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Critique of the book 'The Wind Farm Scam - an ecologist's evaluation', (2009), John Etherington, Stacey International, London.

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ABSTRACT The book entitled 'The Wind Farm Scam' by John Etherington is being championed as a definitive text by anti-wind groups. This critique considers the content chapter by chapter with a serious analysis. The conclusion is that whilst some of the content is standard knowledge and therefore uncontested, much of the rest stems from an emotional predisposition against the visual impact of wind turbines that leads to prejudice and factual error. The amount of electricity from central generation that is abated by wind power is a key issue, which leads, in an illogical manner, to doubt about climate change. Encouraged by his publisher to state what generation he prefers, Etherington opts for nuclear power.

1. PREFACE AND INTRODUCTION

John Etherington is an ecologist of academic and proven standing, having been Reader in Ecology at the University of Wales, Cardiff, and a former editor of 'The Ecologist'. In this book however, he departs from mainstream ecology to air his views on the technical and sociological status of electricity generation from wind turbines on windfarms. In doing this, he frequently departs into emotional language and sentiment; for instance, he describes windfarm turbines as '*wind monsters*'[1] spreading '*environmental harm*'. He owes *'immeasurable debt'* to those he has contacted through associations of anti-wind protesters and lobbyists, '*above all*' to the founder of the Country Guardians and to similar '*Nimby campaigners*' who are '*the heroic defenders of the land*'. As he prepared for the book, he became, in his words '*abstracted, even obsessed, by the need to expose the failings of this damaging industry*'. Such opinions, expressed in colloquial and emotive language, appear throughout the book.

Etherington's book is widely quoted by individuals and groups opposed to wind turbine installations, especially if the turbines are near their homes. For instance, the long standing 'Country Guardians' organisation states "we were extremely encouraged by the publication in October of Dr John Etherington's book The Wind Farm Scam"[2].

In this review, I will concentrate on technical and economic facts, hopefully without personal diatribe and hard feelings. For me, renewable energy utilises the same flows of energy that sustain biological life, thereby sustaining human life and technology as part of the Earth's total ecology. I hope that John Etherington, the ecologist, would agree with me that it is our task as humans not to so overplay our actions so that we seriously damage ecology, ourselves included. There are windfarms that may have done this in a local ecosystem, probably inadvertently. It is vital that the wind industry respects professional and academic ecologists who investigate and seek remedial action for any such damage. However, ecologists cannot justifiably be concerned for climate change and other impacts of fossil-fuel and mining industries unless they respect the abatement of such impacts by renewable energy, for which wind power provides the main opportunity for electricity.

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[1] All italicised quotations in this paragraph from page 11 of the author's Preface

[2] www.countryguardian.net/, accessed 8/2/2010

In analysing this book, it is useful to classify comment between (1) Science and technology, (2) Errors of substance, and (3) Emotive diatribe. Not all comments are negative, as I seek to give credit where credit is due.

2. COMMENT BY CHAPTER

Foreword

The writer of the book's foreword, Christopher Booker[3], is a known newspaper satirist and sceptic, for instance discrediting dangers from inhaling asbestos fibres and tobacco smoke, attacking Darwinism and criticising the establishment of the European Union. With such a background, he leaps to the attack of wind farms. Clearly Etherington has chosen Booker to authenticate the style and stance of this book.

Chapter 1, 'Wind turbines', is generally an excellent introduction to the basic mechanics and aerodynamics of modern wind turbines. Unfortunately, Etherington inserts many comments and footnotes that criticise wind power, so that the unknowing reader may not discern what is accepted fact [4], what is erroneous[5] and what is speculation[6]. Nevertheless, overall, this is a well-written text of didactic value; clearly a hand is behind the text that understands the principles of wind power. However that hand is out of date for some aspects of the modern technology, e.g. pitch-controlled variable-speed turbines, indirect and double-fed induction generators.

Chapter 2, 'Wind energy', begins with the political and institutional aspects of renewable energy, especially wind power, as considered mostly for the UK economy. Etherington describes the UK governmental targets, but concentrates on electricity supply. Correctly, he identifies the shortfall between the government's targeted capacity for wind power and the actual present installed capacity. He then backtracks to an historic review of wind energy, which progresses somewhat illogically into his expressing his own severe doubts about the authenticity and independence of the UN International Panel on Climate Change (IPCC). '*Reducing fossil fuel use and controlling carbon dioxide emission*' is a '*perceived need*', '*in part deliberately cultivated' 'in response to powerful lobbying by well-intentioned green campaigners and less altruistic pressure from multinational power companies'*[7]. The chapter continues by considering wind shear as a function of height, and, in a somewhat muddled manner, turbulence in the wind. As is common with many accounts of wind, wind-speed statistics are given mostly without clear identification of the heights involved. The vital need to understand the probability distributions of wind speed is completely neglected, with the reader told of the '*Long persistence of wind-free or low wind conditions [*across *England and Scotland]'; n*o frequency of occurrence and no mention of prediction of such circumstances are included.

Chapter 2 continues with a description of the Lanchester-Betz limit of energy capture and the non-linear relationship of energy capture to wind-speed. The averaging of wind power generation across a windfarm and region is acknowledged, but with an emphasis on the significant changes in a nation's wind power generation over periods of days. The steadily increased size of state-of-the-art turbines is recognised, but there is no recognition that for a given total capacity the larger size means far fewer turbines in a vicinity. Etherington now considers the National Electricity Grid and the need to balance supply and demand. Although most of the technical basics are correct and well-explained, he fails to mention that demand is constantly changing, and that supply has to be

