

Frequently Asked Questions

ABOUT WIND FARM PROJECTS



VOYAGER
RENEWABLES



This document intends to answer Frequently Asked Questions around wind project development, design, construction, operation and end-of-life, as well as provide some insights around wind technology.

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1

What is a meteorological mast?

A meteorological mast (met mast) is a measurement tower equipped with instruments that are used to measure the wind and weather conditions at a project site.

It is crucial that we understand the wind conditions at a site, as it will determine which models of turbines can be used, how many turbines can be safely fit within the available land, where to install the turbines and how much energy they are likely to produce.

Before installing a met mast, its location is agreed with the landowners, the aviation agencies and other relevant local groups (e.g. airstrip users).

The mast itself is a steel lattice structure, typically about 0.5 metres wide, and 100-150 metres high. They are at this height to collect data at the hub height of the turbine.

The mast is supported by guyed wires that secure into the ground in usually three or four directions, making the structure safe.

Depending on the local jurisdiction, a planning permit may be required for a met mast.

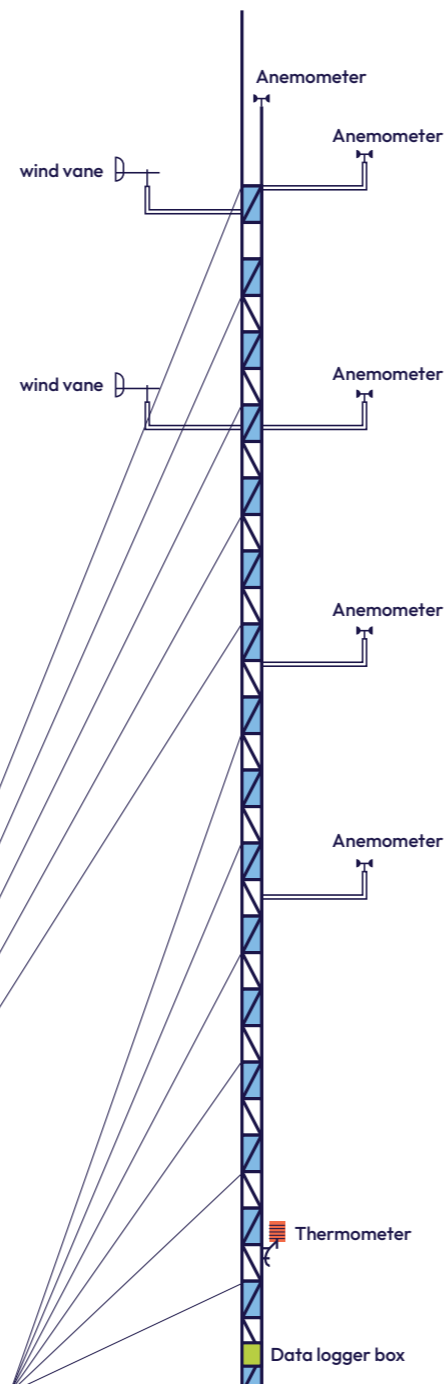


At several heights up the mast (usually 4 or 5 in the upper half), 3-metre-long horizontal arms (called "booms") are attached, and the measurement instruments are mounted on these booms, extending out on each side of the mast. Different types of instruments are used to measure wind speed (anemometers), wind direction (wind vanes), temperature, and pressure – all of these are important for understanding the wind conditions.

At the base of the tower there is a data logger which collects and stores all the data measured by the mast, and a modem to send the live data back to the Voyager team on a daily basis. There is also a small solar panel and battery, which provide power for the instruments; the mast does not need a main power connection. A lightning protection system is installed at the top of the met mast and connected to the ground to protect the equipment.

At the end of the measurement period, met masts are removed prior to construction of the wind farm. New masts are required during operations to monitor turbine performance at different locations.

Schematic chart of a meteorological mast and its equipment



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What is a LiDAR?

Light Detection and Ranging (LiDAR) is a technology that collects the same wind measurement data as a met mast, but using only a small, ground-level device, which is non ground disturbing.

A LiDAR device uses a vertical laser pulse to measure wind movement above the unit. It aims a laser beam upwards into the atmosphere, and

detects that beam as it is reflected back by moving particles in the atmosphere. By analysing the reflected beam the LiDAR can accurately determine the wind speed and direction at various heights.

The LiDAR units that Voyager use come mounted on a small trailer. Also on the trailer are a solar panel and battery, to provide power to the unit; the trailer does not need a mains power connection. The laser is invisible to the human eye and harmless to humans and wildlife.





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How many masts and LiDAR units will be located, and for how long?

