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College of Agriculture,
Food & Rural Enterprise

Practical On-farm Renewable Energy

2011 / 2012

DARD
Department of Agriculture
and Rural Development
www.dardni.gov.uk

afbi Agri-Food and Biosciences Institute

Ulster Farmers' Union

LEAF

Foreword

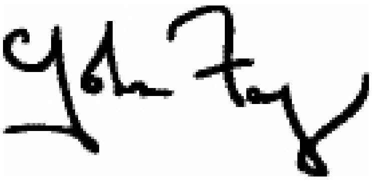
As CAFRE Director I would like to warmly welcome you to this our second Practical On-farm Renewable Energy event held on Greenmount Campus. The day is designed to give you practical information about the many renewable energy technology options available to the farmer and the rural sector.

It is a big challenge to understand how renewable energy technology might bring benefits to an individual farm business. An appropriate investment in renewable energy technology can reduce the high cost of energy inputs and provide an additional source of income for the farm family. The resultant produce will have a lower carbon footprint, contribute to the reduction of greenhouse gas emissions from the agri-food industry and have the benefit of a greener image in the marketplace.

I sincerely hope that today will provide you with the information that will enable you to benefit from renewable energy technology in your own business.

Finally I wish to express my appreciation to the planning committee, made up of the CAFRE Renewable Energy Team and staff from across DARD, AFBI and the UFU.

I hope you have an informative and worthwhile day.



John Fay
CAFRE Director

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The DARD Renewable Energy Action Plan

Joyce Rutherford, Climate Change and Renewable Energy Branch, DARD

It is clearly recognised that the land-based sector has an important role to play in the growth and development of the renewable energy market, which in turn provides the potential to expand our economy. This sector is well placed to take advantage of opportunities to produce and make use of renewable energy, from providing the primary feedstock, to the generation of heat and electricity from renewable sources.

The implementation of the DARD Renewable Energy Action Plan (REAP) continues across the Department to promote the opportunities presented by the development of renewable energy within the agri-food and forestry sectors and the wider rural economy. The Action Plan has the overall aim of creating a favourable operating environment for these sectors to exploit. It[1] sets out the key activities the Department is supporting to assist the sector and meet our policy and statutory obligations. The plan is kept under review by the External Oversight Group, comprised of 3 independent industry experts.

To date, considerable progress has been made in delivering the action plan including the development of an Anaerobic Digestion portal[2] which provides useful information tailored to the local context. The portal will continue to be developed and populated with additional information regarding biomass production and utilisation.

In understanding the importance of research as a key driver of renewable energy developments, DARD is committed to ongoing support of the Renewable Energy Research Programme at the Agri-Food and Biosciences Institute (AFBI). Significant research and demonstration projects on biomass crops and anaerobic digestion are currently underway. It is critical for the research findings to be communicated effectively to the land-based sector to inform decision-making at business level, therefore the results will be disseminated widely across the sector through the Biogas portal and knowledge exchange events at AFBI and the College of Agriculture, Food, and Rural Enterprise (CAFRE).

CAFRE also remain focused on further developing knowledge, understanding and skills within the sector, through a programme of training and knowledge and technology transfer events on renewable energy.

1. http://www.dardni.gov.uk/publications_dard-renewable-energy-action-plan-2010
2. http://www.biogas-info.co.uk

In addition, the DARD Biomass Processing Challenge Fund which opened in 2010 is assisting with the on-farm installation of biomass boilers and anaerobic digesters across the province.

Delivery of these actions will help the land based sector to contribute to achieving the ambitious targets set out in the Strategic Energy Framework for Northern Ireland. DARD will continue to work with other Departments and stakeholders to ensure the interests of the agriculture sector are represented in the renewable energy arena.

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CAFRE Renewable Energy Training Programme

CAFRE runs a series of courses on energy efficiency and renewable energy technologies at venues throughout Northern Ireland. Courses aim to provide participants with an introduction to the technologies, the issues to take into account when considering their adoption, the economics and the payback periods.

Courses are available on the following subjects:

- Energy efficiency on the farm
- Introducing renewable energy
- Energy from wind
- Solar hot water
- Short rotation coppice willow production
- Heat from biomass
- Anaerobic digestion
- Micro-hydro

If you are interested in attending one of the courses, please contact David Trimble
on tel: (028) 9442 6682 or email: david.trimble@dardni.gov.uk

Overcoming barriers to the adoption of renewable energy

Chris Osborne, Rural Enterprise Policy Officer, UFU

The UFU welcomes the opportunity to once again be involved in the CAFRE Renewable Energy event. This article reiterates the role and progress of our organization in working to achieve a sustainable land-based renewable energy sector in Northern Ireland and highlights the progress made with realising these opportunities for farmers and landowners. Ahead of last year's event, the UFU identified barriers which needed to be addressed. Failure to do so had the potential to stifle the development of the land-based renewable energy sector.

The UFU presented their oral and written evidence to the NI Assembly Enterprise Trade and Investment Committee. This contributed to the Committee report, "Barriers to the development of renewable energy production and its associated contribution to the Northern Ireland Economy" which was launched in February 2011.

Other notable successes included;

- **Rural Development Funding -** Axis 3 Rural Development Programme funding for renewable energy has been made available to qualifying renewable energy projects through the Local Action Groups.
- **Grid Connection -** Whilst by no means a complete reversal since the last report, matters have improved in relation to NIE and their interaction with landowners wishing to connect to the grid. However, further progress could still be made.
- **Biomass Processing Challenge Fund -** This was launched last year and the uptake was encouraging especially amongst anaerobic digestion developers. A second tranche of this scheme would be very beneficial.
- **Renewable Heat Incentive (RHI) -** The UFU has been lobbying for this to be introduced. The UFU actively responded to the recent DETI consultation on the implementation of an RHI and we look forward to a positive outcome from that consultation.
- **Cross Departmental Co-ordination -** Whilst the UFU can acknowledge that DETI is leading the Bioenergy Inter Departmental Group, bringing together DETI, DARD, DRD, DFP, DOE and Invest NI, this does not detract from the importance of continued cross departmental co-ordination. Co-ordination is essential if many of the following outstanding barriers are to be properly addressed.

Outstanding challenges and barriers

The two largest single barriers continue to be grid connection and planning;

- **Grid Connection -** Whilst there has been progress made communicating grid connection information to landowners, problems do persist;
  - **Costs -** There is a need for improved transparency in terms of grid connection costs. This is stated as a prerequisite in **Directive 2009/28/EC** Article 16 – Access to and Operation of the Grid, Paragraph 3 and Paragraph 5.
  - **Time Delays -** The significant, unexplained time delays from initial application to live connection are unacceptable. **Directive 2009/28/EC**, paragraph 5 states that a clear timetable for completion should be provided.

The UFU is raising these issues with the Northern Ireland Utility Regulator and NIE.

- **Planning - Directive 2009/28/EC** Article 16 – Access to and Operation of the Grid, Paragraph 1 states that the Member State shall coordinate approval of grid infrastructure with administrative and planning procedures. Experience indicates that this is a long and protracted process. As far as planning policy is concerned, the most common reason being given for refusal is that of "Visual Impact". The UFU has been tasked with getting a theoretical reasoning behind the guidelines and implementation of the rules behind Visual Impact.

  Whilst the UFU is not in favour of the reckless location of wind turbines, we feel that rules concerning the proximity to ASSIs, for example, should be fairly and consistently applied. The fact that a proposed site is within 5 miles of an ASSI should not be reason to refuse planning permission.

  Permitted development for Microgeneration, – whilst this was consulted on 18 months ago, there is still little visible progress. The UFU is calling for parity with GB.

Other on-going barriers include;

- **Banks and Financing -** There is a vacuum in capital funding for many on-farm renewable energy projects, between credit being offered by high street banks and that of venture capitalists. The UFU would not be keen on farmers jumping to accept deals with the latter. The UFU is therefore calling on high street banks to listen to landowners when they seek funding and to carefully consider each individual project on its merits.

- **Tax implications -** There is confusion as far as taxation implications are concerned for on-farm renewable energy projects. Questions have been raised as far as Capital Gains and Inheritance Tax are concerned, namely there are doubts as to whether exemptions may apply for what is deemed as "agricultural use". The UFU will be lobbying HMRC for clarity on all taxation implications for on-farm renewables projects.

- **Renewable Heat Incentive -** The UFU has recently responded to the DETI consultation. As the document currently stands there are concerns in terms of banding and the UFU will be lobbying to have these resolved.

- **Rural Development Funding -** The UFU has concerns about aspects of the funding, in particular the Farm Diversification link, which may have far reaching implications as already mentioned above. The UFU is seeking clarification on this issue.

- **Managing landowner expectations -** Whilst the enthusiasm for on-farm renewable energy remains, there are concerns about managing landowner expectations. Many companies are scrambling to get sites for wind turbines and many landowners are unsure as to what is involved and what constitutes a good business proposal. The concerns are that "land-banking" is occurring and the UFU would be concerned about landowners setting their expectations too high. As far as other renewable energy technologies are concerned, the UFU is urging members to compile structured business plans as upfront capital commitments continue to be requirements.

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Renewable Energy Technologies

Energy Efficiency on the Farm

David Trimble, Renewable Energy Technologist, CAFRE

What is energy efficiency?

This is the first step you take to reduce your energy bills. Before you consider any form of renewable energy you should try to identify the savings that can be made by doing things differently. Only when these savings have been made should renewable energy options be considered.

A simple example

At its simplest, energy efficiency can mean replacing an old light bulb with a new low energy bulb. The financial savings are both immediate and very significant:

Action: Replace a 100 W bulb with a 20 W low energy bulb producing an equivalent amount of light

Savings:

If the bulb is used on average 4 hours a day (1460 hours/year)

- The 100 W bulb uses 1460 x 0.1 = 146 kWh / year
- The 20 W bulb uses 1460 x 0.02 = 29.2 kWh / year
- The saving in electricity = 116.8 kWh
- At 14.87 pence/kWh the financial saving = **£17.37 each year**

What can be done on each type of farm?

In each enterprise there are key areas where savings can be made, often without any financial investment being necessary.

1. For every type of farm it is essential to **check your tariff.** Electricity supply companies offer different deals and within a company there usually will be a tariff with a cheap rate at night-time. Up to one in five of the farmers taking part in the CAFRE electricity benchmarking exercise were on the wrong tariff. This was a major over expenditure, for dairy farmers particularly giving a loss of £10 per cow each year.

Increasingly larger farm businesses should negotiate the price they pay for their electricity with the supply companies.

2. Lighting can be the "Achilles heal" in your energy costs. This is especially true when lighting is used for several hours each day. Install low energy bulbs and make appropriate use of timers, sensors and proximity switches.

3. In a pig unit insulation of houses and draft proofing are critical issues.

4. In mushroom units the hot water distribution system needs to be well insulated. The target should be to use proprietary district heating pipe-work to minimise heat losses.

5. Fuel efficiency on tractors and self propelled harvesters will be improved by using the electronic engine management system correctly.

What's new in energy saving on the farm?

In the past few months voltage optimisation devices have been actively promoted for energy saving on the farm. These have the potential to reduce electricity bills and give a financial return. However, a number of points should be noted:

1. They work with electrical equipment that is "voltage dependent." This is an electrical device whose power consumption varies with the voltage being supplied to it. Examples of voltage dependent equipment include:

- Tungsten filament lamps.

- Fluorescent lamps with ballast i.e. switch start. (The more modern electronically controlled fluorescent lamps without the starter motor are not voltage dependent).

- Electric motors without variable speed drives. Many of the electric motors used on farms are voltage dependent because they are relatively small sized, operate much of the time at partial loads and tend to be over-sized for their application.