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[3] Christopher Booker, see en.wikipedia.org/wiki/Christopher_Booker
[4] E.g. the 2003 UK White Paper introducing Obligated renewables proportions for electricity suppliers; the 2007 EU obligations of 20% of European total energy from renewables by 2020.
[5] E.g. his statement that a 'wind turbine generator' is actually not a turbine because it dos not have many blades nor a shroud (page 163, 3rd paragraph). Here he muddles shaft power machines (turbines) in open and closed fluid flow.
[6] E.g. page 96, 2nd paragraph, where he states that windfarm installations in the landscape are 'akin to demolishing the great cathedrals for road stone'.
[7] Quotes from page 38, top paragraph.

altered to match the demand. This omission is serious, since the impression is given that variations as from wind power are distinct and previously unknown, whereas the variations due to changes in load have always been similar and predominantly more extreme. Thus a grid that copes with load/demand variation, copes easily with the arrival of wind power. A similar unforgivable error is not to mention that <u>all</u> forms of generation fail and hence need back-up strategies. Maintaining short-term operating reserve capacity with a range of mechanisms to balance supply and demand have always been the central tasks for grid operators (see Appendix). Losing connection unexpectedly to a 2 GW nuclear power plant or a submarine cable international connection is a severe test for grid operation; far more severe than the slow loss or gain from aggregated wind power. Moreover, outages of central generation and main transmission can be unpredicted and sudden (of the order of seconds), whereas total wind power is accurately predictable to hours ahead and strategically predictable days and weeks ahead. The failure of a single turbine or a single onshore windfarm connection is not noticed by grid operators. Etherington's failures to mention such factors are unforgivable errors of omission that are used to bias the case against wind power.

Another significant error is that Etherington states that all generators, including individual wind turbines, have to reach exact synchronism with the 50 Hz grid before a mechanically switched connection is made. This is wrong. The error partly arises because he fails to appreciate induction generators and solid-state electronic interfaces; two essential technologies of wind power. Consequently he fails to mention and explain variable speed turbines, which benefit both visual impact and capture efficiency. A less important error is that he does not appreciate that generators are multipole and so gearboxes are not alone responsible for relating rotor frequency to grid frequency. I do not blame an ecologist for not knowing such details of electrical engineering, but I do blame him for making dogmatic conclusions from such errors, as he regularly does against wind power.

Chapter 3: No wind, low wind – intermittent generation*.* Etherington defines 'intermittent as '*unpredictably variable and intermittently available generation'.* Thus he emphasises his complete omission of wind speed prediction and hence wind power prediction. Obviously, if there is lack of wind, there is lack of wind power. The nature of wind speed variation and wind turbine dispersal means that the correct word for this problem is 'variable power' (as for demand), and not 'intermittent power' (as for a central power station). Yes, a problem is presented, but this fact can be accommodated easily for wind grid-connected capacity as now and for the next few years in the UK. As wind capacity increases, especially of large offshore windfarms, gradual change of the transmission network and control method will be needed. But such change is no more unexpected or different in scale from the past connection of nuclear power stations and other significant plant. All plant ages and has to be replaced, back-up and reserve power strategies change, demand-side action is always possible, tariff options alter and technology advances. Etherington presents such change as harm rather than challenge, so exposing his ignorance of the history of technology and the motivation for applied science. His fear of change is compounded by his misunderstanding of grid connection of wind power, for he states[8] *'individual wind farms, even with sufficient wind, are not themselves abler to restore power to the network after failure because of this problem of matching synchronisation… when the "wind engine" stops, there is no recovery without outside help'.* One can only gasp at such erroneous statements, which plant fear in the mind of the reader.

Evidence is given of days when wind speed was insufficient for wind power over whole regions, with separate uncoordinated examples from Ireland, Wales, most of the UK, and Denmark. One does not argue that such examples do not happen, but Etherington offers no information on the frequency of such occurrences, or of their meteorological predictability.

Within the context of national supplies, Etherington makes gross errors by giving national spatially-averaged wind power generation the characteristics of a single turbine. He states[9] *'(wind) generation can be entirely lost and must be replaced by instantly available capacity from another source …backup*"; *" available (wind generated) MW can vary rapidly and unpredictability between zero and maximum…so fossil fuelled backup must…cope with such fast*

[8] Chapter 3, page 55, paragraph 3.
[9] Chapter 3, pages 57 to 58

variation of demand". Here the averaging of widely separated wind turbines and the meteorological prediction of wind speeds are ignored. Demand is muddled with supply. Yet Etherington fails to spot that grid controllers do indeed cope with the normal variations of demand by adjusting supply. He continues[10] '*there is no way of knowing whether there will be (wind) electricity tomorrow morning or even this evening'*, which is erroneous with even elementary weather forecasting, yet alone with modern meteorology prediction.

Although nowhere in his book does Etherington consider the vital probability distribution functions of wind speed[11] and hence wind power, he does discuss load/capacity factors of turbines and capacity credit of assemblies of turbines. He rightly defines the capacity credit of wind power as the reduction in the total controllable capacity needed on a national network for plant margin. Because such networks already have backup capacity to cover outages from large central plant and unexpected increases in demand, initial wind capacity needs no extra backup capacity. Etherington is loath to admit that such backup is a shared resource for all generation on the grid, stating that '*the reserve generation which our wind fleet [sic] uses as backup [is] stolen from the backup power intended to secure conventional supply'*[12]. His use of the word 'stolen' is totally inappropriate.

A more detailed analysis of 'backup', capacity credit etc and windpower is given in the Appendix below.

As wind capacity increases, the need for extra operational reserve capacity increases, since there are times when even widely separated windfarms are all becalmed[13] and the established reserve capacity and load management methods provide insufficient margin. The analysis of such situations is becoming established knowledge[14] and is based on the statistical chance of reserve capacity being actually needed. The crossover when wind power noticeably causes the need for extra operational reserve capacity and load management, as distinct from sharing reserve capacity with other plant on the system, occurs for the UK when wind capacity becomes about 15% of total capacity, i.e. about 12 GW. UK wind capacity now totals about 4GW, with an expectation of about 26 GW installed capacity by 2015.

