Robots of the wind
39 Ways to Save the Planet

Royal Geographical Society with IBG
Advancing geography and geographical learning

Wind turbine design

A wind turbine is a modern windmill complete with a central tower, rotor hub, turbine blades and a nacelle cover.

1. There are other, more intricate, parts within a wind turbine. Read the following passage of text and then label Figure 1. Can you finish the design of the wind turbine?

   A wind turbine consists of three blades are mounted onto a rotor hub, atop a steel tubular tower. A nacelle cover sits behind the rotating blades housing the generation components. Within the nacelle a low-speed shaft is connected to gearbox (to increase the rotor speed from about 18 revolutions to 1,800 revolutions per minute) which connects on to a high-speed shaft. The high-speed shaft rotates faster and is linked to a copper coil within the generator, which also rotates. The copper is surrounded by a magnetic field (created by magnets). As the copper coil rotates a current is induced which is then extracted. Some nacelles are so large you can land a helicopter on them!

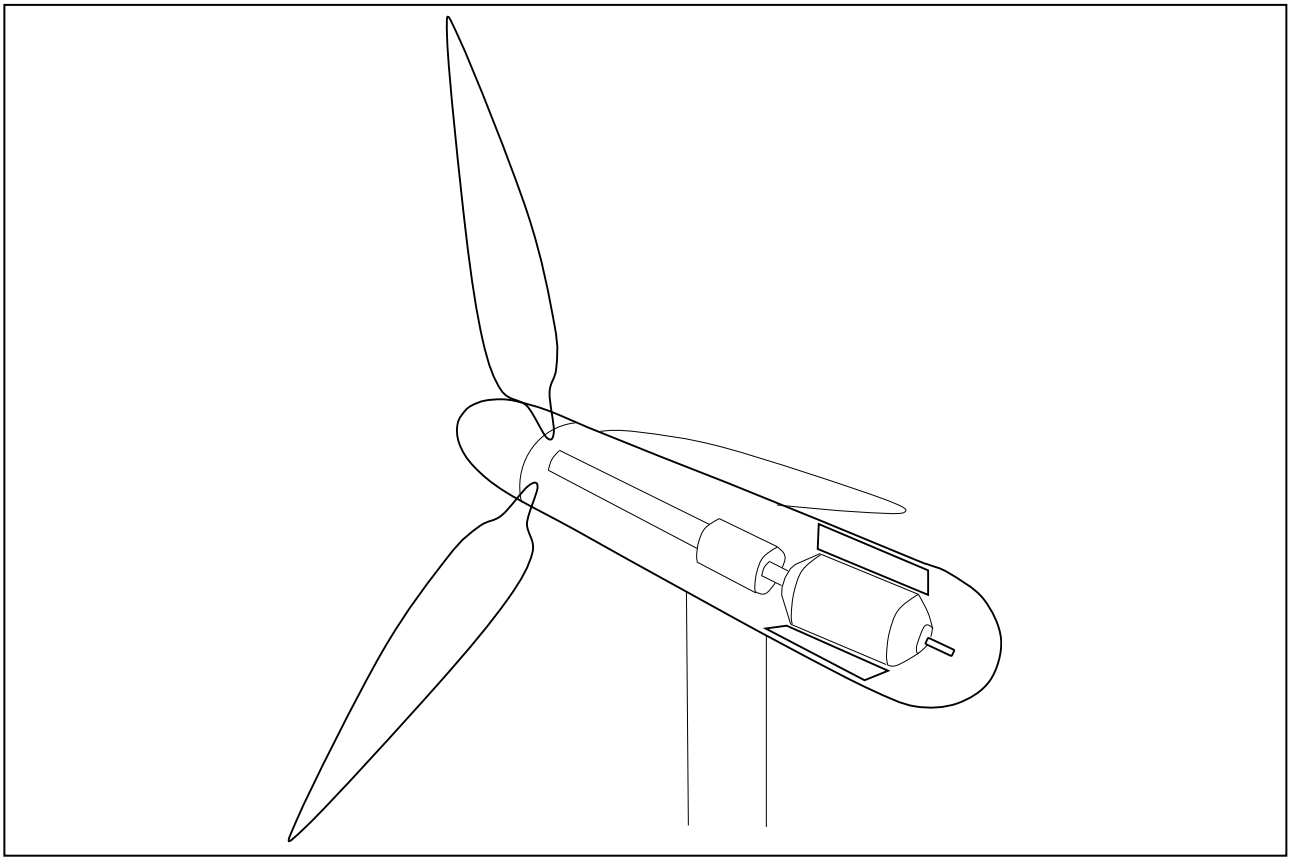


Figure 1

Good land-based and offshore sites are often in remote locations	Maintenance is very costly for wind turbines, requiring manpower	Leading edge erosion damages rotating blades, particularly offshore
Concerns are growing that demand will outstrip installation vessel supply	Aggressive marine environments stress wind turbine foundations	Biofouling occurs on offshore wind turbines from microorganisms

2. Using some of the text boxes on page 1, label and annotate any issues that you think might occur over the lifetime of an offshore wind turbine onto Figure 1.

BladeBUG

As of 2020, the UK has more installed offshore wind capacity than any other country in the world, which amounts to 34% of the global installed capacity.

With this area of renewable technology earmarked for huge growth in the immediate future solutions to tackle inaccessibility and weather damage are fervently being sought.

The bladeBUG is a six-legged robot which, which is an inspection, maintenance, and repair robot — perfectly designed for the harsh conditions around offshore wind farms.

Designed by a micro start-up technology company with financial support from Innovate UK and the Catapult Offshore Energy centre, these robots have been created specifically to work on wind turbine blades (which are often over 100 metres!)

