

**Evidence to the House of Lords Economic Affairs Committee inquiry into ‘The Economics of Renewable Energy’**

- 1 My name is Phillip Bratby. I have a first class honours degree in physics from the Imperial College of Science and Technology (London University) and a doctorate in physics from Sheffield University. I am a semi-retired energy consultant, being the sole director of my own consultancy company.
- 2 This is my personal evidence to the inquiry by the House of Lords Economic Affairs Committee into the economics of renewable energy.
- 3 In calling for evidence, the Chairman stated ***“Renewable energy is expected to play an important role in reducing carbon emissions but we know comparatively little about the possible costs and benefits.”***
- 4 I am not surprised by the statement concerning the lack of knowledge as it has been apparent for a long time that the renewable energy policy is target-driven and is not based upon any engineering or economic analysis of the effect of renewable energy on the UK electricity supply industry.
- 5 The BERR (formerly the DTI) does not appear to have the expertise to formulate a sensible or sustainable energy policy. It has been badly informed by NGOs such as the UK Energy Research Council and the Sustainable Development Commission (SCD), which has produced a series of seriously flawed documents. These documents contain little evidence and much opinion and dogma. This is not surprising given the background of the Commissioners of the SCD.
- 6 The premise for renewable energy is largely based on the perceived necessity to mitigate climate change. Climate change is currently assumed by politicians and the media to imply global warming. However, the concept of anthropogenic global warming is politically-driven by the IPCC. All the forecasts by the IPCC for global warming are based on computer models of the earth’s climate. The behaviour of the climate is non-linear and chaotic and the mechanisms which influence climate are not fully understood. Having worked for several years with computer models of complex flow and heat transfer systems, which were validated against experimental data, I suggest that there is no validity for the results of any computer models of the climate. With so little understanding of how the climate works (the effect of the sun, ocean currents, the atmospheric layers and constituent gases etc), it is evident to any scientist that, with so many degrees of freedom and unknown parameters, the computer models can produce any outcome desired. If we cannot reliably calculate the weather more than a few days in advance, how is it that the IPCC can make forecasts for the climate 100 years ahead? I submit that there is no validity for global warming forecasts. Evidence shows that the earth has been cooling since 1998 despite increased CO<sub>2</sub> emissions and increasing CO<sub>2</sub> concentrations in the atmosphere. None of the climate models have predicted this cooling whilst CO<sub>2</sub> concentrations have been increasing. Instead, the IPCC has perversely claimed that the cooling is masking the long-term warming and that more funding is needed to improve the climate models.

7 Sir John Houghton (Scientific Assessment for Intergovernmental Panel on Climate Change, Chairman and Co-Chairman 1988-2002.) said “*Unless we announce disasters no one will listen*” and “*The impacts of global warming are such that I have no hesitation in describing it as a ‘weapon of mass destruction’*”. Incorrectly predicting future disasters (mainly for political reasons) is nothing new. I give some examples from individuals and government organisations: In 1969, environmentalist Nigel Calder warned, “*The threat of a new ice age must now stand alongside nuclear war as a likely source of wholesale death and misery for mankind*”. C.C. Wallen of the World Meteorological Organisation said, “*The cooling since 1940 has been large enough and consistent enough that it will not soon be reversed*”. In 1968, Professor Paul Ehrlich predicted there would be a major food shortage in the U.S. and “*in the 1970s ... hundreds of millions of people are going to starve to death*”. Ehrlich forecast that 65 million Americans would die of starvation between 1980 and 1989, and by 1999 the U.S. population would have declined to 22.6 million. Ehrlich’s predictions about England were gloomier: “*If I were a gambler, I would take even money that England will not exist in the year 2000*”. In 1972, a report was written for the Club of Rome warning the world would run out of gold by 1981, mercury and silver by 1985, tin by 1987 and petroleum, copper, lead and natural gas by 1992. Gordon Taylor, in his 1970 book “*The Doomsday Book*,” said Americans were using 50 percent of the world’s resources and “*by 2000 they [Americans] will, if permitted, be using all of them*”. In 1975, the Environmental Fund took out full-page ads warning, “*The World as we know it will likely be ruined by the year 2000*”. Harvard University biologist George Wald in 1970 warned, “*civilisation will end within 15 or 30 years unless immediate action is taken against problems facing mankind*”. In the same year Senator Gaylord Nelson warned, in *Look Magazine*, that by 1995 “*somewhere between 75 and 85 percent of all the species of living animals will be extinct*”. In 1885, the U.S. Geological Survey announced there was “*little or no chance*” of oil being discovered in California, and a few years later they said the same about Kansas and Texas. In 1939, the U.S. Department of the Interior said American oil supplies would last only another 13 years. In 1949, the Secretary of the Interior said the end of U.S. oil supplies was in sight. Having learned nothing from its earlier erroneous claims, in 1974 the U.S. Geological Survey advised that the U.S. had only a 10-year supply of natural gas. There is no evidence to suggest that the current global warming predictions have any more validity than any of the above dire warnings.

