APPEAL BY RES

PROPOSED ERECTION AND OPERATION OF 9 WIND TURBINES AND PROVISION OF ANCILLARY WIND FARM INFRASTRUCTURE AT DEN BROOK

In the matter of Appeal Reference APP/Q1153/A/06/2017162 DEN BROOK

Town and Country Planning Act 1990

PROOF OF EVIDENCE OF PHILLIP A W BRATBY, BSc, PhD, ARCS

ON BEHALF OF CPRE

Personal details

My name is Dr Phillip Bratby. I have a first class honours degree in physics from the Imperial College of Science and Technology and a PhD in physics from Sheffield University. I have spent most of my working life in the commercial nuclear power industry and am currently a semi-retired energy consultant and am director of my own energy consultancy company. Within the nuclear industry, working as a safety specialist, I was qualified to author and verify Category 1 safety cases (the highest safety category). For several years I was the independent member of a nuclear safety committee at one of the UK's nuclear power stations.

My experience of the nuclear industry was of scientific and engineering work carried out to an exceptionally high standard, with rigorous use of scientific evidence, engineering judgement and adherence to rigorous quality management procedures.

Glossary

J	Joule; basic unit of energy
W	Watt; basic unit of power
kW	one thousand Watts
MW	one million Watts
GW	one billion Watts
TW	one thousand billion Watts
MWh	the energy equivalent to a power of one MW for one hour
tonne	metric ton; one thousand kilogrammes (kg)
Mt	one million tonnes

CO_2	Carbon dioxide
RO	Renewable Obligation
DECC	Department for Energy and Climate Change
DUKES	Digest of UK Energy Staistics
NOABL	Numerical Objective Analysis of Boundary Layer (DTI wind speed database)
BERR	Business Enterprise and Regulatory Reform
BWEA	British Wind Energy Association (trade body)
DTI	Department for Trade and Industry
HSE	Health and Safety Executive
TOR	Tolerability of risk
R2P2	Reducing risk, protecting people
ALARP	As low as reasonably practicable
OEF	Operational experience feedback
LCA	Life Cycle Assessment
LCPD	Large Combustion Plant Directive
CCGT	Combined-cycle gas turbine
OCGT	Open-cycle gas turbine
IPCC	Intergovernmental Panel on Climate Change

Energy Targets and the Planning Balance

1. The Energy White Paper 2003 (CD) set out the Government targets for renewable energy as "*In January 2000 we announced our aim for renewables to supply 10% of UK electricity in 2010, subject to the costs being acceptable to the*

consumer". One of the goals of the energy policy was "*to put ourselves on a path to cut the UK's carbon dioxide emissions….with real progress by 2020*". The Renewable Obligation (RO) was introduced to "*provide the renewables industry with support worth around £1 billion a year*". The data from BERR shows that in 2007 the UK electricity sales were 327 TWh, of which 5.3 TWh (1.6%) was from wind power and total electricity supplied from renewable sources was 19.7 TWh (6.0%); renewables other than wind were thus 14.4 TWh (4.4%). *Source: DUKES 2008 Tables 5.5 and 7.4*.

2. On April 1st 2009, the British Wind Energy Association (BWEA) website stated that there were 3,327MW of operational wind power, 1,674MW of wind power under construction. 7,249MW of consented wind power and 8,025MW of wind power in planning. Thus the current operational, under construction and consented wind power is 12,250MW.

3. Assuming an average capacity factor of 26.4%, in line with that given by BERR as a UK weighted average figure for onshore wind for 2003 to 2007 (see paragraph 36 below), then the total annual electricity produced by the operational, under construction and consented wind power would be 28.3 TWh. The BERR Renewable Energy Strategy expects total UK energy demand to fall between 2007 and 2010 (CD).

4. Therefore conservatively assuming that the UK electricity sales of 327 TWh in 2007 remain unchanged in 2010, together with an unchanged production of renewables from sources other than wind of 14.4 TWh, then the total renewables

electricity production including the operational, under construction and consented wind power would be 42.7 TWh/year, which is 13.1% of the UK electricity sales. This total, when constructed, will comfortably exceed the target of 10% for 2010.

5. On the same basis, the 8,025MW of wind power in planning would represent a further 18.6 TWh/year of electricity, which if consented and constructed would be a further 5.7% of the UK electricity sales, giving a total of 18.8% of the UK electricity sales.

6. The Energy White Paper 2003 aim for 10% of electricity sales to come from renewable sources in 2010 should therefore be comfortably exceeded when consented projects are constructed, as should the goal of making real progress in cutting CO_2 emissions by 2020. Therefore wind power developments only need to be consented if the benefits exceed the disbenefits or harm.

7. There is no compelling evidence within the Government's climate change policies for the necessity to install wind farms in inappropriate locations.

8. The implication is that this proposal is not necessary for the Government's renewable energy (electricity) 2010 targets to be met. Thus the benefits of this proposal in terms of contributing to the 2010 target are diminished. The next goal is for 2020. Thus there is time to ensure that proposed renewable electricity schemes are approved using a criterion based on a cost-benefit type of judgement. Renewable electricity schemes should only be approved where the benefits are clearly shown to outweigh the disbenefits. That way the most

appropriate schemes would gain approval and the least appropriate schemes would be rejected.

9. The balance between benefits and disbenefits of the proposal is one of the key principles that local planning authorities should examine in renewable energy proposals. This is identified in the Government's planning policy for renewable energy PPS22 (CD) which states: "*The wider environmental and economic benefits of all proposals for renewable energy projects, whatever their scale, are material considerations that should be given significant weight in determining whether proposals should be granted planning permission*" and "*Development proposals should demonstrate any environmental, economic and social benefits as well as how any environmental and social impacts have been minimised through careful consideration of location, scale, design and other measures*."

10. The need to weigh the contribution from this proposal in the planning balance was set out in the case of *National Wind Power v Secretary of State (1999)* when the High Court indicated that it was proper to assess and weigh in the balance the absolute and relative contributions from a given wind turbine generation proposal.

11. The Planning Inspector at the recent Shipdham Wind Farm appeal (CD) stated "*A balancing exercise has to be undertaken*".

12. The primary benefit of the proposal is the reduction of CO_2 emissions by the generation of electricity from renewable sources. The first part of my evidence is a calculation of the CO_2 emissions savings of the proposal and puts the saving into

context with UK and world emissions. The second part of my evidence examines one of the disbenefits of the proposal, namely the risks to the safety of the general public. I do not address any other of the disbenefits of the proposals because these are covered in other evidence.

