BOOK REVIEW

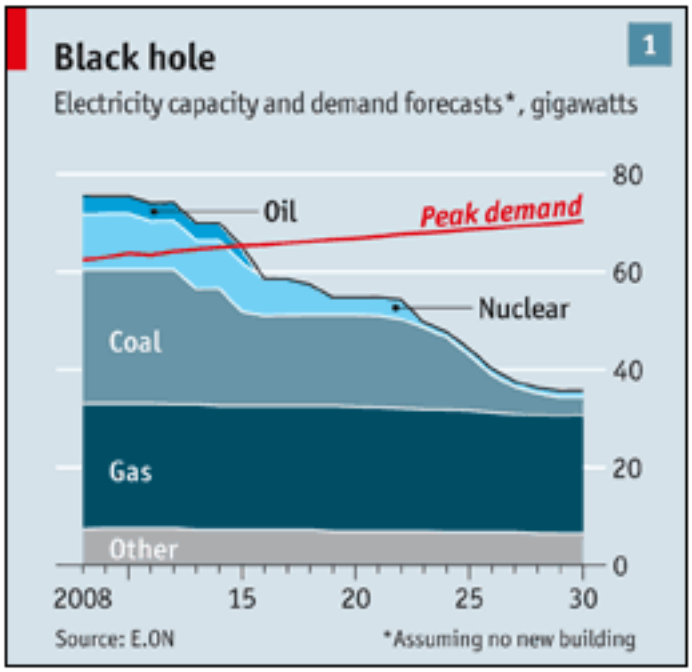
APOCALYPSE SOON!

By ED HOSKINS

I have been reading a book which is crucially interesting and which sadly bode ill for the future, particularly for our children and our children's children.

"**Sustainable Energy Without the Hot Air" by** Professor David J C Mackay, see: www.withouthotair.com/, the entire book or subchapters can be downloaded free on the internet. And, also see a recent review in the Economist at www.economist.com/books/displaystory.cfm?story_id=13437900

Look at this diagram from the economist and be very worried particularly for the UK. Much of Europe will have similar profile except for France with 85% nuclear electricity generation and still building:



Professor Mackay does believe in Man-made Global Warming and considers that reduction of CO_2 emissions are essential to control possible future global warming. He clearly supports the IPCC (the United Nations Intergovernmental Panel on Climate Change) and other institutional party lines.

Sustainable energy to address the problem is a vast subject, much pontificated over, but what is interesting about Professor Mackay's book is that it dispels the many myths that have grown up particularly from within the Green movements and as such it is truly fascinating.

"Sustainable energy without the hot air", applies the numerical mind of a physicist to the problems, the solutions and the policies that are being promoted to combat global warming, carbon dioxide emissions and avoiding the burning of valuable fossil fuels, which will continue to be needed as the feed-stocks for industry.

Mackay makes things straightforward, using round numbers and the concept of personal daily energy requirements, taken in the context of the UK and Western Europe. To maintain current lifestyle the 60 million people in the UK needs about 170 Gigawatts (GW) of energy supply, (ie the equivalent to about 170 nuclear power stations).

Right across Western Europe people are currently using about 125 Kilowatt hours per person per day. By comparison energy usage in the USA is at double this rate, whereas China is now about 1/3 of the European level and India is half of that level again.

At long last Professor MacKay has done the maths and presented the figures in an understandable form. As he says, **"with numbers not adjectives"**. This is what appeals to me so much about his approach. He weighs in on both sides of the equation, both energy consumption and energy production

Energy Consumption

Mackay envisages that the current levels of consumption could be significantly reduced, perhaps by as much as 45% in the following ways. They are radical.

