

UK WIND ENERGY RESOURCE

VARIABILITY

INTERMITTENCY

DISPERSAL

A REVIEW PAPER

By Edward M Reeves

FOREWORD

The three parts of the paper that follow were written before the publication of the DTI March 2006 Energy Trends and before the publication of UK Energy Research Centre's paper 'The Costs and Impacts of Intermittency'.

'Energy Trends' has a section starting on page 28 entitled UK Onshore Wind capacity factors 1998-2004. This exercise demonstrates clearly the lack of data available to decision makers. It is patently absurd to quote a capacity factor for Eastern England and Lincolnshire based on less than a handful of sites clustered in the eastern most part of the region.

Although the rationale for reviewing old research papers can be challenged, UKERC's Report is an elegant but misleading statement on the problem of intermittency/variability which they have not satisfactorily delineated. In reading the preliminary papers it is clear that they have not answered the questions that they themselves posed. Many of the assumptions on wind speeds and capacity factors are not borne out by careful objective scientific analysis, a fact that must nullify the conclusions reached.

The principle unanswered question is "Does the Met Office weather data properly reflect windfarm outputs"? The answer is that in the hands of the Environmental Change Unit it must be a resounding 'no'. But with an appropriate formula arrived at following proper debate it could be made to do so. It is surprising that this has not been done already.

Recent work conducted within the Environmental Change Unit at the University of Oxford by Mr Graham Sinden appears to have been accepted without sufficient critical examination and this work has been ill advisedly used to validate many conclusions of the UKERC's Report. If Mr Sinden has ever disclosed the detail of the methodology used, it would have been useful to have had that included in the Report². In the past Mr Sinden appears to have avoided a simple statement of the process used.

It seems that like, Mr Sinden's work, the UKERC Report has been designed to fulfil a purpose. Is it a case of 'he who pays the piper calls the tune'?

The use of old wind speed data is far too convenient in the cause of justifying large windfarms. It is strange that widely known information is ignored by the eminent group that form the UKERC. The last two winters have demonstrated adequately enough that winter high pressure periods are with us, possibly to stay. Any serious analysis must take this recent data into account. An explanation as to why it wasn't should be given by UKERC to justify the use of public funds. The same funds are used to support research by meteorologists and climatologists based on scientific research and analysis and not based upon "empirical" evidence as seems to be implied in Box 2.8 of the Report. Why have these papers not been part of the review process?

Turning to specific criticisms:-

1. The capacity factors have been exaggerated. Mr Sinden bases his research on the assumption that an average capacity factor of 30% across the whole of the UK is a scientific certainty, which it is not, and he then adjusts his figures to fit this hypothesis. The conclusions about high and low wind speed events are therefore wrong.
2. The argument is put in the UKERC's report that a CF of 35% is reasonable because half the future capacity is expected to be offshore. The data coming in from OFGEM's

ROCs database suggests that on the basis of what has actually been produced, a CF of 35% will not be achieved for offshore windfarms, let alone for a combination of offshore and onshore. The data is still sparse and there are in reality only two windfarms with any useful records, North Hoyle on the west coast and Scroby Sands on the east. Their combined CF is about 35%³ currently but the statistics available include a bias to winter months in a period from September 2004 to December 2005. The latter is the latest date for which statistics are available. The former is the first date where representative figures are available, both being fairly new installations. It is acknowledged by many, Hugh Sharman⁴ included, that the production offshore is more 'spiky' than onshore.

3. Claims made about the percentage of time that turbines will operate are too high. "Wind power sites typically generate electricity for around 85% of all hours"¹. An exercise based on hourly wind speed readings taken over a year to the end of February 2006 shows a very different result. On the basis that turbines start generating electricity at 4 metres per second: then on an average over 66 Met office sites, the notional turbines would be working for 70% of the time. If the wind speed is increased to a more accurate 5 m/s the percentage goes down dramatically.
4. The statement with regards to calm days is irrelevant. The number of days where minimal electricity will be produced by windfarms across the UK is significant. It is misleading to say that the "wind resource is available 100% of the time"¹. The main interest should be in seeing graphically or numerically what the likelihood is of significant production and its stability.
5. The claims as to the accuracy of wind speed forecasting are not substantiated.
6. Unsubstantiated claims with regards to the windiness of the UK, Scotland, offshore and by implication everywhere, need to be reviewed.
7. The claims made for the benefit of diversification over a large geographical area are exaggerated. "A diversified UK wind power system would generate electricity for 100% of all hours"¹. The bar charts in the following paper speak for themselves.

In the absence of reliable data, the following paper defines a theoretical exercise to test the claims, seldom backed up with data, as to the wind resource of the UK and its regions individually. It has to be theoretical as existing data is limited and not appropriate for wide application. The wind power companies consistently refuse to release information from their permanently or temporarily installed anemometers.

"Ultimately, informed energy policy decisions will only result from clear, accurate information".¹

The paper that follows is an attempt to put some flesh on what otherwise remains skeletal. I am wholly in agreement with the statement made by UKERC "Reporting of 'average' wind speeds provides an incomplete and possibly misleading picture. More emphasis should therefore be given to when winds are within turbine operational limits".

The UKERC Report has been informative as to how the grid could work in the future although not fully reassuring as to how it will actually work. The paper that follows may not fully reflect the author's increased knowledge of the grid system gleaned therefrom.

Notes:-

1. Graham Sinden to Intermittency Stakeholder Group 5 July 2005.
2. "Our research also revealed a relatively limited attention to accessible exposition of principles in the literature." UKERC Report.
3. The February 2006 Study by The University of Edinburgh 'Matching Renewable Electricity Generation with Demand' puts forward offshore capacity figures for Scotland in the range of 34.1 to 35.8%. The latter figure being dependent on the exploitation of the higher wind resource of the north and west coasts.
4. See his Powerpoint presentation available on the UKERC website.

PART 1

INTRODUCTION to Papers on

UK (Mainland) Wind Resource (Part 2)

and a site specific investigation of the

Wind Resource in the UK Midlands (Part 3)

There is an urgent need for an up to date analysis of the prospects and economics of wind energy. Past research has been largely based on extremely optimistic assessments of production. Many calculations have been based upon achieving a Capacity Factor of 35%. The following papers show definitively that this figure is much too high leading to overestimates of production. More importantly, the cost of production has been hugely underestimated and the cost of the necessary infrastructure has been largely ignored. The former will fall mostly on the consumer via the ROCs system¹. Whereas the latter will fall on an uncertain mix of consumers and taxpayers². These extra costs have the potential to undermine the competitiveness of all UK industry.

In an attempt to understand the claims and counterclaims made about the usefulness of electricity produced by wind, detailed studies of wind speeds have been undertaken.

These studies have taken place in two sections using data supplied by the Met Office. The purpose of the first study (Part 2) is to look at the broader national issues. The second (Part 3) relates to a specific site in North Bedfordshire where a planning application has been made for nine 125 metre high turbines with a rated capacity of 2.3 mw each. The latter paper also raises important issues of national consequence.

The most important questions in determining the merits of wind energy are:- How much electricity will a given turbine or windfarm produce, and when? The first element of the question can be answered by calculating the Capacity Factor (CF). The CF is the actual (or in the case of this exercise, estimated) amount of electricity produced over a given period expressed as a percentage of the rated capacity. The rated capacity is calculated as the maximum level of production achievable in ideal circumstances. The second element can only be answered by taking frequent wind speed readings. How frequent these readings need to be for this purpose is in part related to how quickly back up systems can be called in to cover for windfarms when the wind ceases to blow. For the purpose of this exercise hourly average readings as supplied by the Met Office have been used.

