

## How much renewable energy generating capacity do we need to build every year to meet carbon emission goals?

Bill Dowling, April.2020

Commitment by many governments to reducing carbon emissions to combat severe climate change impacts also raises significant challenges for global and national economies. Meeting these goals is hugely important and millions of new jobs can be created in a transition to an ecologically coherent economy. Each country will need to set sustainable energy targets to meet their needs.

Overall demand also needs to be reduced from currently unsustainable levels as key resources decline.

The major economic impact of the COVID pandemic is already opening up important lessons we will need for the future, focusing the world on how to manage an 'economy of less' and a more equitable quality of life.

This analysis looks at the energy challenges for the UK, but all countries need to carry out a similar exercise.

In June 2019 the UK government committed to achieving net zero Carbon emissions by 2050.

Net zero means any emissions would be balanced by schemes to offset an equivalent amount of greenhouse gases from the atmosphere, such as planting trees or using technology like carbon capture and storage. But, clearly net zero emissions can only be achieved by generating far more electrical energy than we do now.

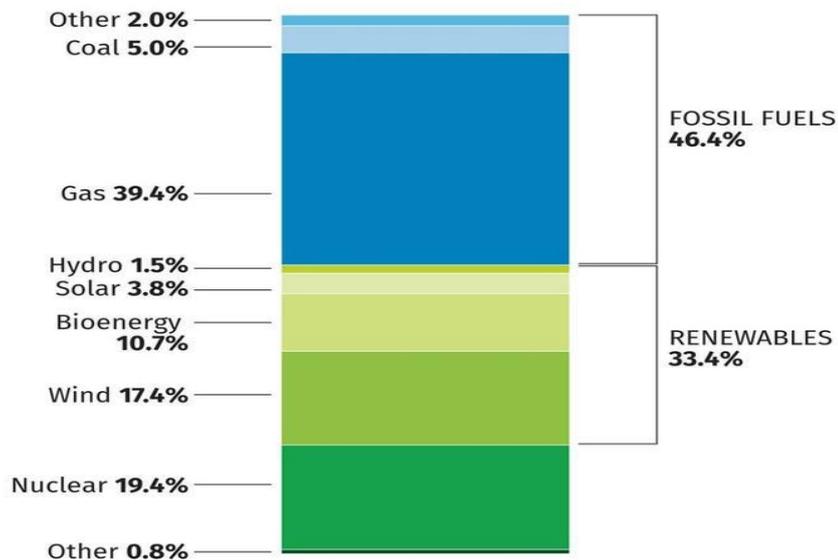
How much more?

This simple analysis attempts to quantify what this might mean in terms of how many more wind turbines, homes with solar panels, solar farms, bioenergy plants, hydro-electric facilities, and nuclear power stations we will need to have put in place by 2050, and roughly what the build rate will have to be.

Since carbon capture and storage will consume additional energy in the process, something many people forget, if we want to bring these numbers down to more manageable build rates it seems we are going to have to learn to live with many more nuclear power stations and/or learn to live with a lot less energy than we are used to - and we are going to have plant an awful lot of trees every day for 30 years as well!

This is how all the electricity was generated in the UK in 2018 (i)

### UK energy mix in 2018



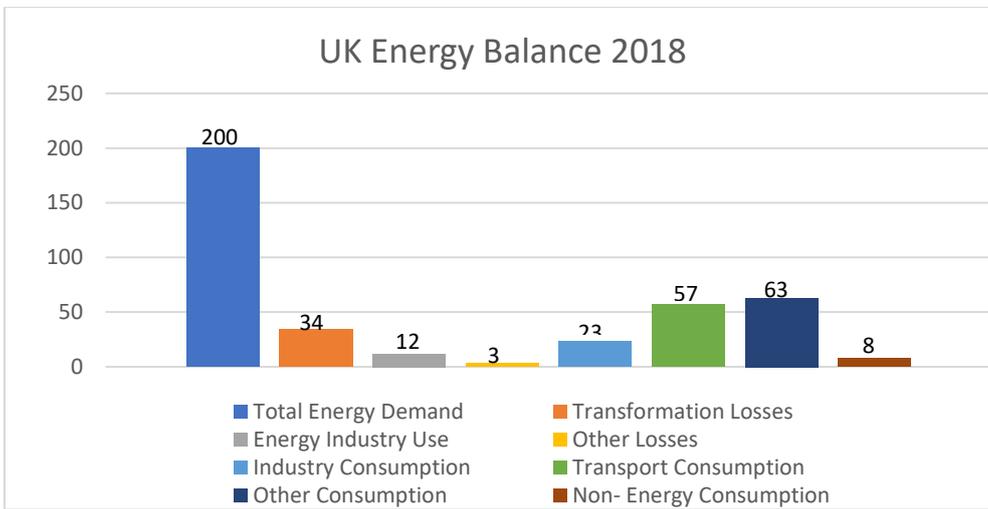
Source: Department for Business, Energy and Industrial Strategy