The advantage of LiDAR is that they are portable and can be moved around the site – this allows us to gain a better understanding of the wind conditions across the project site. The advantage of met masts is that they are considered the “gold standard” and collect the most accurate data, which we require in order to get the best possible understanding of the project’s wind resource. Voyager will typically use a mix of masts and LiDAR.

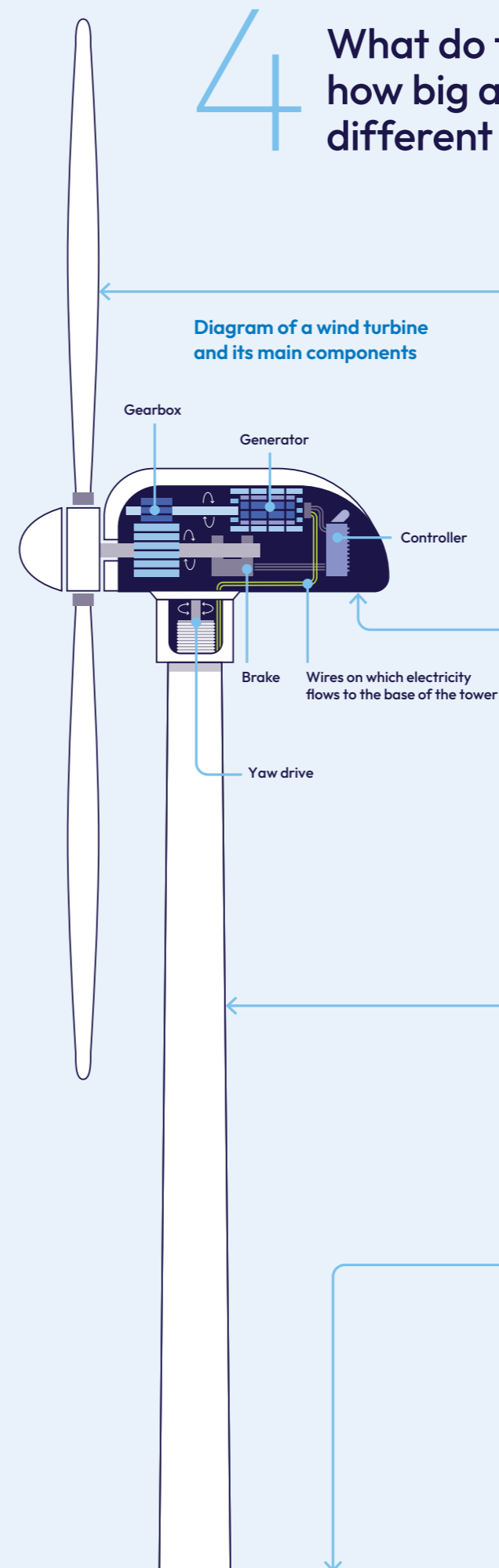
Typically we start by locating a LiDAR in a central part of the project site. This first deployment will collect data for 6-12 months, to provide an initial check on the wind speeds. If the measurements look promising, then the next step is to install a met mast next to this initial LiDAR. This is an important step, so we can validate that the mast and LiDAR are recording consistent results with one another. Once that validation is successful (typically takes about 3 months), the LiDAR unit(s) will be moved around the project site, generally staying in each location for approximately 6-9 months.

Overall, we need to collect measurements at the site for at least 3 – 6 years, and ideally longer.

Wind can vary by the hour, week, month and seasons. It is important that we collect data over long periods of time, to have the best possible understanding of local wind conditions and design a successful wind farm project.

4

What do the turbines look like, how big are they and what are the different components of a turbine?



A wind turbine consists of several key components:

ROTOR & BLADES

Modern wind turbines have three long, thin blades that resemble an airplane propeller. The rotor is designed to face directly into the wind, and each blade can be up to 100 m long. The blades capture the energy of the wind and turn it into rotational force. The blades are mounted on the “hub” (nose of the wind turbine) and automatically rotate along their axis (“pitch”) depending on the wind speed to optimise their capture of the wind energy.

NACELLE

This is the housing at the top of the tower that contains the generator, gearbox, and other mechanical and electrical components. The nacelle is connected to the rotor and blades. The nacelle is mounted on the tower and automatically rotates along the vertical axis (“yaw”) to face the main wind direction. The equipment inside the nacelle takes the power generated by the rotor and converts it into electricity. The average state-of-the-art wind turbine generator has a nominal capacity of 6 to 7 MW.

TOWER

Made from tubular steel, the tower supports the structure of the turbine and elevates the blades to capture stronger winds at higher altitudes. Towers are typically around 100-150 m tall. During construction, towers are typically delivered in 5 to 7 sections depending on height.

