Wind Energy
KS3



What is wind?



How is wind formed . . .
watch the Met Office video below



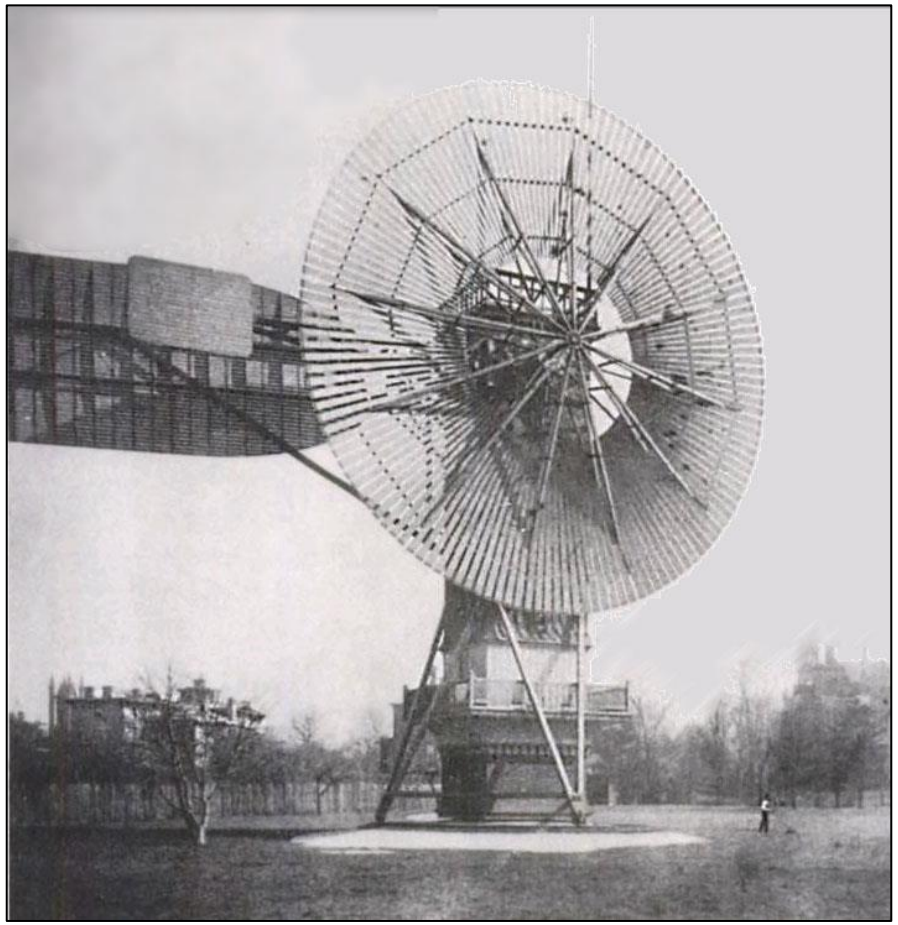
https://www.youtube.com/watch?v=edsNPCwU9lo

How has wind been used by people?