Credit: PA Graphics

**Total UK primary energy consumption in 2018 was about 200Mtoe (ii) consumed as follows:**

(1 MToe = 1 million tonnes of oil equivalent energy – the amount of energy we get from one million tonnes of oil and is equivalent to 11.63TWh (Terrawatt-hours) of Electrical Energy. 1 TWh is roughly the amount of electricity 250,000 average UK homes use in a year at current rates of consumption.)



The total amount of electricity generated in the UK in 2018 was 333 TWh, of which 111 TWh was from renewables – generated by approx. 10,000 wind turbines, 1 million homes with solar panels, 420 solar farms, 44 biomass facilities, 46 waste plants and about 5TWh from various hydro-electric installations. 65 TWh was generated by 8 nuclear power stations. 154.5 TWh was generated by fossil fuels

111 TWh is a very long way away from replacing the balance of all the total energy likely to be required by the UK in 2050 with electrical energy generated solely from renewable sources.

After deducting the non-energy consumption (8 Mtoe) used for making plastics and chemicals etc, and subtracting existing renewable electricity (111TWh= 9.5 Mtoe) and existing nuclear generation (65TWh = 5.5 Mtoe) we are left with about 200 - 23 = 177 Mtoe or 2058 TWh of additional electrical energy capacity needed to make up for all of the fossil fuel energy still being consumed in the UK in 2018.

Assuming the UK will still need this amount of energy in 2050 (which seems quite possible, bearing in mind the projected increase in the population and likelihood of further economic growth over the next 30 years) that would mean having to build 2058 TWh divided by 111, over 18 times as many more renewable electricity energy generating facilities than we have now. However, if the number of nuclear power stations was also increased proportionately, we would only have to build 2058 divided by (111+65 =176), about 12 times the number of renewable facilities - but also 12 times as many more nuclear power stations than we have now!

More optimistically - and realistically, assuming we will have far better home insulation and build standards, with people doing a lot more walking and cycling as well as greater efficiency and economy in our use of electrical power, one could reasonably suggest that only about 120 Mtoe or 1400TWh of additional electricity per annum is going to be required by 2050.

The corresponding multiplying factors work out at 12.5 for renewables only, and 8 for renewables + nuclear. On this basis, the total numbers and the approximate build rate of each electricity generating facility required are listed below, bearing in mind we have only 30 years or 11,000 days to get all of this new infrastructure in place, and that we cannot leave it until the last few years to do it.

This is a huge challenge, particularly since there is little scope to increase the UK's hydro-electric 5TWh output. This leaves Wave and Tidal generation as the only other options. Together they could potentially generate up to 65TWh, but they have been badly neglected so far, due to their high cost compared with wind and solar power generation.

**Renewables only**

Wind Turbines, 10,000 x 12.5 =125,000, 11 a day  
 Home Solar Panels, 1m x12.5 =12.5m, 1100 homes a day  
 Solar Farms, 420 x 12.5 = 5250, 1 every other day  
 Biomass Facilities (1), 44 x 12.5 = 550, 18 a year  
 Waste Plants (2) 46 x12.5 = 575, 19 a year  
 Nuclear Power Stations – keep or replace 8 existing

**Renewables + Nuclear**

10,000 x 8 = 80,000, 7 a day  
 1m x 8 = 8m, 700 homes a day  
 420 x 8 = 3360, 1 every 3 days  
 44 x 8 = 352, 12 a year  
 46 x 8 = 368, 12 a year  
 8 x 8 = 64, 2 more every year!

**Notes:**

- (1) Burning wood faster than trees can supply it is neither sustainable nor renewable energy and should stop.
- (2) Burning waste that can easily be recycled is neither sustainable nor renewable energy and should stop.

**References:**

(i) <https://www.itv.com/news/2019-01-03/renewables-rise-to-new-record-as-overall-electricity-generation-falls/>

(ii) <https://www.gov.uk/government/statistics/digest-of-uk-energy-statistics-dukes-2019>