Power, Energy and Efficiency

13. The Government's Climate Change Act 2008 is predicated on the presumption of the need for the UK to make drastic cuts in greenhouse gas (CO_2) emissions. The Climate Change Act expresses the Government's policy in terms of targets for CO_2 emissions reduction. Specifically, a key provision is a legally binding target of a reduction "*in CO_2 emissions of at least 26% by 2020, against a 1990 baseline*". Thus any national, regional, county or district policies or targets expressed in terms of renewable energy are surrogates for the CO_2 emissions reduction targets and contribute towards that target. Any outcome in terms of renewable energy (MWh) must be converted into CO_2 emissions reduction in order to measure progress towards the target. Other greenhouse gases are considered, but for simplicity, only CO_2 emissions savings will be discussed here. Oxides of sulphur and nitrogen are pollutants, controlled by other means.

14. There is a great deal of confusion at all levels (from Government departments down) concerning the difference between energy (MWh) and power (MW). I will firstly attempt to dispel this confusion by explaining the difference between energy and power.

15. In physics, we have no knowledge of what energy is. However, it is generally understood that energy is the ability or capacity to do work. There are several forms of energy, such as kinetic energy, gravitational potential energy and electromagnetic energy. A fundament law of physics is that energy is conserved at all times. The base unit of energy is the Joule (J).

16. Power is energy flux. It is the rate at which work is done or the rate of energy transfer. The base unit of power is the Watt (W). A Watt is thus a Joule/second (J/s) and a Watt.second (W.s) is a Joule.

17. Thousand multiples are used because of the small magnitude of the base units. Thus for power we use kW (a thousand Watts) at domestic scale, MW (a million Watts) at small industrial scale, GW (a billion Watts) at power station scale and TW (a thousand billion Watts) at national scale. Similarly for energy we use kWh (an energy equivalent to one thousand Watts for one hour), MWh, GWh and TWh.

18. Since the CO_2 emissions reduction from a renewable energy source is a function of the energy produced and not the installed capacity (power), it can be seen that a CO_2 emissions reduction target cannot be simply replaced by a surrogate power target. Thus the Devon regional target of 151MW of installed renewable electricity capacity, set out in Policy CO12 of the Structure Plan, cannot be used to calculate Devon's contribution to the Government's CO_2 emissions reduction target. This has led to confusion on two fronts. Firstly it is necessary to convert an installed capacity measured in MW into an expected energy output measured in MWh and

secondly it is necessary to determine the CO_2 emissions savings from that energy output.

19. The energy output is obtained from the installed capacity in units of MW of electrical power and the capacity factor (sometimes termed the load factor). The capacity factor is the ratio of the actual energy produced over a period of time compared to the energy produced if the facility were to operate at the full rated (or installed capacity) over that period of time (multiplied by 100 to give the capacity factor as a percentage figure). The capacity factor of a baseload power station or wind turbine embedded on the grid is essentially the reliability of the plant to perform as designed.

20. Capacity factor is sometimes confused with efficiency. Efficiency is a defined term given by the ratio of the energy output to the energy input (multiplied by 100 to give the efficiency as a percentage figure). There is no relationship between efficiency and capacity factor.

21. It is straightforward to calculate the theoretical efficiency of a wind turbine from the wind profile at the turbine site and the theoretical performance characteristic of the turbine. The theoretical efficiency is the electrical output of the turbine/generator divided by the energy of the wind, integrated over time.

22. The calculational method for determining turbine efficiency is given by the Danish Wind Industry Association (Appendix 1). The turbine operational characteristic and wind conditions are required inputs to the calculation. In essence, the

efficiency is zero below the cut-in wind speed (the wind speed at which the turbine starts to generate and export electricity to the grid), the efficiency rises with increasing wind speed until the turbine rated power is reached and then falls with increasing wind speed since the turbine power is held constant at the rated power. Above the cut-out wind speed (the speed at which the turbine is stopped to prevent damage) the efficiency is zero. Since the power of wind is proportional to the cube of the wind speed, the power output of a wind turbine is very sensitive to changes in wind speed between the cut-in wind speed and the lowest wind speed at which the rated power occurs (this is the range of wind speeds over which most of the electrical energy is generated).

23. Based on the unadjusted measured mean wind speed of 5.40m/s at 50m (using the appellants measurements taken between 4th August 2004 and 30th November 2007), a calculation using the method given by the Danish Wind Industry Association gives a corresponding wind speed of 5.75m/s at the hub height of 75m and an efficiency of 30.0% for the Vestas V90 2MW turbine with a 90m blade diameter. This calculation is shown in Appendix 1. Inherent in the calculation are assumptions about the land form (roughness) and associated wind shear (the wind altitude profile). The roughness is assumed to be class 2 (roughness length 0.1) corresponding to agricultural land with some houses and 8m tall sheltering hedgerows within a distance of approximately 500m. The shear is assumed to be logarithmic for neutral atmospheric stability conditions. The calculated theoretical maximum capacity factor of 21% is also given in Appendix 1.

Benefits in CO_2 emissions saved

24. The appellant has overstated the benefits of the proposals in terms of CO_2 emissions saved by a considerable amount as shown below. There are six factors to consider and these are discussed in turn.

25. First is the issue of CO_2 emissions saved by the electricity produced. The RES ES Appendix 1 gives a projected figure for CO_2 emissions savings of between 37,291 tonnes/yr and 40,681 tonnes/yr, these figures being based on a BWEA figure of 860 kg/MWh, which is the typical emission from a coal-fired power station, and assumed capacity factors of 27.5% and 30.0% respectively. The appellant is thus assuming that over the lifetime of the wind turbines, the electricity generated by the turbines would otherwise have been generated by coal-fired power stations, which are assumed to emit 860 kg of CO_2 for each MWh of electricity produced.

26. The DTI Wind Energy Fact Sheet 14 (Appendix 2) made clear in 2001 that projected emissions savings should be based on displacing ‘average plant mix’ and not solely on coal-fired power stations. The annual emissions savings would be likely to decline over the life of the wind farm, through the introduction of new, less polluting technology and the replacement of coal-fired power stations (under the EC Large Combustion Plant Directive (LCPD) 2001/80/EC) by more efficient and highly flexible gas-fired power stations (combined-cycle gas turbines (CCGT) and open-cycle gas turbines (OCGT)).

