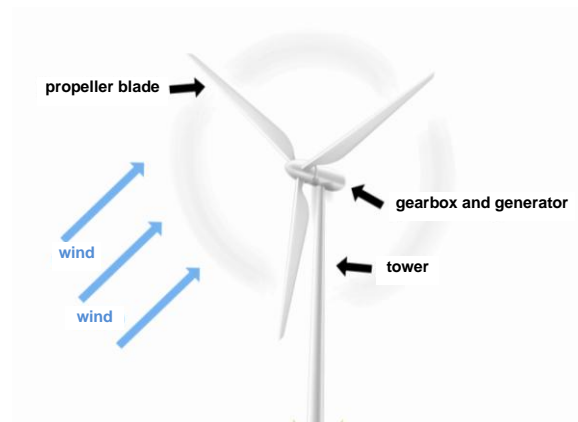# Wind turbines

People believe that the power of the wind can be captured to solve our energy needs for the future when oil and gas run out.
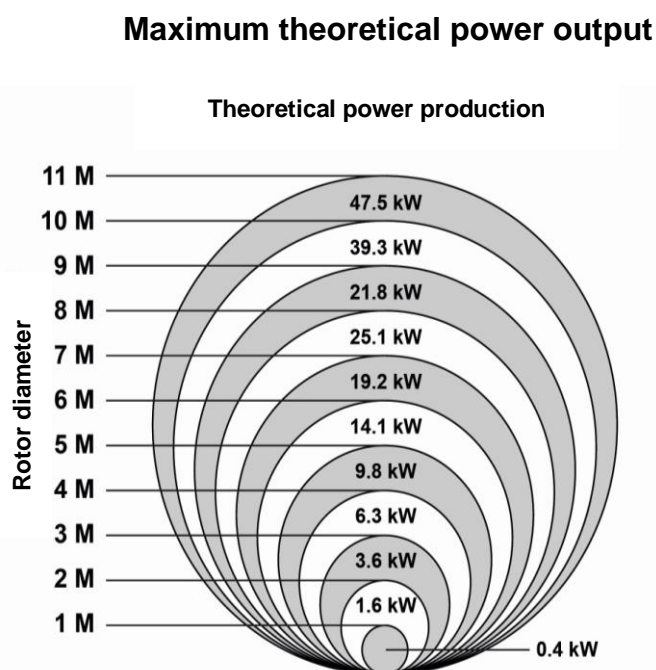
We can use the energy in the wind by building a tall tower, with a large propeller on the top. This is called a wind turbine.

These can be installed locally, even in people's gardens, to supply individual homes with power.

The wind blows the propeller around, which turns a generator to produce electricity. However the efficiency of wind turbines usually does not exceed 50%.

Scientists have collected some data about the amount of power generated using different diameter propeller blades and the amount of power produced in different wind conditions.

Maximum theoretical power output

Theoretical power production

Rotor diameter	Power
11 M	47.5 kW
10 M	39.3 kW
9 M	21.8 kW
8 M	25.1 kW
7 M	19.2 kW
6 M	14.1 kW
5 M	9.8 kW
4 M	6.3 kW
3 M	3.6 kW
2 M	1.6 kW
1 M	0.4 kW

Wind speed (m/s)	Power output (kilowatts)
3	0.0
4	2.2
5	8.1
6	15.2
7	24.8
8	35.8
9	43.8
10	50.9
11	54.8
12	57.3
13	59.3
14	59.3
15	58.6
16	57.1
17	54.9
18	51.4

The design of the generator (design criteria) should include a way of:
- only turning the generator on when a suitable power output of at least 20kW can be produced
- limiting the rotor from turning any faster than that which produces maximum power from the generator, for safety reasons, which should not exceed 50kW.
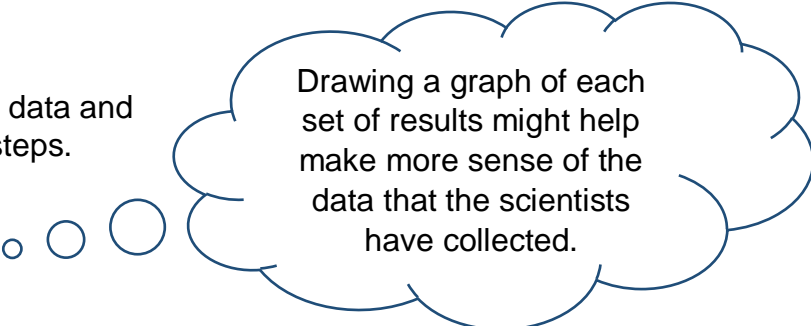
Using the data investigate the effects rotor diameter and wind speed have on the power generated by wind turbines.

Comment on the best conditions and rotor design that can meet the design criteria set by the scientists to give maximum output power.

Task 1

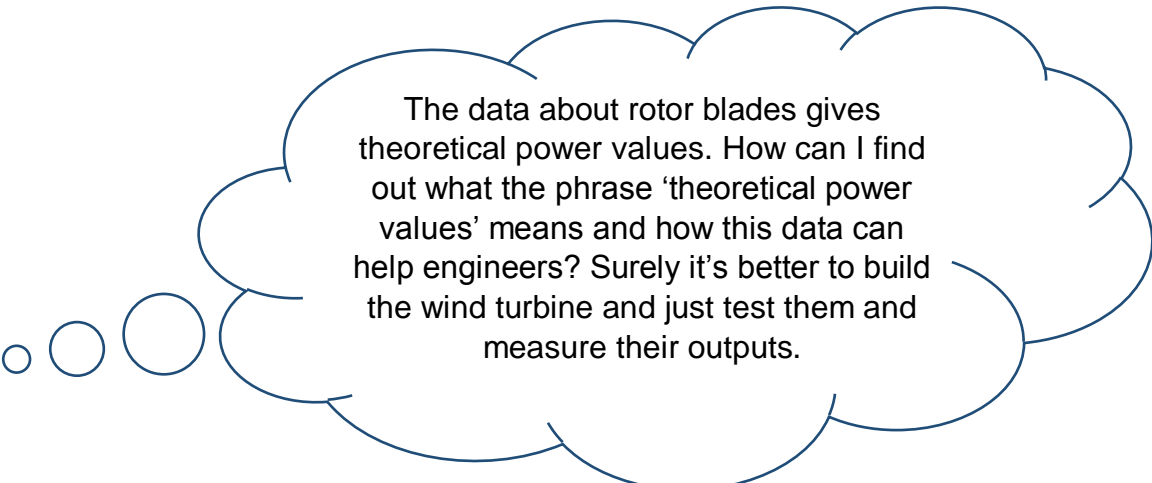Cerys has studied the data and thinks about her first steps.

Cerys thinks:

> Drawing a graph of each set of results might help make more sense of the data that the scientists have collected.

- In groups discuss what the graphs might look like, e.g. is it best to display the data as a line graph or bar chart, what variable is plotted on the two axes. Remember to justify your choices.
- Use graph paper to draw the graphs.
- Write your conclusions after thinking carefully about your data.

Task 2

Siôn thinks:

> The data about rotor blades gives theoretical power values. How can I find out what the phrase 'theoretical power values' means and how this data can help engineers? Surely it's better to build the wind turbine and just test them and measure their outputs.

Can you help Siôn with an explanation?