Energy Efficiency and Renewables   Dave Elliott

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The debate between exponents of 'supply side' and 'demand side' approaches to dealing with environmental problems like climate change can sometimes become polarised. At one extreme it is sometimes claimed that the potential for energy efficiency and demands reductions is so large that we hardly need to worry about the supply side. At the other extreme it is sometimes claimed that the potential for renewables is so large that we can forget about energy conservation. This paper looks at how these views stand up in the context of both short and long term sustainable energy policy and seeks a pragmatic strategic compromise.

Renewable Energy- no limits?

'In 50 or 100 years time, we will be able to practice energy profligacy again, thanks to renewables'. This view, expressed by Robert Webb of the XCO2 Group, in Green Futures (Webb 2004) neatly summarises the 'technophile' proposition that, although there are problems with the existing range of energy technologies, the development of new technology can allow economic growth to continue, presumably indefinitely. A less assertive version of this argument is that, if we have zero or low emission supplies from renewables, then consumption levels become less important.

It is true that renewable energy can help us transcend some of the environmental limits of fossil fuels, in that they do not contribute to climate change directly, but there are other limits and other impacts. The planets renewable resources are not indefinitely large and there are environmental impacts associated with exploiting them. Moreover, for the present, there are other ways of reducing contributions to climate change, most obviously, by investing in the more energy efficient use of fossil fuels. It is also usually argued that this is in fact the easiest, cheapest and quickest option. Longer term, even when and if we manage to shift over to using renewables, we will need to use their energy efficiently, to avoid resources limits and local impacts.

Let us look first at the limits to the renewable resource. Estimates vary, but in theory it has been estimated that, of the 90,000 TW of a solar input (measured in continuous power terms), we might hope to extract around 1000TW (Jackson 1992). That should be compared with the 13TW of generating capacity we have at present globally, using existing, mostly fossil, energy sources. On this basis, we could hope to expand energy use more than 70 fold before we came up against the renewable resource limits. In reality there are a range of geographic, land-use and technical constraints which would reduce this dramatically, quite apart from any economic constraints. Optimists argue that since, if we covered just a few percent of the world desert areas with PV cells, we could supply all our energy needs, the potential is very large- perhaps 20 times current energy use, or more. Pessimists are concerned about local land use impacts, energy conversion efficiency and economic viability and claim that renewables cannot substitute significantly for the conventional range of energy sources. Some see these constraints as requiring us to cut back dramatically on our use of energy (Trainer 1995).

Falling somewhere in between these extremes, Gustav Grob has estimated that we might only expect to be able to use renewables to double our use of energy globally (to very roughly around 200,000 TWh p.a. or about 720 exa joules) before we came up against what he calls the 'natural energy limit', although, as the technology improved, this limit could gradually rise (Grob1994). Even so, there remains an upper limit to how much we can expect to obtain from renewables.

Whatever this ultimate limit is, it will be some time before we reach it. The very radical global energy scenario for a non–fossil future proposed by Greenpeace in 1993 was based on the assumption that global energy demand would increase to just under 1000 EJ, or around 2.5 times the expected year 2000 level, by 2100, with renewables meeting just about all of it (Greenpeace 1993). Even with proper attention to energy efficiency, demand may well reach this level and perhaps more. But the reality is that, despite the growing concerns about climate change, we may not reach this level of substitution by renewables by 2100. So even if Grob's estimate was right, we would still not be near to the renewables limit.

However, well before we reach whatever the limit is, we are likely to come up against other limits. Indeed some of the environmental constraints are already becoming apparent at local level. Renewables may not have the same large global environmental impacts as fossil based technologies, but many of them have local land-use impacts, particularly in the case of wind farms, hydroelectric plants, tidal barrages plants and biomass plantations (Clarke 1995). Solar technology can mostly be on roof spaces and so have no additional land-use impact, and the offshore /marine renewables may have a different range of impacts e.g. on sea mammals. Some of the land based impacts are 'perceptual' and effect only human observers, but others have wider ecological implications e.g. in relation to biodiversity and soil quality in the case of biomass plantations (Clarke and Elliott 2001).

Issues like this may increasingly limit the practical deployment of some renewables, so that Grob's estimate of the total practical resource well may turn out to be nearer the truth than some of the more optimistic estimates. Even so, that still gives us plenty of leeway to expand energy use, as long as we shift to using renewables. One key strategic question for the present is, should we focus on deploying these new supply options or on reducing demand?

The limits to conservation

Now that the environmental costs of using fossil fuels is becoming apparent and access to reserves of cheap fuel is diminishing, energy efficiency is being taken more seriously. Given that fossil energy has been relatively cheap since industrialisation began, and attention to energy efficiency has therefore been minimal, there is a significant potential for quick, easy and cheap energy savings. However once all these cheap and easy options have been exhausted, it seems likely that energy efficiency will become a more expensive option.

