

Climate Change and the Mis-Marketing of Renewable Energy

In only the very loosest sense can we say that there is a global climate change policy. We have a general set of aims, and the details are left to national governments for implementation. This is both laudable and dangerous, for though self-determination has obvious merits, national governments are prone to misconceptions of their proper role. This has certainly happened in Europe, and in this paper I shall comment on the situation in the UK, a country which aspires to leadership on these issues, as a type-specimen of flawed endeavour.

Indeed, failure to grasp the numerical realities about the UK's energy needs, its role in tackling climate change, and the limitations of renewable energy in general and wind energy in particular run like barely visible but devastating fractures throughout the unquestionably well-intentioned policies issuing from the landmark Energy White Paper of 2003. Facing the music on all these points is a pre-requisite to rational engagement with the issue, and to do that we have to turn to the East.

In 2003 China's demand for electricity was five to six times that of the United Kingdom. By 2020 the Chinese government expects demand to have grown six-fold, making it three times greater than that of the United States, four times the needs of the whole of western Europe, and nearly thirty times greater than UK demand.

These figures are so breath-taking that it is worth looking at them in concrete form. In 2003 China generated 1,800 TWh from a portfolio containing approximately 356 GW of power plant.

The UK generates roughly 390 TWh from a portfolio of approximately 78 GW. Western Europe generates approximately 3,000 TWh from a portfolio of about 670 GW. The United States requires 3,900 TWh, and has power stations totalling just over 1,000 GW.

Chinese electricity demand for 2020 is forecast to be approximately 11,000 TWh, and the generation portfolio needed to provide this will have to be around 2,400 GW, which is equivalent to 2,000 power stations of similar size to the UK's latest and most advanced nuclear reactor, Sizewell B.

Some of this electrical growth in China will be supplied by hydro, and much by nuclear power; but a very large part will be derived from coal, which is wholly unsurprising since China has large reserves of fossil fuels under sovereign control, and is at present mining over 40% of the world's coal.

Still more thought-provoking than this astronomical expansion of Chinese electricity is the prospect of corresponding growth in the country's overall energy consumption.

Electricity is generally reckoned to be approximately 1/3 of a state's total energy demand. Perhaps modern China will prove to be more electrically intensive than other countries, but even if overall consumption is only, say, double the electrical sector, this is still an extremely large quantity of energy.

These are simple facts, and have been well-known for some time to all specialists in the field, and yet the United Kingdom's current energy and climate change policies, particularly the *Energy White Paper* of 2003, appear to ignore them. Correspondingly, little or no attempt has been made by government agencies or by the Green NGOs to ensure that our national debate engages with the all-important realities that define the limits of what the UK should attempt, and without adequate recognition of which we will achieve nothing and may even disgrace ourselves.

But the ground is moving. The Government's Energy Review, *The Energy Challenge*, which in spite of its stale title has to some degree reventilated the issues. Growth in China and India is mentioned, not with sufficient force or detail admittedly, but at least we now have some reason for feeling that the relevant ministers will not turn a deaf ear to analyses and recommendations that are grounded in the overwhelmingly important international context.

Perhaps the most powerful indication that a douche of cool reason is beginning to break over the government, and over Whitehall, is found in the simple remark that "UK emissions are only about 2% of total global emissions", and the conclusion that "our own actions will have no impact on climate change unless they are part of a wider [...] effort". Quite so. The UK emits roughly 550 million tonnes of CO₂ per year, and the world around 24,000 million tonnes. Even without the prospect of Chinese growth, a magically Zero-carbon UK would have no significant effect at all on rates of global climate change.

In a recent letter to Stop Climate Chaos, an umbrella group representing a wide range of environmental lobby groups, the Prime Minister, Mr Blair, has himself written that:

*Even the most extreme and unrealistic action taken in the UK will have only a tiny impact on global climate change. Even more crucially, it would do nothing to protect us from its worst effects. I am afraid that, in this case, being virtuous alone will not bring much reward.*¹

This is a credible and sober view of the scope available to the United Kingdom, and represents a real shift in policy.