27. With increasing amounts of intermittent wind power embedded on the electricity grid system it is likely that the flexible gas-fired power stations will be used in conjunction with the wind turbines to enable electricity supply to match electricity demand within the constraints required of the grid code. Coal-fired power stations are generally less flexible than gas-fired power stations and gas turbines and cannot respond as rapidly to changing grid demands.

28. Defra (Appendix 3) state that a CO_2 emissions saving of 430 kg/MWh, based on mixed plant, should be used, i.e. half the figure used by the appellant. The figure for CO_2 emissions saving of 430 kg/MWh has been verified by the Inspector in his report when recommending approval for the Fullabrook proposal (CD) and by the Secretary of State when approving the Inspector's report. The Inspector said *"Regarding predicted CO_2 savings, there is a considerable gap between DWP, on the one hand, and NDDC and CAWT on the other. [2.46, 4.98, 6.9] Having reviewed the assumptions used, my conclusion is that those savings are more likely to be in line with the estimates made by NDDC and CAWT. Those calculations are of CO_2 avoided and, in accordance with Defra guidelines, they assume a grid average mix figure of 0.43kg CO_2/kWh. Using that figure, NDDC predict likely savings of the order of 64,600 tonnes per annum, about half of DWP's estimate. [4.98] In my view, the annual saving would be likely to decline over the 25 year life of the wind farm, through the introduction of new, less polluting technology, for example carbon capture and sequestration."* In November 2008 the BWEA finally reduced its claim for CO_2 emissions saving from 860 kg/MWh to 430 kg/MWh (Appendix 4).

29. The Sustainable Development Commission (SDC) conservatively used a CO_2 emissions saving of 355 kg/MWh based on displacing gas-fired plant in 2020 (Appendix 5). It is likely that future emissions savings are likely to be of the order of 350 to 370 kg/MWh, figures given by Centrica (Appendix 6), as more coal-fired power stations are replaced by gas-fired power stations.

30. Further evidence that the CO_2 emissions savings will decline during the lifetime of the proposal was given by Energy Minister Malcolm Wicks in written response 175696 in the House of Commons on 14 Jan 2008 when he stated "*Assuming that renewable energy displaces gas generation, with a carbon factor of 95.7 MtC per GWh additional generation, estimated carbon saved is given in the following table*". 95.7 MtC per GWh corresponds to 350 kg/MWh. Thus it is assumed that the Government is expecting the CO_2 emissions savings from renewable energy schemes to fall by about 20% from 430 kg/MWh to 350 kg/MWh as coal-fired power stations are replaced by gas-fired power stations.

31. As stated above, the figures of between 37,291 tonnes/yr and 40,681 tonnes/yr are based on CO_2 emissions savings 860 kg/MWh. Use of the currently recommended figure for CO_2 emissions saving of 430 kg/MWh would reduce the projected CO_2 emissions savings from 37,291 tonnes/yr and 40,681 tonnes/yr to 18,646 tonnes/yr and 20,340 tonnes/yr respectively. These emissions savings are very conservative because, as discussed at paragraph 30 above, it is likely that the annual CO_2 emissions savings will decline further by about 20% during the lifetimes of the proposed turbines due to the continued introduction of flexible,

more efficient gas-fired power stations and the closure of old, less efficient coal-fired power stations.

32. Second, is the effect of capacity factor. As stated above, the capacity factor is unrelated to the efficiency. However it is dependent on the prevailing wind conditions.

33. In the ES Appendix 1, the appellant assumes a capacity factor of 27.5% based upon UK data from operational wind farms between 1997 and 2004 (DUKES 2005, table 7.4) and also a capacity factor of 30% (presumably based upon BWEA guidance because the BWEA states on its website that "*The Digest of UK Energy Statistics, compiled annually by the Department of Trade and Industry, reports an average capacity factor for onshore wind of 28.2% in 2005. This compares favourably with the commonly applied industry average of 30%*"). The 30% capacity factor used by the BWEA appears to be a mythical number whose only basis is common usage by the wind industry. The annual average capacity factor in England has not reached 30% since 1998.

34. The theoretical maximum capacity factor has been calculated using the calculational method given by the Danish Wind Industry Association as discussed at paragraph 23 above and shown in Appendix 1. For a mean measured wind speed of 5.40 m/s at 50m and a calculated mean wind speed of 5.75 m/s at the 75m hub height, the theoretical maximum capacity factor for a Vestas V90 2MW turbine is 21%. This theoretical maximum capacity factor assumes that the turbine is operational 100% of the time. The capacity factor that will actually be achieved

will be lower than this figure because of curtailment factors such as unavailability due to planned and essential maintenance, wind conditions not being ideal (effect of shear, not smooth, not constant direction, not constant strength etc), turbine blade fouling, wake effects, mechanical degradation, noise and shadow flicker conditions, grid availability, icing shutdown and many other factors.

35. More recent evidence to support the likely capacity factor can be gained from the official figures for the achieved capacity factors for on-shore wind turbines in the UK from 2003 to 2007.

2003	2004	2005	2006	2007
24.1%	26.6%	26.4%	27.2%	27.5%

Source: DUKES 2008 Table 7.4

Because of poorer wind conditions, capacity factors for England are lower than for the UK, as can be seen from the table below.

	1998	1999	2000	2001	2002	2003	2004
England	30%	28%	27%	23%	27%	24%	25%
UK	31%	31%	29%	26%	28%	26%	29%

Source: DTI Energy Trends March 2006 Table 1 Page 29

The regional capacity factors for 2007 are:

England	**25.68%**
East Midlands	27.83%
Eastern	27.18%
London and South East	20.17%
North East	23.05%
North West	24.54%
South West	**23.76%**
Yorkshire and Humber	26.09%
Wales	26.15%
Scotland	27.58%
Northern Ireland	31.75%
UK total	**27.26%**

Source: BERR Energy Trends September 2008 Table 1 page 37.

36. It can be seen that operational data from England support a theoretical 21% capacity factor for this proposal because the average capacity factor for the south-west of England for 2007 was 23.76% and Den Brook is a much less favourable site than others in the south-west due its non-ideal location in an inland valley with low mean wind speed. Most existing wind farms in the south-west are on more exposed coastal and hilly locations.

37. The 27.5% and 30% capacity factors used by the appellant are not supported by the evidence from operational wind farms or by calculations based on measured wind speeds.