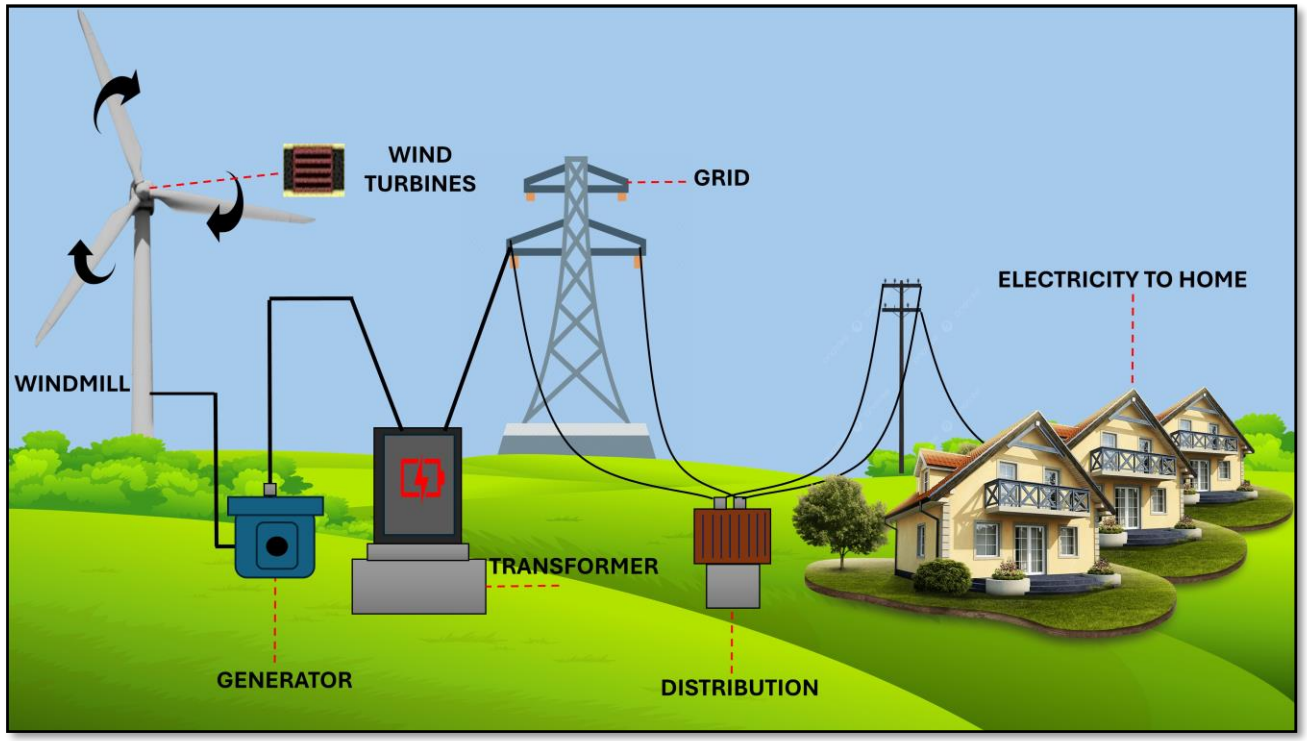
How can wind generate electricity?

