SADBERGE PARISH PLAN

WIND FARMS BACKGROUND DOCUMENT

Introduction

At its meeting on 30th July 2008, Sadberge Parish Council agreed that the Sadberge Parish Plan will be extended to cover the issue of wind farms near Sadberge.

The aim is to establish Sadberge residents' views on the principles of wind farms in the vicinity of Sadberge. The conclusions of the discussions will be written up as an addendum to the Parish Plan, which the Parish Council will use as the basis for Sadberge's response to any specific wind farm planning applications.

This background document is intended to provide information that will help Sadberge residents to participate in the debate.

Because there are conflicting opinions – and even conflicting data – about wind farms, this document makes it clear when it is quoting an opinion of a particular group or organisation.

Sources of Information

A lot of the information in this background document comes from the following two sources:-

Wind Power in the UK: A guide to the key issues surrounding onshore wind power development in the UK [1], which was produced by the Sustainable Development Commission (SDC).

The Case against Wind 'Farms' [2], which was commissioned from Dr. J R Etherington by Country Guardian.

Other references are listed at the end of this document.

Climate Change

There is now a strong scientific consensus that the Earth's climate is changing and that greenhouse gases from human activity are a significant cause of this change.

The Intergovernmental Panel on Climate Change (IPCC) has stated that no more than ten of at least three thousand international climate scientists reject the idea that greenhouse gas emissions are causing the planet to warm, and in 2004 the UK's Chief Scientific Adviser said that, in his view, "climate change is the most severe problem that we are facing today".

The Kyoto Protocol targets reductions in the emissions of the following greenhouse gases – carbon dioxide (CO_2), methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride.

On a weight-for-weight basis, carbon dioxide has a weaker global warming effect than the other gases in the list, but the scale of carbon dioxide emissions makes it the largest contributor to climate change.

UK Government Targets

Under the Kyoto Protocol, the UK Govermnent has a legally binding commitment to achieve a 12.5% reduction in UK greenhouse gas emissions from 1990 levels, averaged over the period 2008 - 2012.

The Government has set a national goal of a 20% reduction in CO_2 emissions by 2010 as a first step in a strategy to achieve a 60% reduction by 2050 and in order to show international leadership on this issue.

The Government has also set a target to generate 10% of UK electricity from renewable energy sources by 2010, and has annnounced an aspiration to generate 20% by 2020.

Planning Considerations

As the Local Planning Authority, Darlington Borough Council has to assess wind farm planning applications in accordance with national and regional guidance.

The national guidance relevant to wind power is contained in **Planning Policy Statement 22: Renewable Energy** [3] and its Companion Guide [4].

The regional guidance is contained in **the North East Regional Spatial Strategy** [5].

Summaries of the guidance on specific issues is included in the sections on those issues later in this document.

Note that the following are not planning considerations:-

- The economic viability of the proposed wind farm.
- Any effect on local property prices.
- Possible distraction of drivers on nearby roads.

Wind Turbines

A wind turbine extracts kinetic energy from moving air – i.e. wind – and converts it into electrical energy.

The three main components of a wind turbine are the **tower**, the **nacelle** and the **rotor**. See figure 1.