2. Before investing in a voltage optimisation device the farm should be surveyed to determine the voltage drop between the incoming supply point and the electrical equipment being supplied. The size of this "voltage drop" along with the type of equipment on the farm will influence the investment decision. It may well be more economic to replace voltage dependent lighting with newer high efficiency bulbs or install variable speed drive motors in some instances.

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Solar Water Heating on the Farm

David Trimble, Renewable Energy Technologist, CAFRE

In agriculture in the UK solar hot water systems have most application in the high energy using sectors. For example a dairy cow uses 350 kilowatt hours (kWh) of electricity per year of which around 40% is used for heating water.

A solar hot water system has three main components

a. Solar collectors.

These "collect" as much heat as possible from the sun's radiation, retain the heat against loss to the surrounding environment and transmit the heat as efficiently as possible to the hot water storage system.

The collector ideally should face due south, although the annual energy collection will only vary by a maximum of 10% when the surface is anywhere between 30° to the south east or south west.

There are two main types of collector:

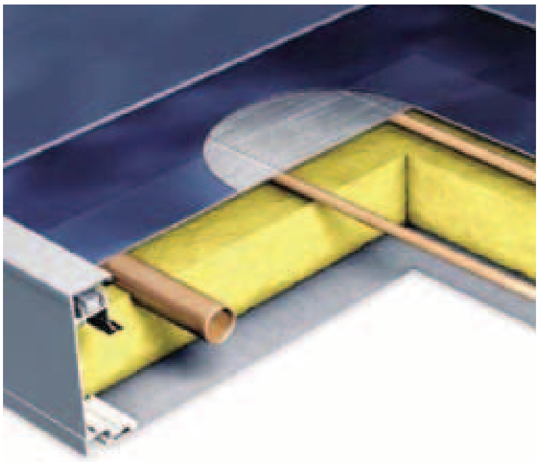
i. Flat plates

A flat plate collector is made up of three parts:

(i) A transparent collector cover. This needs to have a high transmission of visible and near infra-red radiation to capture the maximum amount of solar radiation and a minimum transmission of infra-red radiation to minimise heat radiation back from the absorber to the atmosphere.

(ii) An absorber plate from which heat can be removed by a heat transfer fluid.

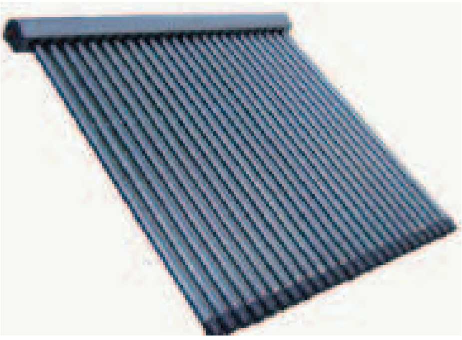
(iii) Substantial insulation to minimise heat loss back into the atmosphere.



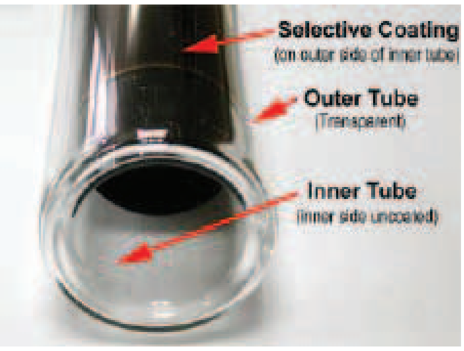
Cross section of a plate collector showing the pipe work attached to the absorber plate

ii. Evacuated tubes

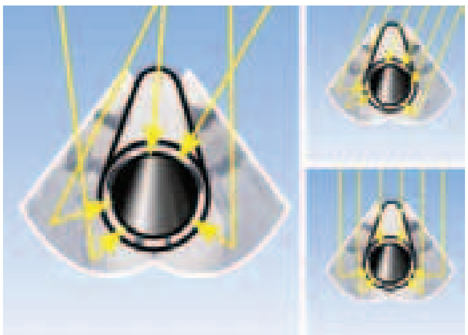
These are glass tubes evacuated similarly to thermos flasks, to reduce the heat losses from convection and thermal conduction. The absorber can be a thin strip of coated metal running the length of the tube or a coating on the outer surface of an inner glass tube. In this case a reflector is necessary to make use of the absorber area away from the sun. These reflectors are frequently used as concentrators and the entire unit of tubes and reflectors is referred to as a Compound Parabolic Concentrator (CPC).



An array of evacuated tubes



Evacuated tube of the type in the Greenmount dairy unit



The operation of a parabolic concentrator in a CPC system

Evacuated tube systems are more expensive per square metre of collector area than flat plate systems. However they would be expected to perform better in cold, changeable and windy conditions. This is particularly the case when the system operates at higher temperatures. Typically a dairy plant cleaning system requires water at 85°C whereas domestic heating systems use water at 60°C.

b. A heat transfer system

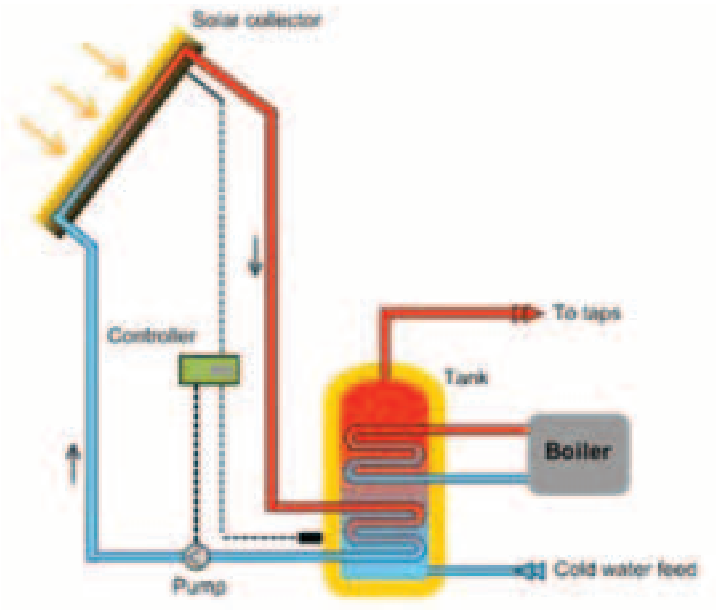
This consists of insulated pipe-work containing the heat transfer fluid, a water pump, a heat exchange system, measurement equipment and a control system. The heat transfer fluid has a high proportion of antifreeze for frost protection.

c. Hot water storage

The water heated by the solar system during the day needs to be stored for later use. The storage vessel can include the electric water heater where the pre-heated water has the temperature raised further as necessary.

Are there a range of possible systems for farm use?

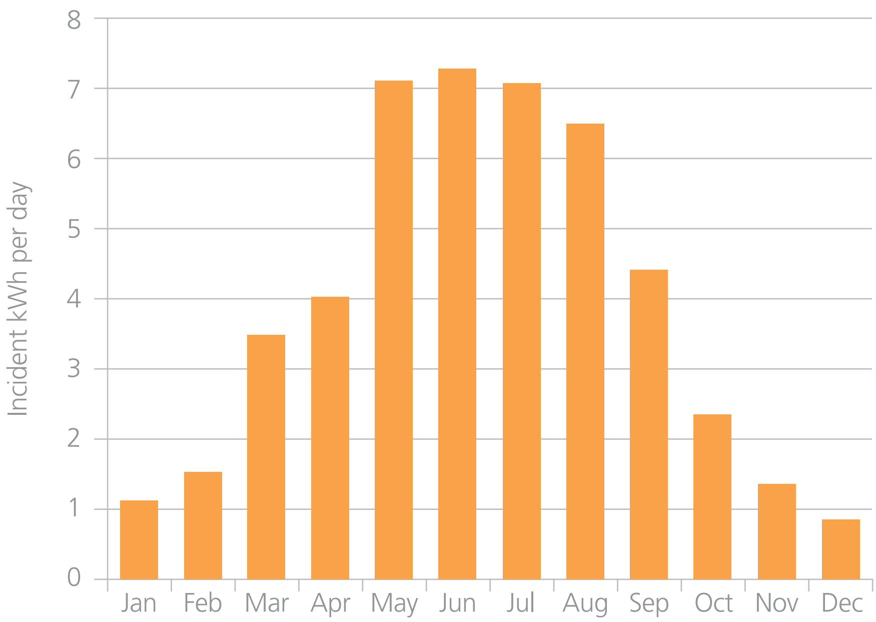
The most common system is a pressurised indirect primary circuit. In this system the hot fluid from the solar collectors is pumped through a heat exchanger in the boiler to pre-heat the water. It is a sealed system i.e. the fluid in the system does not come in direct contact with the hot water supply.



Lower cost options are available and include thermo-siphon systems. In these the collector is integrated with the storage tank in a prefabricated unit and the heat transfer fluid circulates without pumping due to the differing densities of hot and cold water.

What is the annual output of a system?

Systems are designed to deliver a high proportion of the requirements in the summer months, make a significant contribution in the spring and autumn and provide some input during the winter. The system is designed to give the best economic balance between the initial set-up cost and the year round output. Well designed systems normally provide no more than 50% of the annual hot water requirements. This is the aim for the Greenmount system.



Annual distribution pattern of solar radiation in kWh per m^2 per day

What about running costs and maintenance?

Solar heating systems have a long life with low maintenance.

A recent survey by the DTI (UK) of 700 systems installed over the past 30 years showed that the majority of the systems had no significant problems and work reliably for 20-25 years or more.

An Action Renewables study in 2007 reported that it took £12 a year to run the pump for a domestic system. This will be greater for a farm scale system but overall will not be a significant cost.

Experience with the Greenmount system indicates that solar tubes need a degree of maintenance and therefore need to be positioned in an accessible location.

What is the payback time on the investment?

Payback periods on domestic systems are around twelve years. This is a modest return on capital, however there are a number of factors that will shorten the payback period:

- A farm system used 365 days a year will be more efficient than a domestic system.
- Increasing energy prices.
- Tax write-off on the investment.
- DETI have proposed introducing an incentive in Northern Ireland in 2012 for the installation of systems producing renewable heat; the Renewable Heat Incentive (RHI). This is a government support measure that will pay a few pence for each kWh of renewable heat produced.

Is Planning necessary?

The Carbon Trust recommends that a business should contact their planning authority for advice before proceeding with a solar installation.

Should I install solar?

For any process requiring energy the first step is to cut costs by improving the efficiency of the existing system. Use of solar water heating systems should only be considered after achieving the maximum benefit from energy efficiency measures such as the timing of use, insulation and monitoring and control systems.

Performance of the solar hot water system at the Greenmount Campus dairy unit

Providing hot plant wash water for the Greenmount dairy unit prior to the solar system being installed required 48 kWh per day. In the first full year after the solar system was installed the average daily usage fell to 16.9 kWh, a saving of 11,343 kWh at a value of £1,400. A proportion of these savings were due to the improved energy efficiency of the new system. The new boiler and pipe-work were much better insulated that in the older system.

Checklist for solar installations

- Orientate the collectors between SE and SW
- Angle the collectors at around 40° to the horizontal
- No shading
- Space for a hot water storage tank
- Area of collectors – 1 sq metre will heat 45 litres to 60°C

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Short Rotation Coppice (SRC) Willow

Alistair McCracken, Applied Plant Science & Biometrics Division, AFBI

Short Rotation Coppice (SRC) is the practice of planting woody crops at high density, and which are harvested every 2-3 years. While there are a number of candidate crops, willow is particularly well suited to Irish climatic conditions. Willow produces vigorous juvenile growth when it is coppiced, i.e. cut back to ground level. The coppiced stools that remain after harvest re-sprout to form multiple stems giving dry matter yields in excess of 10t/ha each year, depending on site and climate.

Site selection

Soils: Willow will grow in most agricultural soils with a pH of 5.5-7.0. Medium to heavy clay soils with good aeration and moisture retention are ideal, although it must be possible to cultivate to a depth of 25cm to enable mechanical planting. Light sandy soils may have a problem with moisture retention and organic soils should be avoided because of difficulties with initial weed control.

