Towards better energy efficiency

Should we follow the European example?

As concern for future energy supplies increase, it seems strange that here in the UK the debate fails to take into account the lessons to be learned from the experience of other countries. Decisions have been made on the basis of anecdotal or corporate lobbying information, when scientifically tried and tested examples from abroad are ignored. Dr. Irene Schoene of Ecostudies reports ...

I believe that the UKs' most serious omission in the present energy debate is energy efficiency. It is the one area where low cost progress can be made now, without any new technology needed. Though American biologist, Barry Commoner's most famous quote is: "There is no such thing as a free lunch,"[1] what is less well known is another of his quotes - that the world's main energy resource is 'energy saving'. Why, indeed, are we not focusing better on using energy more efficiently, instead of only exploring new resources? The qualitative approach Commoner takes seems more reasonable, and it's cheaper!

There are, of course, people who think energy efficiency cannot be increased, as if energy consumption levels are based on some sort of natural law. In fact wastefulness is only a cultural habit. No law of physics prohibits the more efficient use of energy. Steven Koonin, BP's leading scientist and CalTech professor, warned that, 'based on today's consumption only 41 years of oil are left, 67 years of gas and 164 years of coal'.[2]

However, energy use is based on laws of physics, in particular the laws of thermodynamics, which say:

- ***energy can neither be produced nor destroyed***
- ***energy can only be transformed from one quality into another, i.e. from primary resources into electricity.***

We also need to understand that the transformation of one type of energy into another cannot be achieved without losses.

Of today's total global energy supplies:
- 40% is used for generating electricity mostly from coal
- 40% is used for heating buildings and water, mostly mineral oil or gas
- 20% is used for transport, mostly mineral oil.[3]

Electricity

Electricity is not the same as other forms of energy, it needs (other than when generated from renewables, such as wind, solar or hydro) transformation from finite fossil fuels such as oil and coal, which are called 'primary' resources. Electricity is a 'secondary' energy and of the highest energy quality.

Electricity is often referred to as 'clean' energy. This, however, totally ignores its origin from primary resources and the unavoidable side effects of transformation. Therefore electricity generated from fossil fuels should only be used for appliances and light, never for heating buildings and water heating.

According to the Federal Ministry for Trade and Technology in Berlin, Germany[4] the efficiency of energy use for electricity generation is:
- coal fired power stations - 45%[5]
- combined power & heat stations - 70 – 85%

which means that in coal fired power stations generally 55% of energy is lost just in the transformation process, and this is usually as wasted heat.

This wasted heat, normally emitted into the atmosphere through cooling towers, should be used to heat buildings and water, as is done in other European countries, especially in Scandinavia[6]. The technology is called 'district heating' and was invented in 1877 in Lockport, New York by Birdsill Holly. It has more recently become know as combined heat and power (CHP).

Using district heat (heat distributed by underground piping throughout the community) is as economical for electricity producers as it is for consumers. Electricity producers profit from selling what is otherwise wasted; consumers buy cheap, reliable and secure heat - and nature profits from less pollution. A law could compel big electricity producers to build up the necessary infrastructure so that CHP could be used at all electricity generation stations. Such law might be supported by infrastructure grants.

It is really hard to understand why, these days, any government would grant permission to build new coal fired power stations without trying to make them more energy efficient by using their waste heat emissions for heating buildings and water - besides reducing carbon dioxide emissions.

Energy is not only lost in transformation, but also when electricity is transported over long distances[7]. Transporting electricity should therefore be replaced by transporting the primary resources to much more

localised, decentralised power generation stations. The most efficient use of primary energy is micro-generators for individual buildings and CHP stations for more populated urban areas. Parliament could strengthen the support for building local CHP.

Electricity should not only be generated locally, but also finite fossil fuels should be replaced with non-fossil, carbon-free and renewable primary resources, such as biomass, solar, water (hydro) and wind.

Though the UK has the best available wind resource of the European Union (EU), it has failed miserably to invest in the technology. In 2005 the amount of installed wind power capacity per capita from a selection of countries in the EU was;

Denmark	0.58 megawatt,
Spain	0.24 megawatt,
Germany	0.22 megawatt,
UK	0.02 megawatt.[8]

The 'angst' that renewable resources are not reliable enough to deliver a steady basic amount of electricity, as so often reported in the English media – for example that the wind does not blow steadily everywhere, every time - can now be eased. Scientists from the Institute for Solar Energy Versorgungstechnik, Kassel University, Germany, have invented a steady supply network of renewables, balanced by water storage capacities in Scandinavia.

A 'feed-in-law', launched in 2000 by the members of the Deutsche Bundestag, Hans-Josef Fell, Die Gruenen, and Dr. Hermann Scheer, SPD, requires electricity companies in Germany to buy locally generated renewable electricity at guaranteed prices. In 2003 Germany alone could thus avoid 23 million tons of carbon dioxide emissions.

Energy for heating buildings and water

Heat losses in existing buildings are the overwhelming cause for high energy demand. Tackling such losses is essential in gaining more energy efficiency and thus reducing energy costs. So how can we improve efficiency?