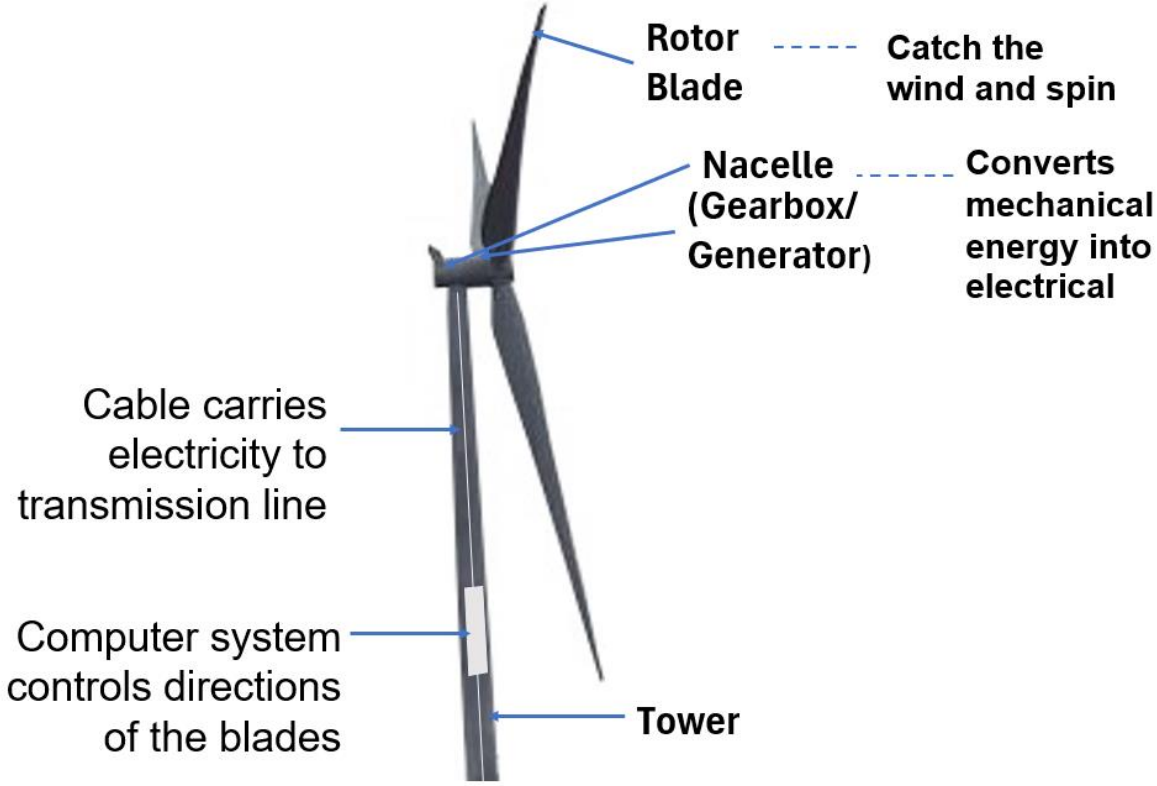


- This is a windmill constructed by Charles Brush in the USA in 1888.
- It was used to power light and machines in his factory in Cleveland, Ohio.
- Brush's wind turbine was mounted on a tower 18m high.
- Despite its size, it only generated 12 kWh of electricity.

History of Wind Turbines (renewableenergyworld.com)

How do wind turbines generate electricity?





Images courtesy of Swati Sood, PhD candidate UWE

Watch this excellent video to discover
how wind energy is converted into electricity



How does a wind turbine work? | Sustainability - ACCIONA

https://www.youtube.com/watch?v=DILJJwsFl3w

Why is wind a renewable source of energy?



Wind is a renewable source of energy because it is abundant and inexhaustible. It does not burn any fuel and does not pollute the air.

https://unsplash.com/s/photos/wind-farm Credit: Nicholas Doherty

How have wind turbines developed?