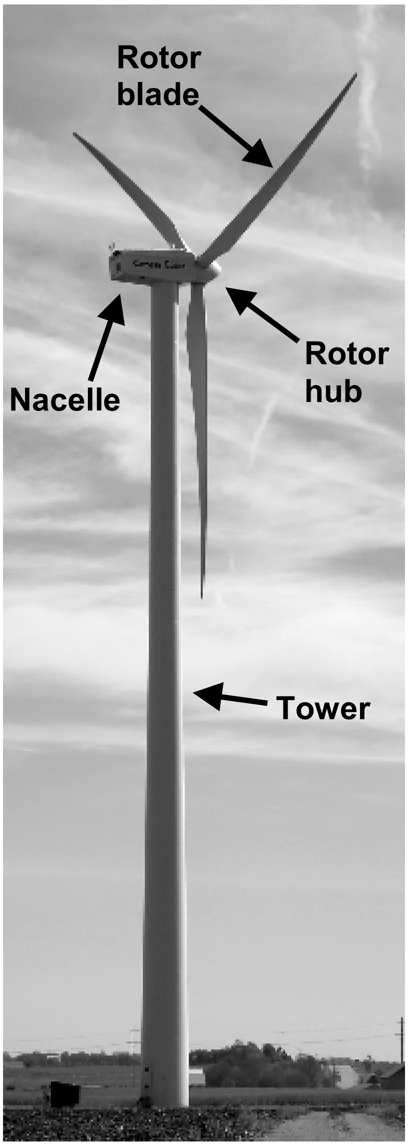

Figure 1

As wind passes through the swept area of the rotor, aerodynamic forces on the blades make the rotor turn. The rotor hub is connected to a shaft extending into the nacelle, where it drives a generator, usually via a gearbox.

The tower holds the rotor high above the ground, where the wind speed is higher and there is less turbulence.

A **yaw drive** mounted in the nacelle keeps the rotor facing into the wind.

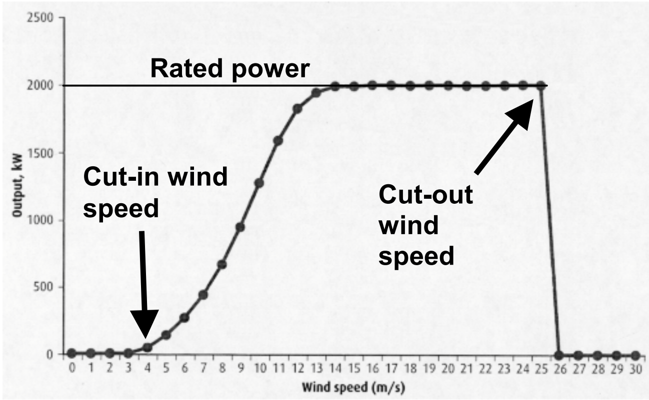

Figure 2

Figure 2 shows how the power generated by the wind turbine varies with wind speed at hub height.

Below the **cut-in wind speed**, there is insufficient energy in the wind for the wind turbine to generate any electricity.

Between the cut-in wind speed and **the rated wind speed** the wind turbine generates electricity at increasing rates.

Once the power output reaches its rated value – 2MW in the case of figure 2 – the wind turbine's rotor blade pitch is varied to keep the wind turbine operating at its rated power.

When the wind goes above a **cut-out speed** the wind turbine stops and parks the rotor in order to protect itself from damage.

People sometimes think that a wind turbine creates an air flow in the same way as a fan. This is a misunderstanding. In a fan, the motor drives the blades round and the blades push the air to create a flow. In a wind turbine, the moving air (i.e. the wind) pushes the rotor blades round and the generator in the nacelle turns that rotation into electrical energy.

As well as the wind turbines themselves, a wind farm will require infrastructure consisting of:-

- Road access.
- On-site tracks.
- Turbine foundations.
- One or more anemometer masts.
- An electrical sub-station and control building.
- Electrical cabling (normally underground) between the turbines and the sub-station.
- Electrical cabling (either underground or on wooden poles) between the sub-station and the electricity distribution network.

Wind Turbine Economics

At present, there are no Government grants towards the costs of buying or installing commercial-scale wind turbines.

However, the Government has set up mechanisms that subsidise electricity generation from renewable sources. The two main mechanisms are Renewable Obligation Certificates (ROCs) and Climate Change Levy Exemption Certificates (LECs). These are explained in Appendix 1.

Taking into account the income from ROCs and LECs as well as the income from selling the electricity, wind farm projects offer attractive financial returns to the developer / operator.

Capacity Factor

A wind turbine's **capacity factor** for a given period is defined as the electricity that it actually produced during the period divided by the electricity that it would have made if it had operated at maximum output for the full period.

Strictly speaking, in the UK and Europe the correct term is **load factor**, but most people now talk about "capacity factor".

Unlike conventional power plants, which can control their supplies of fuel, a wind turbine can only generate electricity when the wind is blowing. Wind turbines therefore have significantly lower capacity factors than conventional power plants.