38. Of the curtailment factors discussed at paragraph 34, the wake effect may impact the capacity factor in two ways. Firstly, inspection of fig 2 of the Non Technical Summary 2005 (site layout) shows that for the prevailing wind direction (in an arc centred slightly north of west), turbines T2, T7, T4 and T5 are approximately four blade diameters downwind of another turbine, turbine T6 is approximately four blade diameters downwind of turbine T8 and turbine T3 is approximately five blade diameters downwind of turbine T1. These separation distances are about 2/3 of the generally accepted minimum figure of six diameters from an upwind turbine in the prevailing wind direction (CD Companion Guide to PPS22). The wake effect (increased turbulence and reduced wind speed compared to the free field wind) can result in a significant reduction in power production for downwind turbines (six of the nine turbines) and thus a reduced capacity factor. An appropriate curtailment factor is 0.92 (a reduction of 8%).

39. The second effect of the wake is that downwind turbine blades experience greater turbulence and hence increased fatigue loading. This will result in an increased likelihood of blade failure. No wind turbines of the size of those proposed for Den Brook have completed their lifecycle. Replacement of failed blades and inspection of all other blades would be a lengthy process and would result in a reduced capacity factor. However, since there is no operational experience on which to base the probability of fatigue-induced blade failure, I have made no allowance for curtailment due to this effect.

40. An appropriate curtailment factor for the other factors identified at paragraph 34 is judged to be 0.94 (a reduction of 6%).

41. Based on the calculated theoretical capacity factor of 21% given above at paragraphs 23 and 34 and using factors of 0.92 and 0.94 to allow for the curtailment factors discussed above, a capacity factor of 18% is judged to be a conservatively high figure for Den Brook.

42. Use of a 18% capacity factor rather than the 27.5% and 30% figures used by the appellant would bring the CO_2 emissions savings down further from 18,646 tonnes/yr and 20,340 tonnes/yr respectively to 12,204 tonnes/yr.

43. Third, the appellant's calculations of CO_2 emissions savings do not take into account CO_2 emissions arising from manufacture, transport, construction, operation and decommissioning of the wind turbines (during the life cycle of the wind farm).

44. Life Cycle Assessment (LCA) reports have been carried out by wind turbine manufacturer Vestas. The reports for the Vestas V80 2 MW turbine and the Vestas V90 3.0 MW turbine (Appendix 7) for onshore application show that for a 20 year turbine life the payback time (the time of operation before the energy used in the life cycle of the turbine is generated) is 7.7 months for the 2 MW turbine and 6.6 months for the 3 MW turbine, based on capacity factors of 32% and 30% respectively.

45. The payback time for a 2.0 MW turbine can be estimated, using Vestas data, to be about 8 months for a capacity factor of 30% and more than 13 months for a 18% capacity factor. However, inspection of the two reports (which are somewhat opaque in explaining what has been assessed) indicates that the assessments do not include energy expended in extraction and refining of raw materials, transport of foundation material, construction of on-site tracks, hard-standings and roadways etc and only include transport from a factory in Denmark to a nearby location in Denmark. The time of 13 months is thus an underestimate of the payback time.

46. The BWEA on its website states that "*The average wind farm will pay back the energy used in its manufacture within 3-5 months of operation. This compares favourably with coal or nuclear power stations, which take about six months.*" and references an obscure newsletter by Milborrow, a BWEA director (Appendix 8). The newsletter gives three definitions of 'energy payback' and gives results of '*between 3 and 10 months*' and provides graphs showing payback periods of 4 to

9 months and 4 to 34 months. There is no mention of the 3-5 months claimed by the BWEA.

47. However, the BWEA on its website also states "*The comparison of energy used in manufacture with the energy produced by a power station is known as the 'energy balance'. It can be expressed in terms of energy 'pay back' time, that is the time needed to generate the equivalent amount of energy used in manufacturing the wind turbine or power station. The average wind farm in the UK will pay back the energy used in its manufacture within three to ten months, and over its lifetime a wind turbine will produce over 30 times more energy than was used in its manufacture. This compares favourably with coal or nuclear power stations, which deliver only a third of the total energy used in construction and fuel supply. So, if fuel is included in the calculation, fossil fuel or nuclear power stations never achieve an energy pay back. Wind energy not only achieves pay back within a few months of installation but does so from a fuel that is free and inexhaustible.*"

48. Surprisingly, the BWEA appears to claim that coal and nuclear power stations have a payback period of 6 months but never produce more power than is used in their manufacture and construction and in production of the fuel. This is a patently ridiculous statement, since coal-fired power stations have been in use for nearly a century and would not have stood the test of time if they were net consumers of power. The industrial revolution would not have occurred were it not for the net usable energy (in the form of steam or electricity) provided by the combustion of coal. The BWEA estimates of payback time are contradictory and thus are unreliable.

49. Two independent assessments of the above calculations of payback time by Vestas and the BWEA are given by Ward (Appendix 9). Using the concept of embedded energy (the energy consumed by all of the processes associated with the production of a building, from the acquisition of natural resources to product delivery, including mining, manufacturing of materials and equipment, transport and administrative functions) he obtained a payback time of 16.5 months for a 2 MW turbine. Using the concept of the total economic activities (investment cost divided by cost of electricity produced) associated with a wind turbine, he obtained payback times ranging from about 10 years up to the full lifetime of the turbine (reflecting the need for a huge subsidy to enable a wind turbine to be economically viable).

50. It is evident that there is no simple answer to what the payback time for a turbine is or how it should be calculated. The industry derived figures are clearly too low and the Ward figures may be too high. However, based on the figures at paragraph 41 above of 8 months derived from Vestas data for a 2.0MW turbine at a capacity factor of 30%, it is judged that, for a capacity factor of 18% and allowing for the energy embedded in the on-site trackways and the transport associated with the foundation material, the trackways and the long distances from the manufacturing facility to the site, the payback period for this proposal is at least 2 years.

51. For a 20 year lifetime, this equates to a 10% reduction in the CO_2 emissions savings. This brings the CO_2 emissions savings down further from 12,204 tonnes/yr to 10,984 tonnes/yr.

52. Fourth, the electrical losses between the wind turbines and the consumers has to be considered. Historically, the electricity transmission network has been developed around large power stations. The national grid system is designed to accommodate large injections of electrical energy from these power stations and is operated at very high transmission voltages (275kV and 400kV) for reasons of efficiency (losses are proportional to the square of the current and thus inversely proportional to the square of the voltage).

