Sustainable Energy – without the hot air

By David MacKay

Reviewed by Bernhard Haubold, Germany

Have you ever wondered how best to make students aware of the issues surrounding our current fossil-fuel-intensive lifestyle? After all, they stand a good chance of seeing fossil fuels perhaps not run out but become unaffordable in their lifetime. *Sustainable Energy – without the hot air*, by Cambridge professor of physics David MacKay, is an exemplary blueprint for engaging curious minds in the energy debate (it is also freely available online[w1]). Because fossil fuels are not only guaranteed to run out, but in so doing also lead to a potentially catastrophic increase in atmospheric carbon dioxide concentrations, MacKay's refreshingly radical aim is to live 'without fossil fuels'.

Whether or not this is an attainable aim is a matter of numbers: how much energy do we need and how much can we extract from various sources? Because raw numbers tend to be mind-numbing, MacKay presents the pertinent facts in many beautiful graphics, and as memorable number games. His back-of-the-envelope calculations are based on a single unit for measuring all energy consumption and production: the kilowatt-hour per day, which we can all relate to by reading the electricity meters in our homes.

The book is divided into four parts, the first two of which carry the main argument. Part I asks whether we can generate enough renewable energy to replace fossil fuels without making other adjustments. The somewhat disillusioning answer is, almost certainly not. So in Part II, alternative scenarios for weaning ourselves off fossil fuels are explored, such as electrifying transport. Part III supplements Part I by giving more rigorous calculations on the energy balance of cars, bicycles, planes, windmills, tides, and so forth. This part contains ideal material for teaching various elementary topics in physics, including car travel, plane flight, and heat transmission. Finally, Part IV consists of useful data for extending MacKay's UK-centric calculations to any country in the world.

Part I is structured as a clever race between energy consumption and energy production. Cars are the first consuming device considered, and MacKay asks: How many kilowatt-hours per day do we use by driving to school? Part of the answer is found by looking up the nutritional value of butter or margarine in your fridge and estimating the energy content of a litre of fuel from that. This exercise is then repeated for all of our well-known energy-consuming activities, including air travel, heating and lighting, but also for the traditional renewable energy sources centered on wind, sun, water and geothermal heat.

The conclusion from this race is that in the UK, renewable energy sources cannot nearly cover current energy consumption, so Part II explores new approaches to balancing demand and supply. MacKay emphasises *big* measures here, as the problem cannot simply be solved by disconnecting the phone charger. One such big measure would be to use bicycles whenever they can replace cars, which consume at least an astonishing 25 times more energy per kilometre travelled. Where is the cycle-lane building programme to reflect this fact?

Although most of us are aware that the bikes ridden by our students are more efficient than the cars we drive, this part of the book also contained surprises for me. For example, electrical heat pumps for heating houses are more efficient than condensing boilers, even if the heat pumps are powered by electricity generated from burning fossil fuels. Why is this fact not embodied in standards for new buildings?

MacKay is clearly aware of the politics of energy production and consumption when, for instance, he deftly compares the cost to the USA of the war in Iraq as estimated by Nobel Prize-winning economist Josef Stieglitz (USD 2000 million million) to his own estimated cost of converting the UK to sustainable energy production

(GBP 870 million million, the equivalent of about USD 1400 million million at the current exchange rate). However, in most of his book, MacKay steers clear of such considerations, while insisting that we should make an energy plan that actually adds up. For this we need to understand a lot of science, as shown throughout his book. But this is part of the fun of reading *Sustainable Energy*: the author is convinced that "simplification is a key to understanding" and thus allows his audience to grasp so much more than they might initially expect.

The intended audience for the book is the intelligent layperson. Although not specifically written for students, the book's engaging style and colourful illustrations make it suitable for anyone aged 14 and above. The chapters on the quantitative aspects of energy consumption and production would make excellent source material for secondary-level physics classes, the discussion of CO_2 emissions in rich versus poor countries would add spice to a geography class, the computation of the energy content of a kilo of margarine could enliven a biology class, and there is plenty more science for schools to be discovered in the book. If you are curious but wary of its full 384 pages, take a look at the 10-page synopsis posted on the book's web page[w1]. You will find a brilliant example of the power of simple scientific reasoning – exactly what science teaching should be about.

Details

Publisher: UIT Cambridge
Publication year: 2008
ISBN: 9780954452933

Web reference

w1 – *Sustainable Energy – without the hot air* is freely available online at: www.withouthotair.com

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