A wind turbine's capacity factor is affected by:-

- Wind speed and duration.
- The efficiency at which the turbine extracts energy from wind at different wind speeds.
- Breakdowns.
- Scheduled maintenance.
- Any times when the wind turbine's electricity output cannot be used.

The SDC document says that individual onshore wind turbines in the UK may have capacity factors in the range 20% - 40% and that a figure of 30% - 35% is often quoted for the average capacity factor of onshore wind turbines, but acknowledges that this figure has been challenged in the light of experience.

The table below gives Government figures for the average capacity factors of onshore wind turbines for the years from 2003 to 2007 [8].

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

Energy and CO_2 Payback

Both the SDC document and Dr. Etherington agree that a wind turbine will pay back the energy consumption of its construction – and the associated CO_2 emission – in less than a year.

Integrating Wind Power into the UK Electricity Supply System

Because wind speeds are variable and uncontrollable, the rate at which wind turbines feed power into the UK electricity supply system also varies. This means that:-

(a) Other forms of generation need to be available to cover for wind turbines when the wind is not blowing.

(b) Wind turbines do not help the system operator to control the balance between supply and demand, and in fact introduce additional variation into the system.

When wind power makes up only a small percentage of the total electricity supply, these issues are easily dealt with.

Dr. Etherington argues that when wind power makes a larger contribution – e.g. the Government's target of 20% by 2020 – then it will be difficult and expensive to maintain the necessary balance between supply and demand, and wind power will not deliver the expected reduction in CO_2 emissions.

However, the SDC document says that it will be possible to integrate significant amounts of wind power into the supply system, and that the National Grid Company has confirmed that this is not likely to pose any major operational challenges.

Appendix 2 has more details.

An electronic copy of this Background Document is available from the Sadberge web site at www.sadberge.org.uk.

Reduction in CO_2 Emissions

Wind power reduces CO_2 emissions by providing electricity that would otherwise have to be generated from fossil fuels. The exact reduction in the CO_2 emissions depends on which fossil fuels are assumed to have been displaced.

The SDC document gives the following CO_2 emission figures for fossil fuels:-

- Coal 0.889 tonne of CO_2 per megawatt
- Gas 0.355 tonne of CO_2 per megawatt

According to Dr. Etherington's calculations, a Boeing 747 airliner emits more CO_2 in 24 hours' operation than would be saved over the same period by a 58.5 MW wind farm operating at a 30% capacity factor and displacing coal-fired generation. His figures are:-

Airliner CO_2 emissions: 506 te per 24 hours

Wind farm CO_2 savings: 362 te per 24 hours

Note: He chose the value of 58.5 MW because that is the installed capacity at Cefn Croes, which was at the time (2005) the largest wind farm in the UK.

Landscape and Visual Impact

Commercial scale wind turbines are very tall structures and have large moving parts. They also need to be positioned in open areas and to be well spaced out in order to avoid "taking the wind out of each others' sails". This all means that wind turbines tend to be very noticeable in a landscape.

People's reaction to seeing wind turbines in a landscape vary. Some people see wind turbines as quite attractive features and others do not have any strong views, but to some people wind turbines are ugly and unsighly structures that are out of place in any rural setting.

PPS22 states that landscape and visual effects should be assessed on a case by case basis. The assessments usually include **photomontages**, and may also include wireframe views and/or **zones of visual influence (ZVI)** diagrams.

A **photomontag**e is an image showing what the wind farm will look like from a specified viewpoint. It is created by superimposing images of the wind turbines on to a photograph of the relevant area.

A **wireframe view** is a a computer-generated image.

A **zone of visual influence (ZVI)** diagram is a map showing the area from which the wind farm may be visible.

Wireframe views and ZVI diagrams usually exclude buildings, trees and other obstacles, so they can give a "worst case" picture of the visibility of the wind turbines.

The assessment will also consider the cumulative effect of several different wind farms in the same area. The Companion Guide to PPS22 says that *"cumulative visual effects concern the degree to which renewable energy development becomes a feature in particular views (or sequences of views)"* and that *"cumulative effects may arise where two or more of the same type of renewable energy development are visible from the same point, or are visible shortly after each other along the same journey".*

Noise

Noise is defined as any unwanted sound.