In addition to the short-term operating reserve capacity, the vague term 'back up' includes the firm capacity within the whole-system plant margin. Having wind power on the system increases the statistically derived plant margin according to the wind power's capacity credit. 26 GW of wind power would have a capacity credit of about 5 GW[15] in the UK system.

For costs, we must distinguish between the capital costs of plant and of the fuel used. Wind power always displaces fuel costs on the system and also reduces the capital costs of plant margin. By concentrating on 'backup capacity' rather than on the utilisation of that capacity, Etherington ignores the fact that the import of wind power into the grid always displaces and abates electricity from other generation. In the UK the displaced fuel is overwhelmingly fossil-fuel, with associated abatement of carbon dioxide and other pollutant emissions.

Etherington's discussion of national wind power capacity credit, which is definitely a small proportion, is not unreasonable. He is right to raise the subject. However he fails to distinguish between short-term reserve capacity and plant margin. He also fails to explain that national power systems constantly upgrade and replace power plant and transmission systems, from historic beginnings to ever-advanced cooperative and integrated technology. What he sees as doom, others see as challenge.

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[10] Page 59, last paragraph
[11] Weibull, Raleigh functions etc
[1212] Page 94, paragraph 1.
[13] Meteorological forecasting gives several days warning of such possibilities
[14] See publications by D. Milborrow
[15] See Fig 6 of D. Milborrow 'Quantifying the impacts of wind variability', Energy, vol 162 pp 105-112, Proc Institute of Civil Engineers, UK

Chapter 4: Financing the impossible. This chapter concentrates on the institutional support mechanisms legislated by government to encourage and obligate the generation of electricity from renewables. In the UK, this relates mostly to Renewable Obligation Certificates (ROCs). Etherington's explanation of the complex arrangements is essentially correct and he rightly shows that the wind industry depends on these financial arrangements for its capital-intensive technology (i.e. per unit of generation, wind turbines are expensive to purchase, but once installed, the wind, the 'fuel', is free). In addition, offshore windfarms receive grants and accelerated support. He also summarises the support mechanisms used in other countries, including the feed-in tariff mechanism used in a majority of European countries. For all these mechanisms, he complains that the money given in support is raised as a levy on the unit costs of electricity paid by consumers. He sees this as '*huge and concealed benefits to the wind power developers and covert arrangements which prevent this from being common knowledge'*[16]*.* In fact, none of these support mechanisms are secret, with information freely available, especially on the Internet. I would agree with Etherington however, that all levies on consumer payments should be presented clearly on each bill. In practice, very few consumers bother to understand levies made by governments. Nevertheless, we should be pleased that the levies remain accountable for the specified functions and are not sequestered by governments within general taxation.

Etherington ignores the institutional support mechanisms given to other generation, including (i) the basic UK electricity supply infrastructure established by the pre 1989 nationalised industry, (ii) the government owned nuclear industry and the sale at low-cost of capital assets, (iii) acceptance by government for the costs of treatment and disposal of nuclear waste, (iv) considerable 'legacy' costs from the previously nationalised coal industry, (v) significant tax concessions to companies for oil and gas exploration, and for coal extraction. Thus governments have always assisted energy supply industries and continue to do so in their efforts to maintain energy security from diverse supplies. Today, governments have the added duties and obligations to reduce pollution from predominantly fossil fuel use, for which renewables and the efficient use of energy provide the greatest opportunities[17]. Nowhere in this book are such well established economic duties and policies mentioned, so the reader is left with the impression that wind energy is unusual, and therefore culpable, in having support mechanisms.

Chapter 5: do wind turbines abate carbon emission*?* The chapter begins by acknowledging that society needs energy supply, including electricity, and that local opposition to new generating plant of any kind is common. Etherington then makes a fundamental error in stating[18] '*despite wind power having existed as a fairly mature technology since the 1930s, it came to nothing….. until the 1970s-80s when along came the suspicion that man-made CO_2 accumulating in the atmosphere might cause climate change'*. Leaving aside his doubts about anthropogenic climate change, Etherington exposes here his ignorance of modern wind turbine technology and recent energy supply constraints. It was the OPEC nationalisation of oil supplies within the 1973 'oil crisis' that initiated modern activity in 'alternative' energy supplies. Technological advances from the same period allowed wind turbines to utilise computer aided design, composite materials, solid-state digital electronics, remote monitoring and control, and a host of other benefits unknown in 1930's engineering. The 1930s turbines mostly failed to be utilised or developed, whereas the 1980s turbines mostly succeeded in being further developed and utilised. By the 1990s, wind power became a mainstream technology for utility generation of power; a position that has been enhanced since as the technology continues to expand and develop. Of course, as well as supporting energy security and diversity of supply, wind power assists the needs of climate change abatement; a task obligated on governments and societies by both their own legislation and by international treaties and aspirations.

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[16] Page 83, paragraph 2

[17] The fundamental factor is that there are real external (social) costs from pollution that polluters should pay. However, fossil fuel suppliers are not charged with the bulk of these costs, so support to providers of clean energy has to be provided so the pollution is abated. Etherington makes no reference to any such aspects.

[18] Page 87, from end second paragraph

Etherington alleges that wind power fails to abate significant carbon emissions. In seeking to understand how energy from different sources disperses in an electricity grid, he fails to understand the basic principle of Ohm's Law that electrical current, and hence electrical energy, flows down a voltage gradient. Thus the energy from a wind turbine enters a grid because it is at a higher voltage then the grid would be otherwise, and this energy is utilised in the nearest outlets. This principle allows the energy flow in a grid to be monitored, whereby it is apparent that wind power entering a local distribution network is utilised locally. If a windfarm is connected directly to a long-range transmission (very-high-voltage) line, then the energy again follows a voltage gradient to the next outlet. Etherington believes however, that '*because the energy travels at nearly the speed of light it will manage [sic] the length of the British Isles*[19]', i.e. he believes that the electrical energy from any generating plant is equally distributed throughout the whole national network. Perhaps such understanding is not important, but Etherington should not castigate the wind industry for seeking to explain how and where its electrical energy is used. Nevertheless, Etherington correctly exposes some electricity suppliers who overstate their supply of 'green electricity' to their consumers with 'green tariffs'[20]. It may be excusable that an ecologist does not understand electricity supply, but I agree that it is inexcusable that an electricity utility fails to explain the correct situation and uses words that mislead.

