Renewable energy as an alternative farm income.

The benefits offered to agriculture with the move to renewable energy in Australia.

A report for

by Robert Nichols

2011 Nuffield Scholar

November 2011

Nuffield Australia Project No 1104

Sponsored by:

Scholar Contact Details
Robert Nichols
380 Chapel Road.
Sassafras 7307 Tasmania
Phone: 03 64267218
Fax:
Email: Robert@nicholspoultry.com.au

Nuffield Australia Contact Details

Nuffield Australia
Telephone: (03) 54800755
Facsimile: (03) 54800233
Mobile: 0412696076
Email: enquiries@nuffield.com.au
PO Box 586 Moama NSW 2731

Foreword

You would need to have been living on another planet for the last 10 years to have missed the debate regarding human induced climate change and the need for a move to renewable energy. If the science is correct then a new planet is what we will need if our consumption of the worlds resources, in particular energy, continues at the current rate. Whether or not you support the science or choose not to believe the doomsayers that proclaim the end of fossil fuels is upon us, few of us would deny that a cleaner environment with an economy that is fuelled by a sustainable, renewable energy is a desirable goal for mankind. It is this changing world that offers so many opportunities to farmers. Not just in Australia but around the world, and it would be foolish to ignore the potential that this new world offers to our businesses.

Renewable energy offers a viable opportunity for many of us to diversify our businesses in the coming years, but the myriad of options can be very confusing for potential new entrants. This report gives a background to a few potential technologies, the key considerations for installation and some examples of how these can be integrated within farm businesses.

In studying these various examples it became obvious that hurdles exist with regard to planning, community support, and government support. Some shining examples of how best to assist the sector do exist and it is hoped that sharing these will help to make a more sustainable, cohesive and profitable renewable energy sector.

Acknowledgements

The best ideas often come from the most unexpected meetings:. The inspiration that helped drive me into the renewable energy industry came some years before embarking upon this Nuffield scholarship, after a chance meeting with a Danish businessman who is involved in the wind energy business, Neils Mejholm has been a wealth of information to me over the years and I thank him for his patience.

I would like to thank the numerous people who have given their time so freely over the past 12 months and enabled me to better understand the renewable energy opportunities that exist for the farming communities. Jane Bennet, a former Nuffield from Tasmania was most insistent that I should embark upon this journey and those that know Jane will understand why I could not refuse, thanks Jane! The list of contributors is a lengthy one and includes farmers, rural advisors, businesses that are involved in the industry and even the founder and former president of the World wind energy association. The chance to meet these people has seen me travel to numerous parts of the world and experience their inspired creations first hand, I thank them all.

My mother and father have always been a huge support and inspiration, without their belief in me our business would not be what it is, nor would I have ever had the courage to step up to the challenge that this year has had to offer. I thank you both for being who you are and for your belief in me to deliver.

I would also like to thank my sponsors, the RIRDC chicken meat industry, for their support and encouragement. The chance to study my topic also gave rise to significant opportunities to better understand the challenges faced by agriculture around the world. These experiences have changed my outlook on the farming industry and will be a source of inspiration for the rest of mylife.

Finally I would like to thank my immediate family for their patience and support, this has been a challenging year in our lives together and I fully appreciate the strain this time has placed upon my wife Jo and my children Rachel, Kate and Meg. Thankyou; my life is more complete as a result and I hope in time you will all enjoy a better future as a result.

Abbreviations

KWhr.................................Kilowatt hour

MWhr................................Megawatt hour (1000 Kilowatts)

FIT.....................................Feed In Tariff.

REC...................................Renewable energy certificates.

ROC..................................Renewable obligation certificate.

BBSRC..............................Biotechnology and Biological Sciences Research Council.

SAC...................................Scottish Agricultural College.

WTG..................................Wind Turbine Generator.

PPA...................................Power purchase agreement.

PV.....................................Photo Voltaic.

HV....................................High Voltage. (12000, 22000 volts or higher)

LV.....................................Low Voltage. (240 volt or 415 volt)

VAWT..............................Vertical axis wind turbine generator.

CHP..................................Combined heat and power.

NGO.................................Nongovernment organisation.

NFF...................................National Farmers Federation.

75B...................................Tax ruling in Australia for irrigation equipment.

Contents

Executive Summary

The time to embrace renewable energy seems to be upon us. An end to the worlds current fossil fuel supplies are said to be before us and it would be a brave politician that did not recognise the vital role that a plentiful supply of affordable energy has had upon our life style.It also significantly affects our subsequent economic growth which has been the foundation of our worlds' spectacular fortunes since the industrial revolution.

Farmers are in danger of missing a once-in-a lifetime opportunity to grasp an industry that has created such mega organisations as BHP, Rio Tinto and BP, to name just a few. The renewable energy industry is the future of our societies insatiable desire for an easy lifestyle and farmers have the resource, the location and the environment to capture this new world.

If we sit back and under-value the resource that we have before us our businesses and more importantly our communities will continue to wither away and become irrelevant. Failure to take control will see city and overseas investors continue to rob our resource and export the financial gains away from our localities and into the pockets of others.

Renewable energy is unique and holds distinct advantages over traditional farming activities, many of us have experienced the competition of overseas commodities squeezing us for market share and eventually price. However because renewable energy is a local product for local consumers, it is unlikely that we will find a ship load of Chinese renewable electricity displacing our production of electrons and so we will for once be competing only with other local energy suppliers.

It is hoped that this report will lift the myth that electrical generation is the domain of the big utility companies and allow farmers to make informed decisions on how they or their communities can join in and benefit from this new industry.

In putting this report together I have called upon the experience and expertise of people from around the world who have contributed not just to the expansion of the renewables industry but most importantly the acceptance of renewables within their communities. There is no one simple solution to how best renewables can be integrated within a business or a community, however by sharing the examples I have managed to witness I hope that individual solutions can be found to suit individual cases. The future of energy production will be different to the current centralised generation facility; the future will be a shandy of different technologies, it is this variety that offers so many opportunities to us all.

These opportunities will be lost if our policy makers don't rise to the challenge and provide a framework for agriculture to work within. I don't just encourage state and federal governments to listen to the plea but also encourage bodies like the NFF and affiliated state representatives to encourage representation at ministerial level. The goal should be for renewable energy to be the portfolio of the agricultural minister, after all it is a primary industry no different to beef, sheep, essential oils or viticulture. Maybe if this sector was not administered by the resources sector we would see some synergy between our businesses and the opportunities that we have before us.

Introduction

I farm on the North West Coast of Tasmania in an area called Sassafras. It is a small community with a farming tradition dating back to the early 1800's. The region is renowned for its rich fertile volcanic soils and in the spring and summer months is a patchwork of numerous vegetable crops, essential oils and various cereals and legumes.

I emigrated to Tasmania from the UK in 1982 along with my mother and father and two brothers. At the time I was 18 years old and started my farming life with my mother and father. In 1988 I married Jo and have 3 daughters, Rachel, Kate and Meg.

Today we farm 250 hectares and like everyone else we grow a mixture of vegetable and essential oil crops for the processing companies in the area. Diversification has always been an important part of our farming mix and so very early on we commenced poultry production. Initially this was limited to eggs, however the demand for processed chicken and turkeys saw us establish a processing plant that now produces about 25% of the states chicken meat and a significant amount of the states turkey, particularly at the busy Christmas period. Our chicken business has seen us expand to a point where contract broiler growers now supply a large volume of our raw material and this in turn is offering a valuable diversification opportunity to others in the region.

In 2005 I was fortunate to be in Europe and saw a series of wind turbines that were of a size and scale that enabled them to be located in proximity to farms. The idea had immediate appeal and the stage was set. Upon return to Australia I started to investigate the possibility of doing something similar and in 2008 was successful in pioneering the first embedded wind turbine generator in Tasmania.

This turbine is 225KW and is located close to our processing plant and provides about 50% of our electrical needs. The interest that this development has caused has been immense and as a result a number of other farmers look likely to do similar projects and benefit from the ability to harvest renewable energy themselves. Our installation is just one example; each and every application differs in some way or another and this lack of information is a significant stumbling block to others who want to enter the industry..I hope my Nuffield studies will allow me to investigate these alternative applications and deliver a report that removes the mystery that surrounds this exciting diversification opportunity that we farmers have before us.

Objectives

Farmers from around the world have one common feature that determines their fate. All of us are in the business of extracting a living from our environment and doing so in a sustainable manner. The debate regarding renewable energy in Australia seems to have overlooked the fact that the rural community is the best suited to host our renewable energy future and that the production of many of the resources or the location of most of the infrastructure will, most likely, be within rural areas.

Emerging technologies have given significant opportunities to farming enterprises around the world to either diversify their business or to value add an existing waste-stream. It is my hope that this report will highlight just a few of these opportunities and provide a framework for the industry to expand for the benefit of farmers, local communities and the various stakeholders within the renewable energy sector.

It is not my intention to promote a particular renewable energy technology over another, or the benefits of a specific piece of equipment for a certain application. Rather I hope this document will outline the enormous opportunities the renewable energy industry holds for agriculture and provide a framework showing how these industries can be encouraged and adopted by the broader farming community.

Some confusion exists regarding the carbon cycle and the approach taken by many large companies to offset their emissions. The biggest of these misconceptions seems to be that used within the airline industry when they offer carbon offsets against the emissions of aircraft by encouraging the customer to buy into various carbon sequestration schemes in some way making the customer feel the damage of travel has been undone. This confusion needs to be sorted out at the beginning of this document to ensure that the point of renewables is not lost to the reader.

Short term carbon cycle.

I am sure we can all remember the school textbook descriptions of how trees and plants use the energy in the sun to take carbon dioxide from the atmosphere and lock the carbon within the plant and emit oxygen back into the atmosphere through the action of photosynthesis. Likewise we can all grasp the concept that to chop down the tree and burn it will reverse to process, energy is released in the form of heat and the carbon is released back into the atmosphere as carbon dioxide. As such it is possible to restore most of the damage done by the destructive process within a fairly small period of time with a concerted effort of conservation and regeneration of habitat.