When partnered with a drone project called Mimree and a specially created 'repair arm' by the Royal College of Art, it is hoped inspection and repair missions will require less time, money, and risk to technicians. A huge amount of collaboration and innovation has already gone into bladeBUG with for example the electronic skin of the robot bug's feet which uses advance nanobiology technology from high tech start-up Wootzano. The cutting-edge design of bladeBUG means it can undertake certain tasks very effectively, summarised neatly as the 5 D's of robotics: dull, dangerous, dexterously, dirty, or dear (expensive). A spinoff from such high-tech production it, it is hoped, that expertise and the designs themselves will then be sold around the world as offshore wind continues to grow. Listen to Robots of the wind from *39 Ways to Save the Planet* to learn more.

Further reading

- The structure of a wind turbine How does a wind turbine work? (actionrenewables.co.uk)
- Watch the bladeBUG review BladeBUG - The Game-Changer Series - YouTube
- Using robots to maintain offshore wind farms BladeBUG: using robots to maintain offshore wind farms - YouTube
- Floating turbines — the future? Floating Turbines: Offshore Wind's Game Changer – Engineering Matters (reby.media)

Suggested questions for Robots of the wind

a. What is the 'answer out there, that has six-legs' to the problem of climate change?

b. What will the robots actually do?

c. As the wind turbines are turning how fast do the blades go?

d. What can the bladeBUG robots do?

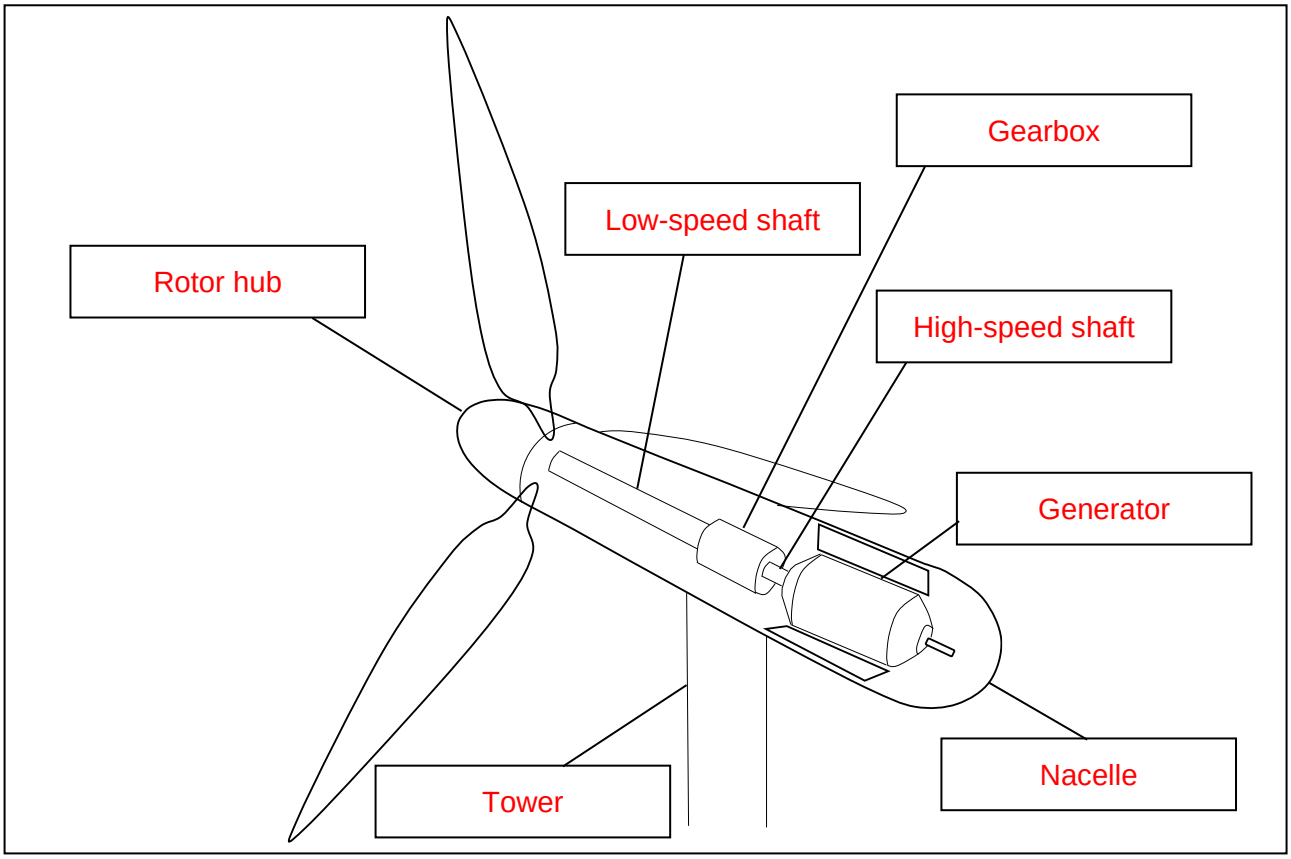
e. What is the forecast growth year-on-year predicted for UK offshore wind energy (in GWh) for 2030?

f. What could we potentially reduce our 2050 greenhouse gas emissions (GHGs) by (from increasing wind energy production)?

g. Why is the red-throated diver mentioned by Dr. Tamsin Edwards?

Answers

1. Diagram below.



2. Wind blades rotate at 200mph, leading edge erosion (LEE) causes loss of aerodynamic performance (estimated energy loss is 2-10% per turbine).

An RGS-IBG expert

Go to What our expert says to hear further analysis from Professor Stephen Peake (below) and Ocean Resource Engineers Limited Director Rob Maynard on the use of robotics in offshore wind maintenance and repair in *39 Ways to Save the Planet*.