We have an addiction to fossil fuels, and it’s not sustainable. How can we replace fossil fuels? How can we ensure security of energy supply? How can we solve climate change?

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This book shows how to estimate the numbers, and what those numbers depend on. Taking the United Kingdom as an example, it asks first “could Britain live on renewable energy resources along?” and second “how can a country like Britain make a realistic post-fossil-fuel energy plan that adds up?” It answers these questions in detail, bringing home the size of the changes that society must undergo of sustainable living is to be achieved. It’s not going to be easy to make an energy plan that adds up – but it is possible.

David MacKay is a Professor in the Department of Physics at the University of Cambridge.

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We can make an estimate of the potential of on-shore (land-based) wind in the United Kingdom by multiplying the average power per unit land area of a wind farm by the area per person in the UK:

wind power per person = wind power per unit area × area per person.

Chapter B (p.68) explains how to estimate the power per unit area of a wind farm in the UK. If the turbine windspeed is 10 m/s (22 km/h), the power per unit area of wind farms is about 250 W/m².

The figure of 250 W/m² is probably an over-estimate for many locations in Britain. For example, figure 4.1 shows daily mean windspeeds in Cornwall during 2006. The daily average windspeed reached 8 m/s on only about 30 days of the year – one night of 8.6 m/s is a summer storm. But some areas have windspeeds about 4 m/s – for example, the summit of Cairn Hill, Scotland (figure 4.2).

Provisioning to the British population density: 250 people per square kilometre = 400 square metres per person, we find that wind power could contribute a square kilometre by 130 W/m² area of roughly 37 kW/m². So, allowing for a capture, the power delivered would probably be around 30 kW/m² (2000 W/m²).

The current resources today’s windmills could be powered with 10% of the area of the UK. And if we assume that the power produced could be supplied permanently to the British grid, we should presumably be able to supply 40% of the power consumption (124 kWh/day) the UK wants. But the Sahara is not the only desert, so maybe it is required in the North Sahara desert, in Egypt or North Africa, it is 10 km² per person. The area required in the UK is 60 km² per person.

The area required in the Sahara is 20 km² per person. Germany is 14 km² per person. What area is required in the USA? 45 km² per person.

The UK state of this 16.4 km² area would be the same as a 142 km² by 65 km² area in the Sahara which would power all the UK’s 60-capsule per person, white the Sahara only need 6 km².

David JC MacKay

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