

Energy and Power - Dispelling the Fog

This note has been produced by SONE in consultation with engineers and scientists to try to clear up some of the confusion that surrounds energy developments. We commend it especially to the so-called Green movement and to politicians who seem to dance to their tune.

We do so because SONE is an organisation seriously committed to improving the environment and combating global warming in an effective and economical way. Most remedies espoused by the professional “Greens” are inadequate or impractical.

Confusion No.1 – Energy and Power

People tend to use the terms energy and electricity as if they were the same thing, though they clearly know that electrical power is only one form of energy. They are in good company because an EU Ministerial Council in 2007, attended by Tony Blair, committed itself to producing 20 per cent of Europe's energy by 2020 from renewable sources of energy – that is, those that constantly renew themselves in nature.

The Government's former Chief Scientist, Professor Sir David King, doubts whether they knew what they doing. He thinks they meant electricity not energy. This seems very likely for a variety of reasons.

First, coal, oil, gas, uranium, wind, tides, waves and the sun's heat are all sources of energy but to deliver it they have to be harnessed, converted or processed. What they deliver as a result is power.

But there is another element to the equation that drives, heats and lights the nation. That is time. Systems to harness, convert or process sources of energy into useful power such as power stations or wind turbines are rated by their production capacity. But that does not mean that all of them are capable of delivering their rated capacity all the time. Indeed, wind turbines are incapable of doing so; the delivery of their power is unpredictable because of wide variations in wind speed.

So, we have to bear in mind two things: the capacity of energy conversion installations to produce power (kilowatts) and the total electrical energy they deliver over time (kilowatt hours). It is very much open to doubt whether European Ministers had these considerations in mind in committing themselves to produce 20 per cent of Europe's energy from renewables by 2020.

The impossible dream

The two elements to the equation would have told them that the 2020 environmental aim would require them to generate at least 40 per cent of their electricity with renewables. There are five reasons why they have espoused an impossible dream:

1. To achieve 20 per cent of energy from renewables, they will have to offset in the form of electricity the energy that will continue to have to be provided by fossil fuels for transport, heating etc.
2. Even though uranium is the cleanest fuel, even cleaner than wind power, nuclear power has so far not been regarded as a renewable source, presumably since it relies upon a metal – uranium – which, while inevitably finite, is about as prevalent in the Earth's crust as tin.
3. The current contribution to Britain's electricity (not energy) supplies by renewables is a mere five per cent – 1.3 per cent from wind, 1.2 per cent from fully developed hydro-power and the rest from landfill gas (methane) and biomass (wood).

4. The only renewable source of energy capable of generating large amounts of electricity in Britain is wind. We have no tidal barrage and probably could not build one inside 10 years. Wave power is still at the experimental stage and is likely to remain there for a long time. Britain is not over-endowed with sunshine and in any case solar power derived from it ceases at night.

It is true that biomass (wood) and methane from tips could, if we had enough of them, provide energy to generate electricity continuously. But both are likely to remain marginal because of limitations in supply.

Biomass requires a vast amount of land to grow the wood necessary to keep one large power station going – in fact, a forest the size of North Wales. Britain simply does not have that amount of land if it is also to grow food.

5. There is no means of storing electricity to the extent required by a developed nation of 60m people.

Yet, in spite of all this, Britain has saddled itself under the 20/20 agreement with producing eight times the current amount of electricity delivered by renewables apparently because policymakers either did not know the difference between energy and power or the limitations of renewables, or probably both.

Confusion No. 2 – Can we use any amount of wind power?

It is probably true to say that nobody knows how much wind power the British National Grid can take. But two things are clear: the amount is inevitably limited by the cycle of demand and, given the inability to store electricity in bulk, the need minute by minute to balance supply and demand throughout the day and night.

This being so, it is an even greater indictment of European policymaking to have committed the EU to providing 20 per cent of its energy from renewable sources by 2020.

Everybody is familiar with peak demand, if not when it occurs. There is a well established pattern in which demand rises from breakfast to reach an early evening peak, which is particularly well marked on freezing winter evenings, before tailing off during the night. But there is always a basic demand for 25,000MW to 35,000MW.

Another well established pattern is the difference between summer and winter demand. At slack times, summer demand is invariably about 10,000MW – or the equivalent of the output of 10 average conventional power stations – below winter demand and at peak periods about 25,000MW below the winter peak.

So how does this get in the way of taking as much clean wind power as we can generate? The answer is simple if you accept, as you must, that bulk electricity cannot be stored and that wind power is unpredictable and can vary wildly in the course of any 24 hours as the weather changes.

