# THE COMPATIBILITY OF WIND FARMING WITH TRADITIONAL FARMING IN AUSTRALIA

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This document is a detailed briefing paper discussing the compatibility of wind farming with traditional forms of farming in Australia. This paper was prepared as background information for the preparation of a fact sheet for dissemination to the general public. As a result this document, any related documents (listed below) and the fact sheet itself attempts to be as non-technical as possible and sometimes goes to great pains to explain what may appear to be quite obvious to someone intimately involved in either wind energy or specific environmental issues.

However, as is often the case, such attempts may unintentionally oversimplify the issue or present information in a distorted way. We may also have made errors or omissions in the preparation of this document. Please do not hesitate to forward any suggested changes or additions to this document to Grant Flynn at Sustainable Energy Australia (Grant@SustainableEnergyAustralia.com.au).

Where possible footnotes have been provided within the text to allow the reader to consult the source article directly.

This document should be read in conjunction with the following sub-documents;

- None

This document has also been distilled into a very brief fact sheet of just 2 pages which can also be downloaded from the AusWEA: Australian Wind Energy Association web site at www.auswea.com.au.

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## *SOURCES OF INFORMATION*


- Does Wind Energy Utilisation have Regional and Global Climate Impacts?' B.Sorensen, Rosklide University. 1996 European Union Energy Conference Proceedings. (Professor Bent Erik Sørensen)

## Introduction

Many wind farm developers do not purchase land for a wind farm but rather lease that part of a property, or group of properties, they require to host the wind farm. Generally the wind farm developer will feel that farmers are best left to manage their farmland and that the wind farm operator should focus on electricity generation. Essentially each party should focus on what they are good at, while maintaining a healthy interest in their partners' activities.

This approach means that the landowners and their families continue to be a part of the community and the lease payments paid by the wind farm operator can contribute to the wealth of the local community. Leasing of the host land for very long periods (25 years or more) means that it is important that developers find landowners that are interested in and supportive of the project. Success of the project relies on a good partnership between the two parties.

Wind farms use very little of the land surface area over which the turbines are spread. Generally this leaves the owner of the land to continue their traditional farming operations on more than 99% of the land occupied by the wind farm. Consequently the interaction of wind farming with "traditional" agriculture will be important and is the topic of this paper.

**Figure 1 Crookwell Wind Farm (NSW)**

## An Additional crop

Wind farms can be thought of as a vertical crop for the property. More often than not the impact on normal operation of the farm is very slight (especially after construction is complete). For many landholders the small pieces of land taken up by the wind farm are the most productive land they own.

Traditional agriculture may continue directly underneath and around the wind turbine generators. The only restraint imposed (if any) is on activities that may have an adverse impact on wind farm profitability. The main prohibition is agro-forestry because the trees would significantly reduce the wind speed and increase the turbulence of the wind[1].

## Landowner Agreements

Wind farm developers will require legal contracts with landholders to give them proper access to the land. These agreements set out what each party can and must do and what they cannot and must not do. It is important that a landholder fully understand these agreements and seek expert independent legal advice before signing.

Generally speaking there are two phases of legal agreement involved with wind farms. The first covers only the development phase and allows exclusive access to your property so the developer can properly assess the viability of the site for wind farm development. Wind farm development is a very expensive, slow and risky business and a developer is unlikely to begin any work unless they have secure access to the land.

The second phase of agreement covers the long term operation of a wind farm and usually only comes into force once the viability of the wind farm has been confirmed. Again it will set out the rights and responsibilities of each party as well as the remuneration.

### *Typical Payments*

There are various methods by which rent may be paid to a host landholder (fixed amount, royalty, bonus payments, etc). Regardless, typical remuneration is in the order of $3,000 per MW installed, per annum before income tax and outgoings.

## Co-habitation of an operational wind farm with traditional farming

The impact of a wind farm on traditional farm activities will depend upon the activity concerned; however it can generally be divided into the short term construction impacts and the longer term operational impacts.

### *All weather tracks*

All weather access tracks are required for access to each turbine and are generally made from limestone or other suitable road making material. They can be integrated into the farm's existing track network. They may be allowed to grass over but obviously cannot be cropped. They allow for much easier access across the property – both for the wind farm operator and wind farm host.

[1] This is cause by the resulting increase in surface roughness and increase of displacement values in the vertical wind speed profile.

### *CABLES ARE MOSTLY UNDERGROUND*

All cabling internal to the wind farm will be underground and buried at a suitable depth to allow for cropping over the top. Surface cable markers may be required at intervals along their route. Only the interconnection to the existing grid will be above ground and is a typical pole mounted three phase power line.