- Improved efficiency, can reduce heating and cooling costs by at least 25%. This means much improved insulation in new build, which can virtually eliminate heating costs, but which is not often an option in older building stock.
- Turning down thermostats, and putting on an extra sweater, 10% of the average heating bill can be saved by a 1C° reduction in the internal thermostat.
- Of course cooling in summer to below winter temperatures, (very common in the US), with air conditioning is a real waste of energy.
- The use of air source and ground source heat pumps is a choice for change made by individuals and can be very effective. Currently the equipment is costly but with enhanced take-up they could become much more economic.
- Lighting Energy usage, is only about 3% of current overall consumption, nonetheless energy saving bulbs make a difference, mini fluorescent bulbs are at least five times more efficient than incandescent bulbs and the LED bulbs coming on stream promise even greater efficiency and reliability.
- Using electricity for transport, MacKay's calculations show that electric cars are about 4 times more efficient than using any hydrocarbon fuel. But to give an idea of the scale of alternatives, if we were to convert all road transport in the UK to bio-fuels it would require a cultivated land area about the same size as Wales. MacKay regards hybrid cars as an insignificant possible stop gap. He sees the use of hydrogen as a fuel to be worthless and particularly misleading, (in spite of its clean emissions on the road), because of the energy requirements needed to generate and distribute hydrogen, give an actual energy consumption of some 2.5 times as much as an ordinary petrol car.
- Incidentally keeping head lights on in the daytime increases fuel consumption by about 2%.
- Thus providing well-loaded high-speed electric trains are really efficient ways to get around.
- Not flying: David MacKay's calculations show that a single long haul flight, (for example London - Johannesburg - London), in a year uses as much energy per person as motoring an average of 50km every day. So when we Europeans gaily commute 5 or 6 times across Europe on airlines that charge us next to nothing, we are really contributing massively to the energy usage problem. Some time soon cheap flying will have to be a thing of the past.
- MacKay also notes the laws of physics simply make it unlikely that there can be any significant efficiency improvement in flying as a means of transport. Whatever money is spent on research and development, the new materials, the new engines etc. all improvements will be marginal whatever the manufacturers may say.

So only radically changing habits could make a real difference in energy consumption.

But such a change will also require a greatly increased scale of electricity generation, doubling UK electrical generating capacity to about 90 Gigawatts from the current 45 Gigawatts.

The question then is where can this increased electricity generation come from and what the likely alternate sources are going to cost in terms of finance, use of land and security of supply. David Mackay draws a scaled map of the UK showing the vast land areas that would be taken up even by a rational combination of various alternative energy generation schemes.

He makes a further crucial point that some alternative energy sources only generate heat energy rather than the higher grade more valuable and transportable electrical energy. However probably his most important point is that whatever is done, it will only ever be effective if it is on the grand scale. Turning off battery chargers and not leaving equipment on standby or other minor gestures are not going to dent the problem or save the planet. As David MacKay says **only "every BIG helps".**

Energy Generation

So what are the main alternatives for sustainable power generation. These can be compared by their likely cost / Gigawatt and by their land area requirements.

Wind power: the wind is intermittent and thus can only ever be about 20% effective.

- Wind power requires equivalent back-up standby generating power or storage capacity for the times when the wind does not blow or blows too much. The investment and massive subsidies for wind power seems to be utterly misguided. The energy companies are beginning to realise this and are cancelling projects.
- **On-shore wind farms:** in average generating capacity these are reasonably cost effective (rather the less than the total equivalent cost of nuclear power, but this does not count the essential "spinning" back-up generating, grid or storage resources). Wind farms take very large areas of land and are environmentally obnoxious. To provide the 90 Gigawatts, (without the essential backup) would mean covering 2/3 of the of the land area of the UK with wind farms. Incidentally they don't kill that many birds, domestic cats are 1000 times as effective.
- **Off-shore wind farms:** are at least twice as expensive as those built on land, but they are probably a somewhat more consistent source of power. However they require massive engineering, and they still need backup generating or storage capacity. Offshore wind farms have very considerable maintenance problems and are subject to much heavier wear and tear and corrosion difficulties.

Using water power: water is a 1000 times denser than air, the tides and their associated currents are therefore much more powerful and more importantly entirely predictable when compared with the power from wind. Better still the tides around the UK are out of phase so tidal power has potential to provide continuous power day and night. The use of waterpower for electricity storage by pumped storage on demand schemes is well understood and effective:

- **Tidal lagoons** could be used in a similar manner. Estuarine barrages and tide lagoons use the outgoing and incoming tides released through turbines to generate electricity.
- These projects have the potential to be of sufficient scale to make worthwhile contributions. It has been estimated that the Severn barrage alone could well contribute 5% of UK power needs: then there are the Wash, Morecombe Bay, Strangford Loch, etc. However the schemes would not be cheap, at their average output estimated at as much as 5 times the cost of nuclear generation. Such schemes will also run into massive environmental protest.
- **Tidal stream:** there are many locations around the UK where tidal currents are powerful and predictable. These could be exploited by submerged fields of free-standing turbines but a great deal of research and investment in development still needs to be undertaken. They are likely to be costly, at about twice the price of nuclear power and are also likely to be subject to maintenance problems.
- **Wave power:** the technology has been developed on a small scale. One established form operates with long snakes of jointed floating caissons, which generate power as they flex in the waves. The scale necessary to generate worthwhile power would be enormous about 70 kms / Gigawatt. They are also entirely dependent on the weather and sea-state and so can only ever give irregular output and like wind energy would require back-up generation. Current costs for average output are about 5 times cost of nuclear power. They will also have all the maintenance problems of off-shore wind power.
- **Hydroelectricity:** is well established, but in the UK the uplands sites for generation are comparatively limited in comparison to the generating capacity needed. However they can be controlled to provide backup energy on demand.

Heat pumps: extracting heat from the air or the soil is a very effective way of using electric power for heating and possibly the reverse for cooling. The technique only produces lower grade heat energy but the costs are comparatively low, a quarter of nuclear energy. The use of such equipment is an individual decision and pumps are integrated into new or existing housing and thus make no demands on land use.

Energy Storage: storage of electricity is notoriously difficult, sources of standby capacity are essential for most renewable energy sources, (wind, solar etc.).

- **Pumped storage:** There are a few operational UK schemes where pumped storage is achieved very effectively. These are essentially two water reservoirs one above the other with reversible generators / pumps. When there is excess, "cheap" power in the grid, it is used to fill the upper reservoir and later the water is released to recover the power via the turbines. The largest UK installation at Dinorwig in North Wales has an output greater than 1GW. The technology is reasonably priced, needs suitable upland sites, but is replicable and does not use much land.
- **Other storage:** the most promising of these is the future use of battery storage in a large fleet of privately owned electric vehicles as mentioned earlier using intelligent charging and control technology.

Solar energy: the sun is intermittent day by day and not particularly effective as far North as the UK. The value of solar input potential in Southern Spain, the Southern USA or the Sahara is more than twice the UK level.

- **Solar hot water:** individual domestic and industrial water heating systems can make a contribution even in the UK. They would absorb a lot of urban roof space, which objectors would find unsightly. In cost terms although they would be individual purchases, they are expensive for their relatively small productive capacity of low-grade thermal energy.
- **Photovoltaic farms:** with high technology it is possible to convert sunlight directly into electricity and there are some small scale examples. Of course these systems work better the further south you go and returns in the UK would be comparatively small. They would take up significant but not enormous land area. The estimated cost is about 3 times that of nuclear power generation.
- **Solar power in deserts:** a serious proposal is that solar power could be collected and imported from other peoples deserts and transmitted north to Europe, (the long distance transmission technology does work). Also technology is available to ensure local overnight local storage to improve the consistency of supply.
- The scale would have to be enormous, (a plant area of plant the size of Wales would be needed to provide the UK with its power needs), and the costs also are very high, about six times that of nuclear energy. Of course having such plants on other peoples' territory would raise security of supply problems.

Waste incinerators: incineration of household and agricultural waste has real potential for a limited amount of power generation. It costs about twice as much as the equivalent nuclear generation. So far the UK has some limited success but is lagging far behind the best. In Denmark for example, where waste incineration is already 11 times more effective than the UK. Incineration of collected waste seems much more effective than attempts to gather gas from rotting landfill sites. Incinerators may not be thought to be the best of neighbours but they need only take up a limited amount of urban land.

Clean coal: there are very substantial fossil fuel coal reserves in the UK and around the world, but the normal way coal is burnt results in significant CO_2 release. It is conceivable that the waste gasses could be collected and sequestered underground. It is not easy and it will be expensive. The cost is estimated to be about twice current generating costs and at least half as much again when compared with nuclear energy. However the land take would be modest. As the CO_2 produced is a plant fertiliser, sequestration of CO_2 would seem to be a particularly pointless exercise unless it can be conclusively proven to be the cause of climate change.

Growing plants for fuel, biomass: photosynthesis, though effective in nature on a world scale, is a very poor way of converting solar energy and atmospheric CO_2 into fuels useable for electricity generation or transport, (about 0.2 watts / sqm as opposed to almost 20 watts / sqm for photovoltaics in Southern California).