Water: Willow is a water demanding crop and needs soils with good water retention. Optimum growth is achieved with annual rainfall of 900-1,100mm. Willow will thrive in wet soils but will not tolerate waterlogged anaerobic soils and excessive soil moisture and poor structure will have implications for harvesting machinery.

Elevation: The production site should be less than 100m above sea level and have slopes of less than 13%.

Access: It is essential to have hard access to the plantation, particularly for the movement of harvesting machinery in the winter. The root systems of the willow will support the harvesters during cutting, but hard access is vital for the export of cut willow from the site.

Area: A minimum of two hectare blocks is recommended. Smaller blocks make it difficult for planting and harvesting. Furthermore it is expensive to rabbit fence small areas if required.

Location: SRC willow will blend into the landscape in most situations. However as it can grow to a height of 5-6m by harvest this needs to be taken into consideration. Neighbours will need to be consulted.

Site preparation

SRC willow will potentially be in the ground for a minimum of twenty years so thorough and careful site preparation is essential.

Initial treatment: In September there should be an application of herbicide (4.0-5.0 l/ha) while vegetation is still actively growing. If the site has excessively heavy vegetation it should be cut and removed. Allow sufficient time for regrowth to allow herbicide uptake.

On grassland and set aside sites an application of 3.0 l/ha of Dursban will be needed for leatherjacket control. A minimum of ten days after treatment the site should be ploughed. Ploughing should be to a depth of at least 25cm.

Seed bed: If the site is suitable it can be ploughed and power harrowed in mid-March, six weeks before planting. Any germinating seed can then be sprayed off using 2.0 l/ha Glyphosate. If the site has a heavy clay soil it will be necessary to power harrow as close to planting as possible. Additionally it may be necessary to lift large stones which have the potential to interfere with the planting machinery.

Rabbit and hare fencing: Rabbits and hares can cause significant economic losses, especially during establishment. If there is a rabbit or hare population then the crop needs to be protected using an appropriate rabbit fence.

Planting

Planting material: There are two willow breeding programmes in Europe developing new improved varieties for SRC production. The Swedish programme is controlled by Svalof Weibull AB. Commercially available varieties from the Swedish Programme include; Tora, Sven, Torhild, Tordis, Olof, Gudrun and Inger. The European Breeding Programme which is now based at Rothamsted Research in England has released varieties including Nimrod, Resolution, Discovery, Endeavour, Beagle and Terra Nova.

It is important to note that all of these varieties are protected by Plant Breeders' Rights which means that it is illegal to produce propagation material for self-use or sale. However, it is permitted to produce small numbers for gapping up of established crops, from material produced at cutback. Cuttings will therefore have to be obtained from a specialist grower or supplier and will be supplied in the form of one-year old rods for mechanical planting.

Mixtures: For reasons of disease management it is vitally important a mixture of varieties is planted. The mixture should contain at least six components of which at least two should come from either the Swedish or the European Breeding programmes. The importance of using genotype mixtures cannot be overemphasised. Mixture will reduce the impact of any disease or insect attack; they will reduce the disease pressure on individual components and will ensure the long term viability of the plantation. Use of mixtures will also increase yield.

Timing: Planting should take place from early spring (February/March) to late May depending on weather conditions. The ideal planting density is around 15,000 cuttings/ha. There are a number of types of planting machines but the industry standard has become the Step Planter®. In ideal conditions and large fields a planting rate of 6-8 ha/day can be achieved. In most situations there will be an establishment rate of in excess of 90% giving a final plant density of at least 13,000 plants/ha. Where possible the rows should be planted in parallel with the long axis of the field.

Harvesting

The crop is best harvested during the winter, December-February when there are no leaves on the plant. Two main approaches are used for harvesting, although a third harvester has recently become available:

Direct chip harvesting: The crop is cut and chipped in a single pass, and blown into trailers for removal. The moisture content of fresh wood at harvest is around 50% and so will require immediate artificial drying, which is normally carried out in a ventilated grain drying floor. Heated air (6-10°C) above ambient is used to increase its water holding capacity. It is necessary to reduce the moisture content of the chip to less than 20% and this can normally be achieved in 3-6 weeks.

Whole stem harvesting: The 'Stemster' harvester cuts the entire rod which can then be stacked, preferably on a hard surface. The rods will dry naturally to around 30% moisture when they can be chipped for use in boilers. This method avoids the need for specialist drying equipment used in direct chop harvesting. However, whole stem harvesting requires collection of the rods and their removal to the standing area. Higher power requirements are needed for chipping the drier rods and the chip produced tends to have a wider particle size.

Biobaler: The crop is cut into billet lengths and baled in large round bales which can be stored on a hard surface overwinter. Bales will dry naturally and are particularly well suited to burn in a big-bale boiler without the need for any further treatment. Alternatively the bales may be chipped to produce wood chip which should not require further drying, although screening may be necessary to remove larger pieces and fines.

End use

Wood chip for heat: Willow wood chip is a high volume low density fuel so it is very important economically that the production site is close to chip utilisation – normally no more than 20 miles. The simplest and most convenient method of energy recovery is combustion to produce heat. A wide range of boilers are available at a range of outputs to match every requirement. At the present initial stages of the development of the industry it is essential to have established possible end use for the wood chip before planting.

Wood chip energy: In energy terms, short rotation coppice willow dry matter has an energy content of approximately 19 MJ/kg or 45% of the energy in an equivalent volume of light fuel oil. This gives a mean annual production equivalent to 3300-5700 litres of oil/ha/yr. It is normally considered that willow wood chip is carbon neutral, having absorbed the same amount of carbon during growth as is released during burning. Additionally, there are significant carbon savings through the displacement of heating oil. It is estimated that 3,300 litres of domestic heating oil produces 8,355 Kg CO_2. Burning wood chip will reduce the net CO_2 emissions by an estimated 90%. Expressed another way, wood produces 7 kg CO_2/GJ compared to heating oil which produces 79 Kg CO_2 GJ. Furthermore, biomass does not contain many of the other noxious chemicals that are released when fossil fuels are burnt e.g. sulphur, which can cause major environmental problems.

Bioremediation

SRC willow has the potential for the bioremediation or biofiltration of both solid and liquid effluent wastes. Willow can take up large volumes of water and is efficient in the utilisation of nitrogen, and to a lesser extent phosphorous. The use of a plantation for the treatment of biosolids and effluents could significantly improve the economics of growing SRC willow. However, caution is required when considering bioremediation:

- It is essential to have a full soil analysis to determine whether or not the site is suitable to receive the biosolid/effluent.
- A full analysis of the biosolid/effluent is required in order to ensure that its application complies with all waste treatment legislation such as the Nitrates Directive and the Safe Sludge Matrix.
- Biosolids may have to be pre-treated before application in order to bring about a pathogen kill.
- Approval must be obtained from the Northern Ireland Environment Agency before any waste material can be applied to the land.
- Sites where biosolids/effluent are being applied need to be carefully monitored.

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Utilising Biomass Crops for Renewable Energy

Dr Lindsay Easson, Environment and Renewable Energy Centre, AFBI Hillsborough

In the UK as a whole biomass is the source of over 80% of the renewable energy which is displacing fossil fuels, compared with about 11% from wind. However, only 17% is coming directly from biomass crops such as short rotation coppice (SRC) Willows and Miscanthus or from wood, while the remainder is derived from liquid biofuels, waste materials and landfill gas. In GB most biomass crops are used to co-fire electricity generation or to feed dedicated biomass electricity generation stations. In Northern Ireland the principal market for woody biomass is for the increasing number of small and medium scale biomass boilers (100kW to 1000kW) now providing heat at a wide range of locations across the country.

Over the last few years the supply chain for chipped SRC willow from field to end user has been developing and there is an increasing awareness of the important issues that have to be addressed if the supply is to meet the needs of the end user in terms of both quality and price. While Miscanthus is also a potentially valuable biomass fuel which has been shown to grow successfully in Northern Ireland, the fuel market for it has yet to develop here.

Biomass quality characteristics

To match the design specifications of individual biomass boiler systems important quality characteristics are

- Moisture content
- Chip size
- Ash content
- Chlorine content
- Bulk density

Each boiler works within the quality constraints that the manufacturer sets, although even when operating within these limits the performance of a boiler may vary. Studies have shown, for example, that as the moisture content of the fuel increases, net heat output declines, boiler efficiency declines, gaseous outputs increase and the boiler needs more frequent servicing.

For most boilers the biomass fuel is delivered in a chipped or pelleted form. Generally larger boilers, with greater diameter delivery augers, will be able to handle larger chip sizes. The uniformity of chipped material can be improved by grading to remove both oversized and undersized material. A high proportion of dust can cause particular issues due to the explosion risk from dust laden air.

The most important quality characteristic is the moisture content. Fresh wood at the time of harvest will generally have a moisture content of about 55 percent. An alternative to the widely used self propelled harvester/chipper is to harvest whole willow rods which can be left to air dry naturally and will reach equilibrium with ambient conditions within several months, resulting in moisture contents below 30 percent. Trials have also been carried out in Northern Ireland with a system to cut and round bale willow rods. Although the baled material stacked in the open dried down to below 20% there appear to have been unacceptable high dry matter losses during harvesting.

Artificial drying of freshly harvested wood chips

Artificial drying of freshly harvested wood chips with warm air ventilation can bring the moisture content to below 15 percent, although most boilers will operate satisfactorily at moisture contents between 20 and 30 percent. The lower the moisture content the greater will be the output of heat per kilogram of dry matter, but the greater will be the drying costs. Large boiler systems (above 500kW) may be specified to work at moisture contents of above 50 percent, but even then ignition of the material may be more difficult.

Achieving uniformly dry woodchip using an on-floor drier can be difficult as the lower layers dry quickly while the top layer initially becomes wetter. If any moulding and compaction occurs in the upper layers the airflow can be restricted reducing the rate of drying. In some cases it may be necessary to remix the material after achieving the desired average moisture content and then allow the whole batch to equilibrate. Due regard must be given to running the drying system only when efficient drying can be achieved, and during very cold spells of weather this may not be possible. In experiments carried out by AFBI last winter the drying costs more than doubled when the air temperature fell from above 10°C to below zero, making drying prohibitively expensive and greatly reducing the carbon savings from its use as a source of renewable energy.

Biomass fuel performance

In trials being carried out at AFBI Hillsborough using a range of biomass fuels available locally including SRC willow chips, wood pellets, Miscanthus, forest brash and chipped spruce, all the fuels have performed well with heat outputs of between 3.5 and 4 kWh per KG fuel dry matter. The ash content varied from as low as 0.22 percent from wood pellets and 0.4 percent from chipped spruce to 1.2 percent from SRC willows and 1.9 percent from Miscanthus.

Correctly set-up biomass boilers can achieve measured heat output efficiencies of close to 90 percent, and can run in automatic mode with relatively little attention provided the fuel is of consistently high quality. Nevertheless it must be understood that biomass boiler systems do require significantly more management input than would be the case for oil or natural gas fired systems.

Log burning stoves and boilers

Log burning stoves and boilers have become increasingly popular for domestic heating where there is access to a supply of suitable logs. Some of the best woods to burn are ash, beech, hornbeam, hawthorn, crab apple and wild cherry. Oak and Elm can be difficult to burn, and Spruce and Chestnut may spit badly. In all cases logs should be allowed to season and dry out for at least a year to bring the moisture content to below 25 percent. Log burning boilers require more labour to keep them filled with logs than the more automated chip-fed boilers, and tend to be larger. Nevertheless, highly efficient log burning boilers are available with sophisticated controls and which are suitable for zoned central heating systems or the mushroom and horticulture sectors.