However, the Prime Minister leaves pending the awkward question of how to persuade the developing world to keep us company. But of course, he hardly needs to point it out

¹ The Rt Hon Tony Blair, MP, to Stop Climate Chaos, 28 Feb. 2006. Available from <http://www.number10.gov.uk/output/Page9107.asp>.

since there is only one way. If the UK is to contribute at all to global efforts to tackle climate change it must do so by providing an *economically compelling example* of secure, reliable, low carbon energy provision. The developing world will, understandably, respond to nothing else.

Bearing this principle in mind it is obvious that the UK's most environmentally significant opportunities, both because of scale and the rapidity with which they can be deployed, are in Carbon Capture and Sequestration from fossil plant, which has real potential for China, and in which we could become, with all appropriate modesty, quietly and profitably involved. The Chancellor has even used the budget as a vehicle to announce an investigation into economic obstacles to low-carbon coal generation, and though the Energy Review is weak on this matter, the UK in fact has little scope for preventing over-exposure to gas in the shorter and medium term except by the adoption of high efficiency coal plant with emissions capture and sequestration, preferably for Enhanced Oil Recovery in the North Sea.

Some promising signs aside, the UK's scope for effective action is still widely misunderstood, and the general public, and many politicians, cling to comforting delusions of grandeur of both the moral and the post-imperial kind. There is too much careless talk of the UK "doing its bit", with the implication that every little helps, regardless of its cost or its applicability in other parts of the world. Unfortunately, and I regret to say it, renewable energy plays a significant part of these fantasies.

However, the truth is becoming better known, and, though we cannot expect a sudden outbreak of sanity, voices of reason are getting a hearing, partly because of international movement. It is too soon to say what will come of the Asia-Pacific Partnership on Clean Development and Climate, which brings together Australia, China, India, Japan, South Korea and the United States in seeking advanced technological solutions to providing low polluting and economical energy. The green lobby, in a bizarre act of environmental irresponsibility, seems to wish it ill. In fact we should be praying for its success. The partnership is vastly more promising and practical in its potential than any Kyoto Treaty style attempts to legislate for arbitrary reductions. Indeed, at present, European sincerity in calling for action on climate change is questionable, since our policies produce such feeble results, and, tinged as they are with the pie in the sky of "contraction and convergence", do so little to induce emulation.

Nowhere is this point clearer than in regard to renewable energy. Successful attainment of the United Kingdom's 2010 renewables target is dependent on the action of a complex subsidy system, the Renewables Obligation, transferring somewhere between 700 million and £1 billion per year from consumers to renewable energy generators. According to the UK government's Department of Trade and Industry (DTI) this vast expenditure will save a mere 9 million tonnes of CO₂, which is 1.7% of the UK's

emissions and 0.0004 of global emissions. This is very bad value for money, will impress no one internationally, and offers little chance of replication in other locations.

Nevertheless, the Renewables Obligation might have made some limited sense if the technologies brought forward were likely to be of real worth, but, in common with other European support mechanisms, a lack of discriminatory “banding” in the system has resulted in a stampede for the least capital intensive ticket to the gravy train. In the UK this was initially land-fill gas, but there are few further opportunities, and the current focus is on wind power, and onshore windpower at that. The DTI expects three-quarters of the 2010 target to be supplied by wind turbines. Superior alternatives, biomass, tidal energy, are being largely neglected.

Unfortunately, due to the low intrinsic merits of wind power, the subsidy support is barely deserved. Due to stochastic variability even very large quantities of wind generation provide no significant level of “firm” power (i.e. energy when it is needed and as it is needed). E.ON Netz in Germany, a company which controls a grid area the size of the UK and serves 20 million customers, revealed last year that according to their own extensive and unmatched experience some 48,000 MW of wind (over 20,000 wind turbines of over 300ft) would only obviate the need for 2,000 MW of conventional generation, or about two medium sized power stations. To appreciate just how disappointing that is, we need only remind ourselves that even the far from gargantuan UK needs a portfolio of some 78,000 MW of plant. Those who believe that wind power can obviate the need to renew our conventional stations are simply ignorant of the facts. In the report on its Energy Review, *The Energy Challenge*, the UK government itself now concedes that wind will not offer any significant degree of firm capacity.