53. The proposed wind turbines will be connected to the low voltage distribution grid, at either 11kV or 33kV. The transmission and distribution grids were designed to operate as a tapered voltage system, with current flowing from the high voltage transmission system to the distribution system and to the consumers, with transformers reducing the voltage between power station and consumer.

54. Because electricity cannot be stored on the grid, despatchable power stations maintain the grid frequency and the current flows through the system to the consumers as required. Wind turbines embedded on the low voltage distribution network can affect the current flow through the distribution network. Current flows may be reversed (particularly at times of high wind speed and low downstream consumer demand) and the current may have to travel a considerable distance along low voltage distribution lines to the consumers.

55. The wind turbines of this proposal will be connected to the distribution network locally. The population, industry and commercial densities are low because of the rural nature of central Devon. It is therefore very likely, especially at times of low electricity demand, that the electricity from the proposal will have to travel a considerable distance along low voltage distribution lines to the consumers. There will be considerable losses in these distribution lines.

56. The total losses in the transmission and distribution system are about 7.3%, averaged over the last 10 years.

1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
7.5%	7.4%	7.6%	7.8%	7.6%	7.5%	7.7%	6.8%	6.8%	6.6%

Source: DUKES 2008 Table 5.1.

It is judged that additional losses of at least 5% will result from embedding the proposed wind turbines in the local low voltage distribution lines. These additional losses of electricity reduce the CO_2 emissions savings down further from 10,984 tonnes/yr to 10,434 tonnes/yr.

57. Fifth, the effect of the wind turbines on the operation of the national grid has to be considered, since operation of the turbines affects the operation of conventional power stations. Wind turbines are embedded locally on the distribution network. This means that their output is uncontrolled, is dependent on the vagaries of the wind, and the network has to accept the power generated by the turbines.

58. Conventional power stations are despatchable, which means that their output can be controlled automatically or by the grid operators to match the expected demand

for electricity. The demand for electricity varies with the time of day, the seasons and the temperature, but is predictable to a reasonable degree of accuracy by the grid operators, based on temperature forecasts and decades of experience.

59. Based on the predicted demand for electricity, the grid operators are able to schedule production from conventional power stations and minimise the amount of ‘balancing power’ or back-up power needed to balance scheduled output with instantaneous demand (within the grid frequency limits permitted by the grid code).

60. ‘Spinning reserve’ (also known as regulating reserve) is the term used to define generation that is synchronised with capacity to enable the grid operators to instruct increases (or decreases) in output to assist with short term demand forecast errors or plant losses. The spinning reserve may be provided by generators operating at part-power or even at zero power.

61. Because the power provided by wind turbines is embedded, is very sensitive to the wind speed (the power output is proportional to the cube of the wind speed over most of the operating range) and can fall rapidly when the wind drops, the amount of spinning reserve has to be increased in line with the amount of embedded wind power

62. The E.ON Netz Wind Report 2005 (Appendix 10) covering a large grid network in Germany states *“Wind energy is only able to replace traditional power stations to a limited extent. Their dependence on the prevailing wind conditions means that wind power has a limited load factor even when technically available. It is not*

possible to guarantee its use for the continual cover of electricity consumption. Consequently, traditional power stations with capacities equal to 90% of the installed wind power capacity must be permanently online in order to guarantee power supply at all times".

63. Furthermore, the E.ON Netz report shows how rapidly the power output of conventional power stations has to be raised or lowered to compensate for the changing wind speed and how, even with 48,000MW of installed wind capacity, 46,000MW of conventional power stations would have to be kept operable for periods of low wind speed (Appendix 10).

64. The increased spinning reserve to accommodate the vagaries of the embedded power results in increased operation of conventional plant acting as spinning reserve, which in turn results in increased burning of fossil fuel, increased wear of conventional plant and increased maintenance requirements of conventional plant. All these factors result in increased CO_2 emissions from conventional power stations. This effect will increase as more wind turbines become embedded and more spinning reserve will be required.

65. There is no direct evidence for the increased CO_2 emissions arising from increased spinning reserve, since no analysis has been performed. However, the following statements have been made concerning the effect of back-up power on CO_2 emissions savings from wind power:

66. Regarding West Denmark, Mason (Appendix 11) has stated that "*The concentration of installed wind power in this region (819 MW per million of population) is amongst the highest in the world. To date, West Denmark's wind power resources have had little or no beneficial impact on Danish carbon emissions because the turbines depend on the continuous (and less efficient) operation of backup from the region's modern, coal/gas-burning stations, or imported power, to protect the integrity of its domestic grid"*.

67. In a further analysis of the carbon dioxide emissions in Denmark, the country with the highest per capita installed wind power, Mason (Appendix 12) stated that "*The intermittent and variable nature of its industrial wind power system and the associated need for dependable sources of spinning reserve mean that the operational efficiency of its backup plant is reduced (i.e. greater amounts of carbon dioxide produced per kWh of conventionally generated electricity). This counteracts a significant proportion of the carbon saving claimed for wind power*".

68. Liik et al (Appendix 13) have stated that: "*Participation of thermal power plants in keeping the reserve capacity for wind turbines and in compensation of the fluctuations of wind power increases the fuel consumption and emissions substantially. The case study shows that the integration of considerable capacity of wind turbines would increase the fuel consumption and emissions of thermal stations about 8-10%, which will reduce the environmental effect of windmills substantially. There can be situations where probably no environmental gain can be achieved at all.*"

69. In a key-note address to the Institute of Mechanical Engineers in 2003, Tolley (Appendix 14) stated: "*When plant is de-loaded to balance the system, it results in a significant proportion of de-loaded plant which operates relatively inefficiently. Coal plant will be part-loaded such that the loss of a generating unit can swiftly be replaced by bringing other units on to full load. In addition to increased costs of holding reserve in this manner, it has been estimated that the entire benefit of reduced emissions from the renewables programme has been negated by the increased emissions from part-loaded plant.*"

70. Courtney (Appendix 15) has stated: that "*Wind farms for power generation provide intermittent power so they merely displace thermal power stations onto standby mode or to operate at reduced efficiency while the thermal power stations wait for the wind to change. They make no significant reduction to pollution because thermal power stations continue to use their fuel and to produce their emissions while operating in standby mode or with reduced efficiency that can increase their emissions at low output. And this need for continuously operating backup means that wind farms can only provide negligible useful electricity to electricity grid supply systems.*" He concluded that *"The UK Government is spending much public money to subsidise on-shore and off-shore wind farms in an attempt to contribute to its target of a 20% reduction to* CO_2 *emissions from power generation. This policy is endorsed by the Energy White Paper 2003 and the Energy Review 2006. However, the intermittent supply from wind farms means they provide no useful electricity and no significant reduction to* CO_2 *emissions.*"

71. Thus there have been numerous warnings about the impact of wind turbines on conventional plant and the resultant increased CO_2 emissions emanating from conventional plant. However, the warnings from German and Danish experience have been ignored by the UK renewables industry and by the government and the lessons from the operational experience has been ignored in desk-top calculations that have been carried out to determine the future impact of wind power embedded on the grid on the increased CO_2 emissions from conventional power stations operating as spinning reserve or at part-load. Indeed how the grid can operate with a large amount of embedded and intermittent wind power has been totally ignored. I have therefore made no reduction in the CO_2 emissions savings from the proposed wind farm for this effect. However, I conclude that the above figure of 10,434 tonnes/yr of CO_2 emissions savings is likely to be a very conservatively high figure.