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Heat Pumps

David Trimble, Renewable Energy Technologist, CAFRE

Heat pumps are a renewable energy technology that extract low grade heat from the ground, water or air and transfer this heat, usually into a water heating system. They are to be distinguished from geo-thermal heating systems which extract heat from the earth's core a few kilometres below the surface.

Is this a new technology?

No. The first heat pumps were designed in the 19th century and have come to prominence in the last few decades of the 20th century. The table below shows that they are widely used in many developed countries. Use in the UK and south of Ireland is increasing but is still at a much lower level than in many comparable countries.

Country	Installed Capacity (MW)	Population (m)
Austria	228	8
Canada	360	33
Germany	344	82
Sweden	377	9
Switzerland	300	8
U.K.	0.6	61
U.S.A.	4,800	312

Where are they likely to be of use?

This is a fairly high cost technology so it will be most relevant where:

i. energy costs are high

ii. there is a constant demand for heat throughout the year.

Heat pumps typically produce water at temperatures of 40-50°C. This temperature is suitable for under-floor heating systems in dwelling houses and this is one of their main uses worldwide.

In the agricultural sector one application is for heating pig pads in farrowing houses. In systems where the heat is provided by warm water circulation the temperatures provided by a heat pump match the piglets' requirements, around 40°C. There is one such system operating in Northern Ireland and the results are very satisfactory.

An air source heat pump was installed in the CREAM dairy unit on Greenmount Campus in April 2011 to pre-heat water for the milking plant washes. The effectiveness of the pump will be investigated over the next few years.

How do they work?

The most common type in use is the ground source heat pump where a few hundred metres of pipe-work in the ground at least 1.2 metres deep provides the heating for a dwelling house. At this depth the temperature of the ground remains constant at around 10°C throughout the year. Other types include heat pumps that extract heat from bodies of water or from either internal or external air. Regardless of the heat source the principles of operation are the same.

There are four stages in the operation of a heat pump.

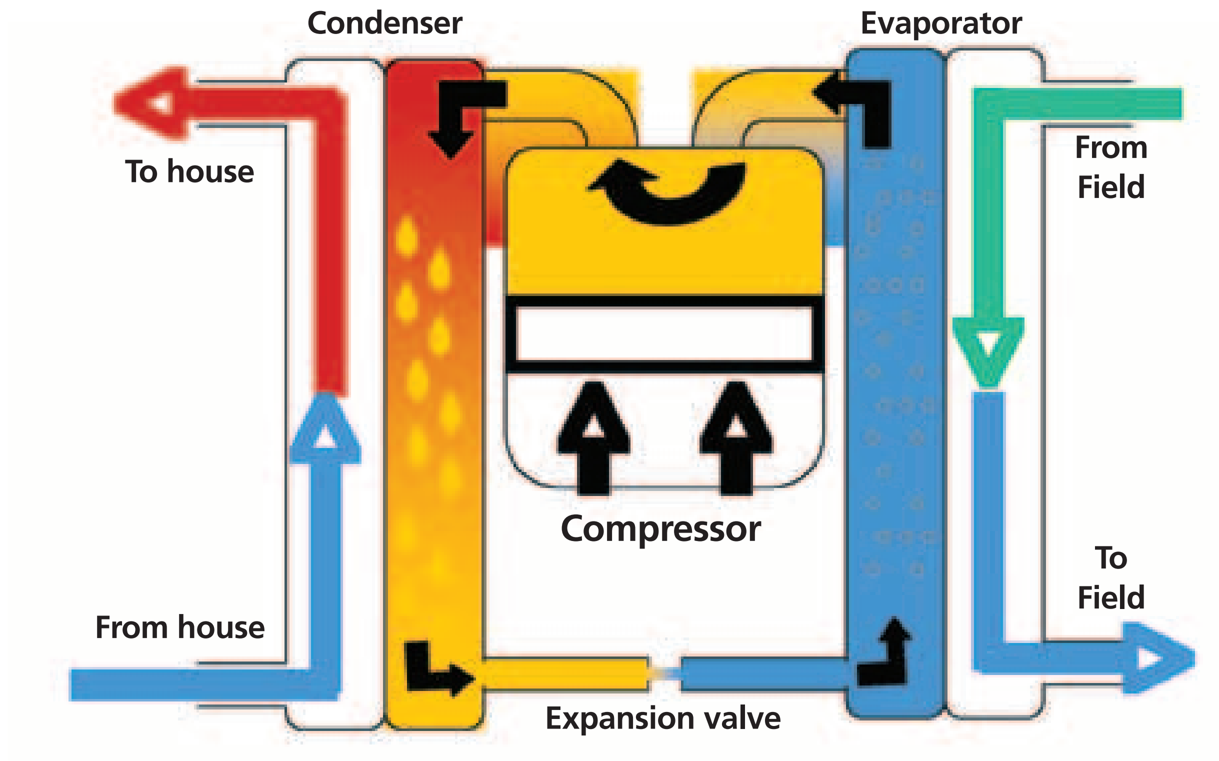
1. **Evaporation** - The liquid refrigerant circulates through the pipe-work in the ground (or other heat source) under low pressure and at a low temperature. By taking heat from the ground (the heat source) the refrigerant evaporates to become a gas.

2. **Compression** - This refrigerant gas (or vapour) is compressed to a high pressure by the use of electrical energy by the compressor. This causes the temperature of the refrigerant vapour to rise sharply (40-50°C).

3. **Condensation** - The pressurised refrigerant vapour is condensed back to the liquid form, giving up much of its heat energy in the process. This heat energy is "collected" for use, generally through heating water by means of a plate heat exchanger.

4. **Expansion** - The liquid refrigerant moves from high pressure to low pressure. The refrigerant undergoes a sharp drop in temperature and is circulated again round the heat source.

These four stages are illustrated in the diagram below.



What are the keys to a successful installation?

Surveys carried out in GB and other countries have found that there is a wide range in the performance of heat pump installations. Overall the performance in GB has been less good than for similar systems in continental Europe. A number of reasons are given for the varying success rate:

- The design of the system is a key issue. The pump needs sized correctly for the heat demand and the inclusion of a thermal store often has a major effect on running costs.
- One company should be responsible for the overall installation and commissioning of a system. A range of trades and skills are needed to complete an installation but overall control is required by someone with the necessary expertise.
- The user of the system needs to understand how it operates and how to get maximum benefit from it.
- The system needs to be designed and operate in such a way as to obtain maximum benefit from the cheaper electricity tariff, usually a seven hour period at night.

What about the economics of heat pumps?

One of the key characteristics of a heat pump is the Coefficient of Performance (COP). This is the ratio of the energy produced as heat compared to the electrical energy used in the process by the compressor and pumps. A typical COP is 3:1 - this means there is three times as much energy is produced as is used to drive the pump. The additional energy comes "free" from the heat source, be it the ground, a water source or internal or ambient air.

The COP will vary depending on a number of factors:

1. The quality of manufacture of the pump.
2. The temperature of the heat source, the warmer the better.
3. The temperature of the water being heated. The efficiency of the pump decreases as the temperature of the water being heated increases.
4. The presence or absence of a buffer tank. The buffer tank will allow the heat pump to run for longer periods of time. This may allow heat storage in a period of low cost electricity. Longer run times also are better for the equipment and will reduce the maintenance required.

The economics of heat pumps will be influenced by the potential introduction of a Renewable Heat Incentive. This is planned to start in April 2012 for the non-domestic sector and from October 2012 for the domestic sector. While the terms are still under discussion the proposal is to pay a few pence for each kWh of heat produced by qualifying installations. For a dwelling house this could range from £500 to £800 per year and would make heat pumps a more attractive option in a range of situations.

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Solar Photovoltaic (PV) Technology on the farm

Greg Forbes, Environment and Renewable Energy Centre, AFBI Hillsborough

Photovoltaic panels are now fairly common throughout the country on many buildings or sometimes as stand-alone features. Recent legislative changes by Government aim to increase the uptake of this technology and the development of microgeneration, allowing homes, small businesses and farms to set up electrical energy schemes. This electricity can be used internally or can be sold, thereby earning the producer an income that may offer enhanced payments under the Northern Ireland Renewable Obligation Certificates (NIROCs).

What are solar PVs – how do they work?

PVs are powered by sunlight and they convert light energy to electricity by a phenomenon known as the photovoltaic effect, whereby some materials, such as Silicon, become electrically charged when exposed to light. Often referred to as solar panels, PVs are entirely different from the thermal solar panels that are used to heat water. The most common form of PV cells consist of one or two thin layers of silicon covered by a transparent film and light falling upon them creates a small electric field. The amount of electricity, measured in kilowatt hours (kWh) produced from one PV cell can be very small (often just a few watts). To increase output to provide enough electricity to be worth connecting to an end use, PV cells are normally fixed together as a panel and panels joined to form arrays that are fixed on a frame and set to a certain angle **(Figure 1)** to maximise light capture.

Figure 1. Solar PV panels fixed together on a frame. Each panel has a dimension of 163cm x 81cm

The electricity produced is of the form known as direct current (DC) and normally, before it can be wired into the electrical system of adjacent premises, it has to be converted to alternating current (AC) by being fed to an inverter. Often, these panels will be arranged in arrays (sometimes termed modules) that will have an appropriate number of inverters. **Figures 2 and 3** show the array's of panels and of inverters for the PV installation at AFBI Hillsborough.

Figure 2. An array of seven stand-alone PV modules set on a southern facing slope at AFBI Hillsborough. Note the angle of the panels – some are set at 43° and some at 51° off vertical

Figure 3. The seven Inverters for the AFBI Hillsborough PV array. Each module is connected to a single inverter and the current then transformed to AC is passed directly into the electrical network

It is not always necessary to convert the current as there are applications where the direct current can be used to power devices such as pumps. PVs can also be linked to storage batteries to provide power for equipment and lighting in remote locations.

Do they only work on sunny days?

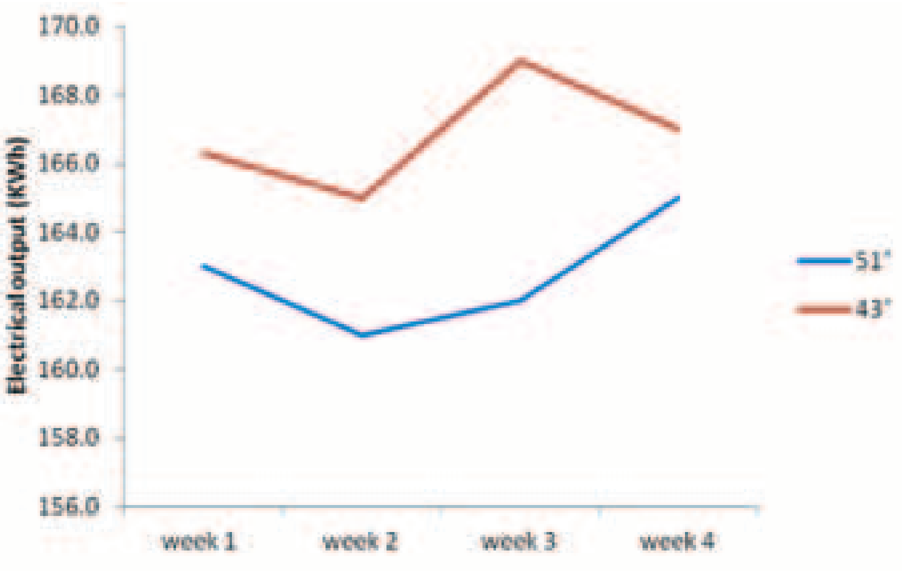
From the meters on the AFBI Hillsborough system, the average daily output from one module ranged from less than 0.1 to 7.8 kWh, and this wide variation can be ascribed to three factors. The first is light duration and the second light intensity. Obviously there is virtually no output during the hours of darkness but on even very dull days the PV will continue to function, so the longer the day, the longer the output occurs for. However, direct sunlight greatly increases the electrical production. **Table 1** on the next page compares two weeks with similar hours of daylight but with contrasting levels of direct sunshine.