Wind energy proponents correctly state that using longer term averages than hourly wind speeds to calculate a CF gives a false figure. They argue that frequent readings of wind data are necessary because output increases very rapidly as the wind speed increases. Output is determined at the cube of the wind speed. Developers rarely make data available from their anemometers so other means have to be found to test the claims of the wind industry as to average CFs, numbers of houses supplied, carbon savings and all other calculations dependent on the output. As developers themselves dispute the best efforts of the UK Department of Trade and Industry (cf Digest of UK Energy Statistics) to produce accurate CFs, it is reasonable to question their claims – rarely supported by evidence.

The wind industry usually uses an average CF of 30% or more in its publications. However, it is known that the figure extracted from the Ofgem ROCs returns for onshore mainland sites is about 24%. It has to be recognised that this OFGEM data relates to the first batch of wind farms developed on cherry picked sites. The more recent developments and proposals often relate to much less windy sites. The exception to this general rule are the mountainous areas

of northern England, Scotland and Wales, where it seems considerations such as the environment, scenic beauty, accessible wilderness and tourism are too readily sacrificed in order to accommodate windfarm development of dubious usefulness. It is true that higher wind speed can be obtained by siting turbines on conspicuous mountain tops and on islands. But the question has to be asked: Do any benefits outweigh the damage caused? The public has a right to honest answers to this question. When the Brundtland Commission produced its report "Our Common Future" nearly twenty years ago, local environmental impacts were considered one of the four key elements of energy sustainability. They still are.

The site specific study provided here, Part 3, suggests a CF for an inland site of 16.7% for 2005 before allowing for any down time. The methodology used was to assume the presence of one Nordex N90³ with the CF calculated using Met Office data from a nearby weather station and the manufacturer's claimed power curve with a due allowance for wind shear, and terrain differences, by increasing the wind speed by 16%. This was done hourly over the whole of 2005. The average wind speed for 2005 was compared with wind data for the last five years which demonstrated that the winds in 2005 were slightly above the average for that period. This result was examined against longer term data.

The 1980s and 1990s were slightly more windy than the past five years: it is possible that the UK is at the beginning of a statistically defined long term downturn in wind speeds. In order to assess wind energy potential, the most appropriate data must be that gathered from the last few years. The DTI wind speed database⁴ is out of date and should not be relied upon, as Part 3 demonstrates.

In order to look at the national picture, it has been assumed in Part 2 that all 66 mainland Met Office stations have a Nordex N90³ at the site and then the CFs have been calculated daily at 7.00 pm (1900 hours) from the 1st March 2005 for a year until 28th February 2006. The average CF of 18.7%, before allowing for any down time, is much lower than previously anticipated (although the Chairman of the Policy Committee of the World Renewable Energy Network and Congresses suggested a figure close to 18% was likely when first asked to look at development potential). Another fact is that when the nation really needs electricity in the depths of winter the CFs for Scotland were below those for the rest of the UK excluding Scotland. Note 3 to Part 2 sets out the detail.

The hourly charts in Part 2 demonstrate the extreme unpredictability at a national level of the electricity produced by wind, in a system that needs to be balanced. This intermittency makes electricity produced by this means virtually worthless.

Proposals to upgrade the grid system at great expense to transport an unreliable product are unsound; where up to 15% will, in any event, be lost on the way to the point of demand.

It is regrettable that recently published 'research' sponsored by government is misleading and with uncertain methodology. The public has a right to fair, objective and scientific information on a subject of the utmost importance involving global warming, the price of electricity, and the visual and other impacts on landscapes. The burden of the extra cost of wind produced electricity will hit both domestic consumers and industry alike. However, it seems that the Government is not yet prepared to give up its role of funnelling consumer's and taxpayers' money to the British wind industry. For example, Mr. Malcolm Wicks' (Energy Minister) comments, following the publication of the DTI funded paper entitled "Wind power and the UK wind resource" produced by Graham Sinden of the Environmental Change Institute, University of Oxford. See <http://www.eci.ox.ac.uk/renewables/UKWind-Report.pdf>

This paper was followed by a press article to be found on:- <http://www.eci.ox.ac.uk/lowercf/renewables/UKWindResource-EnergyPolicyPaper.pdf>.

Malcolm Wicks' claim that myths have been exploded by this paper is way off the mark. It is worrying that so much unsubstantiated data, and the claims based on it, are presented as scientific fact. This is doubly worrying when there is an energy review being undertaken by government. Where are the necessary critical faculties and knowledge in place needed to make decent decisions? *The ETSU Section of the DTI has been disbanded and it is believed that most of the employees now work for private organisations that work in variably for the wind industry.*

Numerous energy specialists and other scientists take issue with the validity of data used in Sinden's paper, and therefore the conclusions, for the following reasons.

1. Using data for the period 1970 to 2003 gives a false impression as the wind speeds prior to 2001 are generally higher on average. There is a cycle that can be related to centuries of past data that suggests that we are at the beginning of a periodic decline in wind speeds that could last decades.
2. There have been a number of adjustments made to the raw Met Office data. One adjustment is to calculate a shear factor to allow for a turbine hub above ground level. This could be perfectly valid but must be treated as unscientific until the formula for this adjustment is disclosed. Despite personal email contacts with and requests to Graham Sinden this information has not been forthcoming.
3. There is another adjustment made that defies belief and which certainly invalidates the use of Met Office data. Again there is no complete explanation of the methodology. The written word states " Each site was classified on the basis of being coastal, inland or island, and being located in southern, central or northern UK. Based on this categorisation, and by referring to the European Wind Atlas (Riso 1989), the wind speed at each site was corrected to achieve a regionally appropriate annual capacity factor (CF) with the average of all 66 sites achieving a predetermined UK average annual CF of 30%". The analysis appears to have been carried out to obtain the required result. Inspection of the European Wind Atlas and the extremely coarse classification used is not suitable for the analysis undertaken. From the Ofgem ROC Register it can be easily be discerned the microclimate superimposed on the general meteorological conditions probably has more influence on windfarm production than the overall conditions alone.

The wind atlas is out of date and inaccurate; it generally overstates the wind speeds. The other part of the adjustment is to take a predetermined UK CF (based on wind industry hype) and adjust the wind speeds to fit. This exercise defies basic scientific principles.

4. Papers and calculations described in Part 2 show that mainland Scotland has in the last few months had lower CFs than the overall UK average.

Parts 2 and 3 give a very different results compared to Sinden's papers, producing CFs substantially below 30%, in the case of the inland site about half. The power supply is intermittent as demonstrated by the figures and charts, and is much more volatile than he claims. Sinden's papers need to be subjected to proper scientific review and policy makers should be made aware of the flaws. The same approach should be taken to many of the

misleading claims made by, or on behalf, of wind energy companies. The National Grid operates on 30-minute time slots; it is the effect any change in output of wind turbines during these time slots which needs to be transparently assessed. Yearly averages are not an appropriate tool to use when assessing the operation of a system which has to be balanced in real time.

Notes

1. Whether or not the Renewable Obligations system is a tax is debateable: what is certain is that it is not under the appropriate scrutiny of Parliament. This is a matter being currently looked into by the National Audit Office and other professional bodies.
2. Consideration needs to be given to the new and insidious use of lottery money to support wind energy development.
3. The affect on Council Tax and general taxation may also be indirect in that government, both local and national, will be hit by higher electricity prices which will in turn cause the tax to be increased. It has been reported that 58% of the workforce in Scotland work in government related jobs. It is the productive 42% who are ultimately going to have to pay the price.
4. The Nordex N90 is one of the most highly developed and efficient turbines available and is the machine of choice for the developers of Airfield Farm.
5. The Dti windspeed database relies on the NOABL mathematical model to extrapolate measured values for each 1km grid square. The measured values were obtained between 1975 and 1984 and the model consistently outputs average values which are 1m/sec higher than the WasP model.

