How Many Homes

National Curriculum
Maths- handling data, application of number, calculations, problem solving
Science- energy resources and energy transfer, investigative skills

Teacher's Notes
The number of houses that can be provided with energy from one turbine is a simple calculation. The capacity of the turbine is multiplied by the number of hours in a year.

Since wind speeds are not high enough to enable the turbines to run at 100% capacity all the time, we then need to use a 'capacity factor'. This is estimated by Renewable UK to be 30% on average for onshore wind. (The actual capacity factor will depend on the wind regime of each particular wind farm site. Some, such as Forss in the Highlands of Scotland, are over 40%). So the total amount of energy that could be produced each year is then multiplied by 0.3 (30%). This resulting figure is then divided by the average amount of electricity a household uses in a year (Renewable UK estimates this to be currently 4.423kWh in 2011. We arrive at the number of homes we would expect to be supplied by one turbine.

The amount of CO_2 displaced is a measure of how much CO_2 is prevented from entering the atmosphere by generating electricity from the wind rather than by burning fossil fuels in a power station.

This activity could be preceded by 4. Carbon Saving from the Introduction to Renewables Pack.

Aim
To show how to calculate the number of houses a wind turbine can support and the amount of carbon dioxide it displaces.

Resources
Copies of the worksheet

Timings
1 hour

Outcomes
Every student will know how we calculate the amount of power produced by any given size of wind turbine.

Differentiation
The extension activities allow the more able to extend their knowledge

Answers

Capacity of turbine in MW	Energy produced each day (x24)	Energy produced each year (x365)	Capacity factor 30%	Number of houses Divide by 4.423MW	CO^2 displaced CO_2 (in tonnes) =(Ax0.3x8760x430)/1000
1	**24MW**	**8760MW**	**2628MW**	**594.167 homes**	**1130.04 tonnes of CO^2**
2	**48MW**	**17520MW**	**5256MW**	**1188.334 houses**	**2260.08 tonnes of CO^2**
3	**72MW**	**26,280MW**	**7884MW**	**1782.50 houses**	**3390.12 tonnes of CO^2**
5	**120MW**	**43,800MW**	**13,140MW**	**2970.834 houses**	**5650.2 tonnes of CO^2**
			A wind turbine does not operate at rated power all the time. The Capacity Factor is the equivalent time in a year expressed as a % when the turbine would be operating at full rated output	4.423MW is the average amount of energy used in UK households	Where: A is the capacity of the turbine in MW 0.3 is the Capacity Factor 8760 is the number of hours in a year. 430g is the average CO2 per tonne emitted by fossil fuel power stations in the UK

How many homes can 1 x 2MW turbine supply with electricity? 1188.334 *homes*

1. A) If you owned a wind farm and it had 10 x 2MW turbines how many homes could you provide electricity for?

   1188.334 x 10 = 11883.34 homes

   B) How much CO_2 would you displace?

   2260.08 x 10 = 22600.8 tonnes of CO_2

3. A) How much electricity could you produce if you owned 25, 5MW offshore turbines? How many homes could you supply?

25 x 13140 = 328,500MW *328,500 / 4.423= 74,270.85 homes*

B) Can you think of another way of doing the second part of this calculation to check your answer? 2970.834 x 25 = 74,270.85

Extension

1. An average tumble drier uses 3.5kWh per cycle. How many tumble driers could be powered from one 1MW turbine in a day?

   3.5 x 1000 = 3500 Watts

   24 x 1,000,000 = 24,000,000 Watts

   24,000,000 / 3500 = 6857.1428 so 6857 tumble driers

2. Look at the right hand column. Can you see a relationship between the figures you have calculated? Can you describe this relationship?

Having calculated the CO_2 displaced by using a 1MW turbine you simply multiply by the capacity of the turbine to calculate the others.

3. Does this work for the other columns?

Yes it does

How Many Homes? WORKSHEET

Using the example in the first row can you calculate how many homes could be powered by the different sizes of turbine and how much CO_2 would be saved?

Capacity of turbine in MW (A)	Energy produced each day (Ax24 = B)	Energy produced each year (B x365 = C)	Load factor (C x 30% =D)	Equivalent electricity consumed by: number of houses (D divided by 4.478MWh =E)	CO_2 displaced CO_2 (in tonnes) =(Ax8760x0.3x430)/1000
1	24MWh	8760MWh	2628MWh	**586.869 homes**	1130.04 tonnes
2					
3					
5					
				4.478MW is the average amount of energy used in UK households	Where A is the capacity of the turbine, 8760 is the number of hours in a year, 0.3 is the load factor and 430g is the average CO2 per tonne emitted by fossil fuel power stations in the UK.

Now answer these questions:

1. How many homes can 1 x 2MW turbine supply with equivalent electricity?
2. A) If you owned a wind farm and it had 10 x 2MW turbines, how many homes could you provide the equivalent electricity for?

   B) How much CO_2 would you displace?

3. A) How much electricity could you produce if you owned 25 x 5MW offshore turbines in a year?

   B) How many homes could you supply?

   C) Can you think of another way of doing the second part of this calculation to check your answer?

Extension

1. An average tumble drier uses 3.5kWh per cycle. How many tumble driers (equivalent) could be powered from one 1MW turbine in a day?

2. Look at the right hand column. Can you see a relationship between the figures you have calculated? Can you describe this relationship?

3. Does this work for the other columns?