No wind, no wind power. No wind power either in a 55mph-plus gale when turbines have to be shut down for safety. Worst of all, no wind power in freezing cold weather in winter produced by an anti-cyclone with still conditions.

First, you cannot rely on wind to make sure that the basic minimum demand is always met. That requires entirely predictable and reliable fossil-fuelled or nuclear plant. So if the role of wind has, in practice, to be topping up supply over and above basic demand its opportunity varies between 10,000 and 25,000MW. That means, that it cannot have unconstrained access to the National Grid.

The Government's plans for vastly increasing wind power by adding 10,000 or so wind turbines to the existing 2,500 (3,360MW capacity) on- and offshore to provide, say, 30,000MW of wind capacity seems to take no account of these limitations.

Confusion No. 3 – What is possible?

Nor do Government plans for a vast wind power industry take any account of the feasibility of placing turbines on- and offshore.

So far, virtually every attempt to introduce so-called wind "farms" has met with objections from people living in the area, mainly on aesthetic grounds but also because they fear the impact on, for example, property values and tourism. It has taken 18 years to build the current wind capacity of 3,360MW, mostly onshore. Now the Government has announced an additional 25,000MW or so of offshore capacity from 7,000 turbines.

In a recent report, Professor Ian Fells, Emeritus Professor of Energy Conversion at the University of Newcastle upon Tyne, said this would require 10 turbines to be installed every available working day (restricted to 60 days per year in North Sea conditions) from now until 2020. This is 10 times the best installation rate yet achieved anywhere for offshore wind turbines. Currently, he says, there is only one heavy-lifting barge (cost £75m) capable of planting these huge machines in the seabed.

Perhaps the greatest confusion in this part of the energy scene is what is possible. You might reasonably have thought that governments would find out what is possible before they unveiled their objectives.

Confusion No. 4 – What are we talking about?

The whole argument about renewables is also distorted by utter confusion in the highest circles about what is being discussed: capacity or supply.

It doesn't matter whether you have 10,000MW or 100,000MW worth of turbines, as defined by their capacity to produce electricity, you will get not a drop of juice out of them if the wind does not blow. This is what makes the claim that a wind development will provide enough power to light a town or city of a certain size utterly ridiculous. The only value of wind capacity figures is to provide the basis for a rough calculation as to how much electrical power you could get out of them.

The National Grid's view seems to be that the largely discreet British system – that is with only minimal access to the Continental grid on which to dump excess supply at minimal prices – can take 30,000MW of wind capacity. Some Government officials have even gone to 35,000MW.

Seeing these figures bandied about, many people may be led to believe that wind could provide half our peak demand of 60,000MW. The truth is somewhat different.

The reason for this is that because of its unpredictable output the average wind turbine produces over the year only around 25 per cent of its rated capacity. This percentage is known as the load factor and the average across the country is published every year.

So when people talk loosely about the National Grid being able to accommodate 30,000MW of wind power, they actually mean, though whether they know it or not is another matter, 7,500MW average generation. That is at best equivalent to 12 per cent of maximum demand, though you could never rely on it to meet that maximum demand.

Similarly in Denmark, where wind popularly provides 20 per cent of Denmark's power, the actual amount delivered to the grid is put at just 8 per cent.

There is a lot of smoke and mirrors involved in the renewables game and the only reliable guide to seeing through it all is to **divide any wind turbine's capacity figure by 3 or 4 to establish the likely average output.**

In other words, you can count on 7,500MW of nuclear capacity to deliver as much electricity as 30,000MW of wind capacity. Nuclear – or indeed coal, oil and gas – will deliver that amount predictably, without varying minute by minute. Moreover, the wind power produced would not be saleable if it were not subsidised by the consumer and if the subsidy system did not compel its use when delivered.

Confusion No. 5 – Can there be priority for renewables?

This is not an academic question. The draft EU directive setting out the 20/20 requirement states:

“When dispatching electricity from generating installations, transmission system operators shall give priority to generating installations using renewable energy sources insofar as the security of the national electricity system permits”.

In other words, you have to have a pretty good reason for not accepting wind power – or else.

But what does this imply? Given the unpredictability of wind power and the wild swings in supply because of the vagaries of the weather, conventional plant is going to be metaphorically shaken until the rivets rattle and operators of the National Grid are going to have their ingenuity tested, perhaps to destruction.

It certainly means that, at a time when bills are going through the roof, the supply of electricity is being rendered more expensive and less reliable. This stems from the wear and tear on conventional generating plant.