These are promising signs of illumination, and actually bode well for those technologies which have more to offer. Nevertheless, the general prospects for renewable electricity are still greatly over-rated, to the likely detriment of the renewable sector. Visions of a wholly or predominantly renewable electricity system are commonplace, and they underpin in a vague, and not wholly rational sense, much of the political will behind current policy and subsidy support mechanisms.

A single representative example will suffice, drawn from the UK’s Sustainable Development Commission (SDC), a government funded body led by Sir Jonathon Porritt. Drawing on two reports, one from the Tyndall Centre and another by the Inter-departmental Analysts Group (IAG),² the SDC writes:

The data on UK renewable resources suggests that the total practicable resource is at least 334 TWh/year, or 87% of current electricity production.

² Interdepartmental Analysts Group (IAG), *Options for reducing carbon emissions in the UK* (2002).

Introducing price restrictions³ reduces this somewhat, but at 258 TWh/year (67%), it is still considerable. [...] Significant technological progress in renewables and infrastructure could push the practicable resource further towards the theoretical resource estimates. It is, therefore, reasonable to state that it is theoretically possible to supply all of the UK's electricity from renewable sources in the long-term, especially when combined with energy efficiency. The main constraint is likely to be economic rather than technical.⁴

With this in view the Commission concludes that nuclear is not a necessary option, and that conventional fossil plant is only needed as a stopgap or interim solution in the shorter or medium term, up to, say, 2050.

However, those of a sceptical turn of mind might still wonder whether this argument is compatible with the technical requirements of an electrical power system. For example, we might ask if the envisaged system can adequately satisfy the demand for instantaneous power vital for any modern digital economy?

In addressing this matter I will draw heavily on an argument presented by Professor Michael Laughton, Emeritus Professor of Electrical Engineering at the University of London, Visiting Professor at Imperial College, and an advisor to the Renewable Energy Foundation. Professor Laughton's outline argument was presented to the Department of Trade and Industry as part of the Foundation's contribution to the Energy Review, which can be downloaded from our website, www.ref.org.uk.

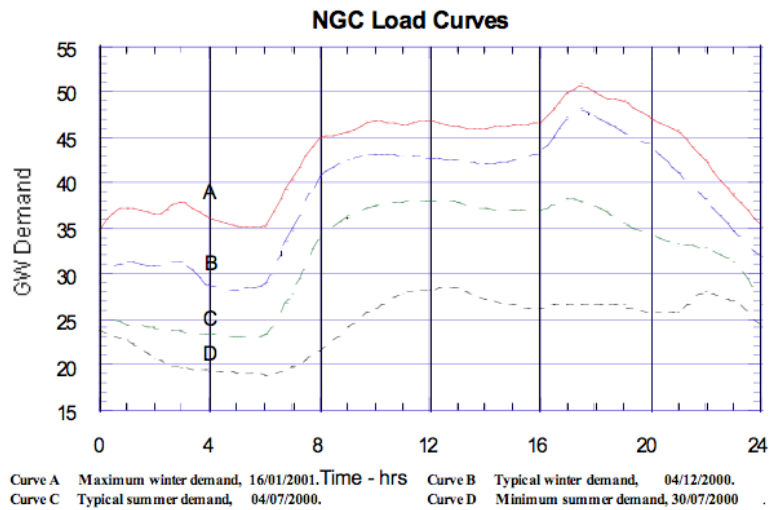
Let us begin by reminding ourselves of the typical and extreme daily cycling of power demand on the UK electricity grid supply system for days in both winter and summer.⁵

³ Up to 7p/kWh.

⁴ Sustainable Development Commission, *The role of nuclear power in a low carbon economy Paper 2: Reducing CO₂ emissions – nuclear and the alternatives* (March 2006), 16.

⁵ The figure is simply to illustrate typical variations over 24 hours in the system power demand. The 2004 peak demand England, Wales, Scotland and N Ireland was 61 GW (DUKES 2005) with an annual average demand of approximately 40.4 GW.