There are also social limits. Energy efficiency measure also sometimes require behavioural changes on the part of consumers for successful operation, which may not always be welcome or adhered to. In addition, the uptake of energy saving measure is often low, especially in the domestic sector, in part since, given the contemporary career related requirement to move house regularly, the pay back times are often seen as too long. Certainly, so far, despite some quite ambitious energy saving campaigns, energy use in most countries has continued to increase- globally at around 2% p.a. - driven primarily by growing consumer demand.

It is sometimes argued by advocates of energy efficiency that concerted efforts to introduce more efficient technologies can nevertheless lead to spectacular savings (von Weizsacker,1994). Innovation can clearly lead to efficiency improvements and reduced costs in may areas. However, it is hard to see how conservation efforts, if just based on technical efficiency improvements, can lead to continued new savings, year by year, sufficiently to offset the continuing growth in demand. That would require the continual development and deployment of increasingly more efficient technologies. Moreover, while it may be possible to slow the rate of energy use to some extent by technical efficiency improvements, that will not necessarily lead to reductions in carbon dioxide emissions on the same scale. The so called 'rebound effect' may undermine at least some of the carbon savings, as consumers use the money saved from energy efficiency measures on new energy using goods and services (Herring 2000). Only if this money is spent in some way on renewable energy can the full carbon savings be secured.

The implications of the rebound effect are that efforts should be made to try to capture the money saved by energy efficiency to support the initially more expensive renewables. However, in the longer term, the balance may shift. For example, in some locations wind power is already commercially competitive with most conventional sources of energy and this trend seems likely to continue. It could be that, as energy efficiency measure become more expensive, renewables can increasingly subsidise them.

Either way, in order to obtain real carbon savings, a synergy between energy efficiency and renewables seems to be required. Not only can they can work together to reinforce each other technically, with for example, energy efficiency making it easier for renewables to meet the reduced demand, they also ensure that this leads to reduced emissions by providing financial cross subsidies.

Some practical examples of synergistic approaches

There are many examples of projects and programmes which combine renewables and energy efficiency as *technical* measures. In most, energy conservation usually dominates, since, quite apart from the current relatively high cost of renewables, it is seen as counterproductive to install renewables unless attention has first been paid to reducing energy demand via proper design of the building and the adoption of efficient energy using equipment.

Certainly, in terms of low or zero emission housing projects, like the BedZed 'zero energy development' in South London, and the Hockerton Housing Project in Nottinghamshire, energy efficiency is usually to first and primary element. In addition to good insulation and the use of energy efficient equipment, these projects have adopted radical design features to reduce energy, including in the Hockerton case, earth sheltering. Some energy use-related lifestyle changes have also been, as it were, built in to the concept – for example a car sharing pool in the case of BedZed. However, the schemes also make use of renewables, including passive solar heating and a small wind turbine at Hockerton and at BedZed an array of solar photovoltaic modules and a wood fired Combined Heat and Power unit (Pearson 2000, EST 2003).

In theory it is possible to build houses with almost zero domestic energy needs other than for basic living requirements (cooking, lighting etc), and some near zero energy houses have been built in the UK and elsewhere (Taylor et al 1996). However, it is usually not worth trying to obtain 100% energy independence, given the availability of power from renewable energy sources, either by importing it via the national or local grid from renewable energy generators (e.g wind farms) at other locations, or by generating it in-house (e. g from roof top solar PVarrays).

In some cases, renewable energy systems are, as it were, simply 'strapped on' to low energy houses, almost as an afterthought. However, the new concept of 'Building-Integrated Renewables' is leading to more coherent designs, like the pioneering 'Integer' house developed at the Building Research Establishment which combines solar and conservation features (BRE 1998). As renewable energy technologies become cheaper, we can expect more radical designs to emerge, with, for example PV solar becoming widely used, along possibly with integral micro-wind generators (Elliott 2000, Taylor 1998).

In the meantime, in terms of synergistic approaches to domestic energy use, the emphasis is on using the savings from conservation to support the development of renewables. Perhaps the most direct example of a *financially* synergistic approach in the domestic sector is the attempt by some energy supply companies in the UK to link their green power tariff schemes to energy efficiency initiatives. Some companies have offered a free Compact Flourescent Lamp to consumers who sign up to green power schemes, so as to offset the extra cost of the renewable energy tariff.

A more ambitious approach would be link sales of 'white goods' (fridges, washing machines etc) to the purchase of green power via some form of discount on the green power tariff, or vice versa, via a discount on the goods if bought in conjunction with a green tariff. Some energy supply companies who offer electrical equipment to their consumers have explored this idea. Speculatively, one might even imagine electric vehicles being sold in this way- with the their 'fuel' being provided from green tariff schemes.