Table 1. The effects of sunlight on electrical output from PV panels

week	Total PV working hours	Total hours sunshine per week	Electrical output (kWh)
08-14/08/2011	628.00	15.3	206.9
15-21/08/2011	633.00	40.3	280.6

The third major influence on electrical production is the angle (tilt) that the modules are set to. Solar irradiation in Northern Ireland ranges from 1000 to 1100 kWh/m^2/year, but of course total daylight hours are much less during winter than for summer. As the angle of the solar radiation changes, most PV panels should be altered seasonally to allow maximum radiant exposure. This is important as even small disregard of this could result in significant reductions of electricity production. **Figure 4** gives an example of the differences in weekly output recorded from the AFBI PV microgeneration.

Figure 4. Electrical output from differently angled adjacent panels

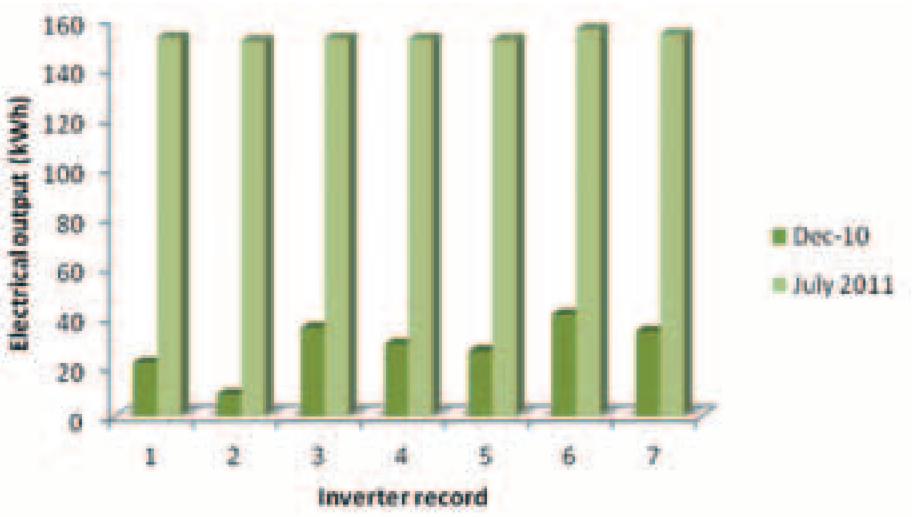


Competent installers set modules to the correct angle and provide instructions for manual adjusting. Automated "sun tracking" mountings are available but costs for these are generally prohibitive for microgeneration schemes.

How much electricity can a solar PV system produce?

This will depend on the location, type and size of panels and many other factors. The AFBI Hillsborough system of seven arrays, each with ten 170 watt capacity PV panels, produced a total 7456.8 kWh of electricity during the year from September 2010 to August 2011. At full capacity this system could provide sufficient electricity for two average households. However, as it is not evenly distributed throughout the year generation would be insufficient during winter and excess for requirements during summer. **Figure 5** shows the stark difference in seasonal production with very low outputs for December 2010 (when there was a considerable amount of snowfall) compared to July 2011.

Figure 5. Monthly electrical output from the AFBI Hillsborough PV system



How does the solar PV electricity contribute to the farm?

There are environmental benefits from a renewable and sustainable electricity supply that runs along quietly while reducing your carbon footprint. According to the Energy Saving Trust (UK) a typical home installation could save over one tonne per year of CO_2. The self generated electricity will reduce bills and where excess is produced this can be sold at a premium, creating a revenue stream. Following changes to energy generation policy* brought in by government since April 2010, the Microgeneration Certification Scheme (MCS) guarantees that electricity from PV is eligible for 4 ROCs for 25 years at an index linked price. This means that for each unit of electricity sold the producer will qualify for a payment at 4 times the prevailing unit price. The metered price currently available from PowerNI for customers for whom they are ROCs agents is 16.92 p/kWh.

*The Renewables Obligation (Amendment) Order (Northern Ireland) 2011. Accessible at

http://www.detini.gov.uk/deti-energy-index/deti-energy-sustainable/northern_ireland_renewables_obligation_.htm

How long will solar PV panels and systems last?

There are numerous reports of PV panels and their electrical systems that have been in operation for 20 years or more and are still functioning and modern versions have normally a similar guaranteed longevity.

What about operation and maintenance?

PV systems do not generally require daily attention but like any other installed power source they should have regular inspection and can need occasional maintenance. Within the farm system at AFBI Hillsborough, while the PV panels have been trouble free, several of the inverters have had to be replaced (free, under warranty) during the 4 years of operation.

Are all PVs the same?

While the same principle of operation applies, there are numerous variations in the materials used, shape and size, colour and form. They can be bought as roof tiles, window units, wall claddings and stand-alone units to match the surrounding environment. This is now regarded as one of the most rapidly advancing fields of modern technology. Innovation and advancement has led to a virtual revolution in design and more importantly, performance. Modern PV cells are now much more efficient at capturing the sun's energy and converting it to electricity while the purchase costs of PVs have decreased by over 90% in certain areas. Over the last five years the PV industry has recorded an annual growth of 60%. Low cost and highly efficient PVs, including thin film and flexible materials that will offer in turn lower installation costs and greater electrical production, are now near-market.

Are they eligible for Grant assistance?

The Northern Ireland Sustainable Energy Programme (NISEP) has limited funding available of £1,105 per kWp (kilowatt peak) or 20% of eligible costs up to a maximum of £5,000. The grants are administered through Power NI* and applications are treated on a first come first served basis. Many installation and power companies also offer a range of incentives to help potential customers avail of the scheme. However, the scheme has various provisos and qualifications to be met so it is imperative that a full assessment of the technology is undertaken before making commitments.

The CAFRE Renewable Energy Team can help here and other bodies such as the Carbon Trust (NI), The Energy Saving Trust (UK) or the Department of Energy, Trade and Industry, Northern Ireland (DETINI) can provide essential information.

*http://www.powerni.co.uk/wp-content/uploads/Power-NI-Household-Solar-Photovoltaics-Conditions-and-Criteria.pdf

Is planning permission needed?

Though rules for incorporating renewable energy sources such as PVs have had many restrictions removed, certain buildings and locations may still have some in place. Therefore it is advised that an initial consultation with the Planning Service should be made before any scheme is advanced.

Installation

It is possible to buy and self-install PV systems but as the process involves electrical installation and linkage to a mains system with approved metering equipment, professional advice and certification should be sought. However, to qualify for ROCs payments all new schemes must be installed by MCS approved installers. Many companies offer complete turnkey installation with periodic maintenance and management contracts, but it is important to use only MCS approved installers. Under the aegis of the Microgeneration Certification Scheme (MCS) a list of approved installers is available and can be accessed at;

http://www.energysavingtrust.org.uk/Media/node_1422/Northern-Ireland-PDFs/Northern-Ireland-MCS-installers

Costs, savings, income and payback period

These vary between regions and relate directly to the type of system most suitable for any location and situation. Estimations from the Energy Saving Trust (UK) range from £4,000 to £5,000 per kW of power installed while the savings offered can be approximately a 50% reduction in imported electricity. If eligible to receive ROCs, savings and income could amount to £1100.00 per year for a household. Payback periods will depend on the size and type of installation and projected returns based on contracts for prices.

The possibilities exist for farms to install larger PV systems up to 50 kW. These offer greater income possibilities but that would have to be set against much larger installation costs.

For further information on or queries about the AFBI Hillsborough solar PV system, contact Greg Forbes on tel: (028) 9268 1546 or email: greg.forbes@afbini.gov.uk

Micro-Hydro

Eoin McCambridge, Renewable Energy Focus Farmer, Co Antrim

Why Micro-hydro?

In a suitable location small-scale hydropower is one of the most cost-effective and reliable of the renewable energy technologies. It has several advantages over wind, wave and solar power:

- A high efficiency (70-90%), by far the best of all the technologies.
- A high capacity factor i.e. time generating power throughout the year (typically >50% compared with 10% for solar and 30% for wind).
- A high level of predictability, varying with annual rainfall patterns
- A slow rate of change; the output power varies only gradually from day to day (not from minute to minute).
- It is a long-lasting and robust technology; systems can readily be engineered to last for 50 years or more.
- It is environmentally benign. Micro-hydro is in most cases 'run-of-river'; in other words any dam or barrage is quite small, usually just a weir, and little or no water is stored.

Hydro Principles

The basic principle of hydropower is that if water can be piped from a certain level to a lower level, the resulting water pressure can be used to do work. If the water pressure is allowed to move a mechanical component then that movement involves the conversion of the potential energy of the water into mechanical energy. Hydro turbines convert water pressure into mechanical shaft power, which can be used to drive an electricity generator.

History

In Northern Ireland in the late 1800s there were approximately 1200 water powered mills, a proportion of which were hydro turbines. By the early 1900s these were the main source of electricity for rural communities. With the development of the National Grid around 1960 and relatively cheap electricity most of these sites became obsolete.

Calculating Hydro Power

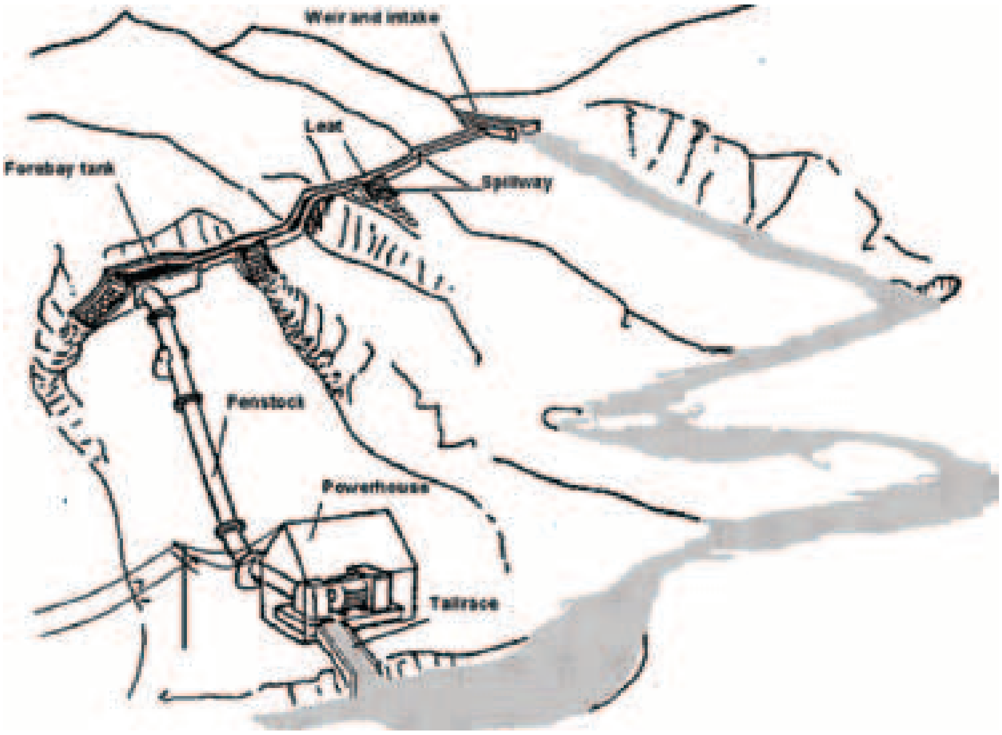
Before embarking on any **hydro power** generation project it is essential to survey the proposed site to calculate the amount of available **hydro power.**

The two vital factors to consider are the **flow** and the **head** of the stream or river.

The **flow** is the volume of water which can be captured and re-directed to turn the **turbine generator.**

The **head** is the distance the water will fall on its way to the generator.