Determining what generation is not used when wind power, or any form of generation, enters the grid, is not an easy problem to solve. In principle, knowing the exact voltage gradients from every generator would allow analysis, but no such detailed measurement is made by the network operators, whose main task is to maintain voltage and frequency for all consumers within the statutory boundaries. In practice, the tariffs for paying generators allows some generators to operate at near-constant power output (e.g. nuclear and most coal plant), some to generate at their capacity and less without restriction (e.g. wind to date and microgeneration), and some to operate intermittently as required (e.g. gas turbines and managed load). However, the scientific law of conservation of energy proves that if wind energy enters a grid, and the demand does not change, then equal energy from regulated plant is not used.

However, determining exactly what sources of energy are not used when wind energy enters national and international grid is not an easy parameter to determine in the absence of accurate on-line monitoring of voltages and currents and their relative phases. Such grids have many hundreds of different generating plants, each operating at different fuel-to-electricity efficiencies. However, with sufficient instrumentation, determining the displaced energy for a single windfarm could be determined. Without such instrumentation and monitoring, it is reasonable to assume that the average output from a specific windfarm displaces energy from the nearest 'conventional' generating plant of larger capacity and operating optimally. If one ignores the energy utilised to produce the fuel and ancillary services, e.g. cooling water, the displaced CO_2 per kilowatt hour of electricity would then be: 860g for coal (thermal station with no combined heat), 360 g for natural gas (combined cycle power with no combined heat), zero for nuclear fuels and for other renewables[21]. Including the energy and the losses to supply these fuels would add about 100 g for coal, about 40 g for natural gas and 100 g for nuclear and biomass[22].

Given the complex challenge of exact measurement of displaced carbon from all windfarms combined across a region or country, various authorities[23] have judged it best to use nationally averaged abatement data which should allow for thermal plant on standby, e.g. as 'spinning reserve', and other non-linearities. Such a national average reduces year by year as more renewables come on line and as thermal plant is made more efficient. Etherington agrees with the British Wind Energy Association (now named 'UK Renewables') that the 2009 average of abatement is 430 g CO_2 per kWh of renewables.

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[19] Page 162, second paragraph and related comment.
[20] Page 161, npower claims
[21] Etherington's data and references, page 88 etc.
[22] My estimates from literature.
[23] E.g the UK Advertising Standards Authority, the UK Sustainable Development Commission, pages 88 -89 Etherington

Although Etherington does not include the 'embodied' carbon emissions from the mining, extraction, processing and delivery of conventional fuels, he does comment on the accelerated carbon emissions that occur around foundation and road construction at windfarms on peat bogs. He reasonably comments that such windfarms are not common and even so the 'carbon payback' may be about 2.5 years[24], i.e. much less than the 20 to 25 year lifetime of the initial turbines. He quotes examples of calculations of the energy payback of wind turbines, with the longest being 1.1 years. Of course, such calculations depend on many factors, including the country of manufacture and the windiness of the site.

Chapter 6: Landscape degradation and wildlife. Etherington does not like the sight of wind turbines, but he assumes, without justification, that neither does anyone one else. Yet he rejoices that the UK landscape is a treasure that is '*nearly all man-made',* with a diversity that is 'a *living history of our country'* [25].

In this chapter, one might expect Etherington the ecologist to write with professional analysis and style. Yet he writes '*the wind power industry is [determined] to drive roadway after roadway through lonely places, to dump concrete in enormous quantity, to bulldoze acres of hillside into wind farms studded with gigantic, identically mass-produced steel and plastic monsters. This is akin to demolishing the great cathedrals for road stone or shredding the contents of the National Gallery to make wall insulation'.* No quantitative or analytical evidence is given for these extraordinary statements.

The chapter continues with quotations from anti-wind environmental commentators and from Appeal Inspector's reports, where wind farm developments have been refused for reasons of visual impact. These are compared with quotations from the wind *'industry and its political supporters [who] have spread a pernicious smokescreen of propaganda'*[26]. Not surprisingly, since more letters are submitted to Planning Authorities against permissions for development than in support, Etherington is able to give examples of such local opposition to wind farm applications.

It annoys Etherington that the UK 'Royal Society for the Preservation of Birds' (RSPB) supports the development of wind power in general as mitigation of climate change. However, he gives information of bird and bat strikes from Europe and the USA to justify his claim of widespread harm to birds. As everyone acknowledges, birds and bats are killed by wind turbines, and also by many built structures in the environment and by vehicles, however Etherington does not consider the effect on <u>populations</u> of birds, which is the key ecological factor. Nor does he explain that every windfarm application has to have an Environmental Impact Statement (challengeable in law) that includes bird and bat impact assessment, and that all permitted windfarms have been judged to have an acceptable impact on local bird and bat populations.

Chapter 7: Noise, shadows and flicker. This chapter includes a reasonable explanation of the main sources of acoustic sound from wind turbines, therefore it is sad that Etherington again resorts to emotional language. *'As the developers have grabbed the remote lands of Britain, so their flailing blades perforce creep closer to habitations'*[27]. He fails to state that acoustic noise measurement and prediction is a major factor in planning applications and that noise already in the environment, especially from road traffic, is also a key comparative factor. He enters the area of quasi-science when he tackles 'low frequency sound', which by definition cannot be heard, but can, in principle, be felt as vibrations in the body. The main example he gives is of a case where careful measurement and diary records by independent assessors have failed to support the complaint.