Long term carbon cycle.

The extraction of fossil fuels, oil, coal and natural gas, is the extraction of years of “fossilised sunlight” that has been locked away within the bowels of the earth for millions of years, this stored concentrated energy can easily be combusted and as we all know will yield energy for our convenience, however the reversal of the process is not as simple as the short term carbon cycle. To truly remove the carbon dioxide that is released in this process requires that the captured carbon be locked away by burial underground. This problem is magnified when you find that to make a seam of coal just one meter thick requires the compression of 12 meters of woody vegetation. Obviously this is not a practical solution and casts doubt over the whole claim by various industries that we can continue current practice with a clear conscience by simply planting a tree.

The renewable energy industry is the only current technology that offers a replacement to fossil fuel, rather than the few years of breathing space that industry (with a vested interest) seems to be happy to cling to. With this in mind it is easy to understand the importance of this emerging sector and the vital connection that agriculture has in hosting the various solutions that will unfold in the coming years.

Chapter 1.

The Danish lesson.

In seeking a role model for the development of a renewable energy industry it is difficult to find a better example than the Danish model.

In the 1970’s and 1980’s Denmark had the vision and foresight to encourage the uptake of renewables. At the time the political landscape was similar to that in Australia at the present time. The balance of power was held by a series of “Green” candidates and real concerns emerged that Denmark’s dependency on foreign countries to supply its energy needs was not sustainable. Denmark is an undulating country with the highest point above sea level being just 170 meters. The current landmass emerged from the last ice age some 10,000 years ago and as a result Denmark has no major mineral deposits to exploit. It does, however, have a never ending wind resource that hits its shores from the North Sea. This resource, when coupled with its flat topography, has seen Denmark become a world leader in wind energy production and wind energy technology.

To encourage the uptake of renewable energy, in particular wind energy, a number of initiatives were adopted to kick start the industry. The obvious stimulus is to introduce a generous feed in tariff (FIT) In the Danish case this was set at 85% of the general tariff of the day and offered a very lucrative return for those early developers. Alas, feed in tariffs alone will do little to gain public acceptance and public support.

Embedded Generation.

Embedded generation is where generation plants are placed in various parts of the community and as the name suggests sees the generation plants embedded within the existing high voltage electrical grid. This differs significantly to Australia’s approach where large utility scale wind farms are clustered in a single area and, more often than not, require transmission line infrastructure to transport the power to the consumer. The Danish model has been successful in a number of ways and lessons can be learnt. In the early years a developer was not allowed to own more than a single turbine and as a result farmers all across Denmark have had a chance to become involved in this industry. This approach was possible in the 1980’s and 1990’s as the size and cost of turbines at this time was within the reach of most people. With the size of turbines increasing, so has the relative cost, making individual ownership unlikely. To maintain this collective ownership approach present developers have been forced to offer local communities the chance to invest in these projects. Currently new developments are required to offer 20% of the development to local investors. These investors must live within 4.5 kms of the turbine and will be rewarded with a dividend being paid for the resource that is now being harvested. This widespread interest has resulted in a high level of community support for the industry. These developments have brought with them new skills and service industries to rural areas and provided an alternative employment for the graduating engineers, fitters and builders across the nation. This community ownership has also resulted in the profits remaining within the rural areas rather than being moved away by the large financial institutions which are financing the utility-scale developments.

Offering community ownership in wind turbine developments has ensured a high level of community acceptance of these developments. It is unlikely that communities will object to an investment that is providing them with a financial return on investment!

Today Denmark can boast that over 20% of its electrical energy is from renewable resources but this is not the entire picture as heating energy, a major requirement in this cold Scandinavian country, is secured from biomass resources. Denmark has a policy in place to be powered by 20% renewables across all energy requirements by 2010 and to be self-sufficient in all renewable energy by 2050, an ambitious goal indeed when road transport is to be taken into account. This ambitious policy is expected to place severe pressure on the prices of commodities in the near future, as energy will compete more and more with food for land use.

Embedded generation on this scale has had a number of valuable spinoffs for the general community as a whole. The geographical distribution of this generation capacity has enabled renewables to be more consistent with their delivery of energy into the grid. If the wind is blowing in the North then maybe it is not so in the South and so on. The wide distribution of this embedded generation and a policy that requires the transmission company to deliver a grid connection at the property boundary of a wind farm has resulted in a well designed grid. This grid is capable of taking the electrical load from these rural areas and delivering to the populous areas of the country. To ensure that this generation is as reliable as the wind, which in Denmark it is, the Danish power companies have buried the majority of medium voltage (11;000 volts up to 60;000 volts) cables so that they are unaffected by storm conditions. An added side-effect of this is the beautification of many towns and villages as unsightly wires are no longer seen strung from pole to pole.

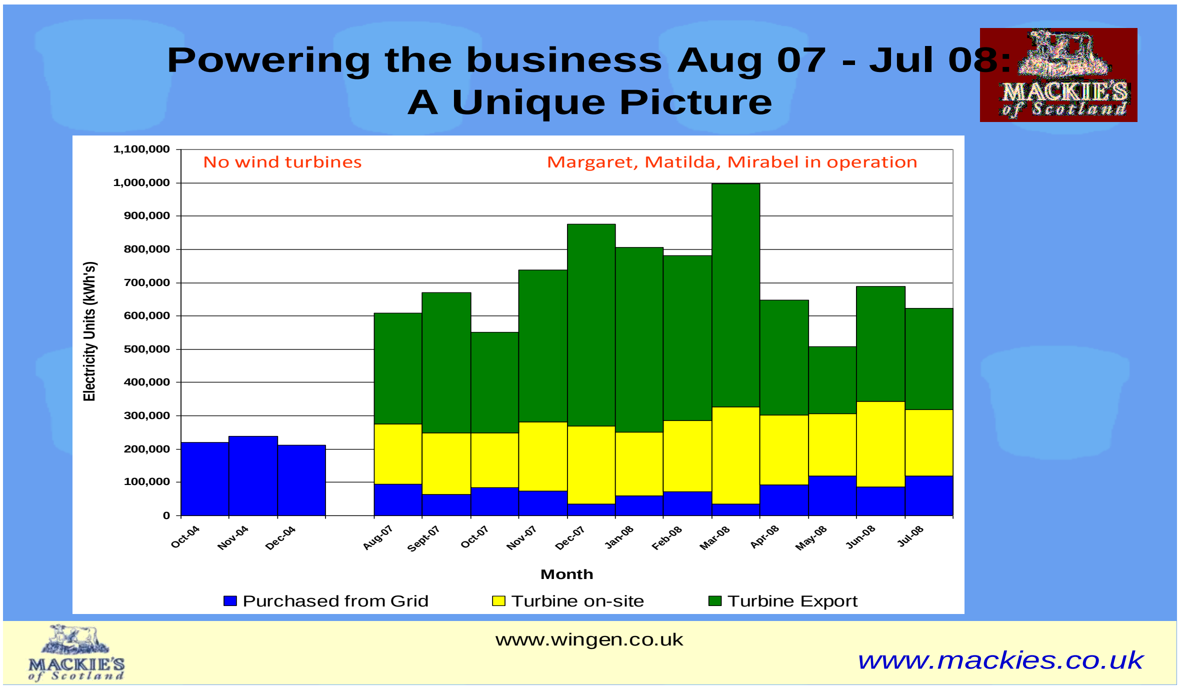
Aberdeenshire; the same story but a different country.

The Aberdeenshire area in Eastern Scotland provided a eureka moment for me and is starkly different in their approach to the emerging renewable energy industry to that of the English farmer. Aberdeenshire also has similarities to Tasmania with regard to population density and diversification options.

Aberdeenshire is predominantly a rural economy with some additional service industries that have developed around the off shore natural gas reserves. The population is roughly 500,000 in an area not too dissimilar to that of Tasmania. This sparse population and reasonably remote location prevents the farmers from engaging in the many normal diversification activities that the English farmers seem to take for granted. In England it is common to see farm buildings rented to light industry, stables being utilised for livery, fields on steep hills being chopped up by weekend warriors on motocross machines and barns being converted for office space or sold as housing. This is less evident in the more remote areas of Scotland. Farmers in these regions have embraced their renewable energy resource and developed a perfect model of embedded renewable energy generation that is providing the proponents with sensible, sustainable diversification. It was this realisation that rural Australia is limited in its diversification options that was a watershed moment on my travels. Let us be honest, how many farm shops or organic vegetable roadside outlets can we develop before we reach saturation? But the general public's insatiable desire for energy can provide many farmers with opportunities for alternative farm incomes.

I visited a number of progressive farming businesses in the Aberdeenshire area and found that, rather than construct a turbine to access the lucrative feed-in tariffs, as seems to be the case in England, the Scottish farmers have realised that larger turbines offer more efficiency and a greater return on investment. Despite the fact that they have to forsake the generous feed-in tariffs that are aimed at the smaller scale installations.

Maitland Mackie of Tarves has been an advocate for wind energy for some years since the construction of his first Vestas 850 kw V52 turbine to generate power for his rural based Mackie's Ice cream factory. Since the first turbine was constructed in 2006 a further 3 more have been installed to provide a significant proportion of his power requirements and to sell surplus power back into the grid. As can be seen from the following graph the progressive application of turbines to the business has not just reduced the need for the business to purchase power but also allowed surplus energy to be exported back into the grid providing a valuable source of alternative farm income.