8 It would be precipitate to bet the house on global warming when, based on historical evidence and not computer models, global cooling may be more likely. The evidence is in the form of the Milankovitch cycles (the earth’s eccentric orbit around the sun, the tilt of the earth’s axis and the precession of the earth’s axis), the sun-spot cycles and the behaviour of ocean currents such as the Pacific Decadal Oscillation (El Nino and La Nina) and the Atlantic Multidecadal Oscillation). The natural climate change consisting of cooling lead to ice-ages and warming (interglacial periods) is well known. Scientists independent of governments for funding have long been sceptical about global warming claims made by government funded and government controlled scientists. Global warming would in fact be more beneficial to mankind than would global cooling which could lead to the next ice-age.

- 9 Thus, although it would be prudent to minimise man-made CO<sub>2</sub> emissions, the need for drastic action which could have a serious effect on the future well-being and prosperity of the citizens of the UK and the need for renewable energy, are seriously called into question.
- 10 My evidence is mainly concerned with wind power stations for generating electricity. This is because these form the major component of all major country's future renewable energy policies. Hydro-electric power has much greater benefit as a source of renewable electricity than does wind power, but the hydro-electric potential in the UK is very limited due to the shortage of suitable rivers and geography.
- 11 The most important consideration for the future electricity supply has to be security of that supply. The effect of the supply of electricity not meeting the demand at some time in the future would be potentially disastrous, possibly resulting in deaths, food shortages, transport problems and collapse of the country's infra-structure. Economic ruin could follow if international financial business relocated from the UK due to uncertainty about the security of electricity supply.
- 12 Security of supply implies firm generation capacity with a margin above the peak (winter) demand. The firm generation is supplied by baseload power stations (such as nuclear) and despatchable (controlled by the grid) power (such as coal, gas and certain renewables such as hydro-electric – including pumped-storage schemes such as Dinorwig). Neither on-shore nor off-shore wind power stations contribute significantly to the security of supply because the electricity is intermittent, unpredictable and is embedded on the grid (not despatchable). Invariably peak winter demand occurs during extreme cold weather when a high pressure system settles across northern Europe and drags in cold continental air with little wind. Even with wind turbines distributed widely across the UK, under these low wind conditions, little electricity would be generated by wind turbines. Wave power is intermittent and unpredictable and tidal power is intermittent but predictable.
- 13 Many nuclear and coal-fired power stations are coming to the end of their lives and need to be replaced to ensure continued security of supply. Thus non-despatchable renewable sources of electricity must not distort the electricity market and divert resources from the necessary construction of new baseload and despatchable power stations.
- 14 In answer to your first issue, non-despatchable renewables should only be considered after security of supply has been guaranteed. The current UK policy of subsidising wind power at the expense of secure electricity generation is typical of most countries such as USA, Canada, Australia, New Zealand, Germany, Spain and Denmark. It contrasts with the policy of France and Sweden which have placed security of supply at the heart of their policy.
- 15 In answer to your second issue, the barriers to greater deployment of wind power stations are suitable on-shore sites, supply of wind turbine components and shortage of equipment needed for off-shore construction. In addition, serious planning issues confront on-shore wind power stations. These include the visual (landscape) and other environmental impacts, military objections (radar interference) and more

recently the effect from the current large wind turbines (heights in excess of 100m) of noise and its consequential health impact. The Local Government Ombudsman has recently stated that the planning condition for noise “*put in place to protect local residents*” and based on the industry standard ETSU-R-97, is “*vague, open to interpretation, immeasurable and thus unenforceable*”). Thus it is likely that planning applications for wind power stations near to residents will receive stronger opposition and planners will not be able to justify their siting on the basis of noise and consequential health issues. Wind turbines will have to be sited in more remote locations further away from human habitation. This will severely limit suitable locations for siting wind power stations. The issue of noise and health from modern wind turbines will need properly addressing before siting close to residences can be justified.