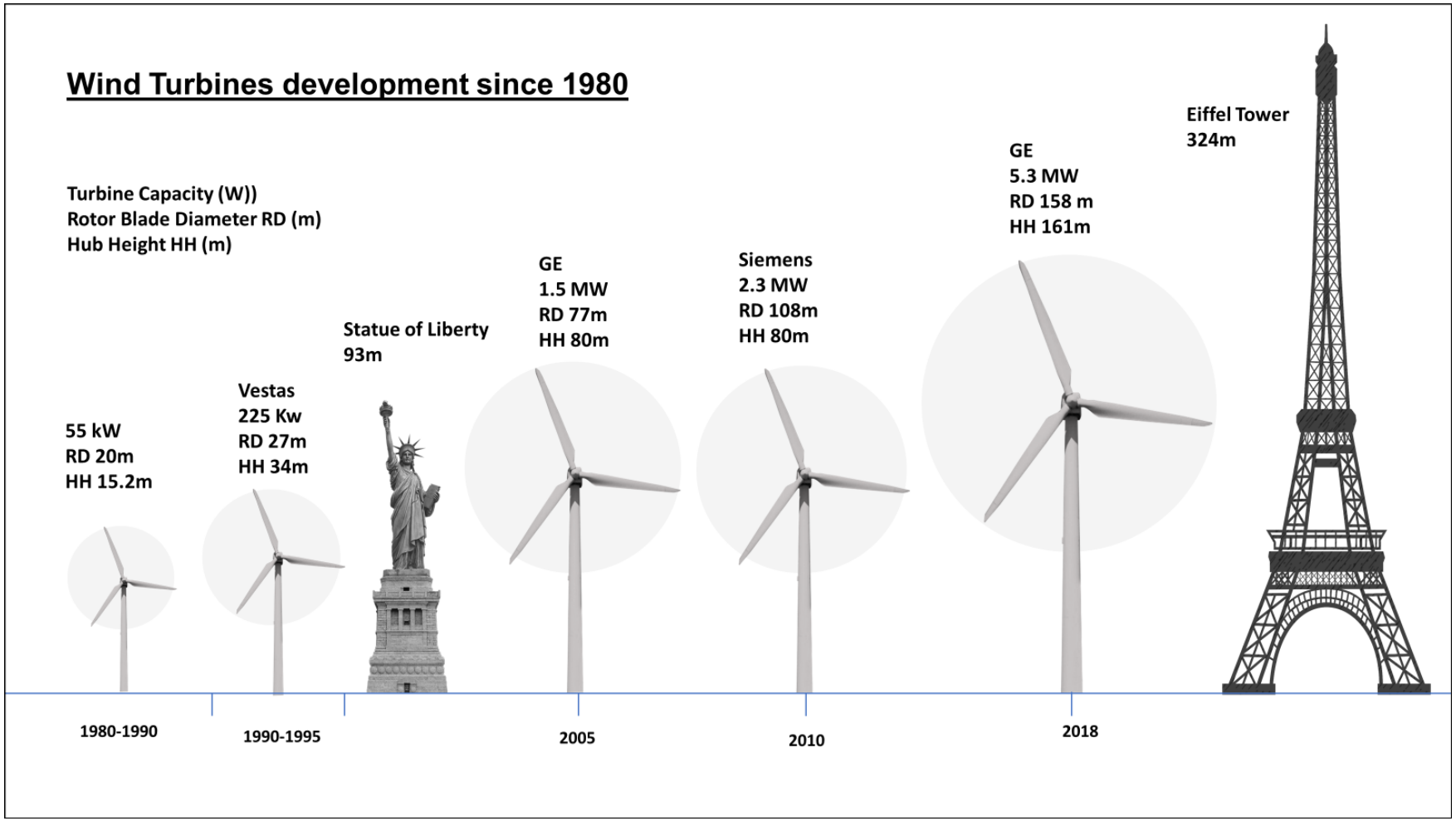
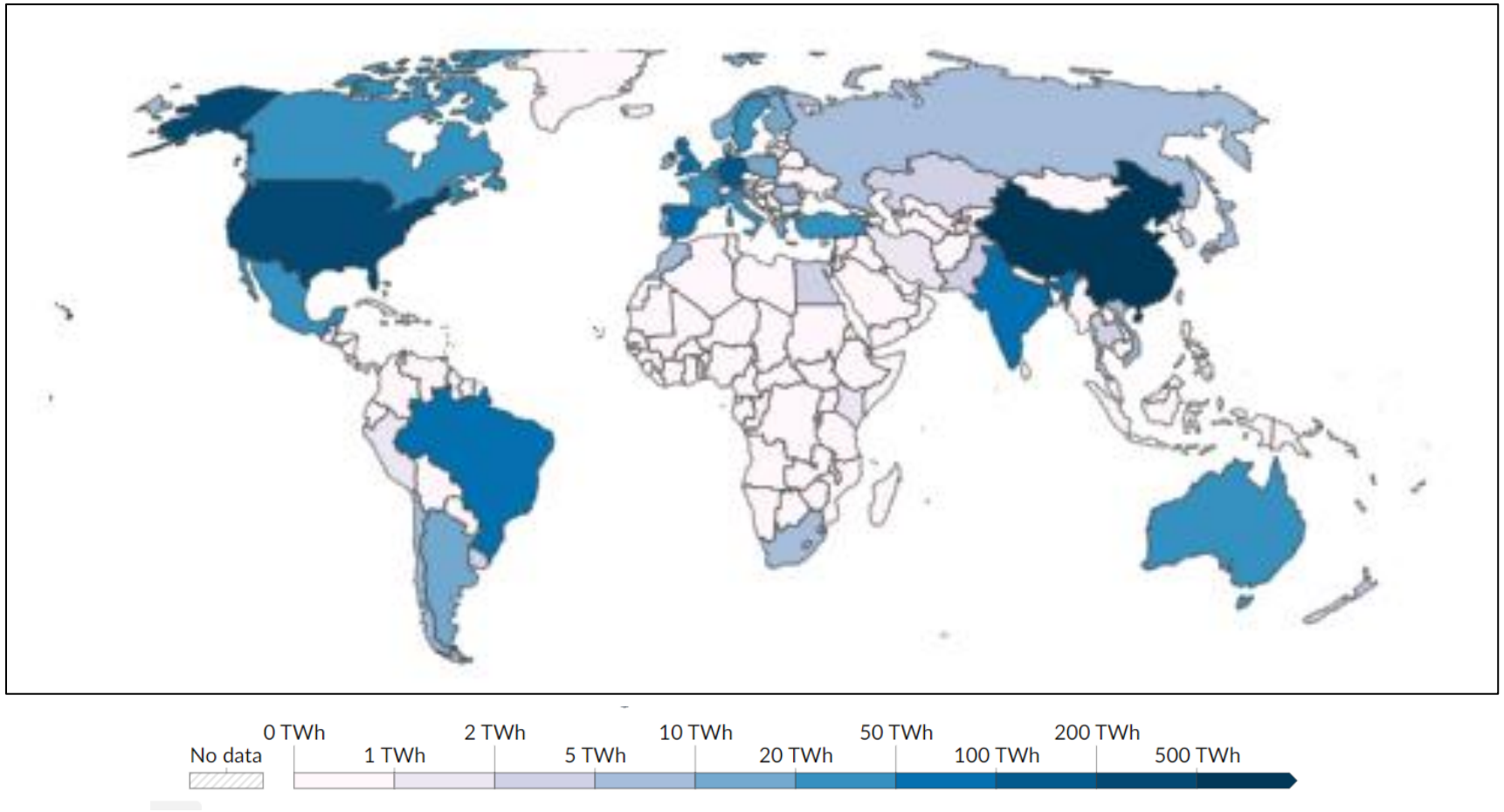