Comparison of power consumption prior and post turbine construction.
(kind permission M Mackie)

The method of electrical connection is such that power produced is utilised by the business when production and demand coincide. In the event of over-production or zero demand then the power is simply exported to the grid and metered accordingly. This is a common system with all installations, but Scotland is the first place that I have seen numerous installations conveying and metering the power at high voltage. The benefits of this are that larger more efficient turbines can be deployed and site selection is less restricted by voltage drop when compared to low voltage installations. Also high wind sites that are within the farm boundary become accessible, rather than sites within reach of the farm switchboard.

India: an unlikely place to find some answers.

India has a limited number of wind farm sites due to the unusual nature of the wind resource. The wind industry in India produces about 80% of the annual turbine output in just 5 months of the year during the wet season, which lasts from April to September. My visit to India was in March, just prior to the windy season. The available sites are limited to certain wind corridors in the central and western sides of southern India The east is prone to cyclones which rules it out as a practical site for development.

View from turbine of Indian landscape. (Thanks to Leit wind)

The industry has been encouraged by generous tax incentives over the years. These incentives have been offered to businesses that invest in wind energy and as a result the industry has evolved with significant local investor ownership. The energy produced does not appear to be subsidised to any great extent but, due to the tax incentives and the obvious low capital cost of machinery constructed in India, the wind industry is able to compete directly with traditional coal-fired generation plants.

Visit to turbine factory in the state of Tamil Nadu.(Thanks to Leit Wind)

The tax incentives are generous indeed and it is easy to see why the industry has flourished in recent years, due to:

- 80% Depreciation in the first year of construction.
- Losses incurred by this depreciation can be shared with associated entities.
- 10 year tax-free on profits from generation. This period of 10 years can be nominated by the developer to suit their needs and is usually chosen to follow the tax benefits that are realised from interest costs associated with the initial loan taken for construction.

On top of this the developer has the ability to utilise the energy produced within its own businesses at any number of sites rather than simply accept the wholesale price for energy that is exported to the grid. This generous option is made more beneficial for the developer by allowing energy produced to be banked for up to one year before any surplus power is relinquished at the wholesale price of energy at year end.

It's not difficult to see why this kind of stimulus would encourage businesses to invest in renewables. Furthermore the businesses have long-term guarantee on significant portions of their electrical power requirements ensuring improved long-term viability for those that get involved.

United Kingdom.

In mid-2009 the UK introduced a system of FIT's to incentivise the small scale renewable energy industry. The FIT's provide a significant tariff for energy produced by units smaller than 5 MW. Larger industrial units are not able to draw on the FIT scheme but do have access to the Renewable Obligation Certificates (ROCs) a scheme that creates a marketable certificate for generation of power from renewable resources. The FIT's are a scaled approach to power pricing as can be seen in the following table.

:

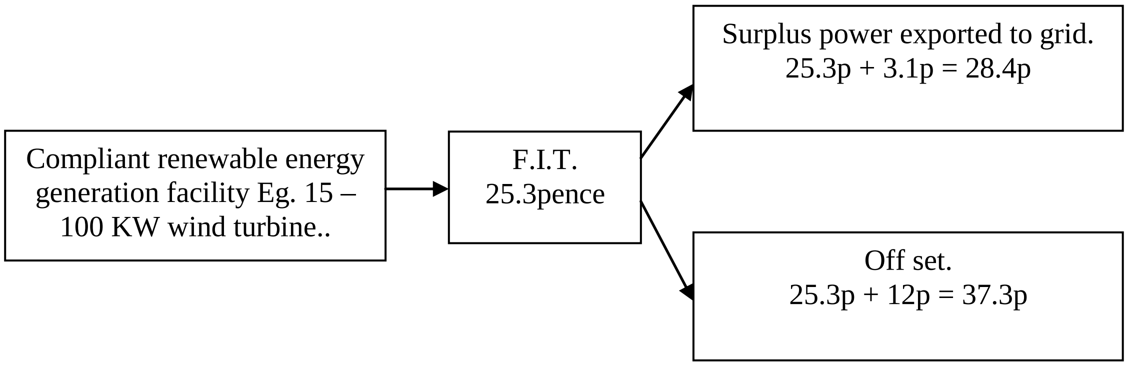
Complete listing of all Generation Tariff levels up to March 2012

Energy Source	**Scale**	**Tariff (p/kWh)[A]**	**Duration (years)**
Anaerobic digestion	≤500kW	12.1 [D]	20
Anaerobic digestion	>500kW	9.4	20
Hydro	≤15 kW	20.9	20
Hydro	>15 – 100kW	18.7	20
Hydro	>100kW – 2MW	11.5	20
Hydro	>2MW – 5MW	4.7	20
Micro-CHP [B]	<2 kW	10.5	10
Solar PV	≤4 kW new [C]	37.8	25
Solar PV	≤4 kW retrofit[C]	43.3	25
Solar PV	>4-10kW	37.8	25
Solar PV	>10 – 100kW [E]	32.9 [E]	25
Solar PV	>100kW – 5MW	30.7 [E]	25
Solar PV	Standalone [C]	30.7 [E]	25
Wind	≤1.5kW	36.2	20
Wind	>1.5 – 15kW	28.0	20
Wind	>15 – 100kW	25.3	20
Wind	>100 – 500kW	19.7	20
Wind	>500kW – 1.5MW	9.9	20
Wind	>1.5MW – 5MW	4.7	20

UK Government website FIT data.

With such generous tariffs and such a long term index linked guarantee on price it didn't take long for knowledgeable investors to over-subscribe the scheme and in July 2011 the price was reduced on the larger scale Solar electric generation facilities, Photo-Voltaic (PV) installations. This sudden change in policy has been a stark reminder to many businesses that these attractive tariffs will not last forever.

The FIT's are structured two ways; firstly the generation tariff pays for all the power produced at the appropriate scale as per the above table. This tariff is paid for all energy produced regardless of whether the power is used on site or exported into the grid. In the event that the power is used on-farm then a further saving of the typical tariff (currently 12 pence) is made over and above the generation tariff paid. If however the energy produced is not used on-site, but is exported to the grid, then an export tariff is paid. This is currently a guaranteed and index-linked figure of 3.1 pence, however producers can opt out of this part of the arrangement and negotiate individual Power purchase agreements (PPA's) if they so wish.



The UK embedded generation industry seems to being driven by the desire to cash in on these once-in-a-lifetime incentives with no regard for efficient generation or suitable turbine sighting As a result we see people making poor decisions based on profit alone, rather than demonstrating a sound understanding of wind energy technology.

This 11KW Vertical axis wind turbine (VAWT) was sited at the base of a hill behind a large barn, blocking the prevailing wind. The turbine had been operational for 5 months. In that time it had produced just 1.5% of its potential installed capacity and although it qualifies for the 20 year index-linked FIT it is hard to imagine that it will still be operational in 2020 let alone 2030.

Although the VAWT concept has appeal in that it is cheaper to construct the close proximity to the ground causes greater turbulence in the wind and significantly reduced efficiency.

However it was pointed out to me that these FITs do offer a way for people with smaller farms or reduced access to capital to be a part of the renewable energy revolution. The question remains that “Is this a sustainable way for the industry to be heading?” I liken it to my own desire to be a world class basketball player. Vertically challenged at 5ft 10 inch no amount of subsidy will enable me to be selected for the Harlem globe trotters, and nor should I.

France.

The French seem renowned for their ability to provide support where it is needed most. Nowhere did this support seem to be more appropriate and well directed than in France. Here the support funds seem to be being used in the most perfect way;

- to preserve the French way of life
- to provide a form of financial assistance,
- to ensure aged crafts are preserved and
- to ensure that the rural communities are vibrant and alive.
-

In the Rodez area a number of sheep farmers continue the business of supplying cheese to the Roquefort cheese plant. This provenance requirements for this product only permit farmers from within a 120 km radius of the Roquefort caves to provide them with their produces so that the tradition can be continued. Opportunities to diversify the farming business are limited by this controlled system of marketing, however the introduction of renewable energy has provided alternatives that enable the family farm to support and encourage future generations.

The example seen here consisted of a total roof area of close to 1,000 square meters that has been covered in solar panels since May 2010. At the time the government offered a feed-in tariff of €0.60 per KW hr (close to A$1.00 per KW hr at the time of this report) this compares to the general tariff rate of €0.10 per KW hr (A$0.17 per KW hr) Although this tariff has since been reduced the initial first round of installations was guaranteed and index linked for 20 years and has provided the family with security and the French region with dedicated custodians for years to come.

The installation visited at Flavin in southern France was 135 KW of total installed capacity and produced an impressive 160 MW of electricity in its first 12 months of installation. In Australian terms that represents an additional $160,000.00 per year of diversification for the family farm with little or no requirements for planning and no loss of production from the remainder of the farmed area. The rate of return was estimated to be a healthy 20% per annum at current energy prices so a very sound investment for the business to become involved in. The same district also hosts a number of wind turbines. Their financial benefits are so welcomed by the farmers who are involved that they are a sought after addition to the suite of income sources that the farming businesses manage. In most cases the developments are small cluster embedded generation projects that have been well received within the communities involved. Small cluster developments as opposed to large utility scale wind farms seem to be better accepted by residents that are close to the development. By utilising the existing distribution network rather than the need for installing unsightly transmission towers the effects are limited to the local regions and further disquiet seems to be avoided.

Chapter 2.

The most likely farm technologies and ways in which they can be connected.