As this point should remind us, renewable energy is obviously important for more than just providing carbon-free power to homes- it must gradually take over the hopefully reduced or at least stabilised energy demand in all sectors. That will of course lead to extra indirect costs to the consumers of goods and services generally, not just direct energy services. For the moment however, the UK government's main concern seems to be to keep basic fuel prices low, and it seems to have recognised that energy conservation programmes can be used to help reduce the impact of initially high cost of power from renewables on consumers. At the launch of the second expanded round of the DTI's offshore wind programme in July 2003, Patricia Hewitt told the BBC: *"There will be a cost to renewable energy. Renewable energy is more expensive than gas-fired because gas prices are very low at the moment"*" but she added that *"as we sort out the energy efficiency side, we can make sure the bills to consumers don't go up because people will need less electricity to get the same amount of warmth and power".*

The 'Energy Services' approach - the Woking experiment

What most consumers want is heating, light and power, rather than electricity or gas, and some local authorities and some energy companies, have decided that it might be more effective, and perhaps more economic, for them to adopt an 'energy services' concept, which could also allow for a more comprehensive and effective approach to meeting energy needs in environmental terms. Under an energy service contract, rather than supplying specific energy sources, consumes are offered energy services, which can include support for improved energy efficiency.

One of the pioneers of this approach in the UK has been Woking Borough Council, which has also taken it one stage further and been able, in effect, to recycle funds saved via conservation programmes to support some innovative supply-side projects (EST 2001). In addition to extensive conventional energy saving measures in buildings, the Councils ambitious energy programme, which began in the early 1990s, has involved investment in small gas fired Combined Heat and Power plants, feeding heat and power both to council properties (including sheltered housing and civic offices) and to commercial properties (including a hotel complex).

The heat is supplied to consumers via heating networks and it was decided that the electricity would also be supplied direct on a 'private wire' basis. So consumers are not linked to the national grid, although there are links to the grid from the power plants for emergency back up. The result of this 'opting out of the grid' approach was that, with national grid and energy supply company overhead costs avoided, power could be supplied at around 1p per kWh less than that provided by the National Grid. Given the efficiency of the gas fired mini CHP units, located near to their loads, the heating was also cheaper than it would otherwise have been.

The Councils web site (Woking Borough Council 2004)notes that to ensure that its investment is paid back, 'electricity and heat are sold at a higher value to residents than the price which could have been obtained by exporting it to the local regional electricity company. However, residents benefit because the price they have to pay is still lower than the normal domestic rate. This means that they make substantial savings on their energy bills with up to- £120 each year off fuel bills for a one bedroom flat. At the same time, the CHP energy efficient technology is good news for the environment saving an estimated 500 tonnes of CO_2 from being sent into the atmosphere each year.' Not surprisingly it reports that there has been 100% take up by residents in the housing where the scheme has been introduced.

The programme has been underpinned by the creation of a recyclable fund, fed by financial savings achieved by energy efficiency projects. The initial £250,000 allocated to the fund, together with grant aid from various government schemes, has allowed the programme to be extended to include the installation on some of its properties (including 85 sheltered houses/flats) of around 500kW of photovoltaic solar modules, making Woking the largest single user of PV in the UK. It has also installed the UK's first commercial-scale fuel cell, a 200kW gas fired unit which supplies power and heat for the Council's Swimming Pool. The heat is used to run the Pool's air conditioning, cooling and dehumidification requirements, via a novel absorption cooling system. There is a similar air conditioning system in the council offices, with combined heat and power and chillers, and this system has also been extended to a newly built hotel.

The Council have pushed ahead their ambitious programme, which so far has resulted in £2.8m in investment, by setting up a joint venture energy services company, Thameswey Energy Limited, which, according to the Councils web site, has as it aim to 'design, build, finance and operate small scale CHP stations, fuel cells and other sustainable and renewable energy systems to provide energy services by private wire and distributed heating and cooling networks to institutional, commercial and residential customers'.

Overall, by 2002/3 the system had produced a 46 per cent energy reduction in energy consumption and a 75 per cent saving on carbon emissions, well on the way towards the councils goal of being 'climate neutral' (Jones 2003).

Conclusions

In a report on carbon saving options, the Carbon Trust concluded that 'as energy efficiency measures to reduce carbon emissions today are cheaper than renewable energy, Government could pursue its environmental goal at lowest cost by focusing on energy efficiency and 'importing' renewable technologies once their cost has been driven down by development at scale elsewhere.' (Carbon Trust 2003)

While this may be true in the short term, as has been indicated, there are limits to what conservation can achieve both in the short and long term, and it would seem unwise to delay the development of renewables, or rely on others to develop them, simply on the basis of short term economic assessments. We are going to need all the renewables we can reasonably muster, as well as all the energy savings that can be effectively achieved, if we are to reduce carbon emissions by 60% by 2050, as proposed by the government.

What seems to be clear form the above analysis is that renewables and conservation can mutually reinforce each other. It is not a matter of 'either /or', but 'both'. Whether this synergy will be sufficient to cut carbon emissions on the scale desired is less clear. That may also require limits to energy demand, implying significant lifestyle changes. Some critics of consumer society would no doubt welcome that. Certainly, if we wish to limit the costs and impacts of climate change, in the longer term, unless we come up with a new non-fossil energy source, a shift to a more sustainable approach to consumption would seem unavoidable (Elliott 2003).

[Words 3150]

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