The larger the flow - i.e. the more water there is, and the higher the head - i.e. the higher the distance the water falls - the more energy is available for conversion to electricity. Double the flow and double the power, double the head and double the power again.



A **low head** site has a head of below 10 metres. In this case you need to have a good volume of water flow if you are to generate much electricity. A **high head** site has a head of above 20 metres. In this case you can get away with having a lesser flow of water.

The key equation is the following:

Power = Head x Flow x Gravity

where **power** is measured in Watts, **head** in metres, **flow** in litres per second, and **acceleration due to gravity** in metres per second per second.

The acceleration due to gravity is approximately 9.81 metres per second per second – i.e. each second an object is falling, its speed increases by 9.81 metres per second (until it reaches its terminal velocity).

Therefore it is very simple to calculate how much **hydro power** you can generate.

Example:

Head of 12 metres

Flow of 200 litres per second

Power = 12 x 200 x 9.81 = 23,544 Watts or 23.5 kW

Types of Turbine Design

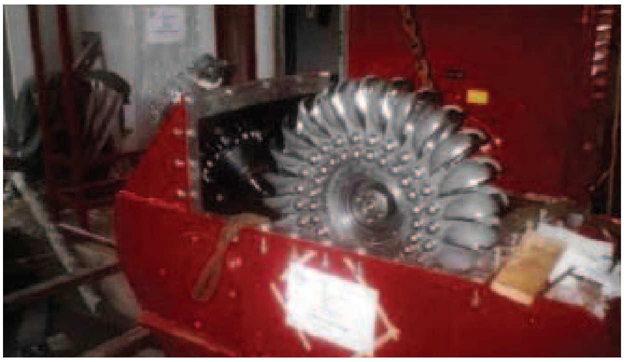
A turbine converts energy in the form of falling water into rotating shaft power. The selection of the best turbine for any particular hydro site depends on the site characteristics, the dominant ones being the head and flow available. Selection also depends on the desired running speed of the generator or other device loading the turbine. Other considerations such as whether the turbine is expected to produce power under part-flow conditions, also play an important role in the selection.

All turbines have a power-speed characteristic. They will tend to run most efficiently at a particular speed, head and flow combination.

A turbine design speed is largely determined by the head under which it operates. Turbines can be classified as high head, medium head or low head machines. Turbines are also divided by their principle way of operating and can be either impulse or reaction turbines. The range of common design types is given in the table below.

	High head	Medium head	Low head
Impulse turbines	Pelton Turgo	Cross-flow Multi-jet Pelton Turgo	Cross-flow
Reaction turbines		Francis	Propeller Kaplan

A Crossflow Turbine installed at the McCambridge Focus Farm just outside Ballycastle



A Pelton Turbine with upper casing removed

Two Archimedes screw water Turbines installed side by side, Devon England

Ballynaglogh Hydro case study

Key statistics:

- Gross head = 7.4m
- Net head = 7.2m
- Flow = 500 litres/sec.
- Turbine type = WKV Crossflow
- Speed 255rpm
- Output power = 30 kW
- 195,000 kWh/year

Ballynaglogh Hydro is located approximately 2 miles east of Ballycastle on the Carey river. This is a spate river with a catchment area of 43 square kilometers with an average annual rain fall of 48 inches.

The water enters the scheme above the weir, flows through a screen and then travels 150 metres down an underground pipe into the turbine.

The turbine is a WKV twin cell operating at a design flow of 500 litres per second on a net head of 7.2 metres and a speed of 255rpm. The crossflow's construction allows an almost constant efficiency from 100% down to 17% of rated water discharge.

This turbine has a peak power of 30 kW and generates on average 195,000 kWh of energy per annum, enough to supply 40 average sized homes.

In addition to the financial return the production of this renewable energy will result in a reduction of CO_2 emissions of around 86 tonnes per year.

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Wind Turbine Technology

Anita Watts, Energy and Environmentalist Specialist, Greengage

Wind turbine technology has developed rapidly in recent years. Wind turbines are becoming more powerful, with the latest models getting larger and bringing down the cost of renewable energy generation.

In many ways, wind turbines are the natural evolution of traditional windmills. There are two basic designs: vertical-axis and horizontal-axis machines. Horizontal-axis wind turbines are most common today, constituting nearly all of the turbines in the global market. Vertical-axis style are sometimes used in urban areas where wind speeds are low and turbulence high.

Horizontal-axis wind turbines consist of rotor blades which rotate around a horizontal hub. The hub is connected to a gearbox and generator, which are located inside the nacelle. The nacelle houses the electrical components and is mounted at the top of the tower. The turbine's blades turn faster as wind speeds pick up. This movement turns a shaft, which passes the mechanical energy created by the wind to the generator which transforms the energy into electricity.

Wind turbines can have three, two or just one rotor blades. Most have three. Blades are made of fibreglass-reinforced polyester or wood-epoxy. Most have gearboxes although there are increasing numbers with direct drives. The yaw mechanism turns the turbine so that it faces the wind. Towers are mostly cylindrical and made of steel, generally painted light grey. Lattice towers are used in some locations.

Site assessment

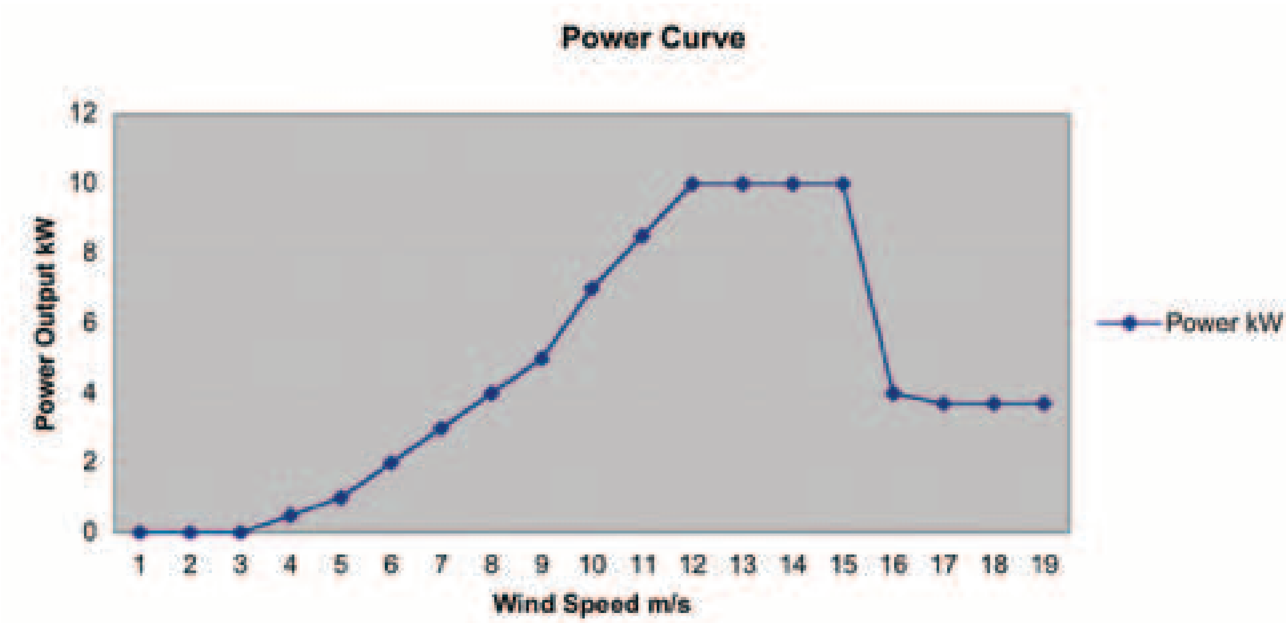
The annual average wind speed is used to give an indication of the quality of a proposed site for a turbine. It is usually expressed as a wind speed in metres per second (m/s). Wind maps can be used to give an initial indication of the wind speed at your site. Visit, for example, www.actionrenewables.org

However, wind maps do not take account of the landscape on a localised scale, such as the surrounding topography which may have a considerable effect on the wind speed. The wind speeds reported could also be recorded at heights that are greater than most small wind turbines. In short, wind maps will not replace the need to record accurate wind measurements at your site.

Most wind turbines start generating electricity at wind speeds of around 3-4 metres per second, (8 miles per hour), generate maximum 'rated' power at around 12-15 metres per second (30mph), and shut down to prevent storm damage at 25m/s or above (50mph).

There is a cubic relationship between power and wind speed. If wind speed doubles, the power in the wind increases by a factor of eight. Therefore, if the wind speed increases from 2m/s to 4m/s you will get eight times as much electricity produced from the same turbine.

As wind speeds increase with height, it makes sense to put your wind turbine on as tall a tower as you can, within your budget and local planning constraints. It also helps to limit the effects of turbulence, created by the wind passing over obstacles on the ground such as trees or buildings. Turbulence has a significant detrimental effect on the amount of electricity generated, and increases wear and tear on a turbine.



In Northern Ireland we experience a wide variation in wind speeds and it is essential that the turbine can cope with this. Every turbine has is own power curve graph, which provides information on its performance at different wind speeds. This graph will be a useful part of the process for choosing a turbine that is suited to the wind conditions experienced by your site.

Wind turbines are available in a variety of sizes. Starting with the smallest such as a 1 kilo watt (1 kW) machine, this is its power rating. The largest could have a power rating of 7 mega watts (7 MW), and they are getting bigger all the time.

The power rating gives an indication of the maximum rate of electricity a turbine can generate when it is working at full power. It will work at full power when the wind speed gets up to the turbines rated wind speed, usually between 12 and 15 metres per second. A 10 kW machine will give 10 kWh of electricity if it operates at its rated wind speed (of 12m/s) for one hour (1 unit of electricity = 1 kilowatt hour (kWh), 1,000 kilowatts = 1 megawatt).

While wind turbines are most commonly classified by their rated power, annual energy output is actually a more important measure for evaluating a wind turbine's value at a given site. The amount of time a wind turbine produces a given power output is just as important as the level of power output itself. Wind turbine operators don't get paid for producing a large amount of power for a few minutes (except in rare circumstances.) They get paid by the number of kilowatt-hours (kWh) their turbines produce in a given time period.

When a wind turbine is used to generate electricity for charging batteries and not physically connected to the electricity grid, it is referred to as a stand-alone system. Such examples include remote locations and island communities, with typical applications being water pumping, electric livestock fencing, or lighting. However, these are not commonplace.

More typical is a grid connected system where any electricity not used in the home or business can be 'spilled' back onto the grid. Connection to the grid allows an uninterrupted supply of electricity at times when the wind is not blowing without the use of energy storage. It also provides an additional income as the electricity can be sold to energy companies.

The financial returns come from a combination of savings:

1. Using your own electricity and not buying it all at the tariff price.
2. The income generated from any electricity sold back to the grid.
3. The Renewable Obligation Certificates (ROCs), which are issued in relation to the amount of renewable electricity generated and have a market value.

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On-farm Biogas Production

Nigel Moore, Senior Renewable Energy Technologist, CAFRE

What is Biogas?

Biogas is a renewable source of energy produced by the action of certain bacteria on organic matter in the absence of oxygen. Growing plants capture energy naturally from sunlight by photosynthesis and store it in the plant. A biogas plant (or anaerobic digester) releases and uses the stored energy from the plants and animal manures.

The process of anaerobic digestion is similar to the digestion process that occurs in the rumen of a cow. In the cow, the energy is utilised for milk production and body maintenance. In the biogas plant, the energy is harvested as biogas and used as a fuel for a biogas engine which produces electricity and heat. Alternatively the biogas could also be fed into a natural gas grid or be used as a vehicle fuel.