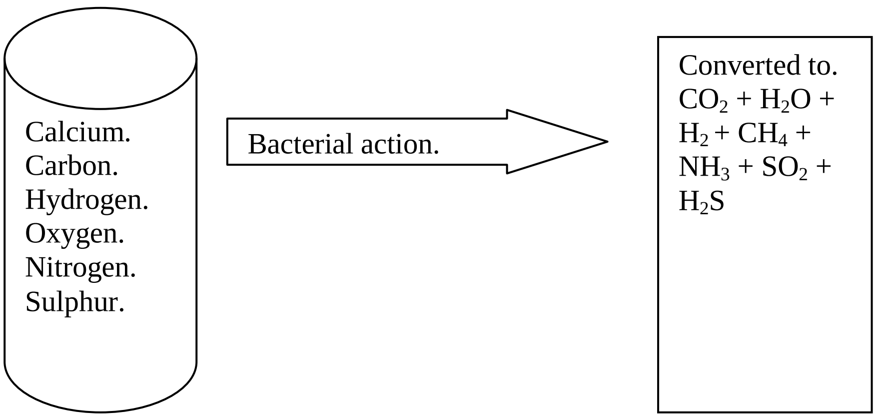
Biodigestion.

It's a cow not a tractor.

Before looking at the practical aspects of biodigestion and the production of bio-methane it is worth spending a moment to understand the basic principles of what is occurring within the Biodigestion chamber.

Our friend and ally in the entire process is a series of micro organisms that live in an anaerobic environment (a sealed compartment that is devoid of oxygen). When given the correct inputs they will flourish and reproduce, devouring the organic matter that we have supplied them and converting it into a range of compounds a significant proportion of which, if conditions are favourable, will be methane gas. In a way the biodigestion process is a little like farming bacteria, and as with any farming process the environment, food source and conditions with which our livestock are kept will determine the quality of the result.

The first law of thermodynamics states that "energy can neither be created nor destroyed it can only change its form." With this in mind the biodigestion process begins with our input ingredients (a soup mix of all our feed-stock ingredients) which will consist of a range of proteins and carbohydrates. These proteins and carbohydrates are predominantly made up of the elements carbon, hydrogen, oxygen, sulphur and nitrogen, when attacked by bacteria they will change their form and represent themselves in a variety of ways such as carbon dioxide, water, methane, ammonia, sulphur dioxide or hydrogen sulphide.



We can establish how this affects the digester product balance by a process is called Mass Balance, and if everything is working correctly then almost all the elements in our bio-digester will find a new, all be it temporary, life as a gaseous substance. For the making of methane we need ingredients which contain carbon and hydrogen. Certain elements will not be affected by the bacterial actions within the Biodigestion chamber. These non-volatile (or non-digestible) components will either be dissolved into the liquid and will just travel through the digester such as inorganic phosphorous and potassium and will be available as fertiliser at the end of the process, or form some insoluable compounds, containing elements like calcium, which will not be effected at all and will simply stick to the inner surfaces of the digester like scale in a kettle or form a pile within the digester itself.

The rate at which these elements are converted to the various gasses depends on the environment within the digester. If the environment were an aerobic environment (open to the atmosphere) then the process may well become a composting process with hydrogen and oxygen forming water and volatilising off from the process in the form of steam. The aerobic bacteria would release carbon dioxide and our compost heap may smell as nitrogen and hydrogen are released in the form of ammonia. However if we assume that the digester is a sealed and controlled environment then the bacteria will thrive. The anaerobic conditions encourage the growth of the bacteria that are needed to convert the organic compounds into methane gas whilst suppressing those that produce the more toxic sulphur dioxide and hydrogen sulphide.

To obtain a consistent result the critical parameters within the chemical process need to be controlled as much as possible. Understanding the make-up of the feedstock is one critical aspect to the volumes of gas that the system will produce. A simple way to understand this is to look at two simple products: grass silage and cow manure. The common misconception is that cattle manure is the perfect ingredient for the biodigestion process. This has already been digested within the cows stomach and has had the many vital components stripped away to provide energy for the animal that ingested the grass. The grass silage however still contains these elements and just requires the bacteria to extract them.

The feedstock is commonly described in two ways, available dry matter (which is sometimes expressed as mass of carbon) and calorific value (CV). The amount of gas that can be produced by a feed stock and the speed at which it can be produced is influenced by the amount of carbon or CV of the ingredient. The non digestible material in the substrate is either in the form of water or a non-volatile substance that will either dissolve and flow through the process or remain within the biodigestion chamber.

Low head Hydro-generation plant.

Hydro-generation (hydro) is regarded by many as the most reliable renewable energy resource that can be embraced. If water is available in a sufficient quantity and flow rate then the output from a low head hydro scheme is relatively easy to harness. If the resource is constant then the results are easily predicted and the availability and utilisation of the scheme can be easily determined.

The variables that need to be determined to calculate the output from a low head hydro scheme are to just determine the head (height difference) in meters and the volume of water that will flow through the scheme in litres per second. The equation to calculate the electrical energy is then:

Output in KW = head X flow X acceleration X efficiency of the system

If we have a site with a 5 meter head, a 1,000 litre per second flow, an acceleration of 9.81 meters per second (constant in all cases) and a system efficiency of 75% then we will have: 5 X 1000 X 9.81 X 0.75 = 37 kw. If we increase the head by one meter then we will increase the output from 37 kw to 44 kw, if we reduce the head to 4 meters then we reduce the output to 30kw and so on. The water volumes required are significant but when compared to the variability of wind then the scheme can be effective for a significant proportion of the 8,760 hours in a year and as such provide a constant output in electricity.

Outflow of the Mann Power 24 KW generator at Howsham Mill near Malton.

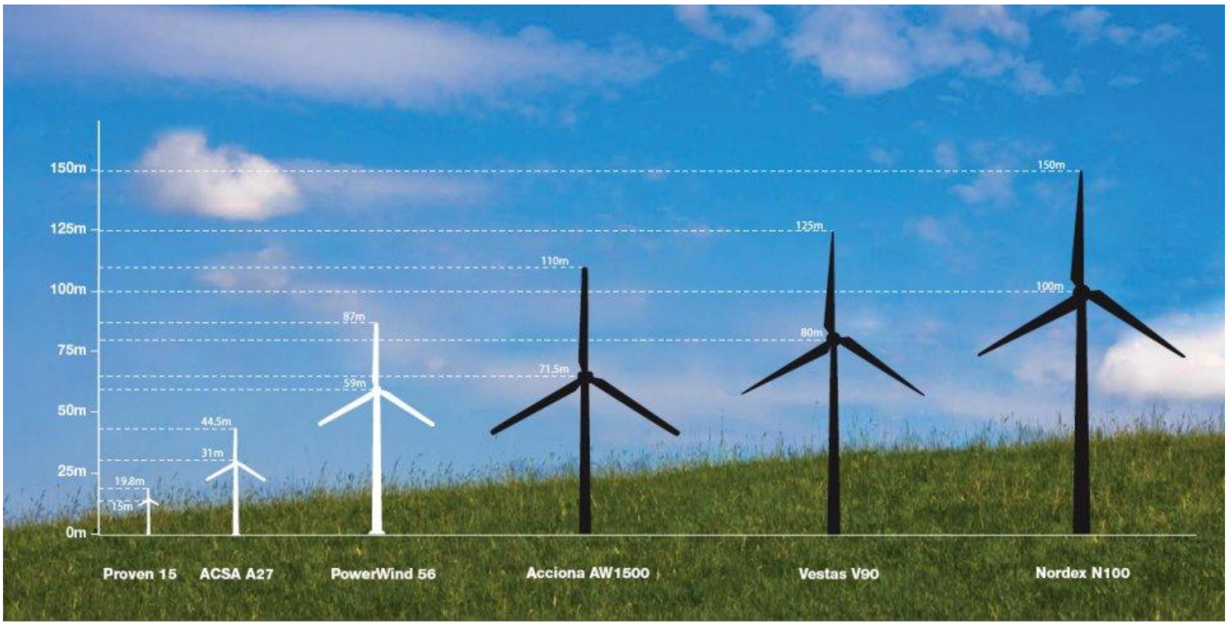
A wonderful example of such a system was seen at Howsham Mill near Malton in North Yorkshire. This demonstration plant utilises the weir of an old water mill and the entire site is being established as an environmental centre. Mann Power Consulting of Kirkham Abbey installed this 24 kw generator that operates with just 1.7 meter head of water and a flow rate of 2,000 litres / second. The unit is estimated to produce around 210,000 KWh of electricity per year and with no anticipated environmental effects as this type of generator is claimed to be "fish friendly" allowing for migration of fish both up and down the Archimedes screw action.

Wind energy in a nut shell.

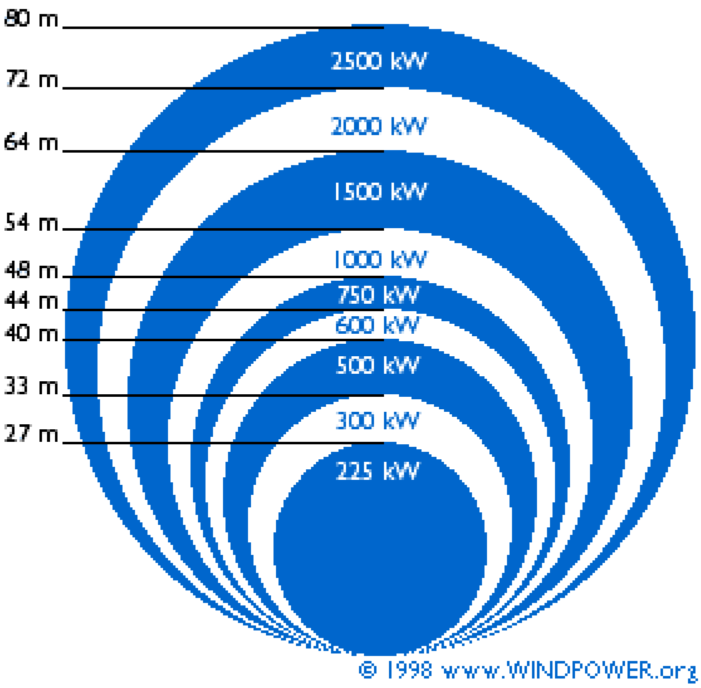
To understand the reason why wind turbines have grown into the massive structures that we see today the following technical points are worth understanding. An understanding of these simple points will offer an insight into why certain sites are more suitable than others.