The level of sound is measured in decibels (dB), which is a measure of the magnitude of the pressure variations in the air. The decibel scale is non-linear, and an increase of 10 dB sounds like a doubling of loudness.

Measurements of environmental noise are usually made in dB(A), which includes a correction to allow for the sensitivity of the human ear to detect different pitches of sound.

The Companion Guide to PPS22 gives the following comparative noise levels:-

Noise source	dB(A)
Pneumatic drill at a distance of 7m	105
Car travelling at 40 mph at a distance of 100m	55
Wind farm at 350m	35 - 45
Quiet bedroom	20
Rural night-time background noise	20 - 40

The Companion Guide to PPS22 also says that *"well-designed wind farms should be located so that increases in ambient noise levels around noise-sensitive developments are kept to acceptable levels with relation to existing* *background noise"* and that *"under most operating conditions, it is likely that turbine noise would be completely masked by wind-generated background noise"*.

Wind turbines generate two types of noise:-

- Mechanical nose produced by the gearbox, the generator and other parts of the drive train.
- Aerodynamic noise produced by the passage of the blades through the air.

The mechanical noise is **tonal**; i.e. it consists of a single pitch or "note".

The aerodynamic noise from the trailing edges and tips of the rotor blades is caused by turbulence effects and is a **broadband** sound; i.e. it is not a single note, but is more like the noise of wind in the trees.

The SDC document says that *"as the technology has advanced, wind turbines have generally become quieter"*.

The Companion Guide to PPS22 refers to recommended good practice in *The Assessment and Rating of Noise from Wind Farms (ETSU-R-97)* [9]. This says that *"noise limits should be set relative to the existing background noise at the nearest noise-sensitive properties and the limits should reflect the variation in both turbine source noise and background noise with wind speed"*. It goes on to say that *"separate noise limits should apply for day-time and for night-time"* and that *"noise from the wind farm should be limited to 5 dB(A) above background"*.

Dr. Etherington says that the disturbance to people depends not only on the level of the noise, but also on the type of noise. He points out that *"a dripping tap making a sound near the lower threshold of hearing can be more infuriating than the continuous hum of traffic on a nearby road"* and says that people's reactions to wind turbine noise are not amenable to noise metering.

In a criticism of ETSU-R-97 [10], Dick Bowdler says that *"the conclusions of ETSU-R-97 are so badly argued as to be laughable in parts"* and points out that *"it is the only standard where the permissible night time level is higher than the permissible day time level"*.

Dr. Etherington says that turbulence generated by a wind turbine's rotor blades reacts with the supporting tower to produce the rhythmic 'whoomph, whoomph' noise that disturbs some people. The SDC document acknowledges that *"the aerodynamic noise results in periodic audible swishes ..... that can lead to a 'beating' noise effect"* but says that this type of noise is generally confined to wind turbines in which the rotor is downwind of the tower and so *"is unlikely to be a factor for modern developments"*.

Low Frequency Noise

Low frequency noise from such sources as ventilation systems or from industrial machinery can affect some people's sleep, and there have been concerns that wind turbines may generate enough low frequency noise to disturb people living nearby.

Dr. G Leventhall, who produced a report for Defra giving *"A review of published research on low frequency noise and its effects"*, is quoted as saying that *"I can state quite categorically that there is no significant infrasound from current designs of wind turbines"*.

Dr. Etherington quotes a Keele University study that showed that *"both fixed speed and variable speed turbines generate low frequency vibrations which are multiples of blade passing frequencies and can be detected by seismometers buried in the ground"*.

However, the Keele University team subsequently issued a statement saying that *"The levels of vibration from wind turbines are so small that only the most sophisticated instrumentation and data processing can reveal their presence, and they are almost impossible to detect .... There is no possibility of humans sensing the vibration and absolutely no risk to human health."*

The SDC document says that low frequency noise generation is generally confined to wind turbines in which the rotor is downwind of the supporting tower.

The Companion Guide to PPS22 says that *"there is no evidence that ground transmitted low frequency noise from wind turbines is at a sufficient level to be harmful to human health"*.

Effect on Air Traffic Control Radar

There are two basic forms of air traffic control radar.