Insulate, insulate, insulate... Existing buildings need an optimal insulation - external or cavity of external walls, roofs, cellars and at least double glazed windows and doors. Properly insulated buildings, with optimal heat envelopes, can have reduced heating costs of more than 80%. For example a 'passivhaus' designed building uses only 10% of the energy for a standard building (see boxout).

For heating, relatively low temperatures are best. The International Congress for the Use of Solar Energy stated in 1977 that the sun delivers 30,000 times more energy per year than the world needs. Relatively low temperatures can easily be gained by renewables, such as solar panels.

However, photovoltaic cells are more versatile because they produce electricity directly, which can then be used for any and every energy purpose, heating the building, hot water, cooking, cooling, running appliances and lighting.

In 2005 alone, one million solar panels were installed in Germany, covering more than 7 million square metres, generating about one billion kilowatt hours electricity, the biggest project spreading over 117 football fields[10]. And in 2007 a further 130,000 solar panels with 1,100 megawatt capacity were installed (see Figure 1 next page)[11].

The more the demand for solar rises, the cheaper the technology will become. It is worth noting that there is a boom in the share prices of solar companies.

Using solar energy comes with two bonuses – as does water and wind power:

- the primary resource for generating electricity is free, infinite, secure and independent from politically unstable global energy markets
- former passive energy consumers become active producers, and the sale of the surplus electricity brings in a welcome additional income.

Parliament should follow the example set by other

Passivhaus

'Passivhaus' characterises a building which is comfortably warm in summer and winter with minimal heating.

A 'passivhaus' designed building uses only 15kWh/m^2/yr, the equivilent of 1,5 ltrs oil/m^2/year, compared with 15 – 30 for existing buildings, 8 – 12 for new builds and 4 – 7 for low energy houses.

This astonishing low demand is gained by optimal insulation, for instance 25 – 40 cm in external walls, triple glazed windows, airtight design and and a heat recovery ventilation system.

The first 'passivhaus' was built in 1990 in Darmstadt, Germany. Today there are about 10,000 "Passivhaeuser" all over Europe.

"These energy standards were then extended to existing buildings," says Dr. Burkhard Schulze Darup, leading architect for energy restoration. "The first projects were carried out in Ludwigshafen and Nuernberg, supervised by scientists, reducing not only energy demand, but also carbon dioxide emissions by 90%. After these successful projects, energy restoration of existing buildings was launched in every German Bundesland, beginning with 20 projects in 2003/04."

Schulze Darup points out that political will played the most important role instigating energy reduction in existing buildings. "The support of Kreditanstalt fuer Wiederaufbau (KfW) in Frankfurt, Germany's Foerderbank/support bank, was absolutely essential."

KfW had, in 2007, a budget of €34.6 billion to support reducing "CO_2 emissions through energy rehabilitation in the housing sector and at the same time to strengthen the German domestic economy. Under the initiative, KfW Foerderbank committed loans totalling €15.8 billion in 2007."[9]

"We believe that in less than 10 years 'passivhaus' standard will be reached by every new building in Germany," said Schulze Darup.

Figure 1. Solar parks are rapidly becoming the norm in Germany, where a single solar tracking installation that follows the sun across the sky can be as large as 117 football fields. This one is at Gut Erlasee. Photo: Paul Langrock

countries and create a feed-in-law with a guarantee for electricity prices generated from renewables, although this has recently been ruled out in a narrow vote in the House of Commons. "The UK damages itself with its policy of not following the example of 18 other European countries, which already have a feed-in-law," says Hans-Josef Fell, "All scientific research carried out by the European Union showed that a feed-in-law is much more successful than the UK's renewables obligation certification model. However, all the discussions I had with Members of parliament and members of the UK government have lead to nothing. It is as if they do not want to recognise the facts." For example in the UK the costs for wind energy are nearly 50% higher than in Germany.

"I fear for the UK," added Fell, "the country makes itself unnecessarily dependent on future price rises for conventional resources and also unnecessarily dependent on old industries. Neither wind, photovoltaic or water power will have a chance to take off in the same way as in Germany. It is inexplicable, why the success story of the feed-in-law elsewhere is so strongly ignored in the UK."