PART 2

UK (Mainland) Wind Resource

In order to be able to evaluate the wind resource across mainland UK, it has been assumed that all 66 mainland Met Office stations have a Nordex N90¹ erected on the site. The CFs have then been calculated daily at 7.00 pm (1900 hours) using the average for that one hour from the 1st March 2005 for a year until 28th February 2006. Wind speeds from the 66 Met Office sites plus 25% to allow for shear² have been used to calculate the CFs on a daily basis.

The average CF of **18.7%**, before allowing for any down time, is much lower than previously anticipated. An interesting statistic is that when the nation really needs electricity in the depths of winter, the CFs for Scotland were below those for the rest of the UK excluding Scotland³.

The charts above are backed by daily spreadsheets with monthly and yearly summaries. These summaries will be made available shortly on the CLOWD Website:- <http://www.clowd.co.uk>

The monthly figures demonstrate the flattening of peaks and troughs inherent in using longer time frames.

A CF of 18.7% (without any deductions for down time or for any other reason) is about half that claimed by the wind industry and significantly below the UK onshore CF 5Year average (2000-2004) provided by DTI in the "Digest of UK Energy Statistics 2005" (Table 7.4, page 188) . The chart also shows that the unpredictable peaks and troughs of the supply indicating the severe problems of integrating wind energy in a grid system. On one occasion the average CF across the whole country dropped from 83% to 9% in 24 hours. This important point identifies why wind energy can only ever be considered as an additional energy conversion technology and is unlikely to replace firm sources of generation. It is also the basis of work done by Michael Laughton, Lewis Dale and Hugh Sharman.

A CF of 18.7% is a very different result to most previous research papers on the subject; in other words, nowhere near a capacity factor of 30% to 35% (these figures are after allowing for stoppages).

The power supply is intermittent as demonstrated by the figures, and is much more volatile than is generally admitted. Arguments to the effect that clustering and national diversity will reduce variability to an acceptable level are not sound.

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Figure 1.

Daily (@1900 hrs) Capacity Factors at 66 Met Office UK Mainland Stations over a year.
Average= 18.7%

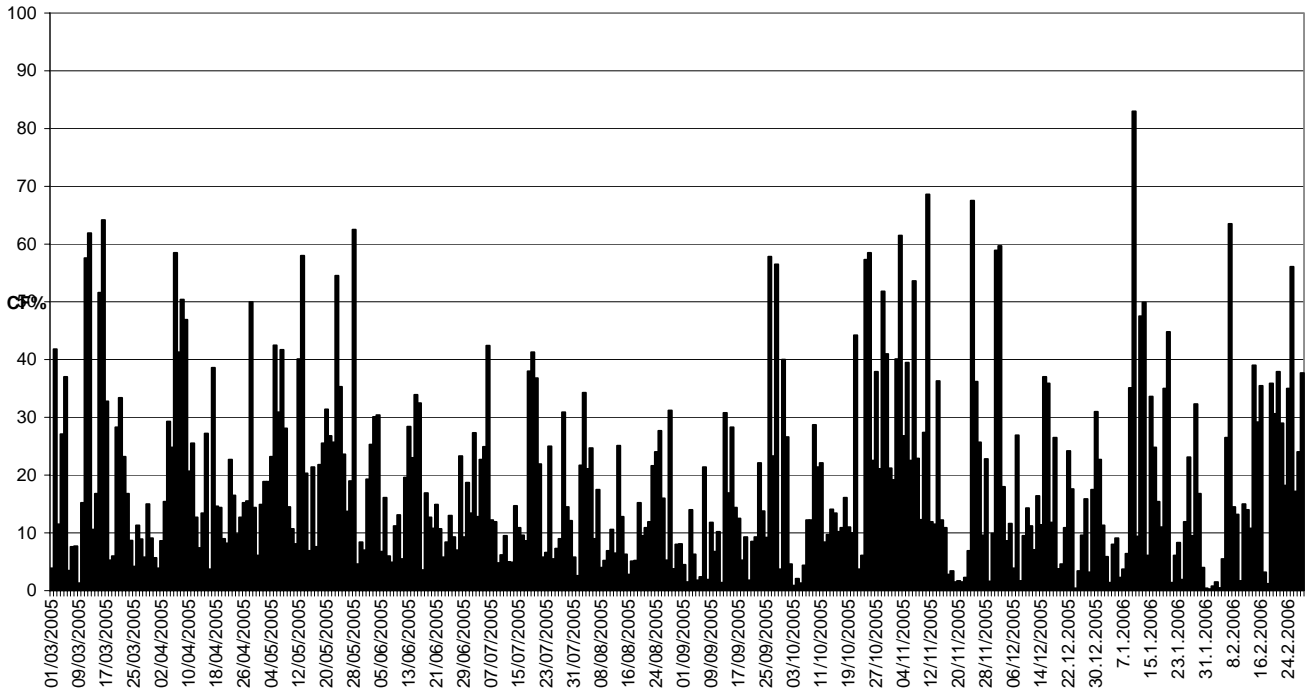
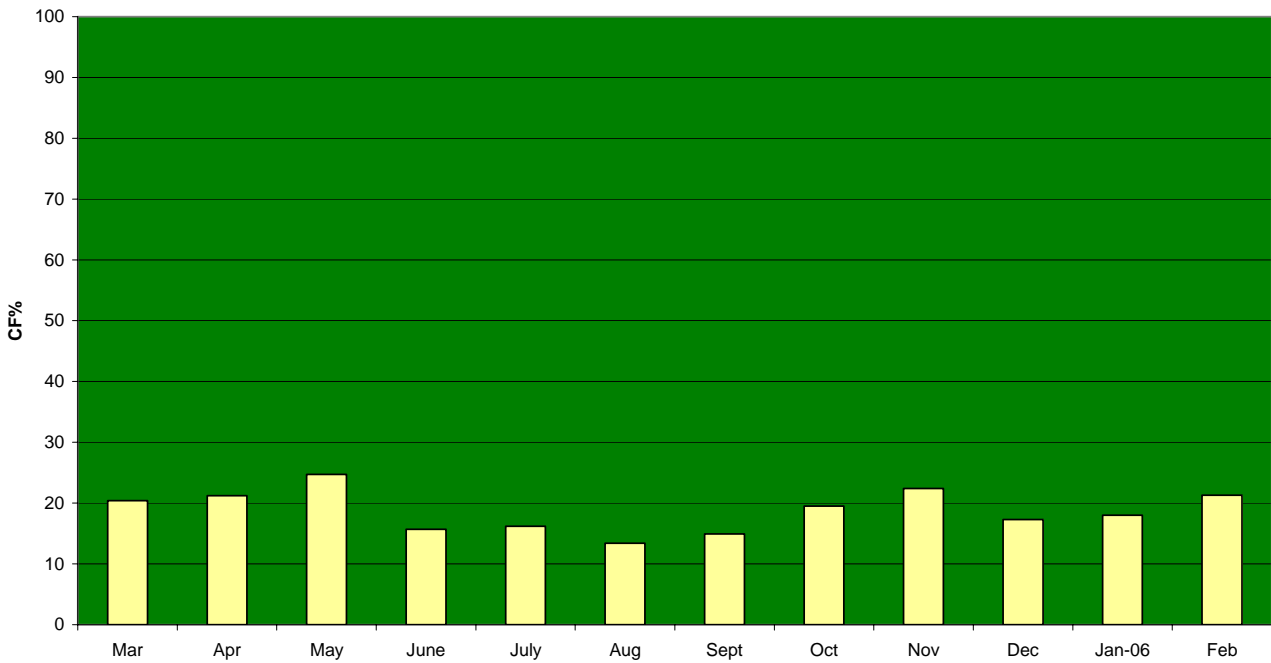


Figure 2.

