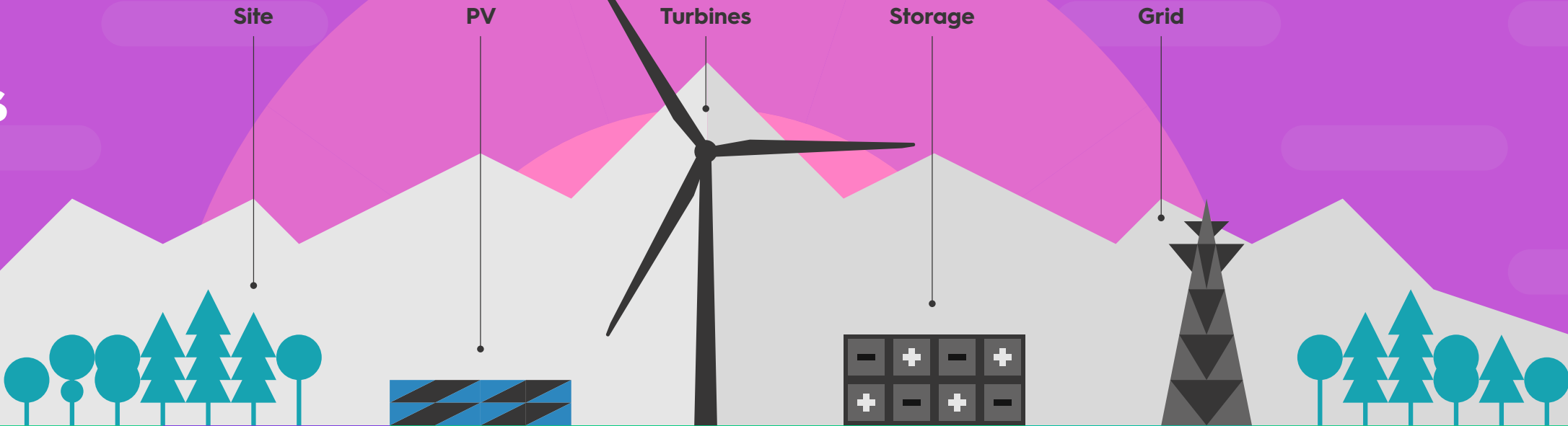


Exploring the options for the next phase of your asset's life



Optimising returns on older assets



All life extension projects need preparation, and each has its own set of needs.

Natural Power supports clients who want to extend the life of their assets by using our experience in analysing, developing and operating renewable assets to work beyond their original lifespan.

Repowering involves removing and taking apart the existing turbine and building entirely new turbines. This is close in size, scope and cost to a new-build wind farm, although it may be possible to use some of the existing infrastructure, such as electrical cables and grid connections.

Replanting sees original turbines replaced with new ones, but they may still use the existing foundations, towers and layouts. Alternatively, the towers are replaced, but the foundations and height restrictions remain the same.

Refurbishment may see the renewal or replacement of generation equipment; blade repairs; repainting of towers; and improvements and upgrades to components such as the electrical infrastructure.

Life extension allows generators to operate turbines for longer than their planned life. This is one of the most cost-effective options as it keeps much of the existing infrastructure.

Decommissioning may be the last remaining option when it is no longer financially viable to operate the assets, or where restrictive planning constraints are in place. On these occasions, the assets may have to be removed and the site returned to its pre-operational state.

Advisory

OUR SERVICES

We provide a project specific tailored approach that is best suited to your unique requirements.

Construction

Analysis

Planning and environment

Inspections



Advisory

We can advise you on whether it's possible to extend the life of your asset(s). We work with you to develop a scenario that illustrates what extending the operating life of your asset could look like. We do this by looking at the assumptions on design life lifecycle, operating costs and availability and, by using our internal benchmarking (cost/failures) database, we can compare it with similar assets to provide a best-case scenario for asset's future life.

We'll review the design limits for the relevant turbine class and technology and compare this to the conditions that have been observed on site since the asset was commissioned. This lets us assess the feasibility of operation beyond the original design life of the wind farm.

We'll consider the feasibility in the context of any wider due diligence review we carry out, as well as current market trends. After this, we'll work with you to agree recommendations for the expected inspections and the added detailed analysis needed to find out the life extension potential of the project(s).