- As wind speed increases the energy it is capable of delivering increases by the cube of the increased wind speed. In other words if the wind speed doubles the energy it delivers increases by 8 times (2 x 2 x 2 = 8).
- Wind speed increases by approximately 1% for every extra meter of tower height.
- The best wind sites are those that have the least turbulence. Trees, buildings and ground undulations will all increase the turbulence of the wind and decrease both the energy output and the working life of the machine.
- As a general rule of thumb the noise from a turbine will not be an issue beyond 350 to 500 meters from the development.
- Cold air is denser than warm air and will deliver more energy for the same wind speed.
- Air at sea level will be denser than air from an elevated district and will deliver more energy as a result.

With these points in mind you can easily understand why site selection is critical, it is also easy to see why size does matter in the phallic world of wind turbines!



If we then look at a comparison between rotors on the various sized turbines it is easy to see how dramatic the increase is in output between small and large turbines. In the words of Maitland Mackie, “the difference between big and very big is not very much”



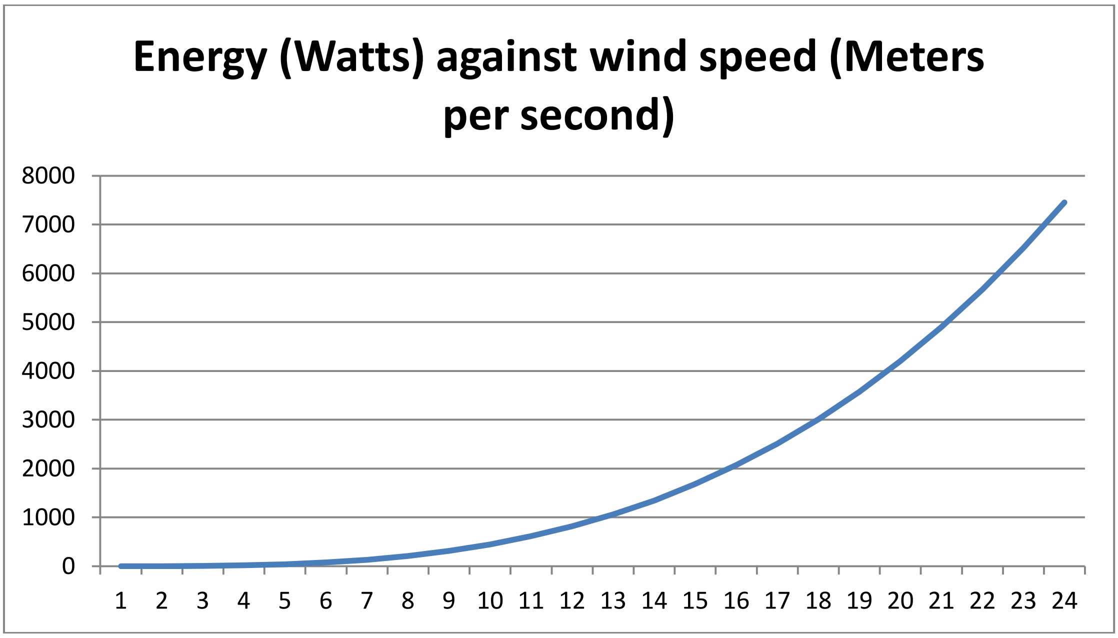
Danish wind industry association.

The importance of wind speed in site selection cannot be overstated. Generally wind speeds are measured in meters per second. The following table may assist to standardise the discussion with regard to wind speeds.

Wind scales and comparisions.			
Knots	**Metres/sec**	**Range knots**	**Descriptive term**
0	0	<1	Calm
2	1	1 to 3	Light Air
5	3	4 to 6	Light Breeze
9	5	7 to 10	Gentle Breeze
13	7	11 to 16	Mod Breeze
19	10	17 to 21	Fresh Breeze
24	12	22 to 27	Strong Breeze
30	15	28 to 33	Near Gale
37	19	34 to 40	Gale
44	23	41 to 47	Severe Gale.
52	27	48 to 55	Storm.
60	31	56 to 63	Violent Storm.
		64 +	Hurricane.

Danish wind industry association. Wind scale comparisons.

Now consider the point that energy in the wind increases by the cube of the increase in speed, our 7 meter a second “moderate breeze” when doubled becomes a 15 meter per second “near gale.” The easiest way to show this is by the following simple graph that demonstrates that this increase in wind speed creates an exponential increase in energy. Nowhere is this relationship between increased wind speed and energy output from a wind turbine more noticeable than in Southern India. Here the wind does not blow at all for 6 months of the year and the blades are totally motionless. When the wind does blow it is continuous and strong for the remainder of the year, the result being that turbines will produce a similar output to many high wind sites in Australia. Constant wind is not always the best thing; strong winds are the real secret.



The first and most essential requirement for accurate site assessment is to understand the available wind speeds at a potential development site. In countries like Denmark these details are easily available via certain web-based databases, however when faced with a lack of this data it is essential to collect this data for each site by the installation of a wind monitoring mast. These masts can be designed to collect data from the anticipated height of a turbine rotor and will enable a developer to collect accurate data essential for turbine selection, foundation design and financial returns. Wind monitoring towers need to be as close as possible to the same height as the anticipated wind turbine to allow data to be collected that will calculate wind speed, wind direction, turbulence and wind shear.

This tower that was being erected near Bedford in the UK was equipped with two anemometers (to calculate wind speed at two different heights) and a wind vane (to calculate wind direction). The tower was 30 meters high and was designed to be the same height as the anticipated wind turbine that was being planned.

Once this data is collected then a wind rose can be created to help with turbine site selection, in the event that more than one turbine is being placed upon a site then consideration needs to be given to the location of the other turbines. Generally speaking, turbines require an area equivalent to five rotor diameters between them when in a row facing the prevailing wind and seven rotor diameters apart if they are sheltered by turbines that are in front of them in the prevailing wind. These points are very important when considering site selection for wind farm developments and are generally left to specialist consultants. However when dealing with site selection with single on-farm developments a number of different constraints may need to be taken into account and a compromise may need to be taken with regard to site selection. Proximity to houses, present and future is an important factor. Maybe less obvious in the eyes of a specialist wind consultant is the future needs for agricultural infrastructure like pivot irrigation, boom sprayers and cultivation equipment that may influence the placement of a wind turbine so as not to compromise future efficiency improvements that may be planned.

Photo voltaic. (Solar electric)

Possibly the most likely technology of all the renewable energy options to be adopted by the general public as well as small to medium businesses is Photo Voltaic (PV) electrical generation from the suns energy.

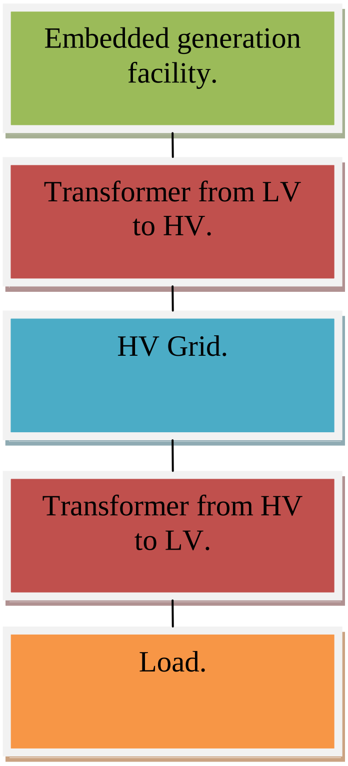
The P.V. technology is advancing at a staggering rate and as such the costs associated are also starting to reduce, however in most countries P.V. is still very much dependent upon the generous FIT’s that are being offered to incentivise the industry. Without them it is hard to see that significantly sized installations will occur. However as a net metering installation (see below) they may become more common.

Ways that these technologies can by connected to the grid and integrated within the farm electrical system.

The electrical connection of net metering embedded generation facilities differs markedly from that of normal embedded generation facilities and larger utility generators. An understanding of how the metering and connection requirements need to be linked to the generation plant is essential and is demonstrated below.

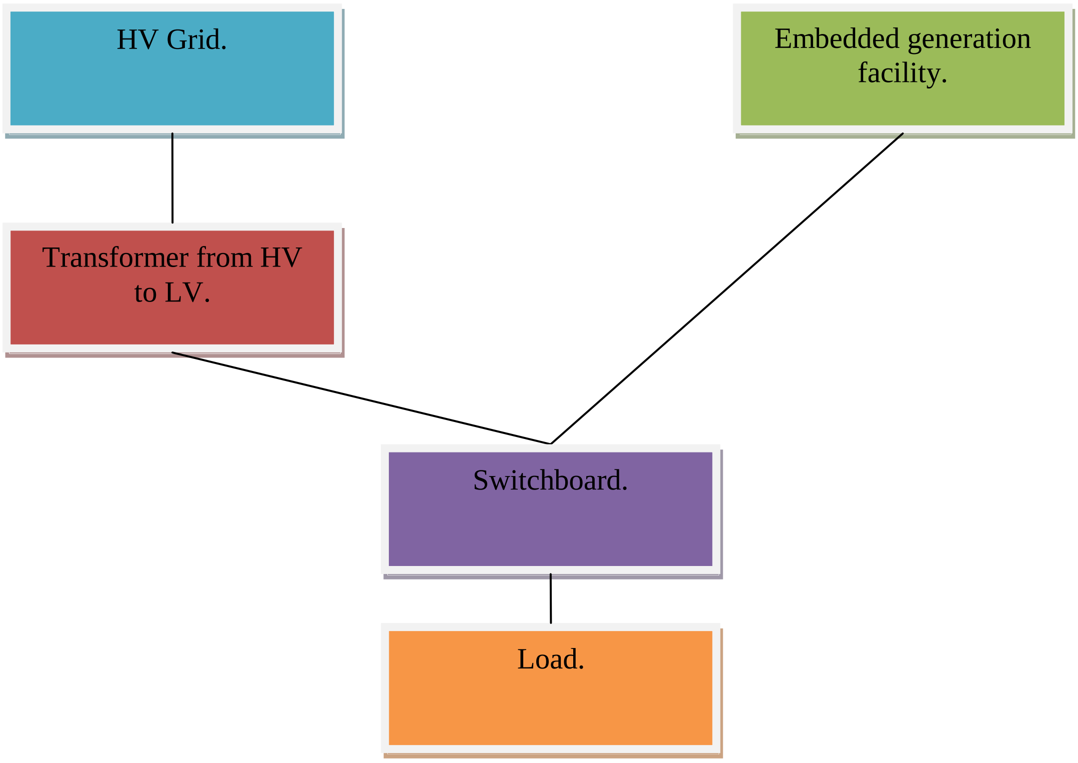
A typical connection of an embedded generator **without** the ability to net meter sees the energy produced fed directly into the high voltage grid via a transformer. When the power is in the HV grid the ability to call it your own is, in most cases, lost.