Average Monthly Capacity Factors at 66 Met Office Mainland Stations
Annual average for a Year commencing 1st March 2005 is 18.7%



Notes

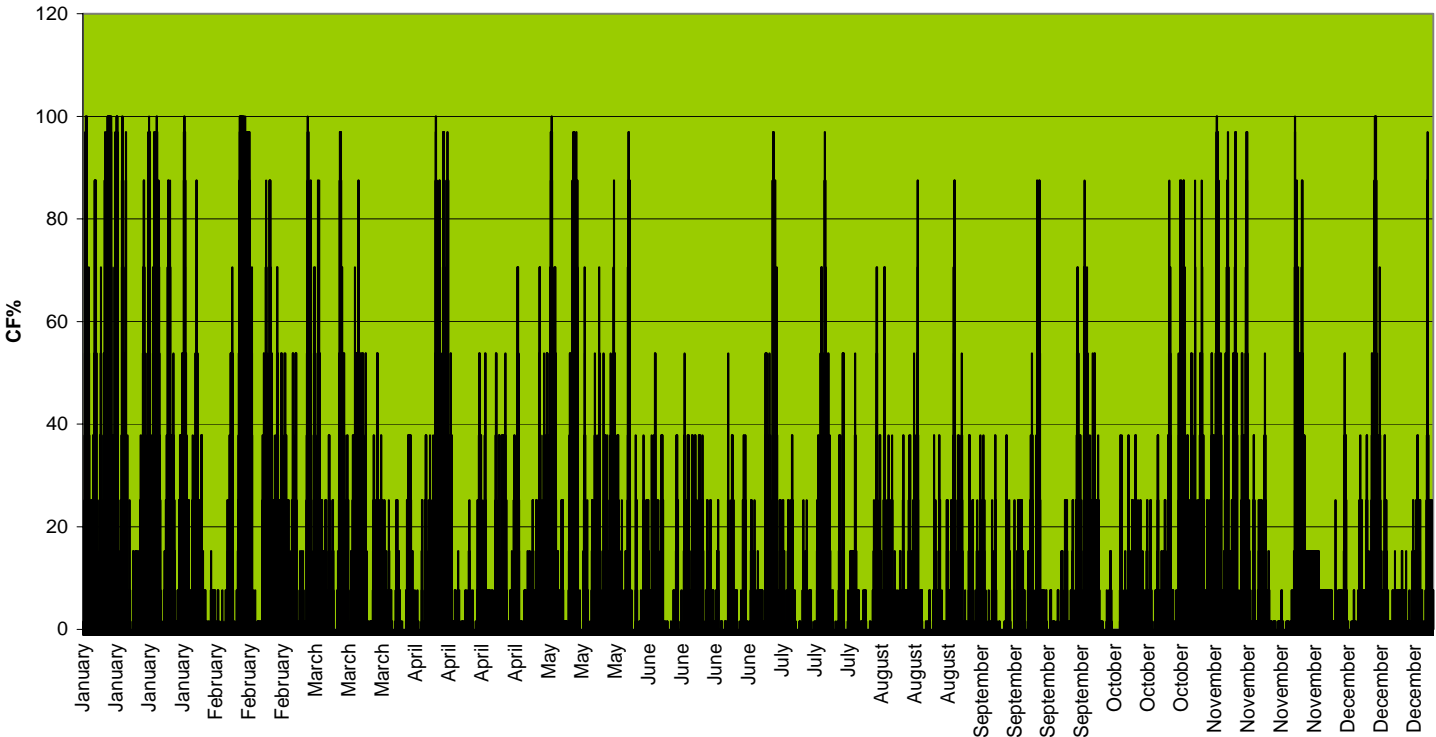
1. The calculations use figures taken from the Power Curve shown in Nordex N90's brochure and are assumed to be accurate.
http://www.nordexonline.com/e/online_service/download/dateien/PB_N80_GB.pdf
2. Wind speed increases at higher altitudes. In the calculation of national CFs shown here there has been added a 25% increase onto the basic Met Office wind data to allow for wind shear. It is assumed that the MET Office figures were taken at 10 metres above ground level and that the height to the turbine hub is 80 metres. The 25% allowance was calculated using the Danish Wind Industry Association's Shear Calculator with a roughness level of 0.5. This equates to a flat open ground with few obstacles. This seems appropriate as Met Offices stations mostly seem to be situated on air bases.
See DWIA Website www.windpower.org/en/tour/wres/shear.htm
3. Comparing the 12 Met Office sites in Scotland with the other 54 in the rest of mainland UK shows that Scotland is not much more windy over a year, and was less windy in the important winter months this season. From 21st December 2005 to 28th February 2006 the CF for the 12 Scottish weather stations was 17.7% and the CF for the rest of the UK for the same period was 18.9%.

PART 3

Airfield Farm – North Bedfordshire THE CAPACITY FACTOR for a notional Nordex N90 (calculated using hourly Met Office wind speed measurements taken at their Bedford (Thurleigh) Station)

Figure 3.

Airfield Farm Hourly Capacity Factors for 2005
Annual Average CF = 16.7%



Just one chart demonstrates that this site is not windy and that the CF would be about half that claimed or implied by the developer Nuon UK Ltd and the wind energy industry in general. It also demonstrates that the supply would be highly irregular and intermittent.

The Airfield Farm wind factory proposal is currently the subject matter of a planning application to the Bedford Borough Council by Nuon UK Ltd and is awaiting determination.

Since Spring 2005 there has been an anemometer of about 60 metres in height at Airfield Farm, but the developers are refusing to make available any data from it. It seems that a planning committee will be asked to make a decision without adequate information on wind speeds. This is equivalent to making a decision on a new motorway without having any traffic flow information to justify the need for an intrusive new road.

In the absence of wind data from the Airfield Farm site, it is necessary to rely on data from the Met Office Station at Thurleigh which is 5 miles from Airfield Farm. The Thurleigh site is at 85 metres above sea level and the sites for the turbines at Airfield Farm are on average 95 metres above sea level. This would give an advantage to the Airfield Farm site of an increased wind speed of about 1.1% (see comments on shear factors below).

Met Office measurements are taken at 10m above ground level so it is necessary to calculate a shear factor to adjust¹ the wind speeds to those that can be anticipated at a turbine hub height of 80 metres. The easiest method of calculation is to use the Danish Wind Industry Association's (DWIA) Shear Calculator to be found on their web site (www.windpower.org/en/tour/wres/shear.htm). This gives a shear factor of 1.25 at Thurleigh, if a terrain roughness level of ".5" is used. This equates to an open airfield site without neighbouring hedges and trees. The roughness level at Airfield Farm should realistically be assessed at "1", or more, because there are many adjacent hedges and woods. Using 1 for roughness gives a shear factor of 1.16 when relating Airfield Farm to Thurleigh wind data. The DWIA website explains 'roughness' and other factors involved in calculating a Shear Factor.

Although these other factors need to be considered, they do in fact balance each other out when comparing the two sites i.e. Airfield Farm is on a slight slope but the turbines are increasingly in a valley or basin as they get near Hinwick Village.

In order to reflect the advantage of higher wind speed at an 80m hub height at Airfield Farm, but with increased terrain roughness, a shear factor of 1.16 has been used to increase the wind speeds in the spreadsheets showing Capacity Factors (CFs)². The statistics for January and February 2006 are summarised below and column charts are attached showing the CFs over the month calculated both as average daily figures and as average hourly figures. This demonstrates the levelling, or flattening, of the peaks and troughs when using daily averages (let alone monthly) rather than hourly. In order to evaluate the true level of 'intermittency' or 'variability' and to determine the usefulness of the electricity produced in the grid context, average hourly figures are crucial. Such figures emanating from the wind energy industry or government are noticeable by their absence. This paper is a limited attempt to fill the gap being constrained by the cost of getting hourly data from the Met Office.