On-farm Biogas plants

Anaerobic digestion has been used in the sewage treatment industry for many years. On-farm biogas plants are common in a number of European countries. While many on-farm plants were originally built to digest animal slurries, it was found that digesters running solely on animal slurry did not produce sufficient biogas to be economical. This is hardly surprising when you consider that around 70% of the energy has already been utilised by the animal. The co-digestion of animal manures with green crop silages greatly enhances the biogas yield.

In recent times, the biogas industry has expanded greatly in Europe due to attractive tariffs for producing renewable electricity and the development of co-digestion of slurry with green crop silages such as maize, wholecrop cereal and grass. The table below gives an indication of reported relative gas yields of different feedstocks in Europe. (AD Portal http://www.biogas-info.co.uk/index.php/biogas-yields)

Feedstock	Dry Matter (%)	Biogas Yield (m^3/t)
Cattle slurry	10	15-25
Maize silage	33	200-220
Grass Silage	28	160-200

Research is on-going at AFBI Hillsborough to examine the potential biogas yields from co-digestion under conditions in Northern Ireland.

European biogas plants are commonly fed a ‘diet’ of 70% green crop silage and 30% slurry. It is possible to utilise many other organic wastes in biogas plants but this will involve extra regulation and licensing, and may require extra plant and storage facilities.

In Europe a typical on-farm biogas plant generally consists of a feed intake system, similar to a diet feeder, a slurry intake system, a primary digester, where around 70-80% of the gas will be produced in a 40 day period, a secondary digester where a further 20-30% of the biogas will be collected and a digestate store, similar to a slurry tank.

The gas is collected in the gas store, from where it is piped to the gas engine which generates electricity and heat. Some of these outputs are utilised to maintain the plant and the balance can be exported as electricity to the grid and heat for district heating use or to provide a drying service for grain or woodchip.

The digestate is a good quality fertiliser for land application. Pathogens and weed seeds are killed during digestion, while the nutrient content of the original slurry is maintained. At some biogas plants the digestate is separated with a slurry separator and some of the heat produced by the plant is used to dry the solid fraction. Following pelletisation it can then be sold as a garden or amenity fertiliser.

Key Performance Factors

There are a number of key factors affecting the performance of a biogas plant:

- Feedstock mixture
- Plant size
- Engine efficiency
- Engine up-time
- Electricity tariff

It is always advisable to utilise proven technology and a reputable technology supplier when choosing a make of plant. Visit a functioning plant, and talk to the operator. Ask about the performance of the plant and back-up service from the technology suppliers.

The plant size will be related to the availability of feedstock and finance available. For silage requirement in addition to slurry, many European technology suppliers quote a figure of silage from 40 ha for each 100 kW of electrical output.

However, this will greatly depend on the management of the land, its location and the crop grown. It is better to assess the tonnage required and relate that to your current forage production.

Aim for an engine with an efficiency of over 40% for electrical output. Lower efficiency engines may be cheaper to purchase but the extra efficiency will normally pay for the extra cost many times over.

Currently, four Renewable Obligation Certificates (ROCs) are issued for each MWh of electricity produced by biogas plants up to 500 kW in size and three ROCs for plants between 500kW and 5 MW. The increase from two ROCs to four ROCs greatly enhanced the potential financial returns from biogas plants. This has resulted in a high level of interest in biogas production amongst farmers. However, raising the required level of finance has remained a major challenge and has encouraged a significant number of farmers to work together to try to obtain the substantial level of finance required to build an on-farm biogas plant in Northern Ireland.

Reliability is the key to a profitable plant. At four ROCs and an export tariff of 4.5 p/kWh, a 300 kW plant would have the capacity to generate over £1.00 worth of electricity every minute. Downtime of the biogas engine costs money which cannot be clawed back.

AD Portal

A very useful source of information on biogas production is the AD Portal on the internet at www.biogas-info.co.uk. This gives information on planning permission, feedstocks, regulations, incentives, digestate quality, useful contacts and much more. This has recently been contextualised for Northern Ireland and will continue to be updated as information becomes available.

For further information contact Nigel Moore on tel: (028) 9442 6648
or email: nigel.moore@dardni.gov.uk

Meeting the Challenges

Connecting Renewable Generators to the NIE Grid System

Andy McCrea, Independent Energy Consultant

One of the key aspects when considering a renewable energy project is connection to the electricity system or grid. Where there is an intention to connect and operate a generator in parallel with the electricity network there is an obligation on any developer to contact NIE and enter into an agreement with them.

The Northern Ireland grid was originally designed and built in the 1950s and 1960s to supply rural areas with electricity generated in power stations close to the areas of largest population – Belfast and Ballylumford on the east coast and Coolkeeragh in the north west. The current situation is different. There are still major power stations at Kilroot, Ballylumford and Coolkeeragh but increasingly there is a need for the grid to take-up electricity generated from smaller, distributed plants scattered across Northern Ireland. The Northern Ireland grid system comprises of circuits at a range of voltages. The high voltage circuits are designed to transport bulk power at 275 kV and 110 kV from the power stations to the load centres and they are roughly arranged in a loop around Northern Ireland with Lough Neagh at the centre. Lower voltage lines at 33 kV, 11 kV and 230 V carry electricity to towns and individual farms, dwellings or businesses to satisfy their demand. Substations are used to transform the voltage to the required level. NIE plan to upgrade the existing grid system over the coming period through a range of projects, including the new North-South interconnector, the introduction of cluster substations and through a comprehensive Renewables Integration Development Plan (RIDP). These proposals are currently under discussion with the electricity regulator (NIAUR) for approval.

The preferred situation is where a generator wants to connect in an area where the grid is strong, that is, close to an existing line or substation. However if the connection of a wind turbine or on-farm anaerobic digester (AD) is required at some distance from a substation or main line, then it may be necessary to construct a new line. It is also necessary to ensure that the new generator connection provides sufficient capacity to allow the export of the electricity generated and that it does not disrupt customers already connected to the system. Typically wind turbines might be connecting in the west of Northern Ireland where the wind resource is plentiful and AD plants will require connection where the farms are located. These locations might be remote from the existing grid or in areas where the grid is weak. The general rule is the closer to the main lines, substations and load centres the better.

Before any new connection is allowed, NIE need to ensure that the required safety and operating conditions will be met by the new generator and a connection study will be required to assess the impact on the existing grid. To ensure new connections comply with these requirements, NIE have introduced a Distribution Code (or D-Code). This code imposes requirements on new generators to ensure they comply with the necessary safety and operating conditions and it also allows NIE to both monitor, and if necessary, control the output from the generator.

A typical connection will also require a new line, transformer and equipment cubicle. Planning permission will be required for the connection. Some connections may require NIE to provide equipment which is not readily available, so delays in connection can occur until planning and equipment are available. This process typically can take from 6 months to a year.

Recent changes to the financial support for renewable generation (Renewable Obligation Certificates or ROCs), such as wind turbines and AD plants, have seen a huge increase in applications for connections. The size of these generators has also increased and this has introduced an unprecedented workload for the network engineering staff who process these applications. Developers will want to maximise their income from the renewable generation and they will want to get the best deal for the electricity, ROCs and Levy Exemption Certificates (LECs). There are a range of companies who will purchase the electricity, ROCs and LECs such as PowerNI.

For more information contact NIE Networks on tel: (028) 9066 1100 and on selling your electricity, LECs and ROCs contact Andy McCrea on tel: 07799 434030.

Planning for Wind Turbines and Solar Energy

Denise Dickson, Principal Planning Officer, Local Planning Division Headquarters

Wind turbines

A wind turbine, whether attached to a building or erected on its own independently of a building, is considered to be, or of the nature of, plant and machinery. Therefore, planning permission is required for all wind turbines, including those on farms.

Planning applications for wind turbines should be submitted on a P1 form along with the appropriate scaled plans and fee. Full details are available at the Planning Portal (www.planningni.gov.uk) or from your local Area Planning Office.

Environmental Impact Assessment

In applications where a development involves the installation of more than two wind turbines, or the hub height of any turbine or height of any other structure for harnessing wind power for energy production exceeds 15 metres, an assessment as to whether an Environmental Statement is required to be submitted shall be made by the Department under Schedule 2 (3) (j) of The Planning (Environmental Impact Assessment) Regulations (Northern Ireland) 1999 as amended by The Planning (Environmental Impact Assessment) (Amendment) Regulations (Northern Ireland) 2008. If you are in doubt as to whether an Environmental Statement is required as part of your application you should contact your local planning office for further information and advice.

Where it is determined that an Environmental Statement is not required, the Department may nonetheless require the applicant to provide additional information to enable it to process the application e.g. a noise assessment, ecological study or information on interference with emergency fixed links.

Each application will be judged on its own merits and additional information will depend on the individual circumstances of each case.

Solar Collectors

Solar collectors include solar water heating panels (SWH) and photovoltaic panels (PV). In certain circumstances, planning permission may not be required for the installation of solar collectors on a dwelling-house or a building within the enclosure occupied by a dwelling-house. However, if your dwelling is located within a Conservation Area you should discuss your proposals with your local Planning Office. Full details of the requirements and application fees are available at www.planningni.gov.uk or from your local Area Planning Office.

Where planning permission is required, an application for solar collectors should be submitted on a P1 form with the appropriate plans and fee. The following additional information could also be submitted to speed up the processing of your planning application:

- The design of the module or array
- Photographs of the existing built environment
- Detail of the roof mounting arrangement, if applicable
- Indicative drawings of the module or array in place
- Connection details to the building or grid if relevant
- If the application involves a listed building, a photomontage of the proposed collector array could be useful

Environmental Impact Assessment

Domestic or small-scale systems are not covered by Schedule 1 or 2 of The Planning (Environmental Impact Assessment) Regulations (Northern Ireland) 1999 and are therefore not likely to require an Environmental Impact Assessment. In Areas of Outstanding Natural Beauty, conservation areas and on listed buildings, the visual impact and impact of the proposal on the building fabric are amongst the issues that are assessed by Planning Service.

Material Considerations

The range of factors that the DOE take into account in determining any individual application for a single wind turbine or solar collector is, in practice, very wide and can vary from application to application depending on the site and its location. However, in the assessment of all applications, the Department is required to have regard to the development plan, so far as it is material to the application, and to other material considerations.

Material considerations include the relevant planning policy and guidance documents and in particular Planning Policy Statement 18 Renewable Energy (these are available to view on the Planning Portal www.planningni.gov.uk), and comments that relate to planning issues from the general public and statutory consultees.

They also include the impact of the proposed development on:

- Public safety; human health; or residential amenity
- Visual amenity and landscape character
- Biodiversity, nature conservation or built heritage interests
- Local natural resources, including air and water quality
- Public access to the countryside

Streamlined Application Process

A planning application for solar panels or a single domestic wind turbine is likely to fall within the Department's streamlined application process, where non-contentious planning applications can be issued without formally bringing them to the Planning Committee of the local District Council unless specifically requested by the local Council. Instead, a decision will issue under the authority of the Area Planning Manager, thus enabling faster decision-making on this type of planning application.

For further information contact Denise Dickson on tel: (028) 9041 6700
or email: denise.dickson@doeni.gov.uk

Planning Permission for Anaerobic Digesters

Kelly Mills, Principal Planning Officer, Strategic Planning Division Headquarters


Planning permission is required for all anaerobic digesters. All planning applications for anaerobic digesters are processed within the Strategic Planning Division in Planning Headquarters. Planning applications for anaerobic digesters should be submitted on a P1 form along with the appropriate maps, drawings and fees.

Specifically, the following information should be submitted:

- A site plan and elevation drawings to determine visual impact
- Photomontages of the digester, plant, building(s) and chimney stack with a clear indication of building material and finishes
- Information on grid connection works, including transformer and transmission lines
- Details of potential noise or emissions to air and an assessment of their impact
- Details of vehicular access and vehicular movement
- Landscaping provisions
- Site management measures during the construction phase
- Model of emissions dispersion
- Community consultation plans

Full details are available at www.planningni.gov.uk or by contacting the Strategic Planning Division.