72. Finally, the appellant has provided no evidence concerning the electricity consumed by the wind turbines. The wind industry does not provide information on the electricity consumption of wind turbines, nor indeed whether the consumption is measured and deducted from the electricity production used to calculate the output under the Renewable Obligation Scheme. Electricity is drawn from the grid by a wind turbine for many functions, including:

- Yaw control (maintaining the direction of the blades into the wind) and pitch control (the angle of the blades)
- Lighting
- Heating and de-icing
- Lubricating pumps

- Controls
- Exciting the stator
- Blade and shaft turning in light wind to prevent warping.

  It is possible that a wind turbine could consume a considerable fraction of the electricity generated.

73. Unless measurements are made of electricity consumed by wind turbines, it is not possible to determine what the net electricity production is and therefore what the CO_2 emissions savings are. It is my understanding that under a 'sell and buyback' arrangement, the electricity produced is sold and metered for calculating and claiming Renewable Obligation Certificates whereas the electricity used to operate the turbines is bought back. Thus gross electrical output rather than net electrical output is used to claim Renewable Obligation Certificates, which are used in official calculations of achieved capacity factors. The official capacity factors given at paragraph 35 are thus based on gross output, rather than net output. The appellant should provide the information to clarify this issue. Thus the figure of 10,434 tonnes/yr of CO_2 emissions savings is also conservatively high due to use of gross electrical output.

74. In summary it is concluded that the appellant has overstated the CO_2 emissions saved by a factor of at least 37,291 / 10,434 = 3.6. Without an independent assessment of the effect of wind turbines on the CO_2 emissions of conventional power stations, without a realistic calculation of the pay back time and without the appellant disclosing the electricity that will be consumed by the proposed wind turbines, it is not possible to be more precise about the CO_2 emissions saved. However the above figure of 10,434 tonnes/yr is clearly conservatively high. It is

indeed possible that there would be no net CO_2 emissions savings from the proposal.

75. The calculated CO_2 emissions savings of 10,434 tonnes/yr can be compared to the total CO_2 emissions from fossil fuel use in the UK and from natural CO_2 fluxes in the atmosphere.

76. The UK figure for total CO_2 emissions is currently 554 Mt CO_2/yr whilst for 1990 it was 592 Mt CO_2/yr (Appendix 16). The proposal would thus reduce the total UK CO_2 emissions by a factor 10,434 / (554 x 10^6) = 0.000019 or 0.0019%. To put this into context, it would require the construction of 530 wind farms of the size of Den Brook to reduce the UK CO_2 emissions by 1%.

77. The UK reduction target of 26% of the 1990 figure of 592 Mt CO_2/yr is 154 Mt CO_2/yr (the Energy White Paper 2003 (CD). Den Brook would thus contribute 10,434 / (154 x 10^6) = 0.000068 or 0.0068% of the UK CO_2 emissions reduction target. To put this into context, it would require the construction of more than 14,700 wind farms of the size of Den Brook to reduce the UK CO_2 emissions by 26% of the 1990 figure.

78. The Intergovernmental Panel on Climate Change (IPCC) (Appendix 17) gives figures for natural fluxes between the biosphere and the atmosphere of 120GtC/yr and between the oceans and atmosphere of 70GtC/yr. Thus the total fluxes are 190GtC/yr. This equates to 697Gt CO_2/year. Burning of fossil fuels accounts for an additional 6.4GtC/yr (23.5Gt CO_2/yr), i.e. about 3.4% of the total flux.

79. Den Brook would therefore reduce the world's fossil fuel derived CO_2 emissions by 10,434 / (23.5 x 10^9) = 0.00000044 or 0.000044%. To put this into context, it would require the construction of more than 22,500 wind farms of the size of Den Brook to reduce the world CO_2 emissions from fossil fuels by 1%.

80. Den Brook would reduce the world's total CO_2 emissions by 10,434 / (720 x 10^9) = 0.000000014 or 0.0000014%. To put this into context, it would require the construction of more than 690,000 wind farms of the size of Den Brook to reduce the world's total CO_2 emissions by 1%.

81. The proposal will therefore have an immeasurably small impact on the human emissions of CO_2. The CO_2 emissions savings will also be immeasurably small compared to the natural fluxes of CO_2.

Disbenefit in Risk to the Public

82. All activities carry a risk and there is no guarantee of absolute safety. Risk may be defined as the product of the probability of an event occurring and the consequences of the event. Thus for example, an activity with a high probability of occurrence, the consequence of which is death, is a high risk activity. An activity with a low probability of occurrence, the consequence of which is a minor injury, is a low risk activity. The acceptability by a person of a risk depends on whether the risk is taken voluntarily by the person because of the personal benefits or is

imposed on a person without the person receiving any benefit for the imposition of the risk.

83. The Health and Safety at Work Act 1974 applies to all work activities in Great Britain including land based wind farms. The act states that "*It shall be the duty of every employer to ensure, so far as is reasonably practicable, the health, safety and welfare at work of all his employees*" and "*It shall be the duty of every employer to conduct his undertaking in such a way as to ensure, so far as is reasonably practicable, that persons not in his employment who may be affected thereby are not thereby exposed to risks to their health or safety*". The Health and Safety Executive (HSE) favours a risk-based approach to safety and emphasises the role of risk assessment, both quantitative and qualitative, in the decision-making process and in determining the control measures that must be put in place for addressing hazards ('Reducing risks, protecting people' (R2P2); Appendix 18). As the appellant is an employer, the risks to the public arising from its industrial facilities must be determined and be shown to be acceptable or tolerable and as low as reasonably practicable.