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[24] Page 91, last paragraph '3.6 years less 1.1 years for the turbines themselves; hence 2.5 years.
[25] Page 96, 1st paragraph
[26] Page 97, 3rd paragraph
[27] Page 112, 1st paragraph

Consideration of shadows and sunlight flicker caused by rotating blades is reasonable and not emotive, with the implied conclusion that such effects are unlikely to cause annoyance, and if they do, amelioration is relatively easy. Nevertheless, Etherington has trawled the literature to quote instances of contrary conclusions.

***Chapter 8: Danger and nuisance*.** This chapter considers failures of turbines resulting in component fires and mechanical failures, including detached blades. Not surprisingly, the number of such failures is related to the number of operating turbines, a conclusion that Etherington manages to present as a threat by stating '*the numbers of accidents are increasing as wind installed capacity grows'.* However, he does not consider the benefit of ever improving and more rigorous manufacturing and operating standards, e.g. as regulated by standards organisations such as Germansicher-Lloyd and as required by financing banks, insurance companies and government inspectors. He fails to mention that, sadly, failures and accidents happen with all machinery and generating plant. Potential dangers abound in modern society and there are many mechanisms to reduce the probability of accidents. Thus, as so often this book, Etherington selectively chooses his content to bias the reader against wind power.

Other factors considered are aircraft collisions and electromagnetic interference (TV, microwaves, radar etc). He is quite correct to raise all these issues, which will certainly have been considered in most planning applications and appeals. Thus, as with all impacts mentioned in this book, permitted windfarms have been judged by legal and democratic principles to have impacts that are acceptable. Etherington the academic departs from accepted scientific practices by quoting selectively to support his predetermined opinion.

Chapter 9: Property, tourism and employment*.* For owner-occupiers, developments that may reduce the selling price of their houses become a major concern. Etherington fails to distinguish between effects on sales at the period of a windfarm application and effects after construction. This is a vital aspect, since the great majority houses are not for sale in any one year during an application and studies show that no linked affect can be determined long-term. Etherington refers to such a study[28], but describes it as '*this flawed report'*[29]. Likewise, with effects on tourism, he does not (or cannot) quote any definitive study, other than questionnaires with indefinite results[30] conducted by tourism agencies themselves. Regarding employment from the development and operation of UK windfarm, Etherington 'wants to both eat his cake and have it'; he bemoans the fact that there is no UK manufacturer of utility-scale wind turbines and hence few jobs in manufacture, at the same time as arguing that turbines should not be installed anywhere[31].

Chapter 10: Misrepresentation and Manipulation*.* This chapter starts with a reasonable explanation of how support for renewables in the UK grew inadvertently from the 1990 government decision to support nuclear power significantly with a 10% levy on the price of electricity. Despite renewables never since receiving such large support and despite not discussing institutional support mechanisms for coal, oil and gas, Etherington remains critical of the support mechanisms for wind power. Nevertheless Etherington's account of the present UK and European Union support for wind power is well written and factually correct. Likewise, he explains fairly the structure and operation of UK Planning legislation regarding wind power, but again fails to mention the necessity of comprehensive Environmental Impact Statements and Planning presentations (which typically cost windfarm developers at least £150,000) that are part of democratic planning that allows all stakeholders to participate.

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[28] Page 142, last paragraph; Report by the Royal Institute of Chartered Surveyors with Oxford Brooks University (2007) by Dent P. and Sims S.
[29] Page 142, 4th paragraph
[30] Pages 144 to 146.
[31] Page 147, last paragraphs argue for combined cycle gas turbine generation rather than wind turbines

Etherington claims that the wind industry regularly misinforms about the carbon reduction and other benefits of wind power. Unfortunately, his main examples (Table 10.1 page 157) are not cited to the named anti-wind organisation in the 'references and notes' of his chapter, which is probably an inadvertent error. However, it is typical of his readiness to cite anti-wind organisations rather than primary sources. Nevertheless, it is clear that windfarm developers may well have exaggerated their claims in the past and that the British Wind Energy Association needs to be watchful of the professional standards of its members. Etherington does not comment on 'misrepresentation and manipulation' of anti-wind organisations, although examples are common[32].

Other content of this chapter tends to repeat accusations made in previous chapters and reviewed above. Etherington also comments unfavourably on wind power production and carbon reductions in Denmark, which is admittedly complex. Denmark has by far the largest proportion of wind power capacity on its utility network and per capita than any other country. Yet it is also strongly interconnected with more countries (Germany, Norway and Sweden) than the UK, with exported surplus wind power being, in practice, exchanged at times of deficiency with the hydropower imported from Norway and Sweden under tariffs negotiated through Norweb, the joint transmission operator. In addition, Denmark has unusually large taxes on internal electricity sales and an unusually large proportion of combined heat and power plant using coal. Since the hydropower is not generated in Denmark, it is not assessed as carbon reduction in standard Danish statistics. Etherington's analysis is therefore incomplete.

Chapter 11: Climate change and Kyoto – is it all necessary? Etherington's arguments in this chapter are threefold. (1) He reiterates his opinion that wind turbines (he here calls them 'windmills'[33]) abate negligible amounts of carbon emissions. (2) In any case, UK wind-abated carbon emissions are always trivial compared with world carbon emissions and therefore not worth pursuing. (3) The evidence for carbon and other emissions causing anthropological climate change is unproven. Point (1) has been considered previously in my comments on chapter 5; point (2) denies the ethical validity of individuals taking responsibility for per capita emissions and is a recommendation for no one to do anything: point (3) is discussed below.

Etherington explains clearly the 'natural' mechanisms for regulation of the Earth's temperatures by the greenhouse effect of atmospheric gases and water vapour, and states that the extreme temperature changes in the long past (e.g. the ice ages) can be expected to occur again and that '*we need to conserve resources to adapt to these changes as they develop''*[34]. Having said this, he fails to state the obvious that using significant proportions of renewable energy does indeed abate the use of finite resources, as he recommends. He agrees that atmospheric CO_2 concentration is '*rising fast*'[35] and '*global average temperature rose with it*'[36].