The Charts below show the hourly CFs over the months of January and February 2006. It should be noted that no allowance has been made for any deductions for items shown in paragraphs 1. to 9. below, or for any other reason.

The important monthly statistics are:-

	January	February
Average wind speed at height of 10m	4.1 m/s	4.7 m/s
Average adjusted wind speed at height of 80m	4.8 m/s	5.5 M/s
The amount of electricity produced	244,527 kwh	327,513 kwh.
The Capacity Factor	14.3%	21.2%
The time when electricity was not produced	27.4% (48%)*	23.5% (35%)*

*The figures in bracket shows the more realistic percentage of time that electricity was not being produced where the first layer of production of 35 kwh is excluded because of the rounding effect on the wind speed data and to reflect the fact that turbines actually absorb electricity below a wind speed of 4 m/s. On this basis a turbine would only have been producing for just over 50% of the time in January.

It should be noted that viability is often said or implied to require a wind speed of 7 m/s or better. Nuon are expecting 7 m/s, as stated by their Mr. Piers Guy to the Wollaston Parish Council. See also the 2002 Report by Ecotec Research & Consulting Ltd to the Bedfordshire County Council entitled "Renewable Energy Policy and Guidance".

If a minimal 16% reduction of electricity produced is assumed for the reasons specified in 1. to 9. below, the CFs would be reduced to **12.3%** in January and 18.3% in February. Both are supposed to be windy months! *The figure of 16% for downtime can be justified using figures four element alone:-*

- i) 2% for repairs and maintenance*,
- ii) 2% for electrical losses within the windfarm*,
- iii) 8% for losses in grid transmission losses. *This figure is probably too low as there is an average system loss of 9% across the whole country.*
- iv) 4% for wake losses due to the 'Park Effect'*,

* These figures are in accordance with those quoted on page 19 of 'Matching Renewable Electricity Generation with Demand' produced by the University of Edinburgh February 2006.

There follow charts showing figures for January and February 2006. The charts are backed by daily spreadsheets with monthly and yearly summaries. These summaries will be made available shortly on the CLOWD Website:- <http://www.clowd.co.uk>

Figure 4.

Daily Average Capacity Factors at Airfield Farm for January 2006

Monthly Average = 14.3%

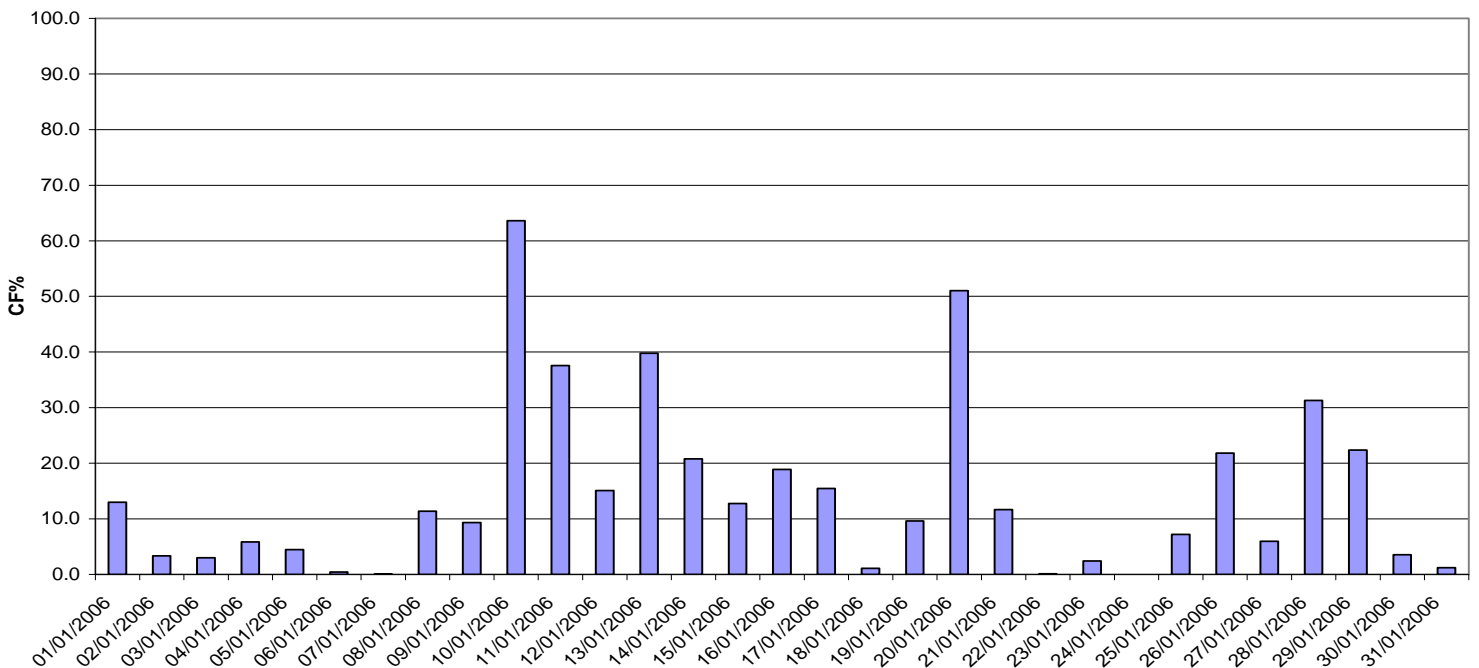


Figure 5.

Hourly Average Capacity Factor at Airfield Farm for January 2006
Monthly Average = 14.3%