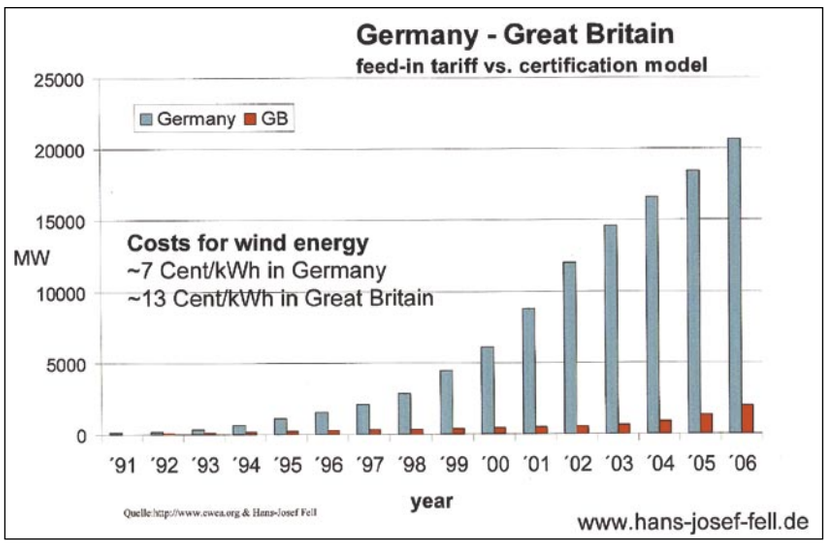

Figure 2. This shows what effect the increased installation of windpower has on costs, which proves that a feed-in-tarrif has much more effect on encouraging investment than does the renewables obligation certification (ROCs).

Energy for transport

A comparison of the energy used by common transport vehicles shows the following consumption levels:

Transport mode	Litres diesel equivalent/100 seat-kilometer
Bus	0.6
Train	0.9
Car - diesel	1.6
Car - petrol	1.8
Aeroplane[12]	4.2

As can be seen from the table, buses and trains are the most energy efficient carriers, so any new or re-developed urban centres should prioritise these over personal forms of transport. They could be run even more efficiently if they used electricity from renewables. Energy efficiency in transport could be dramatically increased if serious changes were implemented to the inter-city public transport network. For instance a network of 350km/h high-speed trains (passenger and freight) could cover long distances economically, which should then be connected to a fleet of reliable, frequently running local buses and delivery lorries. Countries, such as Switzerland, have led the way in proving that public investment in such systems are the most sustainable options.

Public transport should also be free or made available at extremely low prices, because it serves a basic human need. It should not be treated as an opportunity for profit orientated businesses. Using trains can be more time-efficient than using aeroplanes. The fuel savings (and therefore CO_2 savings) are also massive. Trains still also connect major town centres directly without wasting town to airport travel on increasingly congested roads[13].

New networks could be stimulated between railways and roads, small standardized cars could use high-speed trains for long distances, as suggested by Frederic Vester[14].

Conclusion

A clear understanding of the vital importance of efficient use of energy is essential – as is more information about what is going on in other countries who are tackling the same problems. Energy decisions are severely compromised by ignorance of such readily available knowledge (and probably by vested interests).

Furthermore major cultural changes are achievable when informed citizens change their habits: For example local car journeys can be replaced by walking or cycling, councils can be made to install networks of cycle paths,

making cycling safer; meat dominated diets can be replaced by increased vegetable consumption, preferably organically produced, (to produce 1kg meat, 7kg corn is needed). Organic production of vegetables and fruit has a much lower energy input than modern agriculture.

Unfortunately, I conclude with more questions than answers, but it is starting the thought process that is important. Figures about future energy demand need to be questioned not only in terms of quantity, but in terms of quality, i.e how we use energy today. Why is waste heat from generating electricity not used for heating buildings and water, but wastefully emitted into the atmosphere? Why are unlimited, free renewable resources not preferred for generating electricity, rather than fossil fuels, like coal? And why is the wider public not more informed and more involved with the debate over what changes are necessary to achieve a more efficient use of energy?

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Refs

1. Barry Commoner, The Closing Circle, 1971.

2. Steven Koonin in a lecture at John Hopkins University in Baltimore/USA in November 2007.

3. According to Steven Koonin.

4. www.bmwi.de

5. Soft brown coal is 43 – 45%, less efficient than hard black coal with 46 – 48%.

6. As reported by the German Bundesverband Kraft-Waerme-Kopplung/Federal Association for Power & Heat combination www.bkwk.de

7. 'Electric power transmission' in http://en.wikipedia.org it states that 'Transmission and distribution losses in the USA were estimated at 7.2% in 1995, and in the UK at 7.4% in 1998'.

8. Renewable energy sources in figures – national and international development, published by the Federal Ministry for the Environment, Nature and Conversation and Nuclear Safety of Germany, May 2006, p. 33.

9. www.kfw.de (English).

10. 1,500 so called 'solar movers', solar photovoltaic panels, which follow the sun for efficiency, costing more than 70 million euros, were installed in 2005 on the former research vineyard, Erlasee near Wuerzburg, south of Germany. They were produced by the Berlin based solar technology company Solon, and sold and maintained by S.A.G. Solarstrom, Freiburg/Germany.

11. 'Kieler Nachrichten', February 8, 2008.

12. IFEU-Institut, Heidelberg/Germany, 2005.

13. Philip Ball reports in 'Critical Mass', London 2004, p. 194, that 'the economic cost of all the wasted time (in traffic jams) is estimated at around £60 billion a year in Germany ...'

14. Prof. Dr. Frederic Vester (1925-2003) was a biochemist, expert on ecology and network thinking, founder of the Studiengruppe fuer Biologie und Umwelt GmbH, Muenchen, book author (for example, 'Unsere Welt – ein vernetztes System'/'Our world – a system of networks') and presenter of scientific TV programmes.