Diagram of an installation that does not support net metering.



However the rules in most states for net metering will only permit the generator to off-set energy that would otherwise be consumed within the business. To achieve the most lucrative return the generator must be connected directly into the switchboard at the site the energy is consumed. Obviously this can compromise the access to the best sites as the voltage drop due to cable length becomes a limiting factor and prevents embedded generation facilities being located more than a few hundred meters away from the load or demand.

The following diagram demonstrates a net metering installation with a low voltage turbine.



Many areas of Australia do not enjoy the generous FIT that Europe and other parts of the world are currently experiencing. The most lucrative way to justify a renewable energy generation facility on farm is to off-set the purchase of power from the usual supplier.

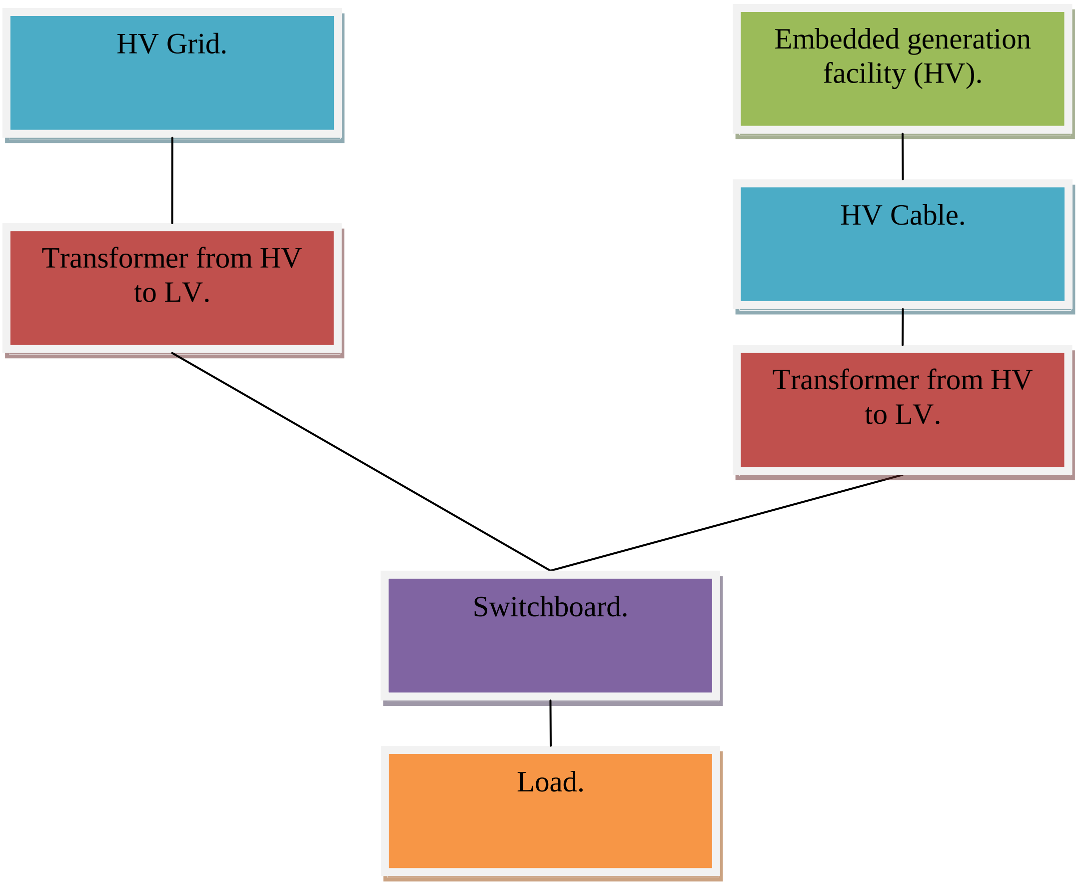
The addition of a feed in tariff has seen the UK poultry sector take advantage of the lucrative incentives. Farm buildings are well suited to the installation of solar voltaic cells as the constant consumption of power enables the power generated to be consumed on site and to make the most significant saving. Keep in mind that this 10 kw installation is not just receiving an income for the power it is generating (37.8 pence per kw hr) but also saving the farmer from buying power at the tariff rate (an additional saving of 12 pence per kw hr) this provides an income of close to 50 pence per kw hr for every kw generated. It is not difficult to

see why such installations are so popular in industries like the intensive livestock sector when such significant savings can be made.

Sadly in Australia we are not generally offered these incentives but the chance to offset power consumption by on site generation will be most lucrative in this type of installation.

Not all net metering installations are limiting themselves to low voltage generation and the results of doing the job properly are very impressive.

Net metering installation for high voltage transmission between generation and load.



Phillip Benzie of Gairnieston farms in Aberdeenshire (see picture at left) has recently installed a 2.4 MW turbine to generate power and transmit via high voltage to the load. Once again power is either used on site, if demand is sufficient, or sold to the grid. The difference being that with such a large machine the connection is via a high voltage connection and as a result the turbine can be located in far more suitable positions and the power-cabled to the factory with little or no voltage loss in transmission. The benefits are enabling this large dynamic business to feel a security not experienced before, the business packs 1,100 acres of potatoes and 330 acres of

carrots for a number of UK supermarket chains, but this diversification allows the business to have an alternate income to support the interest payments the business is required to make even in a bad year.

The previously mentioned Mackies ice cream factory also shows that this is possible and that no matter how daunting the process may seem to the layman it can still be achieved. The boxes, wires and lights don't need to be understood so long as the results are that power is produced and the power bill is reduced! Nobody does it better and with more passion than Maitland Mackie!

Maitland Mackie at the controls of the electrical connection point between turbine and factory.

Chapter 3.

Limitations and considerations.

The technologies that we have discussed in the sections above will not be suitable for every area, landscape, community or location and as such the various pros and cons of the renewable energy solutions need to weighed up on a case by case basis.

Whilst in the United States of America it was mentioned that environmental concerns are everybody's second favourite policy and as such take second place when governments and business sectors come under budget scrutiny. This insecurity and lack of commitment by governments has damaged the industry and peoples' willingness to invest within it. Where incentives have been offered and enshrined within legislation then a vibrant industry has flourished, however the continued partisan gamesmanship being played off within Australia continues to leave doubt in people minds. This is an issue with all the technologies that have been studied.

Biodigestion.

Strengths.

- Provides a method of converting a waste material into energy.
- A more continuous form of generation may enable a better price to be negotiated.
- Provides an opportunity for farmers to be paid an income to treat waste materials.
- Provides a chance to concentrate nutrients from a wide area to build soil fertility in a concentrated area.
- The odour issues associated will limit construction and nutrient utilisation to rural areas.
- Provides an alternative cropping option. Grass silage, whole crop silage and maize silage are the most stable and manageable ingredients that can be used within the system.
- Able to be sited in any area that is close to a grid connection as it is not limited to the location of the resource as is the case with wind and mini hydro.
- Provides employment opportunities within rural areas.

Weaknesses.

- Unlikely to find a market for the heat energy that is created, this is close to 50% of the energy output from a biodigestion facility.
- Costly to establish.
- Odour issues limits' the construction and utilisation to rural areas, although this is also a strength.
- High degree of management and continual operator input for the 20+ year life of the installation.
- Many digester inputs are in some way linked to the cost of oil, e.g. maize silage is linked to the price of oil by fertiliser and vehicle energy costs to harvest and transport, as oil prices increase so will the costs of popular feedstocks.
- Waste materials will also be continually scrutinised for their ability to have heat energy extracted in alternative ways As such their long-term security cannot be taken for granted.
- High margin for error, not only with biogas production in the event of infeed material fluctuation affecting bacterial life within the biogas chamber, but also in the life of the Combined Heat and Generation plant (CHP) that can become damaged due to sulphur contaminants within the gas.
- A lack of support with electrical feed-in tariffs in Australia makes it a marginal option.
- Subject to the variability of Renewable Energy Certificates (REC's)

Low Head Hydro.

Strengths.

- With a reliable water supply this is the most cost effective form of generation of renewable energy.
- Very easy to predict the energy output from with Hydro generation.
- Generation sites can be established on sites with as little as 2 or 3 meters of head.
- Very low environmental impact with flow of the river technology.
- Very little visual impact so a much simpler planning process.
- Energy (water) to power the generator is free and unaltered by the generation process.

Weakness.

- Availability of a suitable reliable water source in Australia may be very limited.
- Some noise issues may require locations away from settlements.
- The need for a weir or the damming of a creek to provide a head.
- Suitable locations may be a distance from a grid connection for electrical installation.
- Vulnerable to volatility in the REC's price.

Wind.

Strengths.