Primary surveillance radar (PSR) usually consists of an antenna constantly rotating around the horizon, sending out pulses of electromagnetic energy. Echos returning from reflecting objects are displayed on a controller's screen.

Secondary surveillance radar (SSR) sends out interrogation signals that trigger responses from transponder equipment in aircraft.

Any object that reflects radar signals can produce an image on the primary surveillance radar screen. However, it is usually easy to distinguish between a stationary object – such as a tall building – and an aeroplane.

The problem with wind turbines is that their rotor blades are rotating, so they may or may not produce a radar return on any given sweep of the radar. In a wind farm, the radar may pick up one wind turbine on one sweep and another on the next sweep. This can produce shifting radar returns from within the wind farm, sometimes referred to as a 'twinkling' appearance on the radar screen.

Also, it is possible for the wind turbine rotor blades or the towers to scatter radar waves, which can result in false signals being received by the radar system.

A wind farm may cause a number of problems for air traffic control radar:-

- It may be difficult for an air traffic controller to distinguish between the shifting radar returns from a wind farm and a return from an actual aircraft.
- The returns from the wind farm can "clutter" the radar screen and obscure genuine returns from aircraft.
- A wind farm may create a 'radar shadow' behind it, within which the radar's ability to detect aircraft may be reduced.
- An aircraft can be shown on the radar screen as being in an incorrect location.
- Aircraft transponder responses to the SSR system may be lost or garbled.

There are several things that can be done to mitigate the problems, ranging from relocating the radar antenna to using sophisticated signal processing to filter out unwanted radar returns.

The Wind Energy, Defence and Civil Aviation Group has issued a general guidelines document titled *"Wind Energy and Aviation: Interim Guidelines"* [11] that includes advice on the consultation that wind farm developers should carry out before submitting a planning application.

Shadow Flicker

Shadow flicker occurs when a wind turbine is directly between a building and the sun, so that the shadows of the rotor blades fall on the building. As the rotor turns, the shadow on the building flicks on and off. The flicker rate is very low – one flash every second or two with large wind turbines.

The SDC document says that shadow flicker only occurs inside buildings where the flicker appears through a narrow window opening. Effectively, the shadow of the turbine blade needs to be able to block a significant proportion of the light reaching the room.

The SDC document goes on to say that any individual window in a single building is likely to be affected for only a few minutes at certain times of the day during short periods of the year, and the Companion Guide to PPS22 states that *"flicker effects have been proven to occur only within ten rotor diameters of a turbine"*.

Dr. Etherington says that flicker can cause serious irritation and that some sensitive individuals may experience physiological responses. He also says that where there are large arrays of wind turbines some properties may be exposed to flicker for substantial periods during the day.

One solution is to stop the rotor of the wind turbine that is causing the flicker. The SDC document refers to a wind turbine in Swaffham that has a light sensor installed for this purpose.

Turbine blades can also cause flashes of reflected light, which can be visible for some distance.

Interference with Television Signals

Wind turbines can affect electromagnetic transmission – including television signals – by blocking or scattering the signal. Interference between a signal received directly from the transmitter and signals that have been reflected from wind turbines can cause 'ghosting' on the TV picture.

The SDC document says that *"impacts on television reception quality are generally only found where the television subscribers are located in an area where they have a wind farm between them and their nearest TV transmitter"*.

The Companion Guide to PSS22 says that when there is interference with television reception *"it is of a predictable nature and can generally be alleviated by the installation or modification of a local repeater station or cable connection"*.

Effects on Birds and Bats

There have been reports of birds and bats being killed by wind turbines.

Dr. Etherington points out that the blade tip of a large wind turbine travels at a speed of over 150 mph, and that *"a bird which just avoids a blade tip has only 1.2 to 1.3 seconds to dodge the next blade, approaching from about 80 yards to 90 yards away on a strongly curved path"*.

The SDC document says that *"certain populations, particularly of the larger birds of prey, appear more prone than other groups to fatal collisions with wind turbines"*. It goes on to say that a number of wind farms have caused significant damage to bird populations – including the Tarifa complex in Spain, Altamont Pass in California, and Navarra in Spain – but that *"there is no evidence that these mistakes have been repeated at UK sites"*.