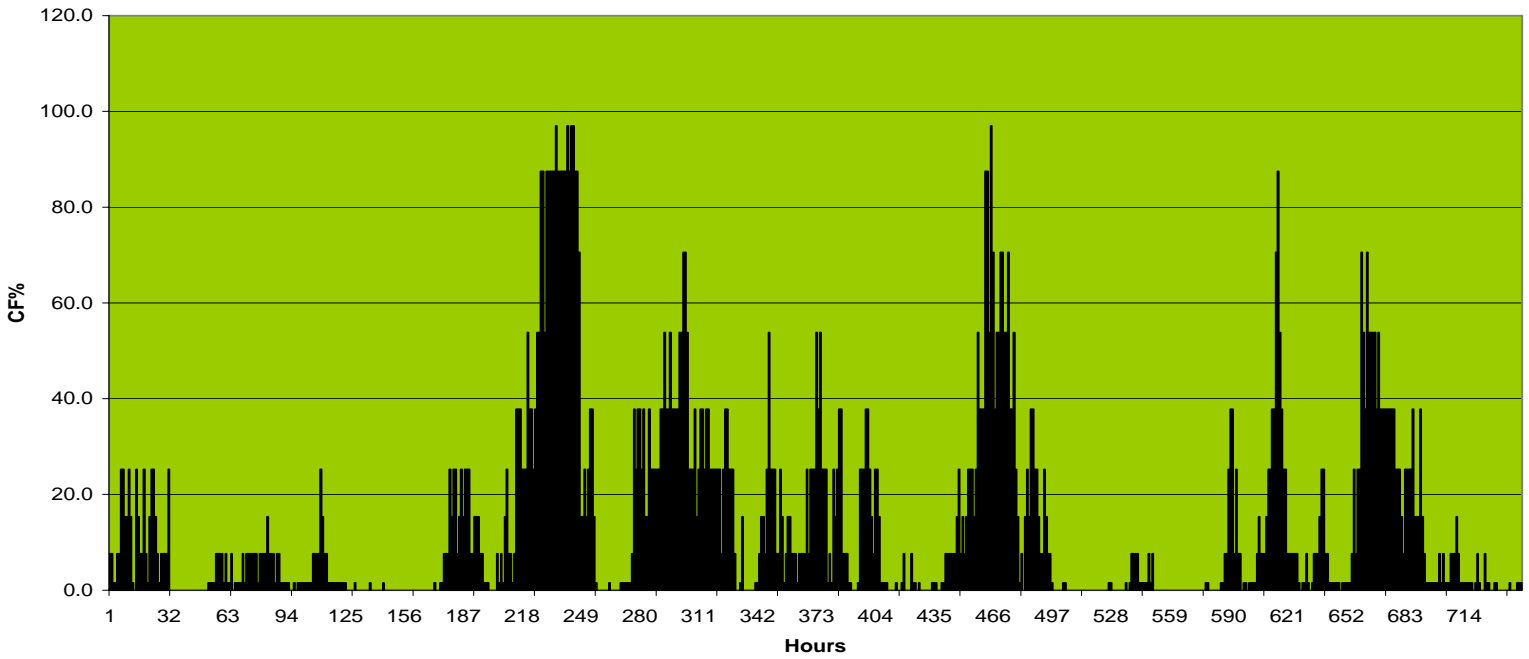


Figure 6.

Daily Average Capacity Factors at Airfield Farm for February 2006
Monthly Average = 21.2%

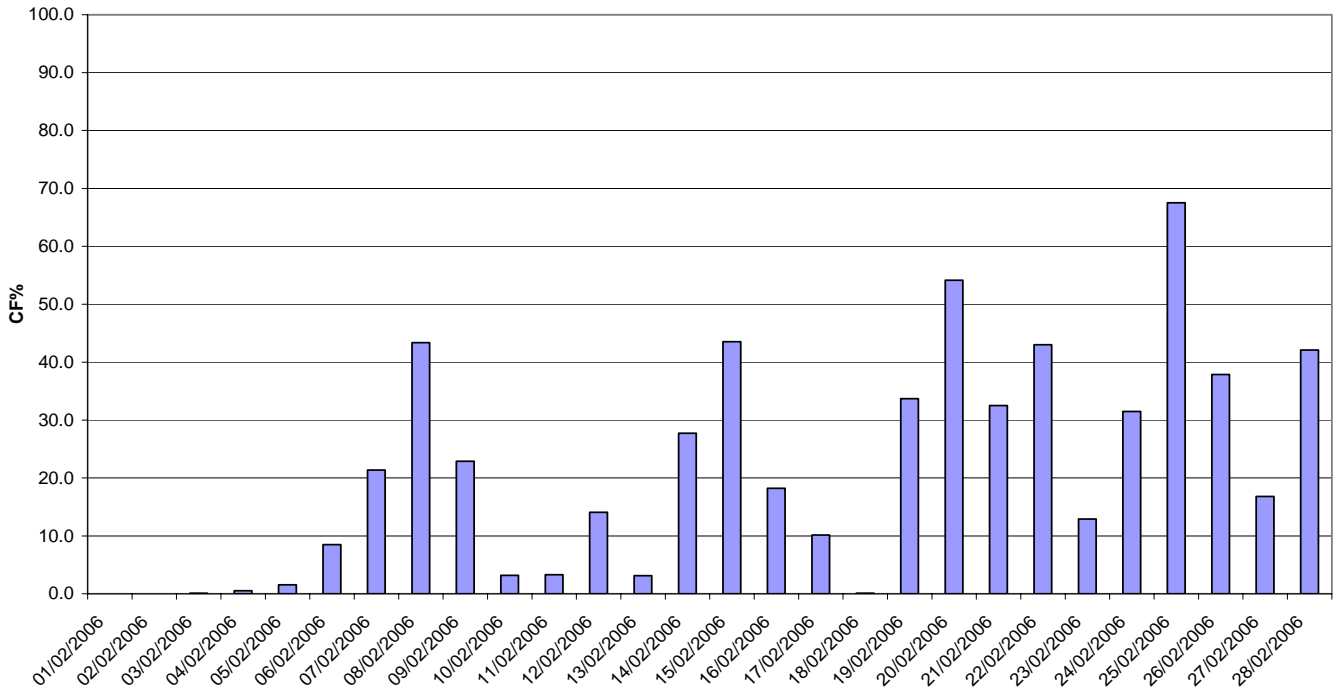
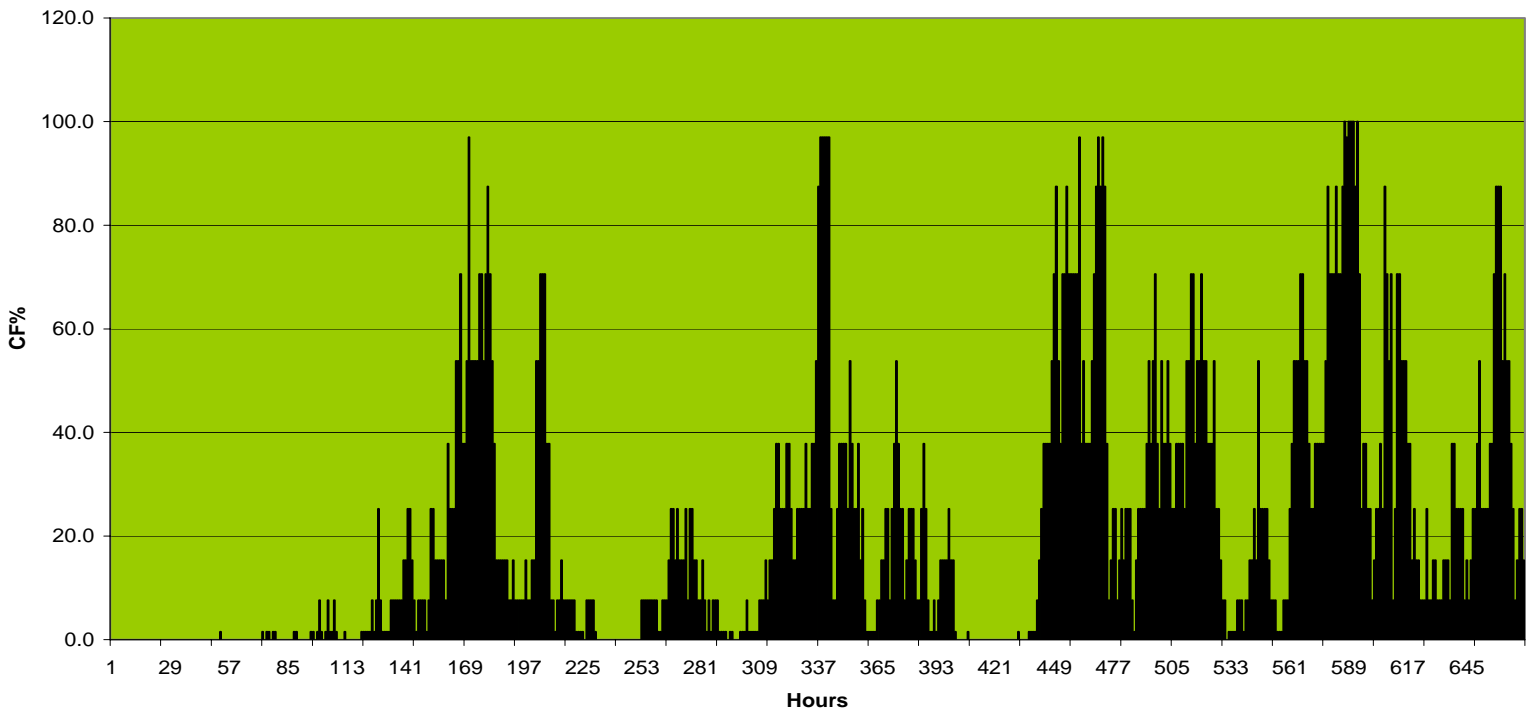


Figure 7.