### *SMALL REDUCTION IN LAND AREA*

Generally less than 1% of the property is taken up by the wind farm – mainly by access tracks. This has little impact on grazing activities but needs to be carefully planned to minimise impact on cropping.

### *EFFECT ON LIVESTOCK*

Sheep, cows, horses and other livestock are not disturbed by wind turbine generators. In fact the biggest problem is keeping them away from the wind turbine generators which appear to be very popular rubbing posts for cattle and camping areas for sheep. Cows love wind turbines!

### *IMPACT ON CROPPING*

So far almost all wind farms on grazing land but what about cropping land? The main impact on cropping is the laying down areas and access tracks. It is unlikely that turbines will all end up on unproductive land or in the corners of paddocks. The location of access tracks can disrupt the normal sowing patterns used on the property. Careful planning and negotiation between the landholder and developer can usually find a suitable outcome.

Developers will generally aim to construct wind farms during the summer and autumn to take advantage of longer hours of day light, stable weather patterns and light autumn winds. This means that winter crops will generally already have been harvested before construction starts and construction completed before the next crop needs to be planted.

## Disruption During Construction

Construction will have the greatest impact. However construction is very short lived and is certainly complete within a single year.

### *Stock Management*

It is important that livestock are kept away from excavations (foundations and cable trenches). This is generally achieved using mobile electric fences but may also involve removing stock from a particular paddock for a short period of time.

Gates will generally need to be left open during work hours to minimise delays to construction traffic. Electric grids can be used to control stock movements between paddocks.

Close consultation is required to ensure stock do not mix (especially between properties) and are not prevented access to water.

### *Vehicle Movements*

The tranquil rural life can become quite hectic with the large influx of construction traffic onto the property, especially once the access tracks are constructed. This is generally well managed by site managers but can become disconcerting. Good signs and maps are required to ensure there are not too many lost contractors asking for directions, or vehicles moving too quickly.

### *Tourists*

The public are genuinely interested in wind farms and inevitably some will want to get a closer look at the site. Again good signs help ameliorate this problem but construction crews and landholders will need to be ready for some well meaning, but perhaps inconsiderate, tourists coming onto the property to have a look.

### *Phone Calls*

The public interest in wind farms will mean that the phone may begin to run hot, especially during the construction period or shortly after media items. You may receive phone calls from a variety of people including, neighbours, the media, government departments, tourism operators, other farmers considering wind farming, etc. The wind farm developer can help manage many of these enquiries if you so wish.

### *Re-fencing and Gates*

New gates and occasionally new fences will be required where access tracks cross fences. Sometimes there is an opportunity for new fencing to be done to create laneway systems for stock as a part of these works.

### *Trenches*

The trenches for the underground cabling need to be inspected before being backfilled but are generally not left open for more than a couple of days. Appropriate fencing is used during this period.

## Turbine Foundations

Typically the concrete foundations have a near-surface footprint diameter of up to 6m upon which the tower is mounted. Excavators are used to dig a hole 13m in diameter and 3m deep, depending on ground conditions. The excavated topsoil (with ground cover) and subsurface material will be kept separate in two stockpiles and used as back fill and road making material. Any surplus material will be spread locally to blend in with the local landscape.

The excavations remain open for a few weeks to allow fixing of reinforcement and the formwork to be installed along with placement of electrical cabling conduits. Each foundation requires about 280$m^3$ of concrete and ten tonnes of steel reinforcing. The concrete will be mixed on site using a mobile batching plant.

The formwork will be removed a day or two after pouring the concrete and backfilling will take place a week or so later after sufficient strength has been gained in the concrete. Each foundation will take approximately one week to prepare and a day to pour. Curing of up to four weeks must occur before the wind generators can be erected. At least three foundations per week may be cast.

## How Much Land Is Used?

Very little of the host property is used by a wind farm, typically less than 1%. About 75% of the land that is used is actually used for access tracks. While existing farm tracks are used where ever possible, they will generally need to be upgraded to cope with the large loads involved in the construction of a wind farm.

While each wind farm will be unique in its layout and configuration, the figures listed below give some indication of the amount of land a wind farm will take up. If nothing else, it provides a list of items to be considered at a wind farm of specific interest to you. Here we assume a wind farm of 20 “megawatt class” wind turbine generators (i.e. each has a rotor diameter of at least 60 metres). The smallest area that this wind farm could fit on is about 38 Ha.