Etherington summarises the role and work to the UN IPCC regarding research in Climate Change and concentrates on the understanding of past climates, including correlations of atmospheric CO_2 concentrations and temperature. Since the publication of his book, there can be no doubt that the publication of emails[37] arising from the Climate Research Unit[38] of the University of East Anglia (UK), the unprofessional tone of some of those emails and the malpractice of seeking to avoid releasing information demanded under the UK Freedom of Information legislation, has brought attention to such critiques as Etherington's. His initial scepticism of anthropological climate change therefore arises from analysis of past climate change, especially the relative timing of CO_2 and temperature. His

[32] e.g. the reprimand by the UK Advertising Standards Agency of the anti-wind organisation against Swinford windfarm in Leicestershire, 2009; submission of false letters of objection to Harborough Council opposing Gartree windfarm, 2009/2010.
[33] Page 168, 2nd paragraph
[34] Page 176, 1st paragraph.
[35] Page 172, 2nd paragraph.
[36] Page 173, 2nd paragraph
[37] See unbiased report on http://en.wikipedia.org/wiki/Climatic_Research_Unit_hacking_incident
[38] www.cru.uea.ac.uk

account of global temperature change since about 1800 is factual and reasonable, but he is sceptical about the calculations of temperature from atmospheric science by computer simulation of the physical, chemical, biological and ecological processes, stating '*It is not credible that the virtual-world output of the models can reliably be used to make policy decision'*[39], *'the computer generated futures are a virtual reality and….cannot be relied upon to be more accurate than tomorrow's weather forecast*[40]*'* [which is a giveaway statement, since next-day weather forecasts are in fact very reliable].

To his credit, Etherington gives detail about many uncertainties in the study of climate science. He oscillates between agreeing that global temperatures are increasing[41, 42], yet the cause is not known he says[43], and disputing any anthropogenic increase[44]. However, he does not put error-bars on his uncertainties, as the IPCC does and he makes no calculations of his own. Until there is such overlap in methodology, there can be no meeting of minds.

Etherington doubts that *'huge financial commitments should be gambled on their [the models'] output'*[45]. In saying this, he forgets the role of computer modelling in so many aspects of modern life, for instance bridge construction and airplane safety. Would he himself go against an expert's warning of danger and commit his own grandchildren to cross a bridge or fly in a plane that had failed computer simulation safety checks, especially when the cost of overcoming the perceived danger is only about 2% of his annual cash flow?[46]. Moreover, for wind energy and other renewables, their installation has many definite additional (no regrets) benefits, including: reductions in local pollution, increased local and national energy security, increased safeguarding of finite resources, increased local cash flow and increased stimulation for advanced systems development and control.

Chapter 12 – Epilogue

Etherington explains that this chapter has the title 'Epilogue' because his publishing editor asked that he be more positive[47] in his opinions of future electricity generation than just wanting 'no wind'. Thus Etherington is forced to say where he wants his electricity to come from, an exercise that most NIMBY objectors refuse to face. He considers four policy 'options' and analyses these with various arguments, some contrary to his earlier opinions in previous chapters. His arguments are:

Option 1 'Wind' – dismissed because (i) wind requires gas turbine and coal-fired backup which would be *a failure to tackle climate change*[48] and would make the UK dependent on Russian gas with reduced energy security;

Option 2. Coal with carbon capture and storage (CCS) – dismissed because the technology is not proven at large scale and '*the prospect of many billions of tonnes of liquid CO_2 corroding its way out of a geological tomb is a disturbing thought'*[49].

[39] Page 75, first line.
[40] Page 178, end paragraph 2
[41] Page 173, 2nd paragraph
[42] E.g page 173
, top paragraph (increasing), page 174, end top paragraph (decreasing),
[43] Page 174, last paragraph
[44] Page 174 2nd , 3rd , 4th paragraphs, page 175, 3rd paragraph, page 179 2nd paragraph
[45] Page 175, end 2nd paragraph.
[46] Comparison with the conclusions of the Stern Report (2009) on the costs of climate change mitigation scenarios.
[47] Page 187 5th paragraph
[48] His words, page 188 Option 1.
[49] Last line of page 188

Option 3 Other renewables - dismissed because he says, without wind, other UK renewable options are not sufficient or sufficiently developed. [It is interesting that Etherington inadvertently acknowledges here that wind is '*in sufficient quantity and developed enough*'[50]]

Option 4 Nuclear – accepted because, he says, nuclear '*could give secure supply of very large amounts of electricity*'[51] and which '*satisfies every demand of a power system and also tackles climate change*'[52]. He neglects to say that nuclear power cannot be varied to match load demand and that it does not produce fuels.

He concludes that future generation must be nuclear rather than from '*twitching crucifixions of landscape*'[53].

It is extraordinary that when made to become realistic about electricity supply by his publisher, Etherington is forced to admit within this last chapter that (i) wind power is a proven resource and could be a major electricity supply for the UK, but he does not want this, and (ii) that carbon emissions should be reduced because of climate change concerns. Such admissions are akin to a whispered deathbed confession!

3 CONCLUSIONS

John Etherington's academic background in Ecology is established and justified by his previous position as Reader in a mainstream UK university. Thus his comments on climate change and environmental science must be taken seriously and can be scrutinised within the ongoing climate change debate. However, the book's title is 'The Wind Farm Scam' and he must not be allowed to detract from discussing wind power by seeking allies from the 'climate change denial' camp. His technical knowledge of wind turbines, wind-generated electricity, wind prediction and the distribution and transmission of grid electricity has some glaring omissions and misunderstandings, as discussed above. His understanding of electricity generators and grid power is dismal. These and the other deficiencies outlined above are sufficient to seriously discredit his opinions about windfarms.

