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Just the Facts: article for RIBAJ on
Sustainable Energy- without the hot air, by David J C MacKay

By Richard Saxon.*

"Have you read David MacKay's book? It's great and so useful," said one of the several fellow sustainability enthusiasts who pressed me to take it in. So I did and it is. And I thought you should know about it too. It helps a lot with sorting the myths from the wishful thinking and the really good ideas.

MacKay sets out to do the physics and the maths to see whether Britain, and the world's, energy needs might be met from sustainable sources without a radical change in the lifestyles to which we seem so attached or to which the Chinese aspire. Is there enough potential to allow us to stop using fossil fuels by the mid century? Is it sensible to capture renewables at the building rather than rely on district or national sources? Is hydrogen the fuel of the future? Can biomass really be significant? Is most 'greenspeak' hogwash? He sets out to provide facts and alternative scenarios, without the economic dimension, leaving that for development by others. Economics however does follow thermodynamic efficiency and that he makes clear. It's written in a very accessible style, with copious footnotes and website links to back it up, and half the book is technical chapters to go behind the storyline into aspects of demand and supply.

His first sensible idea is to convert all comparisons of demand and supply to the same units: kilowatt hours per person per day (kwh/p/d). All forms of energy can thus be read off against each other: we each use about 40kwh/d to run cars on petrol; onshore wind energy developed to a very high degree could deliver 20kwh/p/d. One annual long-haul flight each costs 30kwh/p/d. Solar thermal heating, fully deployed, could provide 13kwh/p/d. MacKay builds up a demand profile (a pink column) for an affluent UK resident and then the supply potential (a green column) of each of the renewables, including nuclear and 'clean coal' if they could supply for a very long

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time (one thousand years).He also describes renewables in terms of their ability to deliver power per square metre of land occupied, enabling comparisons of biofuel, wind and solar.

The RIBA has adopted the stance known as 'Contract and Converge', supporting the idea that developed nations would reduce their carbon emissions whilst those of developing nations initially rose, both falling by mid-century to similar levels considered sustainable. That level is probably about one to two tons of CO2 per capita versus the 11 ton UK average today. It does effectively mean eliminating the use of fossil fuel, not just using it very efficiently. Just to retain jet travel could use all of our allowance. The question of its practicability, and the sensible steps towards it, are vitally important now. By 2050, at normal levels of investment, we will have replaced 40% of our housing and replaced or refurbished all of our non-residential building, some more than once. We shall also have replaced all our fossil and nuclear power stations. The main burden of change in buildings falls on the existing stock, which will still dominate the demand side. Given three strategies: reduction of the use of energy, increase in the efficiency of its use and de-carbonising of its supply, what combination of effort will deliver the most?

MacKay makes consideration of our options easier by devising a simplified 'Cartoon Britain' in which our current demand for 125kwh/p/d is met in a variety of ways. The demand, in Cartoon Britain, is a mixture of need for power for electrical devices, need for heat and need for transport. (*see fig 27.1,p 204*). Future consumption levels, even with economic growth, are assumed to remain similar, thanks to increase in efficiency. For MacKay, the future looks electric, based on its relative efficacy. Whilst some heat needs are met by solar and biomass, especially in new-build, most are better met by ground or air source electric heat pumps. He sees efficient ways of using gas, like CHP, to be wasted steps as heat pumps are far more efficient even when the power is from gas fired stations, and can move on to any renewable source of power. Electric vehicles score well against other possibilities to take over ground transport. Hydrogen is not a runner on the numbers. Biofuel is too small a resource;

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aircraft could use all we could make. Assuming some success in reducing the use of energy and increasing the efficiency of use (our role as designers) he ends up with a demand for 48kwd/p/d of electricity, about two and a half times our current supply.

How could we get that 48kwh/p/d? MacKay shows five alternative plans *(fig 27.9 p212)* for raising it from a mixture of domestic and imported renewables, nuclear, and clean coal. He invites us to consider the environmental and political factors in selecting a mix. A wind dominant scenario sees the UK and its coastal waters plated in turbines, and pumped storage to smooth out supply. He worries about NIMBYs limiting provision. A nuclear dominant scenario has 110GW of power stations, twice the current French fleet. One option, which won't please the independence party, suggests that solar-thermal electricity, made in the Sahara, could provide power for a billion people. All of Europe, the Middle East and Africa could receive power at UK per capita levels with a plant area the size of Morocco. A Wales-sized array would serve the UK. The desert states could thus continue selling us energy, but clean stuff.

The investments will be vast so the cost of power will rise commensurately. That will cost-justify low energy design and smart technologies, compact cities and public transport. But we can get what we think we want without revolution, says MacKay. And it won't be done by Code 6 homes or zero-carbon offices but largely by decarbonising grid supplies.

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