The base of each tower is typically about 5 metres across (i.e. 20$m^2$ x 20 = 400$m^2$).

A hard stand area may remain at each turbine base and can be as large as 20 metres on each side (i.e. 400$m^2$ x 20 = 8,000$m^2$).

A pad mounted transformer may need to be placed outside the wind turbine tower and is typically 3 metres by 1.5 metres (i.e. 4.5$m^2$ x 20 = 90$m^2$)

The access tracks are generally 5 metres wide (but may be wider, especially in bends and at corners). The length of access track will vary from site to site. Based on an assumption that a typical wind farm will consist of 20 wind turbines, each at least 300m apart and at least 300 metres from an existing road, it is reasonable to expect at least 6 km of access track on a typical wind farm site (i.e. 30,000 $m^2$).

The switchyard will typically be 25 metres by 30 metres (i.e. 750$m^2$).

From this we see that the wind farm will take up a surface area of approximately 39,240$m^2$ or 0.39 Ha, of which almost three quarters is from access tracks.

## Can I Still Farm The Land?

Yes. Very little land is taken up by the wind farm and there is generally no reason why normal farm activities cannot continue underneath the wind turbine generators. Of course if there is any risk of impact of one activity on the other, then letting the other party know what is happening is the best way forward.

## Do I Have To Stop Planting Trees If I Have A Wind Farm?

Generally speaking the only restraint imposed by wind farm developers is on those things that have an adverse impact of the profitability of the wind farm (i.e. anything that appreciably diminishes the wind energy or ability to lay out the wind turbine generators). Trees and buildings slow the wind and cause turbulence both of which reduce the commercial returns of the wind farm.

Consequently the main prohibition is on agro-forrestry, because the trees would significantly reduce the wind speed and increase the turbulence of the wind. Developers will often ask to place some restriction on where you can plant trees and what sort of trees can be planted.

This does not necessarily mean that you cannot plant any trees. Many of the wind farm developers will actively encourage you to plant stock shelters, establish laneway systems, put in place land class fencing and pursue other Landcare objectives. You will need to discuss the details of any restrictions with your wind farm developer.

## Do I Have To Fence Stock Away From The Wind Farm

Stock will generally only need to be kept away during the short construction period. This is so they do not get in the way of construction activities, do not fall into open excavations and do not escape from the paddock while gates are left open. Once constructed, there is generally no restriction on stock movements across the wind farm – they can graze right up to the base of the tower. Switchyards and control rooms will be fenced off but these are very small areas (similar to a hayshed).

## What Limitations Are Put On My Farm If I Sign Up To Wind Farms

Generally there are no restrictions placed on your property or how you use it beyond a prohibition on agro-forestry, blasting or extractive mining. This will need to be negotiated with the developer and these activities are not always excluded (e.g. Codrington wind farm has a limestone quarry operation amongst the wind turbines).

The interest of the developer will need to be registered on your title, and should the property ever be transferred (e.g. sold) the purchaser will have to agree to accept your rights and responsibilities under the wind farm lease before the transfer can come into effect.

## Crop Dusting

Agricultural aviation is a traditional part of farming. The impact of wind farming will be site specific. If a product is applied to a paddock from north to south then turbines on the east or west side of the paddock will have little, if any, impact on air operations. However, a single turbine at the south end of the paddock may mean that the whole approach to air operations needs to change, potentially incurring added costs.

Agricultural aviators operate very manoeuvrable aircraft at very low altitudes (as low as 2 metres above the ground!). They are very highly trained and very experienced in hazard management. The local operator is the best person to assess the potential impact of a proposed wind farm layout on crop dusting activities. Once the impact (if any) of a proposed wind farm layout is determined you and the wind farm developer will be in a better position to find mitigation measures.

## How Close Can I Build A House To A Wind Turbine

There are no specific restrictions on how close a house can be to a wind turbine. If it is your own wind turbine generator you could quite legitimately build a house directly underneath the turbine, provided it does not get in the way of any installation or servicing activities.

However, for the most part, operators of the wind farms will not want residential dwellings in close proximity to the wind turbine generators. The main concern relates to noise emissions from the turbines. While the host of a wind farm might agree not to make a "nuisance complaint" (i.e. complain that the noise from the generators causes a "nuisance") there is no legal basis for such an agreement. Furthermore the ownership of the home may change several times during the life of the wind farm (25 years or more). The last thing the wind farm operator will want is to have to curtail operation of one or more wind turbines to ameliorate the noise impact on a house that did not even exist when the wind farm was built.