The style of the book is not that of a scientific or technical publication, despite the author claiming academic distinction. All too quickly he slips into the sarcastic style of colloquial scepticism, rather than try to maintain an academic rationality. The Preface exposes this predisposition. His admission there that he became '*abstracted, perhaps even obsessed*'[54] about his subject is a clue to the intensity of his possible paranoia about windfarms. His consultancy for a leading anti-wind lobbying group and his reliance on leading anti-wind sceptics[55] has clearly affected his opinions. This leads him to suspect misrepresentation[56] in windfarm developers and others. Such paranoia is not helpful for an intended rational publication.

The book does expose some deficiencies in the arguments for wind power, but the central fact that natural, unpolluting wind generates electricity in significant amounts into national grids remains correct. Obviously this electricity displaces an equivalent amount of other generation, which in the UK and most countries abates fossil fuels and CO_2 emissions. Yes, wind turbines are prominent and observable structures in the local environment. Some people like to watch them, others, obviously including John Etherington, loathe such a view. Yet Etherington admits to idolising the manmade landscape of Britain's mountain grazing slopes and hedged pastures. The irony of such dichotomy does not strike him. Visual impact and its psychological implications is probably the key to understanding the divisions exposed by this book; every other criticism from Etherington and his colleagues probably flows from this problem.

[50] His words, page 189, Option 3
[51] Page 189, last line
[52] page 190, last paragraph
[53] Page 191 4th paragraph
[54] Preface, page 11, 3rd paragraph
[55] Preface, page 11
[56] Page 155, 3rd paragraph

Appendix

Backup for windpower

How much backup power capacity on the national transmission grid does grid-integrated wind power require? This analysis considers the meaning of 'back up' and the impact of wind power. It proceeds step by step[57]:

1. The transmission grid controllers have to arrange continuously an exact balance of the demand, C_{dem}, with the supply. This is done partly by the inertial reaction of the system itself and partly by the active initiatives of the controllers. The latter relates to the tariff arrangements for paying the generators.

2. The dominant problem for the operators is to cater for the ever-changing demand of the load, which is outwith their control and may be rapid. They do this by (i) careful analysis of past variations and hence prediction of future hourly, daily, weekly, monthly and yearly loads, (ii) having extra generating capacity waiting for increases in load and likewise generating capacity that can be reduced for load reductions.

3. The control stages are in order: (i) allow the frequency and voltage to vary imperceptively within the statutory limits; (ii) increasing power from part-loaded running plant ; (iii) if necessary, cut off large loads that have special low-price tariffs (load management); (iv) order stationary or 'spinning' plant to come on line according to the tariff agreements with the plant owners and the time periods required by each type of plant (e.g. 'fast' –hydro and pumped hydro ~3 minutes, gas~ 15 minutes; 'standing' - coal ~ 4 hours). The total of all such capacity available for control is the '*short-term operational reserve capacity',* also less accurately called '*spinning reserve'*, labelled here C_{res}. In practice this is about 5% of real-time supply and must cover the risk of rapid disconnection from the largest thermal plant (e.g. large nuclear and coal, ~ 2 GW). For the UK, C_{res} is about 2 to 4 GW, dependent on the load by season and by time of day. In addition, there is the capability to reduce rapidly large loads by a further capacity of about 2GW.

4. The total capacity of all types of plant connected to the grid is C_{total}. This includes plant not able to be used in control, e.g. plant being repaired, maintained or refuelled; operating nuclear; most windfarms; microgeneration, and some partially mothballed plant held in ultimate reserve (e.g. old coal and oil plant). However, national grid operators may not include all forms of renewable energy in their total, e.g. landfill gas, sewage gas, and microgeneration. In the UK C_{total} is about 80 GW.

5. The difference between the peak demand in the year $C_{dem, max}$ and C_{total} is the '*plant margin*', $C_{margin} = C_{total} – C_{dem, max}$. Sufficient plant margin is usually about 25% of annual peak demand. In the UK, $C_{margin} \approx 20$ GW. Only part of this plant margin is used to contract for the short-term operational reserve capacity C_{res}; however much of the remainder could be called for in the unlikely event that C_{res} become insufficient.

6. Thus there is no explicit capacity that can be identified as the vague term '*backup*', however the totality of methods of utilising short-term operational reserve and plant margin may be called 'backup'. The aim is to minimise, subject to costs, the statistical chance that supply cannot meet demand, including the chance that large plant may instantly fail in single or multiple events. Perfect security cannot be provided and is not expected.

7. For long-term planning of total capacity, a statistical method has to be used, since at any one time some plant will be unavailable due to maintenance, faults or, in the case of wind power, lack of wind. The statistical contribution from each plant is called the '*firm power'*, or '*firm capacity'* C_{firm}, e.g. a 1000MW nuclear plant may be allocated a 'firm-capacity' of 850MW.

8. Note that $C_{res} < C_{firm} < C_{margin}$

[57] An in depth review of wind variability and the grid is 'Wind power myths debunked' by M. Milligan et al, IEEE Power and Energy Magazine, Nov/Dec 2009

so $C_{dem} < (C_{dem} + C_{res}) < (C_{dem} + C_{firm}) < (C_{dem} + C_{margin}) < C_{total}$

9. The non-dimensional ratio of the firm-capacity to maximum capacity of a plant or set of plants of the same type is the '*capacity credit ratio' R*. Hence $R = C_{firm}/C_{max}$. For the nuclear example, R=0.85 .

10. Wind is obviously variable, but nevertheless windfarms have a statistical chance of operating. For each turbine, the ratio of the electrical energy actually generated in a year to the notional maximum from its generator operating continuously is the non-dimensional *Capacity Factor, F* . A turbine in Scotland can be expected to have F ~ 0.3, and in midland and southern England F ~ 0.2. Note that the aggregated output of wind power across a region or country such as the UK can never trip out suddenly as thermal plant does quite commonly (perhaps about once per 18 months for a 1 GW thermal plant, perhaps about once per week for all such plant nationally). Wind power variation is due to changes in wind speed, which is predictable meteorologically to a few days ahead. For shorter periods, aggregation of individual turbine and windfarm output greatly improves national reliance.