- Energy (wind) is produced from a free resource.
- Once constructed the running costs are minimal and operator attendance is only required in the event of an alarm situation or service call.
- Income for landowner for either the rental of a site or the sale of power if it is privately owned and operated.
- Large power generation facilities are possible.
- A multitude of different size machines makes wind energy suitable to a variety of embedded generation applications.
- Ideally suited to a cooperative or multi owner business model.
- Provides employment and skilling opportunities for the rural areas.

Weaknesses

- Intermittent energy due to variability of the wind.
- A developer needs to do site specific monitoring of wind to determine energy potential of a site, this needs to be for at least 12 months.
- Major planning issues in some areas may be seen as a deterrent to developers.
- A limited number of windy sites are available.
- Windy sites may not be in the vicinity of a grid connection.
- Vulnerable to the fluctuations in REC's

Photovoltaic

Strengths.

- Low environmental impact.
- Many areas in Australia that suit PV.
- Virtually no running costs when installed.
- Able to be sited in an area close to a grid connection.
- Many farm buildings are capable of accommodating the technology.

Weaknesses.

- Expensive relative to the scale of output.
- Lengthy payback periods due to a lack of suitable government incentives.

Chapter 4.

Benefits for farmers and rural communities.

The future prospects for agriculture's involvement in the race to secure a new renewable energy resource were highlighted in a series of meetings with academics and NGO representatives.

Dr Paul Wilson, School of Biosciences University of Nottingham, discussed the second generation renewables that are being investigated. Second generation are the bi-products from more traditional agricultural crops rather than those that have been grown specifically for energy production. The need for long-term food security is starting to sway policy away from the primary production of energy crops, such as maize for biodigestion and is seeing interest being channelled towards better utilisation of the energy bound up in such things as straw residue. Dr. Wilson highlighted the investment that is currently been made within this sector in the UK The Biotechnology and Biological Sciences Research Council (BBSRC) have allocated 7 million pound over 5 years towards the downstream processing of straw to breakdown the cellulose and to extract the ethanol potential from within. Currently this technology is a long way off, although possible with the use of traditional energy sources. The long-term viability of this technology is dependent upon the development of a bacterial process to make it cost-effective.

The implications of this development would be very significant for agriculture as this would once again underpin the value of agricultural produce by putting in a floor price for the energy value locked within the crop. One word of caution that stuck with me from these discussions was that the value of energy from any crop, no matter if it is a primary or secondary derived resource is inextricably linked to the cost of fossil fuels. No matter what the material that is the feedstock for the energy source it will always have some link to the cost of energy. The locked up phosphorous, potassium or nitrogen that would be returned to the cropping ground has a value that is closely linked to the alternative source that, in the case of nitrogen, is produced with fossil fuels. In the case of other so-called waste streams then the calorific value will ultimately be priced according to the current energy costs. These technologies may find themselves forever out-competed by fossil fuels no matter what the price of a barrel of oil as the margin between will always be small. This logic therefore leads to the realisation that the only real pot of gold at the foot of the renewable rainbow is energy sources that are free to harvest; wind, solar and hydro being those most likely to be available to the farming community. These resources alone are independent of the oil price and over time we will see the difference in cost of production and cost of sale become greater and greater providing greater profits for those involved.

Dr. Wilson's parting words were that farmers should be excited about the future as we are best placed to capitalise upon the energy revolution before us. The real sustainable renewable energy resource is linked to the area of the land that the sun shines upon; the greater the farm area the greater the ability to harness the suns energy or the winds that blow across it.

So how can the farming community manage this quantum leap towards not just feeding the world but fuelling it also? Dr Jonathon Scurlock, Chief Advisor, Renewable Energy and Climate Change for the National Farmers Union at Stoneleigh, pointed out the support that farmer's in the UK have and will receive in the future.

Obviously the feed in tariffs are seen as a significant part of this support package and the reason for them does make some sense when looked at in the broader term. To gain the true benefits from bio-mass or bio-gas then not only the electrical energy needs to be utilised. To really maximise the benefits the heat energy, which accounts for up to 50% of the energy produced, needs to be also utilised locally. , using schemes such as a district heating scheme or an intensive farm industry application. The initial goal of the FIT's were to encourage up to 1,000 biogas plants to be constructed throughout the UK providing a huge potential district heating resource. Without the FIT it is conceivable that eventually a larger multi-megawatt single power station would be constructed with none of the benefits of being able to direct the waste heat to alternative sectors.

An example of how embedded generation can have local benefits.

A great example of how small-scale embedded generation can be successfully spliced into the rural landscape was viewed at the farm of Rob Little at Kirkbride in Cumbria.

The UK, with a seemingly never ending supply of cheap coal and a total lack of political will to embrace change, has examples of a number of major coal fired power plants around the country. Each of these plants pour hot steam clouds into the air in an attempt to condense and recapture the water from the turbine generators. In Denmark this valuable energy would have been captured and used to heat the houses in the nearest town.

This power plant (pictured at right) is located just a few miles away from the city of Nottingham and would surely be more efficient if the energy were piped into the city to provide the heat. Such is the plan with the Kirkbride biodigestion facility. The Kirkbride plant is currently under construction and will see the farm utilise the animal manures from the dairy unit and co-digest a number of locally grown energy crops such as maize silage, grass silage and whole crop (grain crop that is ensiled at the milky stage rather than allowing full maturity to be reached). The Kirkbride Anaerobic Digester (AD) plant will be 500kw in capacity but most importantly will also be linked to the houses within the village to provide hot water for domestic use and household heating. As the heat energy is around 50% of the output from the plant then this will be a vital economic consideration when planning the appropriate location for an anaerobic digester. The success of an AD plant seems to be directly linked with the ability to utilise both the electrical energy and the surplus heat energy.

The sighting of the Kirkbride AD plant is a good example of how the various inputs and outputs can be sourced and utilised within the local community. In this case the following feedstock ingredients are being secured locally from a combination of livestock manures, crop residues and crops specifically grown for the AD process.

Feedstock	**Volume per year**	**Gas production annually**
Slurry	6,700 m3	156,500 m3
Shed manure	1,250 ton	116,700 m3
Grass Silage	7,500 ton	1,046,000 m3
Whole crop (silage wheat)	2,000 ton	344,000 m3

The generation of electricity is via a 500 kw combined heat and power plant with more than 50% of the energy output being presented as hot water, obviously an essential requirement for the economic viability of an AD plant is the sale or utilisation of this hot water. In the case of the Kirkbride installation the hot water will be utilised to heat a number of houses within the village and will provide an alternative income stream to just the sale of renewable energy.

The economic benefits of embedded generation.

In 2010 the Scottish Agricultural college (SAC) commissioned a report to be written on the economic benefits of small clusters of wind turbines within Aberdeenshire. The report was written by Dr Elaine Booth and Julian Bell and highlights some interesting facts that Australian farmer organisations would do well to take heed of when planning how to develop an economically sustainable renewable energy industry within Australia. Once again the similarities between Aberdeenshire and areas of Australia are worth noting. Aberdeenshire is sparsely populated and as such has few diversification options for the rural communities, Aberdeenshire has a close connection to its mineral wealth but has taken the wise decision that the uptake of renewables will help prolong this valuable resource for future generations and that by utilising the wind resource in a responsible manner they can provide valuable diversification options for their farmers.

The SAC report highlights just how valuable these economic benefits can be to the rural sector. For example a relatively small and well-sited 850 kw Wind Turbine Generator (WTG) that is owned by an individual will have a significant economic boost to the local area, it has been calculated that the flow-on effects of this additional farm income could result in an additional 2.47 jobs per turbine, when compared to the employment of just 0.23 jobs per WTG for turbines owned by utility companies. It is estimated that windfarm projects planning in Aberdeenshire will bring additional income to the farming sector equivalent to between 5% and 10% of the country’s £223 million output from agriculture.

The desire to make this industry have a community feel extends to the planning process. Developments that proceed have an expectation to return some benefits back to the local community via community grants. Typically these would be £1,500 per turbine per year and would be to channelled in to the arts, wildlife, schools and housing projects and in the Aberdeenshire example these funds are managed by the local councils. These measures could be seen as a way to mitigate any perceived detrimental effects that developments may have upon the quality of life within the proximity of the windfarm.

The challenges of planning and site development have been a discouragement to a number of developers. Maitland Mackie of Tarves has been instrumental in encouraging the government to establish a fund that will provide assistance for the planning process. The fund can be accessed by potential developments that comply with a simple desktop audit. Once developments that meet the selection process are selected they can borrow up to £150,000 to cover the planning process in the knowledge that if the planning process fails then the funds do not need to be repaid. Developments that do proceed repay the loan at a high interest rate and as such the fund is expected to be self sustaining into the future. Once again the community aspect of windfarm developments is not lost as the loan is conditional upon 20% of the development being offered for community ownership if they are interested.

Availability of finance has been a stumbling block for many potential investors, however the CO-OP bank has been sufficiently encouraged by the combination of security that the FIT's provide and the available wind resource in the Aberdeenshire area that it is now providing funds of up to 90% of the project cost with no security other than the security of the windfarm development itself. As a result the windfarm developments are financially well structured within separate entities, and all access and easements are noted in a way which provides the lender with the security that is required.

Community ownership of a windfarm site.

Adam Twine of Westmill Co-op windfarm near Oxford was the 2010 runner-up of the renewable energy farmer of the year, a Farmers Weekly supported initiative. Adam's passion and determination to establish a community co-op windfarm took over 10 years to complete. The Westmill co-op has a total of 2'400 members with members having a financial stake holding of between £250 minimum to £20,000 maximum. A total of £4,150,000 pounds was raised in this way and presumably a great deal of local interest and local support was generated.