84. Under the Town and Country Planning (Environmental Impact Assessment) (England and Wales) Regulations 1999, the proposal is a Schedule 2 installation under the energy industry category (i) which covers "*Installations for the harnessing of wind power for energy production (wind farms) if (i) The development involves the installation of more than 2 turbines; or (ii) the hub height of any turbine or height of any other structure exceeds 15 metres*". For Schedule 2 developments, Schedule 3 Regulation 4(5) states that "*The*

characteristics of development must be considered having regard, in particular, to (f) the risk of accidents, having regard in particular to substances or technologies used". The proposal is a Schedule 2 installation under the energy industry category (i) and therefore the risks of accidents must be considered.

85. 'Reducing risk, protecting people' (R2P2) has been produced by HSE to "*help reassure the public that risks to people from work activities are properly addressed, taking due account of the benefits of the activities giving rise to the risk. In particular to satisfy the public that industry, in taking advantage of technological advances and in responding to economic pressures, will not be allowed to impose intolerable risks on people*".

HSE:

- "*decides, from the information gathered in going through the decision-making process, how precautionary our approach will be when determining where the individual risk and societal concerns i.e. on the Tolerability of Risk (TOR) geometry;*
- *concentrates on ensuring that duty holders must have in place suitable controls to address all significant hazards arising from their undertakings;*
- *starts with the expectation that those controls should, as a minimum, implement authoritative good practice precautions (or achieve similar standards of prevention/protection), irrespective of specific risk estimates*".

HSE:

- "*regard a hazard as significant unless past experience, or going through the decision making process described earlier, shows the risk from it to be extremely low or negligible when compared to the background level of risk to which people are exposed, and the hazard does not give rise to societal concerns;*
- *consider as authoritative sources of relevant good practice those enshrined in prescriptive legislation, Approved Codes of Practice and guidance produced by Government. We would also consider including as other sources of good practice, standards produced by Standards-making organisations (e.g. BS, CEN, CENELEC, ISO, IEC, ICRP) and guidance agreed by a body representing an industrial or occupational sector (e.g. trade federation, professional institution, sports governing body). Such considerations would take into account that HSE is a repository of information concerning good engineering, managerial and organisational practice, and would also include an assessment of the extent to which these sources had gained general acceptance within the safety movement*".

86. The Tolerability of Risk (TOR) is a framework for reaching decisions on whether risks from an activity or process are unacceptable, tolerable or broadly acceptable. In this context, 'tolerable' does not mean 'acceptable'. It refers instead to a willingness by society as a whole to live with a risk so as to secure certain benefits in the confidence that the risk is one that is worth taking and that it is being properly controlled.

87. However, it does not imply that the risk will be acceptable to everyone, i.e. that everyone would agree without reservation to take the risk or have it imposed on them. HSE starts from the position that, for every hazard, a suitable and sufficient

risk assessment must be undertaken to determine the measures needed to ensure that risks from the hazard are adequately controlled and suitable controls must be in place to address all significant hazards.

88. R2P2 suggests that the boundary between broadly acceptable and tolerable risk of death is 10^{-6}/yr because this level of risk is small when compared to the background level of risk. The boundary between tolerable and unacceptable for members of the public who have a risk imposed on them is 10^{-4}/yr. However R2P2 states that "*hazards that give rise to such levels of individual risks also give rise to societal concerns and the latter often play a far greater role in deciding whether a risk is unacceptable or not*". Such a high level of risk of death of a member of the public would not be tolerated and a realistic figure of 10^{-5}/y is considered to be a tolerable level of risk, provided the risks are as low as reasonably practicable (ALARP) and are maintained ALARP.

89. In summary, risks in the broadly acceptable region are insignificant and warrant no action to reduce the risks further. Risks in the tolerable region are tolerated provided the nature and level of the risks are properly assessed and the results used properly to determine control measures, the residual risks are not unduly high and kept ALARP and the risks are periodically reviewed to ensure that they still meet the ALARP criteria. Risks in the unacceptable region are generally unacceptable whatever the level of benefit.

90. In addition to the risk of death to a member of the public, the other potential risks to society should be considered in a risk assessment. It is normal practice for the

developer to provide a risk assessment since only the developer has the detailed knowledge of the facility and how it will be operated.

91. The hazards arising from operation of a wind farm must therefore be examined and the risks to the public must be demonstrated to be broadly acceptable or tolerable and ALARP and maintained ALARP throughout the lifetime of the wind farm. It is therefore incumbent on the developer to demonstrate that the risks from operation of the wind farm are broadly acceptable or tolerable and to demonstrate the procedures to ensure the risks remain ALARP throughout the lifetime of the wind farm.

92. The BWEA has produced guidelines for health and safety in the wind energy industry (Appendix 19). The guidelines state at section 7.3 that "*This section focuses on the need to ensure that potential risks to non industry personnel e.g. members of the public, are addressed throughout the life phases of projects and that residual risks are acceptable when compared with people's expectation of day to day risk exposure*". The guidelines also state that "*The project development process requires identification of hazards and management of risks to public safety. Risk assessments shall combine consideration of the hazard presented by the specific installation/location (taking due account of all risk control measures) and the nature and frequency of public exposure. The process must provide assurance that the risks from the proximity and layout of turbines in relation to areas used by the public are acceptable*". Furthermore, the guidelines state that "*For wind farm schemes in the process of development, it is recommended that the Environmental Assessment accompanying the planning application includes a*

section on public safety considerations, stating how it is intended to address the above aspects".

93. Risks from wind turbines have not been publicly addressed by the wind industry. However, the Caithness Wind Farm Information Forum (an independent campaign group) maintains up-to-date information on wind farm accidents taken from press reports or official information releases (Appendix 20). Up to the end of 2008, 560 accidents were recorded worldwide, of which 52 accidents resulted in a total of 57 fatalities. 29 accidents involved injury. The most common accidents were blade failure (139 incidents) followed by fire (110 incidents). I have been unable to obtain any operational experience feedback (OEF) and so cannot comment on how the wind industry reacts to accidents. There is no trade body information available.

94. Modern wind turbines are probably the largest industrial facilities with such large and unprotected rotating mechanisms and as such, present a risk to the public. The major types of accidents at operating turbines, and thus the hazards to the public that must be addressed are:

- blade failure
- fire
- structural failure
- ice buildup
- Lightning strikes.