The Companion Guide to PPS22 says that *"early consultation between the developer and English Nature / RSPB is important"* and that *"most sites will require at least a breeding bird survey (between late March and early June and a winter bird survey (November to February)"*.

On its web site, the RSPB makes the following statements:-

"The RSPB views climate change as the most serious long-term threat to wildlife in the UK and globally and, therefore, we support the Government's target to source 15% of electricity from renewables by 2015."

"The available evidence suggests that appropriately positioned wind farms do not pose a significant hazard for birds. However, evidence from the US and Spain confirms that poorly sited wind farms can cause severe problems for birds, through disturbance, habitat loss/damage or collision with turbines."

Dr. Etherington reports that at least 400 migrating bats were killed at the Mountaineer Wind Energy Center in West Virginia, USA, and that – allowing for carcases missed or carried off by scavengers – the death toll may have been over 2,000.

The SDC document says that *"the vast majority of bat fatalities (around 90%) are migratory species during the migration period, rather than 'local' bats on nightly foraging trips"* and that *"in the UK there are very few migratory species and no known migration routes"*.

Effects on Horses and Livestock

The Companion Guide to PPS22 says that *"there is little evidence that domesticated or wild animals will be affected by a wind farm – indeed, there are examples of cows and sheep grazing right up to the base of the turbines"*.

It also says that *"the British Horse Society .... has suggested 200 metre exclusion zones around bridle paths to avoid wind turbines frightening hourses"*, but that *"whilst this could be deemed desirable, it is not a statutory requirement, and some negotiation should be undertaken if it is diffucult to achieve this"*.

Hazards

There have been concerns about a number of hazards such as wind turbine blades shearing off, nacelles and blades catching fire, and ice falling from turbine blades.

The Companion Guide to PPS22 makes the following statements:-

"Experience indicates that properly designed and maintained wind turbines are a safe technology. The very few accidents that have occurred involving injury to humans have been caused by failure to observe manufacturers' and operators' instructions for the operation of the machines. There has been no example of injury to a member of the public."

It goes on to say that "fall-over distance" – i.e. the height of the turbine to the tip of the blade – plus 10% is often used as a safe separation distance between a wind turbine and occupied buildings, and that the weather conditions that would cause ice to build up on wind turbines occur for less than one day per year in England.

Dr. Etherington says that there have been many turbine accidents involving fire, generally because of faults in the transmission train or the wind-shaft braking system, and that *"it is almost always the case that they have to be allowed to burn out as fire fighting equipment often cannot reach to the top of the tower"*.

He also says that *"another common cause of accidents has been the shedding of blades or control-surface elements"*. On this subject, the Companion Guide to PPS22 says that *"the only source of possible danger to human or animal life from a wind trubine would be the loss of a piece of the blade or, in exceptional circumstances, of the whole blade"*. It goes on to say, however, that because of the way that blades are constructed, *"blade failure is most unlikely"*.

Impact on House Prices

Important note: Any impact on house prices is not a planning issue and will not be taken into account when the Local Planning Authority is considering an application to construct a wind farm.

There has been concern that a wind farm development will depress property prices in the surrounding area.

Dr. Etherington says that in 2004 the Royal Institution of Chartered Surveyors (RICS) carried out a study into its members' opinions and concluded that *"60% of the sample suggested that wind farms decrease the value of residential properties where the development is in view"* and that *"once a wind farm is completed the negative impact on property values continues but becomes less severe after two years or so after completion"*.

He also refers to a Times report that a judge awarded substantial compensation to a family in Cumbria because a vendor failed to disclose a wind farm proposal and a Sunday Telegraph report that two independent valuers predicted that a farm property in Devon would lose £165,000 in value because of a wind farm proposal.

In 2007, the RICS Education Trust funded research by the Oxford Brookes University to investigate whether wind farms affect nearby house prices. In their report – *What is the impact of wind farms on house prices?* [12] – the researchers found that:-

"Despite initial evidence that there was an effect, when they investigated more closely, there were generally other factors which were more significant than the presence of a wind farm."