UK Daily Power Demand



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Since electrical energy cannot at present be stored economically on the industrial scale generation must match demand at all times. The variability of a particular system is a key point of interest, and a rough index can be obtained from the ratio of peak to average demand, sometimes referred to as its “load factor”. A “load factor”, in this sense, of 90% would indicate a system with little variation, while one of 40% would indicate a very variable system. In 2004 the UK “load factor” was 66.3% (i.e. average demand / peak demand = 0.663) indicating considerable but not extreme variation.

In grasping how renewable energy generators would access such a variable dynamic system demand, we must refer to capacity factor, namely the energy output actually obtained from a system over a year as a fraction of the theoretical output which would result if the plant were operated at 100% capacity. Of course, the input of many renewable generators, for example wind, wave or tide, usually fluctuates, and thus, the generator cannot operate at 100% capacity for many hours in a year. Capacity factors are thus a vital indicator of economic viability, are used by investors to compute the likely income and hence the likely Internal Rate of Return arising from a particular generation project.

However, and this is crucial, such calculations, and I have seen many investment prospectuses, invariably assume that a renewable project will be able to market all the power it produces over its lifetime, and will not be constrained by fluctuations in the demand curve leading to the coincidence of high generation and periods of low demand. It is at least curious that investors do not more frequently ask whether this is a reasonable assumption.

The Sustainable Development Commission bases its statement quoted above on claims made by The Tyndall Centre in a study which suggests that the practicable energy outputs to be expected from various renewable resources in the UK amount to some 334 TWh. Taking the Tyndall Centre work as a starting point Michael Laughton has calculated the installed plant capacities required to generate this energy by applying typical, perhaps somewhat optimistic, load factors:

Renewable Resource	Expected Practicable Electrical Energy Generated TWh/year	Estimated or Typical Load Factors: %	Implied Generation Capacity: GW
Municipal Solid Waste	13.5	0.66	2.3
Hydro	4.9	0.35	1.6
Wind onshore	58	0.3	22.1
Wind offshore	100	0.35	32.6
Energy Crops	17	0.66	2.9
Forestry & Agricultural Wastes	14	0.66	2.4
Wave - shoreline	0.4	0.35	17.1
- near shore	2		
- offshore	50		
Tidal-stream	36	0.35	11.6 (est. 8.2 peak)
Tidal-barrage	50	0.35	16.1 (est. 11.3 peak)
Photo-voltaic	7.2	0.35	2.3
Totals	334		111

Renewable Resource Energy Generation Potential and Generating Capacity Requirements

Thus we see that to generate 334 TWh of renewable electricity would require at least 111 GW of generating capacity. We could debate the details in this chart, but the fundamental point is robust; to generate in excess of 300 TWh of electrical energy a very large portfolio of renewable plant is needed. To put this in perspective, the current UK portfolio is approximately 78 GW.

Crucially, however, the SDC believes that this 334 TWh of practicable renewable resource generation would be 87% of the annual electrical energy needed (they assume significant energy saving to hold back demand growth). But with a system load factor of 66.3%, as it is at present, the system load demand cycle would have an annual peak demand of only 57.5 GW with an average demand of 38.1 GW.

The question which then arises is whether 111 GW of renewable plant can access the market without being constrained in its output by lack of demand.

As a matter of logic, Professor Laughton has argued, it is quite apparent that a demand bottleneck allowing only a maximum delivery of 57.5 GW and an average delivery of 38.1 GW will offer 111 GW of renewable power plant only a **low probability of unconstrained access to the electricity market.**

However, if access to the market is constrained,⁶ then the renewable generators will not be able to operate for all hours during which their input is available, and thus it must be concluded that the practicable renewable resource generation will be considerably smaller than the anticipated 334 TWh, necessitating an enlarged renewable portfolio operating at still lower capacity factors.

The economic implications for investors are an interesting topic of speculation, and exact calculation of what could be expected of renewables with such a system load factor depends on a better understanding of returns to investors and costs to consumers. However, **it is immediately clear that the SDC's assumption that all of the UK's electricity generation portfolio in the long-term future could in theory be supplied from renewable sources is not well grounded, and is almost certainly false.**

Contrary to the Commission's initial view, the main constraint on renewable energy is technical rather than economic. Power demand, not the quantity of the energy resource available, is the dominating scientific constraint.