This list does not identify the causes of the accidents. For example, blade failure may result from the effects of fatigue as discussed at paragraph 39, but it may also be the result of:

- control system failure
- a design error
- a manufacturing error
- a technician or other human error.

The above list of hazards is not exhaustive, for example it does not include risks to health due to noise or shadow flicker. It is incumbent on the developer to produce a list of all hazards. The rate of occurrence of accidents is increasing, reflecting the increased number of installed turbines. However the accident frequency rate is not known. The increased size of turbines now being deployed is judged likely to increase the accident frequency rate. More detail on the above five hazards is provided in Appendix 21.

95. All wind farm applications that require an environmental impact assessment should be accompanied by a risk assessment to demonstrate that the risks to the public are broadly acceptable or tolerable and that the risks are ALARP and are maintained ALARP throughout the life of the wind farm. In the case of Den Brook, there are several neighbouring properties, a railway line and public roads that are at risk from the wind turbines. Without the results of a risk assessment, the planning balance cannot be judged. The appellant has not carried out a risk assessment of the proposal.

96. Section 12.4.of the ES addresses safety. It states "*Safety of the public is of paramount importance to RES".* There is a general discussion of some of the hazards arising from operating wind turbines, including blade failure, lightning strike and ice throw. However, if a risk assessment has been carried out, in the way that the HSE advises (Appendix 22), then further hazards, such as structural failure, would have been identified.

97. Section 12.4.19 of the ES is entitled 'Risk Assessment'. It states *"As for any mechanical or electrical installation, wind farms could pose a safety risk if not managed and maintained correctly. However, under the Construction (Design and Management) Regulations, detailed risk analysis and avoidance limitation measures are required for every facet of the development and operation of a wind farm. These measures would be contained in the Health and Safety file for the site, which would be open to inspection by the Health and Safety Executive. All site personnel will have full safety training, to ensure an absolute minimal risk of accidents occurring. Electrical installation will be to standards and recognised codes of practice with adequate signage and protection*". The guidelines of the BWEA given above at paragraph 87 have been followed in that section 12.4 of the ES includes a section on public safety. However, the results of the risk assessment (risk analysis) for the operation of the wind farm have not been included in the ES. Instead it is merely stated that "*no effect on public safety is anticipated from the proposed wind farm*". This statement is false, since there can never be an assurance of absolute safety. The risks to the public arising from the proposal must be determined and be shown to be acceptable or tolerable and must be shown to be ALARP.

98. It is evident that the manufacturers of wind turbines recognise that there are significant hazards associated with operating wind turbines. For example, the Vestas operating and maintenance manual for the V90 3MW turbine (Appendix 23) states in the 'Safety Regulations for Operators and Technicians': *Do not stay within a radius of 400m (1300ft) from the turbine unless it is necessary. If you have to inspect an operating turbine from the ground, do not stay under the rotor plane but observe the rotor from the front.* It is thus recognised by the wind turbine manufacturer Vestas that there is a risk to anyone within 400m of a Vestas V90 turbine. In particular, the manual states: "*Make sure that children do not stay by or play nearby the turbine*". No explanation is provided for the 400m radius or for the instruction not to stay under the rotor plane. However I judge that this is due to the hazards identified above, particularly that of blade failure. There is no evidence that the Vestas V90 3MW wind turbine is inherently more unsafe than other modern industrial wind turbines and thus it is judged that all industrial large-scale wind turbines are likely to present similar hazards.

99. A recent event at a wind farm in Cumbria high-lighted one of the potential hazards. EON.UK requested the creation of a 500m 'safety zone' around the Askam Wind Farm because of equipment failure at one of the turbines together with forecast high winds (Appendix 24). In that incident, it was recognised that equipment failure could have resulted in blade failure until the repair was complete and that because of forecast high winds, there was the potential for blade failure with the resultant debris being scattered a considerable distance.

100. Inspection of Fig 2 of the Non Technical Summary of the 2005 ES shows that turbines T6 and T8 are about 100m and 90m respectively from a railway line. The railway is mainly used to run a tourist steam train at weekends, and its use is likely to increase in the future. Both turbines, at a tip height of 120m, are well within fall-over distance of the railway line and there is no evidence that micro-siting will improve the siting of the turbines relative to the railway line. Paragraph 38 discussed the impact of the wake effect on downwind turbines and the increased probability of fatigue-induced blade failure. Inspection of the fatigue-vulnerable turbines shown in fig 2 of the Non Technical Summary 2005 identifies T2 and T6 being in close proximity to the railway line. Turbine T3 is approximately 140m from a public lane and T6 is approximately 90m from the site boundary and thus from a neighbouring property.

101. Inspection of fig 1 (site boundary) and fig 3.1 (turbine layout) of the Non Technical Summary indicates that the layout of the turbines within the site boundary has been based solely on maximising the number of turbines that can be accommodated within the site boundary to maximise the energy generation. Were safety the major factor on which the layout had been chosen, then turbines T2, T6 and T8 would not have been included in the proposal, thereby reducing the risk to the railway line and adjoining property. The remaining six turbines could then have been relocated with an acceptable separation, to minimise wake and fatigue effects.

102. Devon County Council's position on siting of turbines is given in a letter to Torridge District Council (Appendix 25). They state that "*No turbine should be erected*

closer than 600 metres from any sensitive property and *it may be advisable to achieve set-back from roads of at least fall over distance, so as to achieve maximum safety*" and "*The British Horse Society has suggested a 200 meter exclusion zone around bridle paths to avoid wind turbines frightening horses. While this can be deemed desirable, it is not a statutory requirement and some negotiation should be undertaken if this difficult to achieve*".

Conclusions

103. The Den Brook site is one of very poor wind resource which should not be considered as a suitable location for a wind farm.

104. The benefit in terms of CO_2 emissions savings has been over-stated by the appellant by a factor of at least 3.6. The benefits of the proposal would at best be miniscule and may even be non-existent. At best the benefits would be insignificant in comparison to the disbenefits presented in other evidence to be presented to this inquiry.

105. The appellant has not presented evidence to show that the requirements of the Health and Safety at Work Act 1974, namely to ensure that, as far as is reasonably practicable, members of the public who may be affected are not exposed to risks to their health or safety, are met. There would be risks to the public and neighbours from the proposed wind farm. The appellant has not shown what the risks would be and has not demonstrated that the risks would be acceptable, would be ALARP and would be maintained ALARP. The disbenefit to

the public in terms of risk may be considerable, but the risk has not been quantified by the appellant.