The fossil fuels we burn now are the result of many billions of years of photosynthesis. When burnt, the biomass probably increases CO_2 levels even though to arrive as a fuel carbon capture has taken place so the process is essentially carbon neutral:

- **Wood:** growing wood for fuel requires about 2500 sq km to produce a Gigawatt of energy in other words 8 times current UK area of forestry for the 90 Gigawatts required.
- **Biofuels:** growing crops to generate liquid fuels diesel or ethanol for example is possible and proven but is even more space consuming at about 6000 sq km per Gigawatt. This would mean about 12 times the UK arable land area for the 90 Gigawatts required.

  But we also need arable land to grow food. The devastating effects of replacing food crops are already being seen and their replacement for biofuels is leading to rapid food price rises especially in the developing world: biofuels are not a solution but a real disaster in the making.

Nuclear fission: in spite of all the adverse publicity and protest, it seems that nuclear fission:

- is about a million times more effective at energy production than any fuel chemical reaction
- is effective and capable of constant continuous production
- is comparatively cheap compared with more "environmentally acceptable" alternatives
- absorbs very little land
- produces a small amount of waste that can be handled comparatively easily in spite of the propaganda
- produces no CO_2 from its production
- has a virtually unlimited fuel supply
- is immediately available
- has potential for greatly increased efficiency (up to 60 times current output levels) in the future even enhancing current known technologies using fast breeder reactors and / or thorium technology
- does not pose security of supply problems.

David MacKay does not say he is a supporter of nuclear energy but his arithmetic shows that it is likely to be the only real and currently available answer of sufficient scale to tackle the impending energy problem facing the UK and the world.

As the former director of **Greenpeace International** Patrick Moore, (now much vilified by his old movement), has said *"we made the mistake of lumping nuclear energy with nuclear weapons, as if all things nuclear were evil. I think that is as big a mistake as if you lumped nuclear medicine with nuclear weapons"*.

At last David MacKay has done the world a great favour in clearly laying out the numbers involved in sustainable energy.

His book does not make for comfortable reading. It clearly explodes many of the myths promoted by Green campaigners in the past years and negates many of the policies that governments are now pursuing, (particularly, for example the subsidising of wind energy). I sincerely hope that the world's policy makers will sit up and take notice. Fat chance ???

In Conclusion

The greatest tragedy is that the Green Movements have so effectively negated the nuclear energy option in much of the Western world for so long. If, (and this is a very big if), the production of CO_2 from fossil fuels is in fact posing a major the problem and inducing climate change, nuclear energy seems to be the only viable alternative for mankind. Without the malign influence of the "well-meaning" green movements, something might have been done to ameliorate the planet's position as far as its CO_2 emissions were concerned.

Indeed, if CO_2 emissions are the real problem, Green objections to Nuclear Energy will bear a very heavy responsibility for the damage they have done to the future of our planet.

There is even, a not unreasonable, conspiracy theory that Alexander Litvinenko was murdered using the very exotic radioactive element Polonium, simply to make sure that the West remained fearful and antagonistic towards anything nuclear and thus help maintain the full dependence of Western Europe on Russian energy supplies.

France is one of the few countries that has wisely resisted pressures from the environmental lobbies, as a result 85% of all their electricity generation is nuclear. Thus it is the most enlightened in the world. Their nuclear industries now hold the most advanced technologies in the field, (a position once held by the UK, but which was sold off for a pittance by the last Labour government). The French are also fully involved in the next round of fusion power generation at Cadarache, which is a great hope for clean energy generation for the future.

There is already a transmission line from France to the UK capable of carrying the output of two French nuclear power stations, but of course, the French will be able to set the price when the brown-outs start and the lights go out in the UK in only a few years time, (that is likely to start in about 2015, see the earlier diagram).

The French have even embraced high-speed electrically powered trains as an acceptable alternative to medium distance flying within Europe.

Because James Lovelock looks at the world from the perspective of geological time, he feels that whatever is now done to ameliorate the situation, this reduced hotter world will only be capable of supporting about 1 billion people by the year 2100, (not the 9 billion confidently predicted).

That means a huge tragedy will descend and is a very bleak prospect for our children and our children's children.

I cannot help but feel that my generation has had the very best that the planet has had to offer over the past half-century or so.