a wind farm project must take into consideration both the characteristics of the location, and of the potential turbine model. The Original Equipment Manufacturer (OEM) performs a site suitability assessment in order to issue a Turbine Type Certificate, specifying the minimum design life of a specific model of turbine for a specific site ('initial design life'). A tailored maintenance programme is defined by the OEM and regularly scheduled maintenance activities are carried out following commissioning. ERG carries out internal quality inspections on these regular maintenance activities. These site-specific plans to keep the turbines in the best condition possible, help ensure a long operational life can be facilitated from the day of commissioning.

Lifetime Extension Process

In addition to the implementation of high-quality protocols and maintenance plans from commissioning, ERG has developed a Lifetime Extension (LTE) process for onshore wind farms which starts at least five years prior to the end of the initial design life certified by the OEM. At the end of 2022, over 270 MW of installed capacity passed 20 years of operation, and more than 1.1 GW of installed capacity was analysed under ERG's LTE process resulting in the safe extended operation of more than 440 MW. See Appendix A for ERG's LTE process flow chart.

Certification

Following the expiry of the Turbine Type Certificate which specifies the minimum initial design life, turbines can be re-certified for additional operational life, as the operational life of a turbine can be determined by the lifetime of each component. To successfully complete ERG's LTE process, each wind turbine will be assessed in compliance with the IEC 61400-28 standard to gain Certification¹ for safe extended operational life. For all the wind farms analysed, it is expected an operational life of 40 years can be reached, by means of proactive inspection, maintenance, monitoring, and remedial action activities.

ERG's LTE process was developed alongside qualified advisors, UL and NABLA Wind Hub. UL Solutions is a global leader in applied safety science, delivering testing, inspection and certification services. They are accredited according to DNI EN ISO / IEC 17025:2005 and are active in MEASNET, FGW, IEC committees and are certified by DEWI-OCC for lifetime extension of wind turbines. NABLA Wind Hub, a specialist in enabling life extension and performance improvement solutions, are certified to IEC, SGS, AEE and Eurostars standards and lead working groups on the drafting of the IEC 61400-28 international standard on life extension.

Inspection, Maintenance, Monitoring, and Remedial Action

The LTE process allows for the implementation of additional inspections to those regularly scheduled through the OEM maintenance protocol, the installation of additional monitoring technologies, and development of a tailor-made approach for undertaking and optimising remedial works.

¹ As of 2022, ERG's LTE certification process complies with Tier 1 Certification Body internal guideline with IEC 61400-28 certification in a final drafting phase.

The LTE process starts with an in-depth inspection of the actual state of wear and tear of the turbines, to identify potential issues with component parts that, if left unaddressed over time, could compromise the turbine integrity. Targeted monitoring and maintenance strategies are defined so that the turbines can continue operating safely beyond their initial design life.

ERG's LTE process addresses all components that require regular inspection, including components that may not have been within the original OEM maintenance checklists. This ensures all the structural and other critical components that will need to be monitored for a safe and efficient extended operational life are being regularly inspected. Experienced and specially qualified teams undertake these LTE inspections.

A contribution to the safe management and operation of turbines after the expiration of their initial design life is performed through the supervision and monitoring of all the data systems installed. Some of these monitoring systems are active from the commissioning date, others are installed following application of the LTE procedure to reduce the likelihood of defects forming.

Examples of these monitoring systems include SCADA systems that allow real-time monitoring of performance and turbine parameters in order to facilitate early detection of potential failures of the components. Condition Monitoring Systems (CMS), that utilise vibrational sensors and other metrics, allow the predictive detection of mechanical failures on specific components within the turbine, and pinpoint issues which can be used to determine the overall health of these parts, informing the optimal operation and maintenance processes required. Sensors installed on blade bearings and bolts also contribute to these monitoring systems in a targeted manner, detecting any potential failures where load cycles could affect the lifetime of the part.

Enhanced maintenance activities prescribed by the LTE process, are generally conducted more frequently, at two-year intervals (or as defined by the LTE process on a case-by-case basis), than the original OEM maintenance schedules. Additionally, any remedial action identified by regular inspection and monitoring, is undertaken in a way to minimise energy losses, during low wind periods or pre-scheduled grid outages. Predictive and preventative remedial action to avoid failures are undertaken in cases where there is an issue starting to develop on a particular turbine, and, in cases where there is a known issue on a particular turbine type, all turbines of that type may undergo preventative remedial action, even if signs of wear are not showing.