BASE/FOUNDATION

The base of the turbine is usually a large concrete foundation that anchors the structure to the ground. Almost all of the foundation is buried underground, so once construction is complete you can’t see it. The foundation needs to be large – around 20 m in diameter and 3-5 m thick – to support the weight of the turbine. Foundation design will depend on the size of the wind turbine, and existing ground conditions.

5 Will I be able to hear the turbine from my house?

Wind turbines generate some noise, mainly from the spinning blades but also from the nacelle mechanical and electrical equipment. The noise is loudest right next to a turbine, and fades as you move away from the turbines.

During the development process, detailed noise studies will be undertaken to make sure the audible noise at surrounding dwellings will remain under the legal day and night thresholds.

The noise emergence depends on the wind turbine models, locations, hub heights as well as terrain topography, background noise and wind speed and direction.

There is also a minimum distance between each wind turbine and any impacted dwellings, under which no planning permit will be granted. Therefore, special focus will be given to noise impact assessment during the development phase to ensure that noise predictions are accurate and that nearby residents will not be adversely affected by noise.



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What cables are required? Do they run under ground or over head?

Wind farms include a complex electrical system to safely transfer electricity from the wind turbines into the power grid.

The key components are:

CABLING

The project will include a medium-voltage network of cables that connect the wind turbines to each other, and ultimately connect to the project substation. These cables are typically buried underground, and once construction is complete the land along their path can typically be restored to full agricultural use.

SUBSTATION

The substation is the central point where the electricity from all the turbines is collected. Here, the voltage is typically stepped up to higher levels for transmission to the grid.

TRANSMISSION LINE

For projects which are not located next to the electricity grid, a high-voltage transmission line is needed to transfer the electricity from the project substation to the selected grid connection point. Transmission lines are typically overhead, with a range of designs available depending on the size of the project and the local grid voltage.



7 How are turbines transported and will upgrades to the existing road network be needed?



Modern wind turbines are very large structures, so transporting them is a complex and carefully coordinated process. Due to their large size and weight, turbines are broken down and transported as individual main components: blades, tower sections, and the nacelle.

Specialised trucks and trailers are used to transport the components. Blades are so long that they need to be carried on special extendable trailers that can accommodate their length. The radius of road curves on the route to site will also need specific attention. Tower sections and nacelles are transported on heavy-duty trailers that can accommodate their weight; the roads' weight-bearing capacity will be investigated to make sure the loads can be safely supported. Overall, around 10 over-size truck loads will likely be needed to transport each turbine to the site.

Detailed route planning is essential to avoid obstacles like low bridges, tight turns, and weight restrictions. This involves coordinating with Council, police and local authorities. It is common

that upgrades or modifications to the local roads are required: **these upgrade works will be funded by the project developer** and will benefit the local community too.

Once the components arrive at the wind farm site, they are reassembled using cranes and other heavy machinery which require specific platforms to be built in terms of size, slope and bearing capacity.

Wind farm transport is closely managed by road authorities and highly coordinated by specialist engineering transport operators. Temporary road closures for component transport are closely managed by police escorts and pilot vehicles engaged by the Project owner.



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What are the steps to develop a wind farm?

The pre-construction phase is usually split into two stages: the initial assessment and feasibility study, then development and planning phase.



STAGE

1

INITIAL ASSESSMENT AND FEASIBILITY STUDY

This phase typically lasts for 2 to 3 years, depending on site complexity, transmission network options and community sentiment.

During this phase, we will conduct preliminary assessments to determine the feasibility of the wind farm. This includes:

- wind resource analysis,
- environmental impact studies including site surveys for avifauna and flora, as well as heritage mapping,
- grid studies,
- preliminary design, including turbines layout
- early-stage stakeholder engagement.

STAGE

2

DEVELOPMENT AND PLANNING

This phase can realistically last from 4 to 7 years, depending on the planning approval process, grid connection timeframes and community sentiment.

If the initial assessment and feasibility study are positive, this second phase involves:

- detailed environment (including noise and visual impact assessments) and heritage studies,
- technical studies such as topography, hydrology and geotechnical,
- detailed design,
- planning: securing permits and approvals,
- grid connection agreement,
- active community engagement and consultation,
- offtake strategy,
- finalising the project financing.

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Engaging with communities

Voyager actively supports working with communities and key stakeholder groups within those communities. These include host landowners, near neighbours, First Nations Peoples and local Councils.

Our collaborative approach to engagement and communications is featured through every stage of a project, from site selection to decommissioning.