11. Assuming constant demand, or indeed reduced demand due to improved efficiency of use, every unit of renewables electricity that enters the grid reduces the power needed from other plant. In practice it is fossil fuelled plant that reduces output, so fuel and carbon emissions etc are reduced accordingly. Thus the more wind power generation enters the grid, the greater is the capacity of fossil plant that becomes available as 'backup'. Thus, other factors being equal, the entry of windfarms onto the network increases and improves backup.

12. Thus as more wind power is installed across the country and offshore, with total capacity C_{wind}, so its statistical contribution increases as a positive contribution to C_{firm}.

13. The Firm Capacity Margin ($C_{firm} – C_{dem}$) is already present to cater for possibilities of plant outages at times of peak demand; this margin is about 25% of total generating capacity. The margin is therefore available to cover also for the predicted, yet relatively rare, times when there is no wind power across the whole country. If national wind capacity is less than about 5% of C_{firm}, then such total loss of wind does not affect the margin significantly. Should national wind capacity become greater than about 50% of the margin, then extra firm capacity would be needed, e.g. from biomass thermal plant. This condition would correspond to about 10 GW of wind capacity in the UK. So considerable wind capacity can be installed randomly across the whole network before the firm capacity margin is affected by wind.

14. For short-term operating reserve capacity, C_{res}, changes in windpower generation result from changes in wind, which are predictable in national terms several days ahead. The shorter the time ahead, the greater the accuracy of aggregated prediction. The UK National Grid has calculated[58] the extra reserve capacity needed as a function of wind capacity. If wind is 10% C_{total}, then C_{res} should increase by 3 to 6%; if 20% C_{total}, then C_{res} should increase by 4 to 8%. The increase in costs is proportionately much less, just 1% for 20% C_{total} of wind.

15. UK wind power capacity is now (Feb 2010) about 4 GW, so in practice no extra short-term reserve capacity is needed. Only when the wind capacity reaches about 8 GW in the future will special reserve alterations be needed. Then extra fuel will be needed for the extra spinning reserve, In which case the worst scenario is an extra 4% of energy above the wind energy supplied[59]. The net wind contribution to annual abated fuel nationally would then have been reduced by only 4%.

16. As more turbines and windfarms are connected throughout the country, so it becomes more likely that windpower will be operating; consequently windpower is included statistically as a contribution to C_{firm} and so less other plant margin capacity is needed. The *reduction* in capacity of conventional marginal capacity due to the wind

[58] 'Managing variability', D. Milborrow, report to WWF-UK, Greenpeace UK and Friends of the Earth EWNI, 2 June 2009.

[59] ibid M. Milligan et al

turbines is defined as the *capacity credit of windpower* $C_{R, wind}$. The *capacity credit ratio* of windpower is R_{wind} = $C_{R,wind}$ /capacity factor = $C_{R,wind}/F$.

17. The grid operators and other agencies have studied the integration of wind power into the grid with considerable detail. Also available for study is the successful integration of wind power into the Danish network to a capacity of more than 20% of Danish total capacity. Such studies and analytical techniques are published in professional academic literature, including studies for the UK grid[60].

18. The conclusion of such studies is that the maximum capacity credit for UK wind capacity of ~30% of $C_{total,}$ will be about 7 GW. Thus in calculating firm capacity C_{firm} for, say, 22 GW of installed wind power, the grid operators will add 7GW to the firm capacity of all other generators because of the windpower. Note that this is not zero as often implied by those opposed to windpower.

19. What does all this mean in practice? The present grid control methods and operational reserve of ~10 GW is more than adequate for present UK wind power capacity of 4 GW. As the wind capacity *increases* in the future, (i) the short-term operational reserve capacity C_{res} has to increase slightly, with a small increase in costs, (ii) however C_{firm} and C_{margin} will tend to increase due to the capacity credit of wind power, but (iii) since the small increase in C_{res} is obtained from C_{margin}, the net effect on the system is small.

20 As time progresses, plant becomes old and is removed. Thus the plant margin capacity C_{margin} reduces and new plant is built to restore C_{total} .. This progression has always happened and will continue to do so. However in the future the system will include significant wind power. Obviously for these conditions replacement capacity for short-term operational reserve C_{res} has to be other than wind, e.g. thermal plant, perhaps powered by biofuels. However, because of its capacity credit, the wind power will contribute positively to the plant margin, $C_{margin.}$ Overall, by taking the opportunities presented by the replacement of retired plant, the overall system can be expected to accommodate the changes.

These conclusions are supported in the UK National Grid: 'GB Seven Year Report 2009", ch 4 Embedded Generation[61].

"*The persistence effect of wind (i.e. its output is naturally subject to fluctuation and unpredictability relative to the more traditional generation technologies) coupled with the expected significant diversity between regional variations in wind output means that, while the balancing task will become more onerous, the task should remain manageable. Provided that the necessary flexible generation and other balancing service providers remain available, there is no immediate technical reason why a large portfolio of wind generation cannot be managed in balancing timescales. It is anticipated that balancing volumes and costs will increase as the wind portfolio increases. National Grid estimation of these volumes and costs will be highlighted via a separate consultation report on future system operations, which is due to be published in May 2009. In the longer term, we do not think it likely that there will be a technical limit on the amount of wind that may be accommodated as a result of short term balancing issues but economic and market factors will become increasingly important".*

[60] E.g. D. Milborrow, 'Quantifying the impacts of wind variability', Energy, vol 162, issue EN3, pp 105-111, Institute of Civil Engineers, UK

[61] http://www.nationalgrid.com/NR/rdonlyres/0E88D83F-9EF9-47B6-813F-02F7DE245956/34705/SYS09_WholeSysP2.pdf