Practical Example

The oldest turbines in ERG's portfolio, the Vestas V47 turbines, underwent the LTE process in 2022. This resulted in development of an in-house procedure specifically for this turbine type called the 'LTE V47 Checklist'. The checklist prioritises inspecting those structural components of the V47 which show higher potential for developing issues and verifies all safety systems. Over all sites with the V47, special attention is paid to components that flagged up during the LTE studies, such as the capsule mainframe or the anti-lightning system in the case of V47s. Regular, frequent inspection of these components allows condition monitoring and prompt identification of any problems for which a tailored remedial action plan is created.

Summary

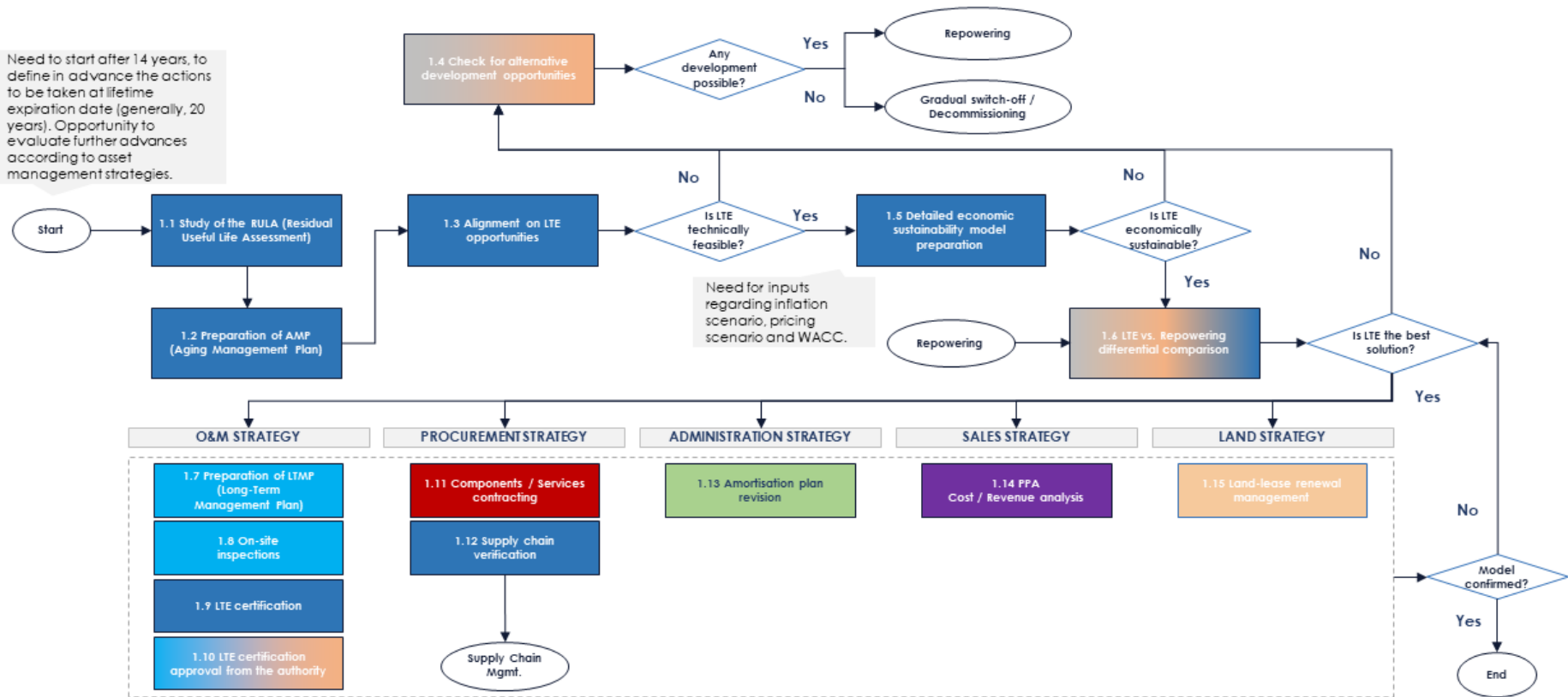
ERG has experience operating and maintaining turbines across its 2 GW European portfolio that includes planning for a long turbine life from the point of commissioning with tailored maintenance programmes. ERG developed and implemented a Lifetime Extension process which involves in-depth inspection, focus on critical components, proactive and tailored maintenance and inspection activities, installation of additional monitoring systems and remedial action plans. Turbines must pass a Certification process in line with Tier 1 Certification Body standards to continue to safe operation past the initial certified design life of a turbine.

Appendix A

ERG Lifetime Extension Process Flow Chart

1 LIFETIME EXTENSION PROCESS DESIGN

Need to start after 14 years, to define in advance the actions to be taken at lifetime expiration date (generally, 20 years). Opportunity to evaluate further advances according to asset management strategies.



Need for inputs regarding inflation scenario, pricing scenario and WACC.