Biomass, tidal, hydro, solar, even wind, have much to offer, and if correctly managed will make a useful contribution to our energy needs, but as renewables can only supply an as yet undetermined fraction of the demand for electrical energy the need for other large, low carbon generation sources remains, and this point should not be withheld from politicians or the public.

Moreover, Professor Laughton's analysis raises various issues that have not been sufficiently appreciated by policy analysts or investors. There are technical features inherent in the character of the electricity supply industry that make it highly unlikely that a portfolio wholly or predominantly composed of renewable technologies, many of which are stochastically variable or intermittent, could operate at the maximum capacity factor theoretically attainable from the available renewable energy resource. In other words, some degree of market constraint is likely to apply to renewable generators, making it very unlikely that they can supply all or even a major part of national electricity. This is of major significance for two reasons:

- The actual contribution of renewable sources to national electricity needs is unlikely to be as large as projected.
- Investors are being misled into making long term income stream projections on a false assumption with regard to achievable capacity factor.

We may draw a number of conclusions from this, the first and foremost of which is that a lack of realism in regard to renewable energy potentials will damage both the UK and the

⁶ As currently happens in Germany with excess wind generation. See E.ON Netz, Wind Report (2005), 18-19.

long term future of the renewable sector. It is vitally important that government and investors are aware of the high probability of inherent limitations to renewable contributions. Admittedly there is a currently available role for offshore wind buffered by flow batteries, but while advances in the engineering and economics of storage options may to some degree alleviate the limitations outlined by Michael Laughton it would be very unwise to bank on such improvements delivering gains of strategic significance in the medium term.

The Renewable Energy Foundation is therefore recommending that the UK government does not regard the current energy debate as concerned with the provision of an interim or bridging solution, which need only prepare for a renewable future.

Instead, our current solution must be a low risk strategy which is robust in the long term and can carry the UK and its people through even the more pessimistic conceivable scenarios.

Renewable Energy will have a role in this strategy, but it will be necessarily modest. As a sector, renewables have for some years enjoyed the status of sacred cow. In the light of emerging data they should now be re-analysed as a collection of standard farmyard animals, each of which must be asked to pull its weight and demonstrate worth in the market. For the UK the first step will be to revise the subsidy system to offer more to those technologies which themselves have more to offer and can work as a part of a team. Biomass is fully dispatchable, and tidal, while intermittent, is wholly predictable. These desirable characteristics should be recognised and rewarded accordingly. And that message does seem to be getting through. To the astonishment of many the DTI has conceded in the Energy Review that the RO will have to be banded to deliver value for money, and indeed the Scottish Executive is now in the process of banding its Renewables Obligation Scotland.⁷ The UK Energy Minister himself has conceded in Parliament that the RO was, in his words, a “blunt instrument” and was suppressing other technologies.⁸ Such re-orientations can’t come soon enough.

From the perspective of the subsidising consumer, the planet, and the long term future of clean energy, such realistically motivated changes are urgently needed. By over-lobbying for its cause, the renewables industry has contributed in no small part to exaggerated, irrational, and counterproductive expectations throughout governments, the green lobbies, the global public, and, not least, the world of finance. There has been

⁷ For the consultation text see: <http://www.scotland.gov.uk/Publications/2006/05/10153327/0>

⁸ See http://www.publications.parliament.uk/pa/cm200506/cmhansrd/cm060504/debtext/60504-02.htm#60504-02_wqn2 online Hansard:

a consequent and grievous misallocation of resources, and irreversible damage has already been done. A backlash is almost inevitable. Indeed, the mis-selling of wind energy should be taught in business schools as a case-study showing that “Hype Destroys Value”. But in setting matters straight we will, in any case, have to be as hard-hearted and practical as the greens have been soft-headed and irresponsible. After years of being spoiled with sentimental affection, renewable energy badly needs a dose of tough love.

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