"Insofar as there was any impact on prices, the results seem to show that it is most noticeable for terraced and semi-detached houses, with there being a significant impact on properties located within a mile of a wind farm. The effect seems much less marked – if at all – for detached houses."

"There is evidence to suggest that the 'threat' of a wind farm may have a more significant impact than the actual presence of one."

Community Ownership of Wind Turbines

In a number of cases in England and Scotland, wind farm developers have agreed to make it possible for local people to invest in the wind farm via a co-operative.

A co-operative – strictly speaking an Industrial and Provident Society – operates like a limited company except that each member has one vote irrespective of the amount that he or she has invested in the co-op.

Individuals can invest any amount from £250 to £20,000 in the co-op, and the co-op invests in the wind farm by either (a) buying one of the wind turbines or (b) buying a **royalty instrument** entitling the co-op to a share of the net revenue from the wind farm.

Investors receive interest payments related to the co-op's revenue, and get their original investment back at the end of the wind farm's operating life.

Further information about wind power co-ops is available on the Energy4All web site at www.energy4all.co.uk.

Notice

This Background Document is issued by the Sadberge Parish Plan Steering Group.

Although we have taken care to try to ensure that the contents are correct and that the information is presented in an unbiased way, we cannot give any absolute guarantee that there are no mistakes in the document.

We encourage you to use the original references to obtain more detailed information, and to form your own opinions about the issues.

If you find any errors in this document then please contact Alastair Mackenzie (01325-333333 or alastair@batmail.co.uk).

Appendix 1 – ROCs and LECs

While reading the following descriptions, bear in mind that electricity is produced by **generators**, who sell it on to **suppliers**, who in turn sell it to **consumers** (including both domestic and business customers).

Renewables Obligation Certificates

In 2002 the Government introduced the **Renewables Obligation**, which requires suppliers to source a specified percentage of their electricity from renewable sources. The specified percentage increases year by year. It started at 3% for 2002/03, and has been set at 10.4% for 2010/11 and 15.4% for 2015/16.

Electricity generators earn one **Renewables Obligation Certificate (ROC)** for each MWhr of electricity produced from a renewable source. The generators then sell these ROCs to suppliers needing to show that they have sourced electricity from renewable sources.

Suppliers that are unable to demonstrate that they have sourced the required percentage of electricity from renewable sources have to make a **buyout payment** to cover the shortfall. The buyout payment started at £30 per MWhr in 2002/03 and has been increased in line with the Retail Prices Index since then. It is currently £35.76 per MWhr.

The income from the buyout payments is not retained by the Government, but is distributed pro-rata to the suppliers who have submitted ROCs. ROCs are therefore usually traded at a price higher than the buyout payment. In an on-line auction on 8th July 2008, the average price for a ROC was £53.27 per MWhr (which is equivalent to 5.327p per kWhr).

Climate Change Levy Exemption Certificates

The **Climate Change Levy** is a tax on the supply of energy to non-domestic consumers. The tax rate for electricity is currently £4.56 per MWhr (which is equivalent to 0.456p per kWhr.)

Electricity generated from renewable sources is exempt from this tax, and renewable generators receive **Levy Exemption Certificates (LECs)** that they can sell to suppliers.

Combined Subsidy

Taking into account ROCs and LECs, a wind turbine operator's income per kWhr is about twice the wholesale electricity price.

Dr. Etherington has pointed out that a subsidy that effectively doubles the value of the product is *"gigantic, historically unprecedented and I believe unsustainable*", and in 2005 the National Audit Office said that onshore wind projects at the best sites "*receive more support from the Renewables Obligation than necessary to see them developed*" [13]. The result is that under the ROC / LEC regime, onshore wind power projects are attractive investment opportunities.

It should be noted that the Renewables Obligation provides a subsidy for wind power (and other generation from renewable sources) by imposing additional costs on electricity suppliers, and these additional costs are passed on to consumers.

It can be argued, however, that the effective cross-subsidy from fossil fuel generation to renewables generation goes some way towards recognising the 'social costs' of fossil fuel generation – including pollution and the climate changing effects of CO_2 emissions – that would otherwise not be represented in the economics of electricity generation and use.