Site design life and condition review

We'll review the turbine specification for the project(s). We use SCADA wind speed signals and/or site met mast wind speed measurements to assess the operating conditions as compared to the site design conditions. We present a qualitative assessment of the life extension potential of the site, including a relative turbine ranking at each site.

Management/OPEX needed so the project will meet the required operating life

We'll prepare OPEX model specific to the project's current (based on wind turbine generator (WTG) O&M contracts) and future estimates of O&M costs (based on a scenario to be agreed with the client for the O&M strategy after the expiration of the initial O&M contract). This OPEX model will extend up to the targeted lifetime and will include budgets related to additional inspections; monitoring and maintenance recommendations; and other management/OPEX additionalities associated with operating projects beyond their initial design lifetime.

We can also provide independent due diligence reviews of third-party life extension assessments and inspections, OPEX models and budgets.

Analysis

In addition to the high-level site design life and condition review for wind projects outlined above, we can perform a more detailed turbine fatigue life assessment. We offer different levels of analysis that are refined to meet the needs of individual projects. While most of the current wind farms in operation were designed with a target lifetime of up to 25 years, it is becoming increasingly common to assess projects based on a 30-year operational lifetime.

Indicative life extension analysis

Using information from available project documents, we can advise on the potential for life extension at sites. We also provide commentary on industry trends and best practice for wind farm life extension, including estimated budgets for additional maintenance or inspections programmes needed to achieve a 30-year lifetime.

Analytical life extension analysis

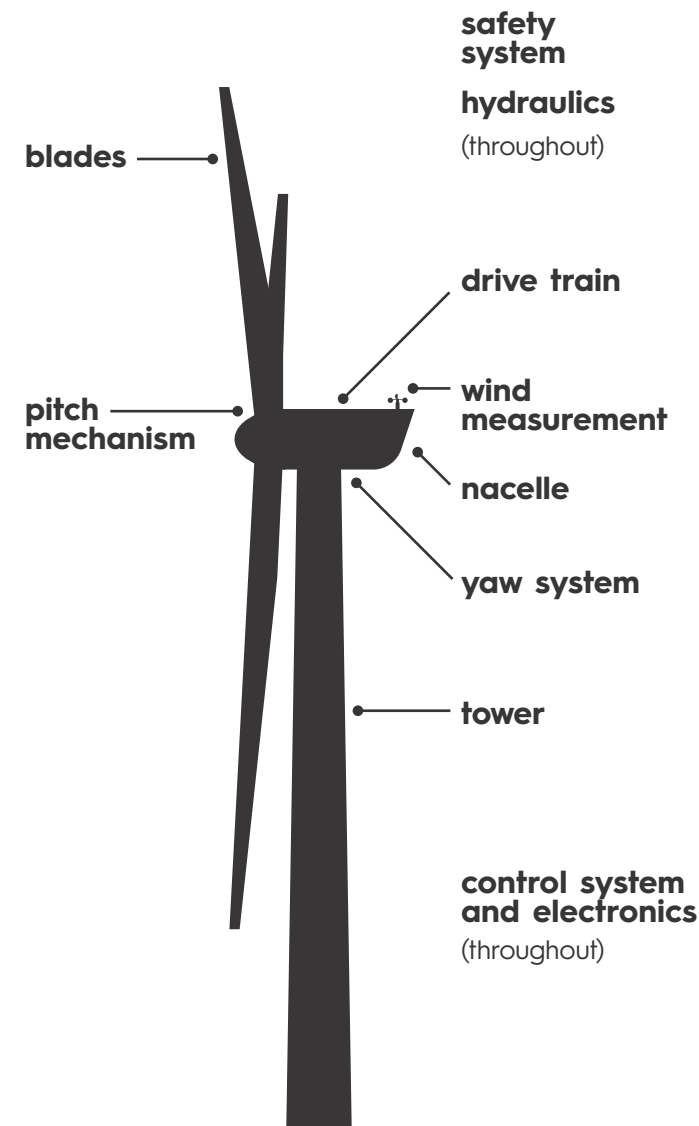
As there are no current international design standards in place, our team takes a simplified analytical approach based on the DNVGL-ST-0262 Lifetime extension of wind turbines standard and combines it with our extensive knowledge of operating wind farms. This approach allows the most likely lifetime extension ranges for critical components to be considered.