Hourly Average Capacity Factors at Airfield Farm for February 2006
Monthly Average = 21.2%



The figures for the full year of 2005 below show that the results for January and February 2006 are not unusual, though February had a relatively windy second half.

A Summary of Hourly Data for 2005

(based on Met Office wind speeds)

	2005	M/S	X Shear	CF	KWH	NIL%
Jan		6.3	7.27	35.7	610928	6.6
Feb		5.1	5.92	24.0	370672	19.3
Mar		4.7	5.49	18.6	317681	19.1
Apr		4.3	4.97	14.7	243931	22.9
May		4.7	5.47	19.3	330824	20.6
June		3.7	4.26	9.2	152016	34.0
July		4.0	4.69	12.5	213050	27.6
Aug		3.8	4.42	9.8	167750	27.0
Sept		3.8	4.35	10.7	176818	33.3
Oct		4.3	4.95	13.7	234728	21.0
Nov		4.9	5.73	21.0	347016	13.5
Dec		4.3	4.98	11.4	194318	13.2
		4.5	5.21	16.7	3359732	21.5

NIL% means the percentage of time when no electricity was produced. Monthly spreadsheets for 2005 showing hourly wind speeds and data are available, as above.

The annual average CF at 16.7% (before any deductions) for the whole of 2005 is about half the average claimed (usually 30%) by the wind energy industry. The 30% average is used by Nuon UK Ltd in the context of Airfield Farm to calculate the number of houses that could be supplied in theory and the claimed carbon saving. The benefits of a proposal are routinely exaggerated by developers, see for example the Inspector's comments in the Winash decision. The extent of this exaggeration is of national importance and should be investigated and quantified to enable informed decisions to be taken at a local and national level.

The charts for CFs and all the figures in the spreadsheets are theoretical only and are based on the impossible situation in which the turbines worked continuously, if the wind permitted.

The following additional factors have to be taken into account in determining how much electricity would actually be produced:-

1. Repairs and maintenance. This includes repairs necessary to recently installed turbines due to defective manufacture: a problem currently for one manufacturer in particular.
2. Park Effect, this occurs when turbines 'take' wind from each other. See below⁴.
3. Stopping turbines when iced and if there is a risk of 'ice throw' causing danger to the public on the many public and private rights of way which are very close to turbines.
4. Stopping turbines for noise attenuation purposes. Turbines in the N90 class are said to be very noisy at wind speeds in excess of 10 metres per second (m/s). There are domestic dwellings close to the turbines and if noise is to be kept to a reasonable level it is to be expected that the turbines will be stopped at wind speeds above 10m/s, at which point the blade tips will have reached a speed of over 100 miles per hour. As N90 class turbines were developed primarily for offshore use noise was not a high priority initial design feature.
5. An amount of electricity is absorbed in order to start or align the blades to face into wind direction when the wind speed is below about 4 m/s. This should be deducted from the production figure.
6. The strong probability is that some turbines will have to be periodically shut down to prevent flicker and glint within neighbouring domestic and commercial buildings.
7. The further possibility is that the turbine, at the end of the Santa Pod Drag Racing Strip, where some vehicles reach in excess of 300 MPH, has to be stopped for reasons of distraction to the drivers and therefore safety.
8. Turbines may have to be shut down due to lack of demand⁵, or alternatively, the electricity may have to be 'spilled', if that can be done. The possibility of grid faults leading to shut down must also be considered.

9. Capacity Factor should be restated to allow for the use of the electricity at the place of consumption: allowance should be made for line losses inherent in remotely sited windfarms with peak demand being in the south of England. A figure for line loss of 10 to 15% has been put forward by Mr Hugh Sharman in his article referred to in Note 5 below. The current ROC's system provides for the calculation of production as it leaves the site⁶, leaving someone else to finance the transport cost through the grid system.

If due allowance is given for these factors it is reasonable to assume that the CF will in fact be in the order of 14% per annum which reflects current inland Continental experience. The CF of 16.7% for 2005 reduces to 14.4% if electricity production is lowered by 16%.

Is it worth destroying North Bedfordshire⁸ for such a miserly and unreliable form of production? The extremely variable nature of the production is best demonstrated by the hourly column charts above. This will need balancing by nearly 100% of the windfarm's capacity from other sources. Little or no fossil fuel generation will be replaced as it will have to be kept as 'spinning' reserve. The first line of action may well be to turn off the hydro plants or to shut down wind turbines themselves. It should be noted that we do not have a similar interconnector system to continental Europe and that it would be very expensive to install one.

All the wind energy developers' claims with regard to carbon saving, the number of houses that can be supplied, payback etc. are grossly exaggerated and very misleading. They should be examined much more critically before a well informed energy policy can be reached. Inefficient operation of the system may be required to maintain the supply within legal requirements, perhaps in the form of spinning reserve or hot reserve. The real problem is the ability of other sources of generation within the system to compensate for the fluctuating output from wind turbines, as these figures predict. The real cost is greater than being purely economic and is reflected as an environmental charge (where an extraordinarily large footprint for renewable sources of generation is required to maintain a very small energy production) or as a carbon charge to maintain firm sources of generation ready to compensate for changes in generation output.

Those paying Council Tax² who consider their amenity value has been reduced by visual and other intrusion by wind energy developments may refuse payment or join the increasing number of affected parties seeking a reduction in their property's banding.

Lest anyone suggests that 2005 was a particularly windless year, some basic historical wind data for the North Bedfordshire area is set out below. In fact 2005 was slightly more windy than the average over the last 5 years (see below).

Longer Term Met Office Wind Data for Thurleigh:-

1) Average monthly wind speed (M/S) 2001 to 2005

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
2001	4.4	4.6	4.7	4.9	4.3	4.0	3.5	3.6	4.8	5.0	4.3	4.4	4.4
2002	4.9	6.9	4.5	4.5	4.	4.0	3.6	3.0	3.6	4.6	4.1	4.8	4.4
2003	5.5	4.1	4.2	4.6	4.4	3.5	3.9	3.7	3.3	5.0	4.6	4.5	4.3
2004	5.5	5.4	4.9	4.3	3.3	4.3	3.8	3.8	5.1	5.0	3.9	4.1	4.4
2005	6.3	5.1	4.8	4.3	4.7	3.7	4.1	3.9	3.8	4.3	5.0	4.3	4.5
2001-05	5.3	5.2	4.6	4.5	4.3	3.9	3.8	3.6	4.1	4.8	4.4	4.4	4.39

YEARLY AVERAGE = 4.39 M/S

2) Average monthly wind speed (M/S) 1971 to 2000

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
5.7	5.	5.5	5.0	4.6	4.2	4.0	4.2	4.5	4.8	5.1	5.4	4.8

YEARLY AVERAGE = 4.8 M/S

3) Average monthly wind speed (M/S) 1961 to 1990

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
5.6	5.3	5.6	5.1	4.7	4.4	4.2	4.3	4.6	4.9	5.2	5.5	4.9

YEARLY AVERAGE = 4.9 M/S

The three tables of averages above show a clear indication that wind speeds are dropping. Could this be a function of enhanced global warming? It is, alternatively, possible that we are at the beginning of a cyclical downturn leading to a colder period with less wind and reduced rainfall. A twenty to thirty year cycle has been identified over many centuries. The research is readily available on the internet under the heading of "North Atlantic Oscillations" (NAO). In the longer term, changes in the behaviour of the Gulf Stream should be considered.⁷

The average figures also demonstrate that the DTI's Wind Speed Database is out-of-date and/or wrong; and, the shear factor calculations do not appear to use up-to-date best practice. The database is available on www.dti.gov.uk/renewables/technologies/windspeed and shows a wind speed of 5.3 M/S at 10 metres for Airfield Farm and 5.2 M/S for Thurleigh.