Sustainable Communities Strategy

It is important to us that we leave a long-lasting legacy in our communities where we operate.

Voyager will collaborate with communities to understand what is important to them.

Through open engagement and communication, we co-design benefits such as enabling infrastructure, services, grants and sponsorship with community and for community.

Some examples of community benefits (including neighbours) are:

- Sponsorship and grant initiatives
- Legacy initiatives such as housing or community halls
- Local jobs during construction but also during the 30+ year operations and maintenance, Local training (including local education) and local procurement
- Local contracts to support long-term business growth, with electrical and civil work companies for instance
- Working to the improve cost and reliability of electricity for affected communities

- Local electricity supply via power purchase agreement
- Community Fund with its independent governance
- Enhancement of Cultural Heritage jointly with Traditional Owners
- Biodiversity offset

Voyager is always looking to identify innovative ways to bring benefits to communities based on what each community needs and wants. An important part of project co-design is listening to concerns and issues of the local community and finding ways that we, as a project developer, can support local communities.

The energy transition needs to happen with community interests front and centre.



10 How do you design a wind farm and decide where turbines go?

Deciding the locations for turbines and other infrastructure is an iterative process. Voyager will consider a range of factors to ensure optimal energy production with minimal environmental and land impacts.

We'll work closely with host landholders to design the project to consider their existing land use, operations and access roads.

Here are some of the main considerations:

1 HOST LANDHOLDER AGREEMENT: Ensure the appropriate agreements and legal terms are in place so that matters relating to insurance, decommissioning and commercial terms are all agreed. Landholders hosting infrastructure will ultimately have the final say about where infrastructure can and cannot go on their land. Turbines, road and cable locations must be well thought through to minimise impacts on existing operations of the property as much as possible.

2 WIND RESOURCE: This is the most critical factor. We want turbines to be located in the windiest places on the site, as this will maximise the electricity that is produced. To identify which areas of the site are windiest, we will measure the wind resource at multiple locations across the site.

3 TERRAIN: The terrain affects wind flow, with the wind typically flowing fastest over hills and at the top of steep slopes. However, the wind farm also needs to be practical and economic to construct. Flat areas are generally easier for construction, whereas complex terrain like steep hills and rocky outcroppings can be very difficult for construction. Therefore we need to carefully assess the terrain, to ensure the turbine locations and connecting roads can all be safely and economically built.

4 SPACING: As a turbine spins and generates electricity from the wind, it creates a turbulent wake that disturbs the air downwind from it. Proper spacing allows the wind to recover and smooth out before reaching the next turbine; it is proportional to the blade length. Typical distance in the prevailing

wind direction is one kilometre or more considering today's wind turbines size. It could lower down to 500m perpendicular to the main wind direction.

5 ENVIRONMENTAL, WILDLIFE, AND HERITAGE IMPACTS: When designing the project, Voyager aims to minimise the impact on local wildlife, ecosystems and heritage sites. We will conduct detailed surveys of bird and bat flight patterns, flora and fauna, historical sites, etc. to ensure we avoid conflicts.

6 GROUND CONDITIONS, WATERWAYS: Modern wind turbines are very large and heavy, and require a large concrete foundation that is designed specifically for the site. We will need to assess the ground conditions (e.g. soil type, rock) across the site through geotechnical investigations, which typically involve boring test holes at a sample of locations. We will also study waterways and flooding risk, to site turbines away from water courses.

7 SET-BACKS: For safety reasons, turbine locations will always be set back an appropriate distance away from roads, overhead electrical lines, railways, etc.

8 DWELLINGS: Turbines will be set back an appropriate distance from dwellings (both within the project area and on neighbouring land) to ensure that noise and visual impacts experienced at those properties are within acceptable limits.



11 What happens at the end of life of the wind turbines?

Wind turbines are designed to operate for up to 30 years. At that time, a review would be undertaken either to re-furbish the existing turbines, re-power the site with new turbines, or to decommission the site.

Under a decommissioning scenario, all wind turbines, overhead cables, hardstands and access tracks are removed, with the land reinstated as far as reasonably practical to its original condition.

Decommissioning of projects is closely managed by state and federal authorities and a detailed Decommissioning and Rehabilitation Plan is required under the project environmental approval. These plans are developed in close consultation with the landowner to ensure that all project infrastructure is appropriately removed and land reinstated to its pre-existing condition, **at the cost to the project owner.**

Some landowners elect to retain specific infrastructure (usually access tracks) as it supports the property management; this would be specifically discussed as we approached the wind farm end of life.



We'd love to hear from you.

Please reach out if you have any questions or need more information.

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