Once a wind farm is built, it is relatively simple to monitor noise emission levels and determine if there will be an acceptable level of noise (i.e. below the limit set by the local or state government) at a proposed house site. During the development / planning stage of the wind farm the developer will have done detailed modelling of the noise emissions of the site and will have a very good idea of where the noise levels will be acceptable.

As with all things, the best approach is to simply talk the matter through either with the operator of the wind farm (if it already exists) or the developer (if it is still only at planning stage).

During the early stages of development the wind farm developer will be keen to know where all the houses are in the area so they can properly plan the wind farm layout. As a potential host of a wind farm, or as a near neighbour to a proposed project, it is important that you communicate to the developer any plans you may have for a new home site (the developer should ask you anyway but it doesn't hurt to volunteer information!) It is very hard for a developer to take into account a house that doesn't exist yet.

## Pivot Irrigation

Pivot irrigators pose a significant problem to wind farm development because they tend to sweep very large areas and it is not possible to locate a wind turbine within the swept area. Consultation with the developer may find a solution to this problem but it may require relocation of the pivot irrigation system or a change to boom irrigators.

## Impacts of Wind Energy on Local Climate

### *LOCAL MICROCLIMATIC EFFECTS*[2]

Numerous measurements have established the type of distortion of the wind profile behind a wind turbine. Wind tunnel measurements indicate a reduction in hub height wind speed that is at its maximum around 2 rotor diameters downwind of the turbine and, in the case of a single turbine, fully restored to the free wind speed some 10 diameters downwind of the wind turbine.

[2]Derived from "Does Wind Energy Utilization Have Regional Or Global Climate Impacts?" B. Sorensen. Roskilde University, Institute 2, Energy & Environment Group

It is seen in actual measurements that little modification takes place near the ground, which may be taken to indicate, that evapotranspiration from the soil below will not be changed[3]. Measurements have found that the only time there is a lowering of rainfall below a wind turbine is when the rotor is not turning, and that there is no discernable change in air temperature or carbon dioxide concentrations around the wind turbine generators[4]. This constitutes the basis for assuming that agriculture can be conducted without disturbance as close to a wind turbine as is practicable.

The wake distribution in a field of several wind turbines is generally complex, and the expected lowering of wind speed by an array of turbines is often found to be less than expected from simple shadowing models.

One reason for this is the enhancement of wind speeds just outside the rotor-swept area. A few rotor diameters behind the first turbines, there is a substantial shadowing effect over the rotor diameter of the following turbine, but further down the array, the increased wind speed just outside each rotor area becomes mixed back into the rotor areas of subsequent turbines.

As regards wind speeds at the ground, the reduction is expected to be low, as in the single turbine situation, and hence the possible impact on microclimate small.

### *EFFECT ON GLOBAL CLIMATE VARIABLES*[5]

To try and gauge the possible impacts of wind energy on the global climate we can model the impacts of a future global penetration of wind energy of say a third of the total energy use or about 3 TW installed capacity (i.e. 10,000 times current capacity!). This is consistent with a number of scenarios for greenhouse mitigation through efficient use of energy and large-scale reliance on renewable energy sources by the middle of the 21st century[6].

Wind power may potentially influence the global climate system through changing the wind conditions near the ground. The energy extraction by wind turbine generators may potentially deduct from the energy flow through the cycle of wind system formation and dissipation. Since the global wind systems plays a crucial role in transporting heat and moisture between oceans and land surfaces, and across latitudes, the water and heat cycles may also be potentially influenced through wind energy utilization with its particular geographical pattern of distribution.

Although the estimates of the possible impacts on the general circulation and the global climate system have been mostly back-of-the-envelope calculations, it appears possible to state with considerable certainty, that even a very aggressive utilisation of wind power will not have any climatic effects, neither globally nor regionally.

[3] B. Sorensen, Wind Energy, pp. 98-116 in "Renewable sources of energy and the environment", Dublin: Tycooli Press (1981).
[4] S. Rogers et al., Environmental studies related to the operation of wind energy conversion systems, US DoE Report COO-0092-77/2 (1977).
[5] Derived from "Does Wind Energy Utilization Have Regional Or Global Climate Impacts?" B. Sorensen. Roskilde University, Institute 2, Energy & Environment Group
[6] IPCC, Second Assessment Report, WG II (Greenhouse Mitigation Options);
B. Sørensen, Scenarios for Greenhouse Warming Mitigation. Proc. IEA Greenhouse Mitigation Options Conf, London; and
European Commission APAS/RENA project RENA-CT94-0041:Long-term integration of renewable energy into the European energy system 96.