Image courtesy of Swati Sood, PhD candidate UWE

How have wind turbines changed since 1980?

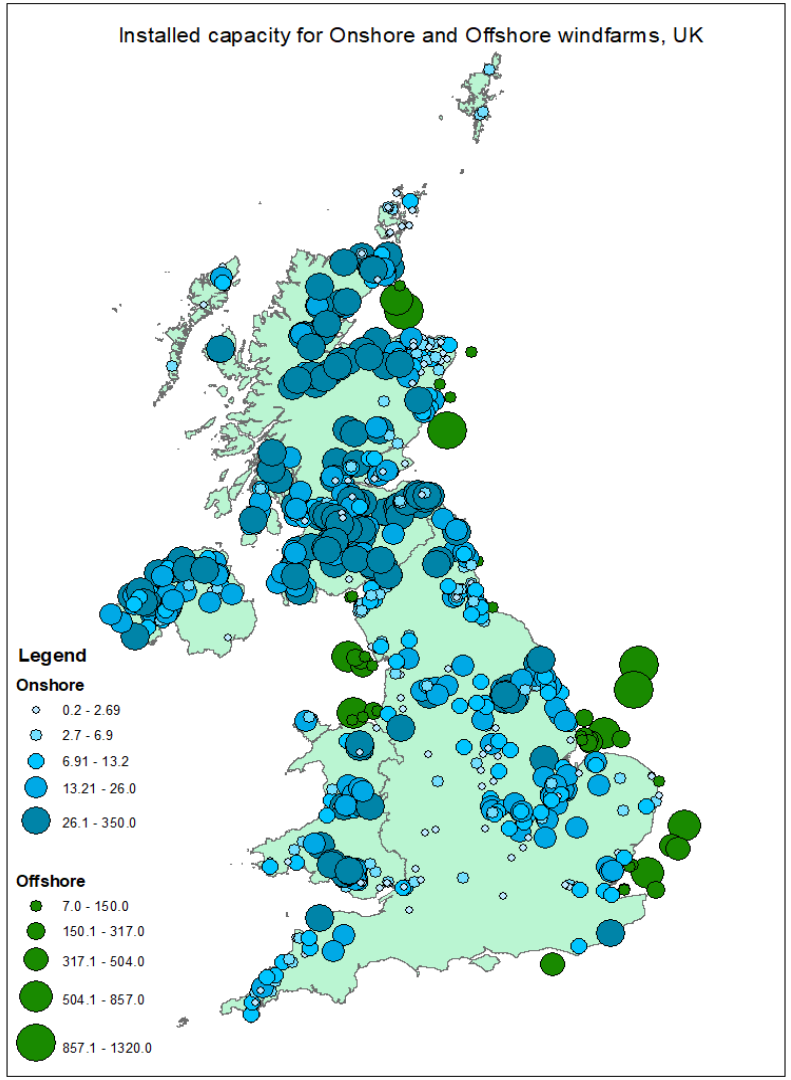
What is the global pattern of wind energy generation?