Professor Michael Laughton, Emeritus Professor of Electrical Engineering at London University, has written to the chief executives of 30 electricity generators about a study led by James Oswald, former head of R&D at Rolls-Royce Turbines, into the implications for conventional generating plant of Government targets for wind power.

The study (*Will British weather provide reliable electricity?*) correlated known wind turbine output with wind conditions at various sites using records published by Ofgem, the energy regulator. On the basis of simulations, it assesses the likely conditions to be imposed on the British electricity supply system by 25,000MW of wind turbines across the Grid.

It concludes: "...the model suggests that power swings of 70 per cent within 12 hours are to be expected in winter and will require individual generators to go on- or off-line frequently, thereby reducing the utilisation and reliability of large centralised plants".

Changes of load stress generating plant and no type is immune. Even large gas turbines suffer a shortened life. Large coal and gas (CCGT) stations designed to operate most efficiently at an optimum output experience a serious increase in stresses during run-up and run-down, lose efficiency and use more fuel per unit of electricity output.

So, Professor Laughton has told the generating companies that the load cycling imposed by a substantial wind power industry will have serious consequences for plant life and maintenance costs, apart from lost electrical output, and the security of Britain's power supply "will be seriously jeopardised".

The inevitable conclusion is that this mad rush for more and more wind power will raise generation costs, electricity bills and fuel poverty and impair security of supply. This is not, of course, how the Prime Minister's determination to create a new energy "Gulf" in the North Sea out of wind power is presented.

Confusion No. 6 – Does wind reduce carbon emissions?

The one justification for developing low carbon renewables – in practice, wind power – is to combat global warming by reducing carbon emissions. It is true that wind emits little CO₂ per unit of output, though twice as much as nuclear power (8 instead of 4 grams per kWh).

However, wind's contribution to cleaning up the atmosphere is far less than is implied by the installed capacity because of its intermittency. But that is not the whole story. When wind power falters other forms of generation have to step in and, in order to do so on the required instant, have generally had to be idling – held in "spinning reserve", as it is described.

That means they are operating inefficiently and, if, as it mostly likely is, they are fossil-fuelled power stations, they will be burning more fuel and causing more carbon emissions. This reduces wind's contribution to the fight against global warming still more. It is further impaired, as James Oswald has shown (above), by the consequences for efficiency of switching on- and off-line frequently.

One thing we can be sure of – wind will not eliminate any fossil fuelled (or indeed, nuclear) power station. E.ON, the German-owned power company, estimates that even if 13,000 wind turbines were erected in Britain to meet EU policy, they could be relied upon to produce only seven per cent of peak winter power demand. That would mean that 92 per cent of installed wind capacity would have to be backed up by traditional stations **and might require more coal-fired stations.**

Professor Laughton goes further on the basis of grid studies. He argues that however much wind power is installed the amount of installed conventional capacity could never be less than the estimated winter peak demand.

As things stand, renewables – and that means effectively wind – do not live up to their sole justification for subsidising their development – namely avoiding carbon emissions. In some circumstances, they might even increase them.

The ultimate confusion – how do we make economic sense of all this?

The short answer is: You can't. It is true that the Government, with the eventual support of the Conservatives, has now embraced the only fuel – uranium – that provides security of supply at economic cost and effectively combats global warming.

But the development of renewables, regardless of cost and effectiveness, continues even in a period of financial stringency and tight money.

It is driven by an irrational and politically correct belief among “Greens”, who have acquired a hold over politicians throughout Europe, that modern industrial nations can be powered cleanly by a variety of renewable and alternative sources of energy in combination with greater energy efficiency to the exclusion of coal and nuclear.

This idealistic notion lies shattered once it is subjected to serious examination on grounds of practicality, consequences and crippling cost.

The moral of this tale of confusion is that only nuclear power provides predictable – i.e. reliable – competitive electricity that effectively combats global warming by reducing greenhouse gas emissions.

Nuclear is the one form of electricity we need and can afford. It is the only one that offers the prospect of security of supply and cheaper low carbon power.

Nuclear gives value for money – and the nuclear renaissance across the world confirms it.

If you want to read more about nuclear issues or different aspects of energy policy you can download the following briefing notes from SONE's website at www.sone.org.uk:

- The Looming Energy Crisis (update) Briefing Note**
(a factual document about nuclear power in the context of the energy scene)
- Uranium Availability**
- Renewable and alternative sources of electricity**
- The Hydrogen Economy**
- Micro-generation Briefing Note**
- The Management of Nuclear Waste**
- Plutonium in Perspective**
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