- 16 In answer to your third issue, the technology of wind turbines is mature and it is unlikely that there are any technological advances that could make it cheaper.
- 17 I now turn in greater detail to the technological concerns with wind turbines. As a physicist, it offends my learning, experience and intelligence to attempt to produce electricity on a large scale from wind power. This is for four reasons. Firstly because of the very low energy density of wind (the energy per volume of moving air). For comparison and in round terms, the energy density of moving water is about 1,000 times as great, that of fossil fuels (coal, oil, liquefied gas) is about 1 billion times as great and that of nuclear is about 1 million billion times as great. Thus wind turbines have to be enormous to capture a useful amount of energy. Secondly, because the power of the wind is a function of the cube of the wind speed, the electrical output is very sensitive to the wind speed. Thirdly, because of the variability of the wind, wind turbines only produce electricity at about 25% to 30% of their rated output (capacity or load factor). Fourthly, because of the intermittency and unpredictability of wind the electricity production bears no relation to the demand for electricity. In summary, wind turbines are enormous, produce a pathetically small amount of electricity, intermittently, unpredictably and not when it is most required.
- 18 The CO<sub>2</sub> emissions saved by wind turbines have been calculated based on the CO<sub>2</sub> emissions from displaced plant (coal and gas-fired power stations). A consensus figure of 430 kg/MWh is currently used. However, this figure is only part of the equation needed to calculate the CO<sub>2</sub> emissions saved. Also to be included in the equation are the CO<sub>2</sub> emissions resulting from the manufacture and construction of the turbine (estimated by various people at the equivalent of between several months to many years of operation – the payback period); the electricity losses down the low voltage distribution line to the consumers (estimated at between 5 and 15% of the electricity generated, due to the long distance as the result of the remoteness of many turbines); and the CO<sub>2</sub> emissions produced by conventional power stations operating very inefficiently on standby (and burning fuel) ready as backup to meet the electricity demand when the wind drops. Evidence from Denmark and Germany suggests that CO<sub>2</sub> emissions savings from the use of wind turbines are at best small and at worst, they may actually lead to an increase in CO<sub>2</sub> emissions.

- 19 Although the wind is a renewable source of energy, wind turbines can only operate on the grid in conjunction with backup generation to ensure demand is met when the wind fails. For this reason, it has been claimed that wind-generated electricity cannot be classed as renewable.
- 20 Because of the intermittency and unpredictability of the wind and thus of the electricity generated by wind turbines, wind turbines cannot replace a significant number of conventional power stations. Thus wind turbines are being constructed as a secondary source of electricity. In essence, the consumer is paying for two sets of electricity generation; the conventional despatchable power stations, necessary to meet demand at all times and wind turbines which operate only when the wind blows and which then displace despatchable power stations.
- 21 Wind turbines are usually connected to the low voltage distribution grid, rather than the high voltage transmission grid to which conventional power stations are connected. Wind-generated is embedded on the grid as it is not despatchable and cannot be controlled. The national Grid was designed so that electricity flows from the power stations on the efficient high voltage transmission lines and is transformed (stepped) down progressively on the distribution grid to consumers. Thus electricity flows one way and by the most efficient route. However, embedded electricity can flow the wrong way if there is not sufficient downstream demand. This can cause grid problems.
- 22 Electricity cannot be stored on the grid and grid voltage and frequency are maintained in tight margins to protect sensitive equipment. This is not normally a problem, the grid having operated successfully for over 60 years. This is because demand is accurately predictable and despatchable power sources of various response times are available to match the grid. However, with increasing amounts of intermittent and unpredictable embedded generation on the grid, control becomes increasingly more difficult. This can lead to grid failure and collapse as has happened recently across a large part of Europe and in Texas.
- 23 In answer to your sixth issue, because of the low energy density of wind and the large separation distance required between individual turbines, the area of land affected by wind power stations is proportionally greater than that of traditional power stations. For example 100m tall wind turbines of 2MW rated power need to be spaced several hundred metres apart and not close to dwellings and roads. Thus except in remote areas, about four wind turbines can be accommodated per square kilometre of land. This is not dissimilar to the figure for nuclear power stations or gas-fired power stations. For comparison purposes, and taking into account capacity (or load factors), the land area covered by a wind power station of the same energy output as a nuclear power station would be about 2000 times as great (or an area of land 20km by 25km would be covered by wind turbines to produce the same electrical output as one nuclear power station occupying an area of land 500m square). Furthermore, the wind turbines are of greater height and rotate so that their visual impact is amplified. A considerable infrastructure in terms of possibly improved roads and access tracks is required for wind turbines. In addition, the wind turbines provide few if any jobs in the district, and possibly destroy employment due to the loss of tourism-related business. Conventional power

stations provide considerable local economic benefits in terms of a range of permanent types of employment.

These external costs in terms of environmental and other impacts should be compared in terms of benefits and disbenefits for each technology on a like-for-like basis (noting that comparing a nuclear power station producing baseload electricity with a wind power station producing intermittent, unpredictable and uncontrollable electricity is like comparing chalk and cheese). The like-for-like basis must be in terms of energy output (i.e. MWh, GWh or TWh of electricity generated per year) rather than installed capacity (MW). Thus, for example the benefits and disbenefits of a nuclear power station of 1600MW rating with a capacity factor of 90% producing 12.6TWh of electricity per year should be compared with a wind power station consisting of 2880 2MW turbines with a capacity factor of 25% also producing 12.6TWh of electricity per year.

The planning system for renewables, as embodied in PPS22, is first and foremost about meeting Government targets for renewable energy, both nationally and regionally. The key principles of PPS22 are written such that planning authorities “*promote and encourage, rather than restrict*” renewable energy projects so that targets can be met. The planning system is thus biased in favour of development of wind power stations regardless of other considerations such as the environmental damage, the effect on competitiveness and the effect on fuel poverty.

23 I am not submitting evidence on any of the other issues.

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This evidence is submitted on an individual basis.