Inspections

We can carry out wind turbine lifetime extension inspections, which involves a visual inspection of the entire WTG, as well as working with clients to meet their internal specifications. We inspect the following:



- **tower**, including the condition of turbine areas and parts, such as ladders and hinges, and checking that the tower base is dry with no evidence of water ingress.
- **nacelle**, including examining the yaw rig gear and the nacelle bedplate, nacelle and nose cone.
- **drive train**, including inspecting the gearbox; reviewing the high-speed shaft; and checking the condition of all components of the generator.
- **pitch mechanism**, including checking the hydraulic pipework, tanks, manifold blocks, valves and actuators and making sure the pitch cylinder, linkages and bearings are in good condition.
- **safety system**, including reviewing the yaw gear stopper device and housing, yaw lock safety, and brake pads and callipers; and inspecting the rotor lock system.
- **wind measurement**, including inspecting the combined anemometer/wind vane unit visual signs of physical damage and corrosion.
- **yaw system**, including examining the yaw system and checking the function of the yaw brake.
- **blades** including internal and external, for any signs of damage.
- **hydraulics**, including checking the hydraulic oil pump, hydraulic pipes and hoses for signs of damage.
- **control system and electronics**, including inspections on cable and turbine machine components and checking emergency lighting, electrical cabinets and cabinet heaters.

Planning and environment

The planning issues around repowering or life extension are potentially complex and need an understanding of policy, existing consents, stakeholder expectations and site constraints. There are a range of issues to consider in relation to life extension opportunities, and most of these will be site-specific and may vary between sites. On the planning side, the process may range from no action required to a simple change to an existing condition. At the other end of the spectrum, there could be a need for a full environmental impact assessment (EIA) planning application. It largely depends on the existing consent and the conditions attached to it. It will also depend on whether the repowering/ life extension proposal would result in an expansion of a site beyond the originally consented project. Engaging with the relevant planning authority is key to helping a life extension project to go ahead.

Our team has extensive experience of the planning issues and local knowledge of large-scale wind energy developments. Through our comprehensive consenting work, we have built relationships with statutory consultees and gained a vast amount of experience undertaking survey and monitoring work on a wide range of sites.

Issue	Item
Planning	Conditions
	Local and national policy
	Section 106/section 75 agreements
Land	Community commitments
	Lease/options
	Wayleaves/easements
Grid	Access
	Capacity
	Constraints
Construction	Outages
	Decommissioning
	CAPEX
Environmental	Operational monitoring data
	Site specific bird data
	Habitat modifications/habitat management plan





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Construction

We assist owners to assess the next phase for their wind farm, whether that is decommissioning, up-powering, re-powering or life extension. Some of our construction services include:

CAPEX. Our knowledge relating to the costs and risks associated with construction can be used in financial models to inform investment decisions.

Forensic engineering. We have in-house civil, structural and geotechnical engineering specialists who can review existing wind farm infrastructure and advise on its suitability for incorporating within an up-powering or re-powering project.

Life extension. Our structural engineers have a vast knowledge wind turbine foundation design, and they understand the critical components that determine a foundation's performance. We have developed a methodology for undertaking initial assessments of the useable life of the foundation beyond its original intended design life.

After initially checking the original design to understand how it was designed and for what loading regime, we would focus our assessment on the original fatigue design. The fatigue life is the key factor for the possible extension of the foundation life and understanding what remains within the foundation. We take account of the as-built information of the foundation design to identify potential issues such as defects and maintenance issues that may have occurred during the construction and operation of the wind farm.

Based on an assessment of this information, this helps us understand how utilised the original design is and whether the foundation could continue to support the wind turbine without remedial works. As further information becomes available, such as specific loading regimes over the life of the wind farm, we can continue to assess the actual impact on the foundation. This would allow us to refine our understanding of the overall fatigue life of the foundation and how it might be used going forward.

Get in touch

We appreciate that the decision on what to do next with your assets is a complex one. To help you review the options, our multi-disciplinary team can work closely with you to gather a deep understanding of your assets and explore the options ahead. For more information on how we may be able to assist you on the next stage of your journey, contact us at

sayhello@naturalpower.com