Which country produces the most electricity from wind?

https://ourworldindata.org/grapher/wind-generation

Where is wind energy generated in the UK?



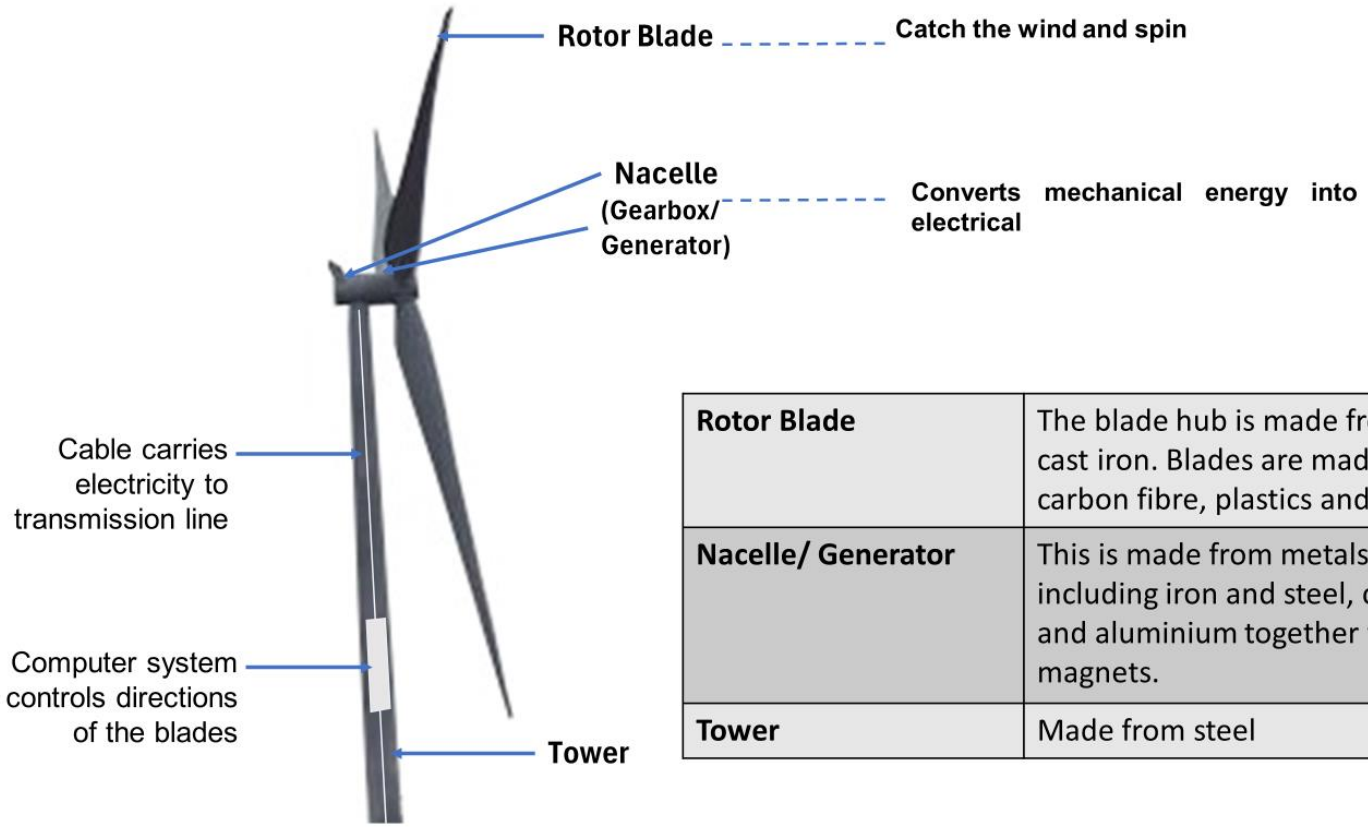
Digest of United Kingdom Energy Statistics (DUKES) 2023

Pen Y Cymoedd wind farm



https://group.vattenfall.com/uk/what-we-do/our-projects/pen-y-cymoedd

What are wind turbines made of?