The wind farm consists of five 1.3 MW turbines with a hub height of 50 meters and blade diameter of 62 meters so this is a sizable and significant site. For a farm of this scale to be successful it requires the passion and foresight of a person like Adam Twine. In this example Adam singlehandedly financed the initial project costs associated with planning and wind mapping. In this way he was able to show potential investors a blueprint for how the cooperative would be structured and what financial returns could be expected. Once the co-operative was operable the development work undertaken was sold to it and Adam now receives a rental for the use of his land and a royalty of 2% as recognition of his contribution in those early days.

The community interests have not been lost with this project, as 0.5% of the wind farm income is directed towards education. To date around 2,500 visits by schools, colleges and planners have been delivered as well as providing advice regarding building insulation and related matters. The development was not without its sceptics and opponents, however the offer of a share in the ownership and a genuine open and honest approach by Adam has seen widespread support for these turbines. This support came from aan area that would be considered by many to be too populated or too close to an area of outstanding beauty (Cotswolds) to even be considered.

The ultimate example of community support and ownership of a windfarm and other renewables is driven by Heinrich Bartelt and the Dardesheim community in Eastern Germany. Twenty years ago the first 80 KW wind turbine was constructed on a farm behind the township of 1,000 people. This development caught the eye of Heinrich Bartelt who had the foresight to involve the local community right from the start. In the early 1990’s the area was troubled with high unemployment of around 15%. Rather than simply ignoring the interests of the local people Heinrich engaged them and set about sourcing all the machinery and expertise in a 70 km radius from the site.

In 1992 and with full consultation and support of the local council and community the development commenced. €80 million has been spent in the local area to date and significant opportunities for the region have occurred as a result. Local residents were invited to invest in the farm and have received a guaranteed 8% return on their investment. The local disused fire station was converted to become the service centre for the turbines and a team of eight local residents have been trained to provide service and maintenance work. The Mayor of Dardesheim, Rolf-Dieter, said to me that “it is like we are all rowing in the same boat” the district has been revitalised and more importantly the renewable industry has “stopped the slide of younger generations to the cities and towns.”

.Dardesheim does not just have a windfarm interest (see photo to the left) but also it has embraced bio-gas and solar voltaic. Over a megawatt of solar voltaic panels have been installed on the roof tops of the village which produces enough power to satisfy the needs of the entire community (see below).

> *“It is like we are all rowing the same boat”*
> *“It is stopping the slide of younger generations to the cities and towns”*
>
> Rolf-Dieter Mayor Dardesheim.

The windfarm at Dardesheim continues to expand, and the district continues to benefit as a result. The farm now totals 66 MW and is dwarfed by the largest turbine currently available from Enercon a 6 MW 120 meter tall machine. The power generated by this machine will help the district in the same way as the others, because:

- 2% of the income goes to the land owner.
- 2% goes to adjoining landowners that may have had their vista or ability to harvest the wind themselves damaged in any way.
- 1% goes back to the local community and is distributed by a panel of locals to various interest groups. The district boasts the winner of the brass orchestra competition for the region and the sports and social clubs all benefit as well.

The employment potential for the renewable energy industry is enormous. Germany currently employs 100,000 people in the Nuclear and Coal fired generation sector and this accounts for 80% of the country's energy; compare this to the 380,000 jobs that are employed in the renewable energy sector that supplies the remaining 20% of energy, of which a significant number are rural based, and it is easy to see why the future looks prosperous for rural Germany and for the job prospects of the young people that live within it.

The future is not being forgotten by the people of Dardesheim. Germany's desire to embrace renewable energy extends to road transport also, and an electric car refuelling station is located in the centre of town. Vehicles are available for hire by locals and can be recharged at the town centre via the solar cells on the adjacent roof.

Service industries.

Everywhere you go in a country that has a strong renewable sector you can see examples of how farms can use this as a means to diversify their business, utilise their equipment and buildings and skill their labour force to deliver the service work that is required. The experience of countries that have embraced these challenges is that it is a world of opportunity that awaits. The message from Germany is clear and simple, 100,000 jobs are employed within the coal and nuclear industry to produce 80% of the countries needs, whilst 350,000 jobs are supported within the renewable sector to produce the remaining 20%. Unlike the traditional energy sector these jobs will mainly be within the rural communities and have the potential to reverse the flow of labour to more urban areas.

Chapter 5.

Non-electrical energy producing alternative energy options.

Although this report looks mainly at renewable energy options it would not be complete without some mention of biomass heaters and boilers that can produce heat for industries like the intensive livestock sector.

District heating systems.

Many countries have sophisticated systems of heating houses and domestic water by means of a circulating hot water system. These are typically within the colder climate countries of the world and although not limited to biomass energy there are many examples where this is the case.

The Danish have entire districts that are heated in this way. Today it is compulsory for all new houses to be connected to a district heating system for their heating needs. The figures and efficiencies of these systems are astounding and although not directly transferable to Australia they do have applications in certain industries.

The system visited at Lokken Varmevaerk in Denmark was a small one, however it heated 1048 houses and businesses within a 1.5 km radius of the plant, the system used wood waste as the energy source on a totally automatic system. (see photo at right)

Water stored within a large insulated vessel is able to store the heat (energy) in a very efficient manner, so that the energy is available for peak periods.

The energy content of timber material is surprisingly high at around 0.8 MW per square meter. Modern well insulated houses within Denmark have a total energy requirement of approximately 5 MW per year. A total of just 4 meter square of woody material will ensure that each house is kept warm through a cold Scandinavian winter period. (compare this to 10 years ago when the average was 12 MW per house per year. A decade of education and encouragement has seen this improvement, a lesson for governments within Australia)

The storage of heat energy as hot water and the transport of it via insulated pipes is improved if the temperature of the water leaving the storage tanks is restricted to 72 Deg C. If the temperature is higher than this the heat loss will be significantly increased and excessive energy is consumed.

Biomass boilers.

Although the district heating systems of Denmark are highly sophisticated and efficient the principles can be adopted to heating systems within the livestock or industrial sectors. Examples are rare but the principles as described in the district heating sector are the same. The system seen here shows a boiler that was able to combust either saw dust or straw bales and was rated at about 1 MW. The major difference between this and the district heating systems is the lack of a storage tank to provide a boost in energy. The system was backed up by typical gas fired heaters, however it does prove the point that large intensive livestock buildings can be heated in such a manner with a simple system of heated pipes and fan-forced radiators, as shown below.

Radiator pipes run around the room to heat the building.

Recommendations

- Farmer lobby groups must become involved in the renewable energy debate to ensure the industry is seen as a primary production activity.
- Farmers must ensure that the renewable energy sector comes under the ministerial control of the Agricultural minister as this is a truly perfect example of primary production.
- Push for the tax scheme to include embedded renewable energy generation to be viewed in the same way as irrigation with regard to accelerated depreciation, an extension to part 75 B could achieve this and would ensure the benefits are only accessible by fulltime professional farmers.
- Encourage councils and local governments to realise the potential that wind sites have for delivering much needed funds into local communities if local ownership can be encouraged.
- Streamline the planning process for embedded generation projects. Make embedded generation a separate area to utility scale installations.
- Push for power retailers to allow energy produced by embedded generation plants to be “banked” for later use within the calendar year.
- Maybe the most palatable recommendation that can be made, do not be tempted to introduce inflated feed-in tariffs as they will result in an inefficient industry that will not have long term benefits. The introduction of a reasonable and sustainable feed in tariff will inject confidence into the industry.
- Define embedded generation as being “A renewable generation facility that is connected to the distribution network and is below 10 MW in maximum generation capacity.”

References

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Plain English Compendium Summary

Project Title:

Nuffield Australia Project No.:

Scholar: Robert Nichols.
Organisation: Nichols Poultry P/L
Phone: 0407879181
Fax: 03 64267414
Email: Robert@nicholspoultry.com.au

Objectives

To investigate the benefits to farmers and rural communities in embracing renewable energy as an alternative farm income.

Background

The political and community desire for renewable energy has great potential to rural based businesses to provide the location and the ancillary services required to support this burgeoning sector. Other countries in the world have benefitted as the renewable energy sector has expanded and matured into the modern industry that we see today. Australia seems to have escaped this exciting evolutional stage in the industries development and is in danger of missing the chance to become involved at a grass roots level. Australia seems to be jumping to the last chapter in the book and gives little guidance to how farmers and communities can become involved and how this changing world can be steered to be a benefit to our beleaguer rural areas.

Research

Over the course of my scholarship I visited numerous countries that have renewable energy industries at various stages of their evolution. A number of technologies were investigated, Wind, Solar, Mini-hydro and biogas (methane) were the four that most suited farming ventures and as such were the focus of my attention. Biogas for methane production was the odd one out as it is a secondary form of renewable energy and investigation soon revealed some difficulties that are experienced. Primary renewable energy sources became the focus of my interest and places like Denmark and Germany which have had many years of exposure were the obvious countries to visit. India opened my eyes to how a sensible government policy can stimulate investment and development without direct subsidised payments. Contrasting this is the UK where throwing money at an industry to kick start it seems to be a regular pastime!

Outcomes

The overwhelming outcome of my visits is realisation of the benefits to communities which can result from the sensible and well planned integration of renewable energy. Embedded generation is the distribution of generation throughout the entire grid. It allows the payment for electricity generated to be distributed to the numerous stakeholders rather than to a few owners of utility scale generation facilities.

The farming lobby representatives need to address the following:

- Ensure farmers have a say in the future of the renewable energy industry to make sure that this once in a lifetime chance for true diversification of our businesses is not lost.
- Define embedded generation as being a small business activity to ensure that incentives that are directed at embedded generation scale installations are not oversubscribed by the larger utility scale operators.
- Push for embedded generation to be treated differently to utility-scale generation with regard to planning and the setting up of various contractual agreements.

Implications

The chance for Australian farmers to develop a viable off -farm income by diversification into renewable energy. This could help our rural areas to be reinvigorated if the opportunities are better understood.

Publications