Economics of a 2MW Wind Turbine

Alastair Mackenzie has drawn on a number of sources to try to come up with an estimate of the financial return from a single 2MW wind turbine within a wind farm development.

Please note that these figures are not intended to represent any particular wind farm and are indicative only.

Installed cost	£2,800,000
Annual electricity generation at a capacity factor of 27%	4,730 MWhr
Annual income	
Electricity (at 4.8p per kWhr)	£227,000
ROCs & LECs (at 5.0p per kWhr)	£236,000

Total annual income	£463,000
Annual costs	
Operation and maintenance	£50,000
Land rental	£15,000
Administration	£20,000

Total annual costs	£85,000
Net annual income	£378,000
Payback time	7.4 years
Project internal rate of return	12.1%

Appendix 2 – Integration of Wind Power into the UK Electricity Supply System

In the UK, we expect electricity to be available whenever we want it. This does not just happen by chance. The National Grid Company (NGC) is responsible for ensuring that electricity supply and demand are matched at all times.

Wind is uncontrollable and variable, so it cannot be relied upon for electricity generation at any particular time. Integrating wind power into the electricity supply system can therefore cause difficulties.

There are two aspects of this issue:-

Periods of low wind

It is possible that there will be times during the year when there will be little or no wind at any wind turbine site in the UK. At such times the wind turbines will not be able to make any contribution to the electricity supply, so alternative generating facilities need to be available to cover the whole of the UK's electricity demand at such times.

If there is high demand for electricity when there is little or no wind – e.g during a winter anticyclone – then there will be problems if a significant fraction of the UK's electricity supply is coming from wind power. However, the SDC document says that *"peak demand periods actually tend to coincide with above-average wind plant output"* because *"cold, windy days will lead to increased demand for heating"*.

The **capacity value** (or "capacity credit") of a generating plant is a measure of its ability to provide firm capacity to the overall electricity supply system. A gas or coal power station can have a capacity value of up to 90%, meaning that a 10,000 MW power station would be treated as providing 9,000 MW of firm capacity.

Quoting data from the National Grid Company, the SDC document says that 8,000 MW of wind power would have a capacity value of about 35%, enabling it to displace about 3,000 MW of conventional power stations. As the proportion of wind power in the system increases its capacity value decreases, and 25,000 MW of wind power would have a capacity value of 20%

Short term management of the electricity supply system

In the short term, reserve generating capacity needs to be available to cover either (a) sudden loss of generation capacity or (b) a rapid increase in demand. This reserve capacity needs to be available at very short notice, and is usually provided by conventional power stations running at reduced capacity (often called 'spinning reserve'). Some industrial customers also receive payments for providing the network operator with a **demand management** facility by reducing their loads on request

Dr. Etherington points out that running turbo-alternators at less than peak output causes a significant amount of extra CO_2 emission.

He also quotes an E.ON Netz report that said that *"traditional power stations with capacities equal to 90% of the installed wind power capacity must be permanently online in order to guarantee power supply at all times"*, and a retired grid control engineer who said *"my instincts react against all thought of unpredictable renewable power on the scale proposed, sloshing aroung the system ...... At minimum levels of system demand, in turbulent conditions, the control of system frequency would become a nightmare"*. Dr. Etherington concludes that *"there is certainly no consensus that intermittent wind power can be fed into our electricity network in large quantities without action being taken soon to ensure stability ..... Such action will add cost to an already very expensive technology and will substantially erode any saving of CO_2 emission."*

The SDC document describes this type of reasoning as "*seriously flawed"* . It says that with modern meteorology, wind is very predictable over the time-scales relevant for balancing the electricity system. "*The GB electricity supply market operates with a one hour 'gate closure', meaning that contracts to supply electricity have to be agreed an hour in advance. By this time the system operator and other market participants will have a good idea of the likely contribution of wind power within the overall system."* Therefore, the reserve capacity only has to cover deviations from the short term forecast, not a sudden drop from full wind power output to zero.

The SDC document goes on to say that the National Grid Company has confirmed that *"accommodating significant amounts of wind capacity on the electricity system is not likely to pose any major operational challenges"*.

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