Rotor Blade	The blade hub is made from cast iron. Blades are made from carbon fibre, plastics and resins.
Nacelle/ Generator	This is made from metals including iron and steel, copper and aluminium together with magnets.
Tower	Made from steel

Image courtesy of Swati Sood, PhD candidate UWE

Can turbine towers be made from wood?





https://www.bbc.co.uk/news/science-environment-67718719

How are wind turbines made and installed?



https://www.atb.group/en/rnw/wind.html



https://coastrenewableservices.com/

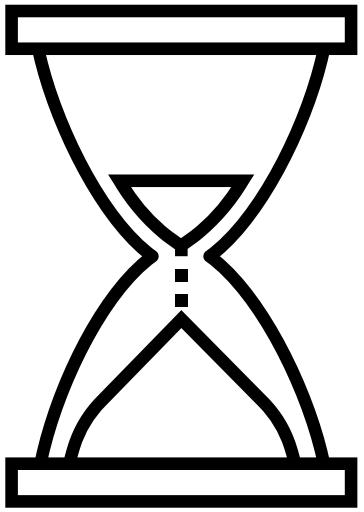
Watch this video to see how a wind turbine is installed, courtesy of Cenin Renewables

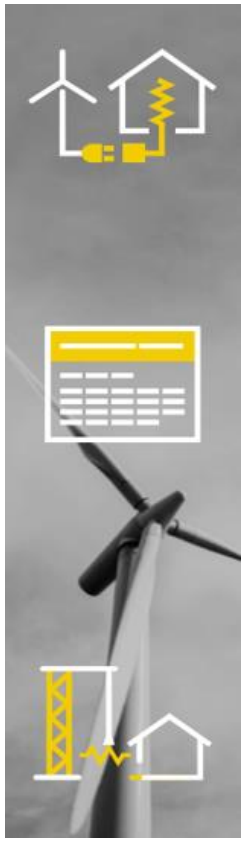


CENIN

What is the life span of a wind turbine?

The standard design lifetime of a WT is at least 20 years according to the International Electrotechnical Commission standard (IEC 61400-1)





Repowering

Life Extension

Decommissioning

End-of-life option 1: life-extension



- Keeping the same wind turbine beyond its life through maintenance and repair.
- This requires the duration condition of the original permission to be altered.
- UK wind farms usually have 25-year planning consent. A life-extension application will try to keep the turbines in place for another 5-10 years.

End-of-life option 2: repowering



- Removing old wind turbines and replacing with new.
- The new turbines are often a lot bigger, can generate a lot more energy and there are often fewer of them.
- This might involve a new planning application and engaging with the local community.

End-of-life option 3: decommissioning



- Removing the turbines and all infrastructure.
- Returning the land to the previous condition, often agricultural land.
- The wind turbine components can be used for spare parts, recycled or re-purposed. Some parts may end up in landfill sites.

What happens to the components when turbines are decommissioned?



Part of turbine	Main Material(s)	End of life handling
Hub	Iron	Recycling (foundry)
Canopy	Glass/ Fibre/Epoxy or steel	Recycling, incineration or landfill
Nacelle	Steel, permanent magnets, batteries	Recycling (as fibre), incineration or landfill
Platforms and ladders	Aluminium	Recycling (foundry)
Blades	Glass/ Fibre/Epoxy and Balsa wood	Recycling (as fibre), incineration or landfill
Cables and busbars	Plastic, copper and aluminium	Recycling (foundry)
Tower	Steel	Recycling (foundry)
Miscellaneous	Lubricants, grease, pain, rubber, plastic	Recycling, incineration or landfill

How is waste managed at end-of-life?



Prevention (lifetime extension): ongoing maintenance and repair

Reuse (resale/maintenance/repair): finding second hand market for turbines; re-use of as many parts as possible

Repurpose (refabrication): find different use for the turbine materials

Recycle (thermal/ chemical/ mechanical)

Recovery: recovering both energy and material

Landfill



Images courtesy of https://coastrenewableservices.com/



Riva Calzoni Wind Turbine M30A decommissioned in 2006, Museum of Electrical Technology, Pavia (IT)

Which of these options is not sustainable?

What can we do with our old turbines?





Images from the Re-Wind Network's Design Catalogue
2nd Edition Fall/Autumn 2022, https://www.re-wind.info/