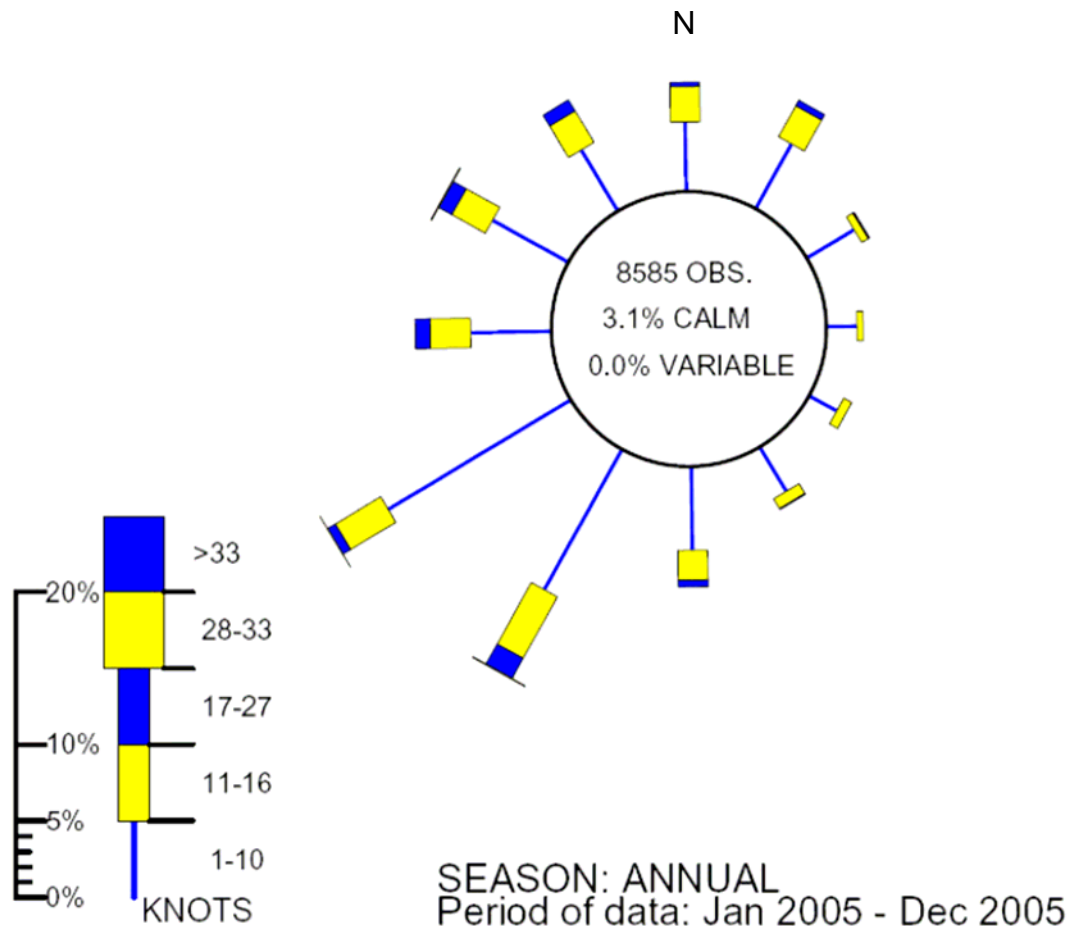
For over 350 years the particular climatic conditions of Central England have been recorded and, in addition, tree rings can be measured to indicate dryer periods for the past thousand years or more. The dryer periods indicate the absence of strong rain bearing winds from the South-West. This effect is said by meteorological experts to be associated with NAOs.

It is an established fact that average wind speeds in Central England have always been significantly below the national average. Wind energy experts have, without pressing, expressed the view that this is not a suitable area for wind energy development because it would be uneconomic. This view has recently (final report August, 2005) been confirmed in a report to the UK Department of Trade and Industry by Oxford Economic Research

Associates (OXERA), which concluded that average wind speeds below 8.25 m/s did not permit economic wind energy developments without massive subsidy.

Wind Roses

Wind Roses have been produced for the Years 2001 to 2005 inclusive. They show direction, duration and wind speed classes. See example below.



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A monthly report is planned in future with a summary of the data for the year to date, which will be made available on the CLOWD website.

Notes

- 1 An adjustment was made by Mr Graham Sinden of the Environmental Change Institute, University of Oxford in the paper entitled "Wind power and the UK wind resource". The exact formula used was not stated. It seems possible that his hypothesis is built on old data and erroneous assumptions. Sinden has been challenged to provide evidence that his research has any bearing on conditions and wind energy output in Central England and has signally failed to do so.
- 2 The Capacity Factor is the actual, or estimated, production over a period of time expressed as a percentage of the turbines theoretical production if running at its maximum output all the time.

3 The Spreadsheets

Columns:-

- 'A' shows the date,
- 'B' shows the 24 hour clock format when the readings were taken,
- 'C' shows the hourly Met Office data in Knots,
- 'D' shows wind speed converted to metres per second,
- 'E' shows the adjusted wind speed in m/s to allow for the shear factor.
- 'F' rounds the wind speed to the nearest whole number. This tends to slightly exaggerate the CFs because of the cube effect. Rounding up is much more advantageous than rounding down is detrimental. Rounding is a 50/50 calculation.
- 'G' & 'H' are hidden because the two columns are only used for calculations.
- 'I' shows the hourly production of electricity for the given wind speed. The figures are taken from the Power Curve in Nordex N90's brochure and are assumed to be accurate.
http://www.nordex-online.com/e/online_service/download/dateien/PB_N80_GB.pdf
- 'J' shows the percentage Capacity Factor for that hour.
- 'K' shows the number of days when electricity is not being produced.
- 'L' to 'S' columns show the wind direction from January 2006 onwards

- 4 The 'Park Effect' has been well researched. The indication is that the wind speeds should be down graded to allow for this to the extent of about 5 to 10%. Wind direction is an import factor, in conjunction with the alignment of the turbines. It should be noted that at Airfield Farm the turbines are closer together than recommended and that the two columns of three turbines are in line on the North-West/ South-East Axis suggesting the downgrade figure of 10% as being the more appropriate.
- 5 Mr Hugh Sharman suggests, in his article ' Why UK wind power should not exceed 10GW' in Civil Engineering, that wind curtailment "is the all-but inevitable solution". Wind curtailment is the management technique used to control unwanted power by insisting that turbines are shut down.
- 6 The Renewable Obligation Certificates (ROCs) are calculated monthly by OFGEM under the reference numbers of the recipient and the data is available to the public in this form. This information is very difficult to distil into CFs for individual windfarms and does not, in any event, demonstrate the hourly or daily average CFs which would enable an assessment to be made of intermittency or variability. Calculations for each windfarm are currently being undertaken to identify their individual production figures per month and the monthly CFs. It is intended to post the results on the CLOWD website.
- 7 See "Ocean Driven Changes to the Uk's weather systems threaten failure of wind power generation in winter." By Prof.Em. Peter Cobbold. See also the research being carried out by Prof. Harry Bryden of the National Oceanography Centre (NOC) at Southampton University.
- 8 The proposed site is within an officially designated 'Area of Great Landscape Value' and abuts a 'Site of Special Scientific Interest'.

Edward M Reeves

16th March 2006