Fees

From 11 April 2011, the fee for an application for an anaerobic digester in tanks on an **open site** is £1,775 for each 0.5 hectare of the site area subject to a maximum of £38,400.

The fee for anaerobic digestion in tanks **within a building(s)** falls within Category 4 of the Fee Regulations which is:

(a) Where no floor space is to be created by the development, £170;

(b) Where the area of gross floor space to be created by the development does not exceed 40 sq.m., £170;

(c) Where the area of the gross floor space to be created by the development exceeds 40 sq.m., but does not exceed 75 sq.m., £335;

(d) Where the area of the gross floor space to be created by the development exceeds 75 sq.m., but does not exceed 3750 sq.m., £335 for each 75 sq.m., of that area;

(e) Where the area of gross floor space to be created by the development exceeds 3750 sq.m., £16,750; and an additional £100 for each 75 sq.m. in excess of 3750 sq.m., subject to a maximum in total of £250,000.

Material considerations

In considering an application for an anaerobic digester, the Department is required to have regard to the development plan, so far as it is material to the application, and to any other material considerations. Material considerations include any responses from the public and consultees as well as amongst other things relevant policy. In terms of anaerobic digesters the relevant policy includes:

- Planning Policy Statement 18 - Renewable Energy including the 'Best Practice Guide to PPS18' which specifically deals with anaerobic digesters in Section 3;
- Planning Policy Statement 11 - Planning and Waste Management: WM 1 and WM 2; and
- Planning Policy Statement 21 - Sustainable Development in the Countryside: CTY 13 and CTY 14.

Each planning application for an anaerobic digester is assessed on its own merits against the prevailing planning policy and taking into account all material considerations. It is the responsibility of the applicant/agent to submit the necessary information to demonstrate that the proposal complies with the prevailing policy and to enable the Department to determine the application. There may be site specific issues that the applicant/agent may wish to address when submitting any planning application for an anaerobic digester, such as odour issues if there are sensitive receptors in the locality. Additional site specific issues may include:

- Noise
- Air pollution
- Visual impact of the anaerobic digester and associated infrastructure
- Impact of any increase in vehicles to site and along local road network

Environmental Impact Assessment

Developments that use waste to provide energy may require an Environmental Impact Assessment. Such projects could fall within projects listed in Schedule 2.3 and/or 2.11 of the Planning (Environment Impact Assessment) Regulations (Northern Ireland) 1999.

For further information contact the Strategic Planning Division on tel: (028) 9041 6700.

The Northern Ireland Renewables Obligation (NIRO) and Renewables Obligation Certificates (ROCs)

Michael Harris, Renewable Electricity Branch, DETI

The NIRO is the Department of Enterprise, Trade and Investment's (DETI) main policy instrument for encouraging the development of new renewables capacity.

How does it work?

The Renewables Obligation places a legal requirement on all Northern Ireland licensed electricity suppliers to provide Ofgem (on behalf of the Northern Ireland Authority for Utility Regulation (NIAUR)) with evidence that a specified quantity of the electricity supplied to final consumers can be accounted for by generation from renewable sources. This specified quantity is measured in megawatthours (MWh).

Evidence of compliance with the Obligation is in the form of Northern Ireland Renewables Obligation Certificates (NIROCs) which are issued free of charge by Ofgem to electricity generators for each MWh of eligible renewables generation.

The NIRO also provides for Renewables Obligation Certificates (ROCs) issued under similar Renewables Obligations in GB (GBROCs) to be used as evidence of compliance and for NIROCs and GBROCs to be mutually tradeable across the UK.

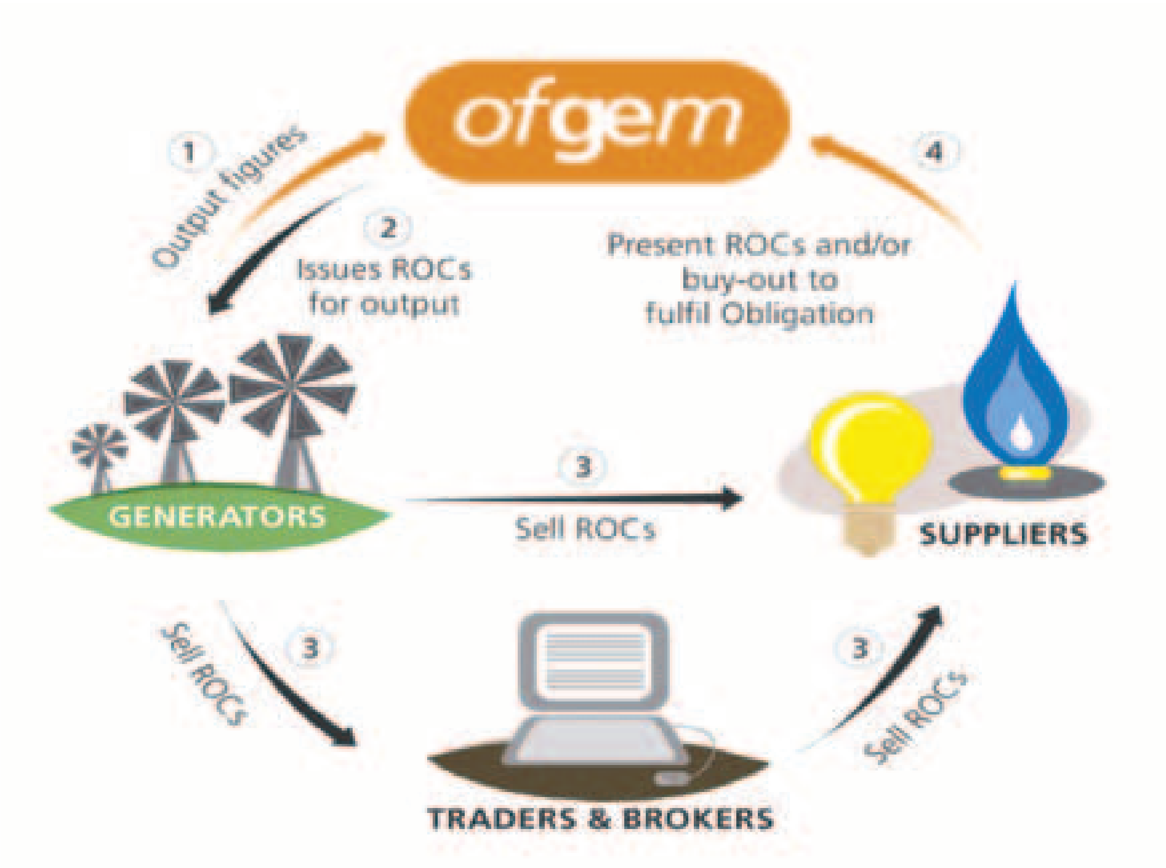
As an alternative to presenting ROCs, suppliers may pay a 'buy-out' fee to Ofgem for each MWh of the specified quantity of electricity that is not covered by presenting ROCs. Suppliers can therefore comply by either presenting ROCs, or paying the buyout (or a combination of the two). At the end of each Obligation period the proceeds from buy-out payments are redistributed among suppliers in proportion to the number of ROCs they produced in satisfaction of their Obligation. With the Obligation set at a level higher than the current level of eligible renewables generation, 'buy-out' fees will always be payable in each Obligation period. This gives ROCs a value and it is this value that provides developers with the financial incentive to invest in renewables capacity. The market value of ROCs (approximately £45) can be expected to be at least the 'buy-out' fee (£36.99 for 2010/11) plus the anticipated Buy-Out Fund redistribution proceeds per ROC presented.

The cost of the NIRO is passed on to consumers by suppliers: it does not involve DETI paying grant assistance but instead provides a revenue support to generators for the electricity they generate after they have set up and are in operation.

How do you get ROCs?

Generators who want to receive support under the NIRO in order to obtain ROCs must first seek accreditation with Ofgem. Once accredited, generators are issued with ROCs for every MWh of eligible electricity they generate. The number of ROCs issued per MWh is determined by the technology used by the generating station, its size and when it first became accredited under the NIRO. Generators can then sell these ROCs directly to electricity suppliers or use the services of an agent. In addition to selling their ROCs, generators can also enter into an agreement with an electricity supplier to export any excess electricity to the grid. ROCs are issued for every MWh generated regardless of whether the electricity is used on site, exported to the grid or a combination of both. Once accredited, generators receive support under the NIRO for 20 years or until 2033 (the current end date of the NIRO), whichever is sooner.

Diagram: How the NIRO works



Source: Ofgem

Consultation on changes to ROC banding levels in 2013

A DETI consultation is due to be published in late October 2011 on proposed changes to the NIRO in 2013. When banding was introduced to the NIRO in 2009 it included a provision to review banding levels every 4 years to ensure that subsidies reflect changes in technology costs. Any banding changes introduced on 1 April 2013 will only apply to generating stations accrediting after this date or any additional capacity added. Generating stations accredited under the NIRO before 1 April 2013 are 'grandfathered' at the ROC level awarded at the time of accreditation. The NIRO consultation can be accessed on the DETI website at www.energy.detini.gov.uk

Northern Ireland Renewables Obligation (NIRO) – Banding Levels to 31 March 2013

Generation type	ROCs/MWh
Hydro-electric	
Up to 20kW	4
21kW-50kW	3
51kW-250kW	3
251kW-1MW	2
Above 1MW-5MW	1
Above 5MW	1
Onshore Wind	
Up to 50kW	4
51kW-250kW	4
250kW-5MW	1
Above 5MW	1
Solar Photovoltaic	
Up to 50kW	4
Above 50kW-5MW	2
Above 5MW	2
Anaerobic Digestion	
Up to 500kW	4
501kW-5MW	3
- Above 5MW	2
Dedicated Biomass	1.5
Dedicated Energy Crops	2
Dedicated Biomass with CHP	2
Dedicated Energy Crops with CHP	2

Notes

1. All microgeneration i.e. up to 50 kW receives 2 ROCs/MWh regardless of technology. Exceptions are onshore wind, hydro, solar photovoltaic and anaerobic digestion as detailed in the above table.

2. A comprehensive list of technologies supported under the NIRO can be found on the DETI website

Microgeneration Certification Scheme

Microgenerators seeking first time accreditation under the NIRO from 1 April 2010 using onshore wind or solar photovoltaic panels for electricity generation will have to use equipment and installers registered under the Microgeneration Certification Scheme or an equivalent certification scheme. This requirement ensures independent assurance and legitimacy to small-scale onsite electricity generators, increases competition within the market and ensures consumers are protected.

Biomass Sustainability Criteria

The Renewables Obligation legislation requires all biomass generators over 50 kW to report to the best of their ability on a range of biomass matters including biomass type and whether the biomass is an energy crop or waste. Generators also need to factually report on whether the land criteria have been met and their level of greenhouse gas emissions.

From 1 April 2013, there will be a formal requirement for biomass generators greater than 1MW to meet a 60% greenhouse gas emissions criteria in order to receive ROCs. However, the sustainability criterion does not apply to the use of biomass or biogas made from waste, landfill gas or sewage gas.

From 1 April 2011, generators using bioliquids must provide evidence to Ofgem verifying that their fuel(s) meets certain sustainability requirements.

Useful contacts:

Information on the NIRO:	Department of Enterprise, Trade and Investment (DETI) Tel: 028 9052 9269 www.energy.detini.gov.uk
Accreditation (including sustainability reporting):	Ofgem Tel: 020 7901 7310 www.ofgem.gov.uk/Sustainability/Environment/RenewablObl
Export tariffs:	Power NI http://www.powerni.co.uk/index.php/saving-energy/renewable-energy

Marketing Renewables Obligation Certificates

Jonathan Buick, Programme Manager, Action Renewables

To date, over 500 businesses in Northern Ireland are embracing renewable technologies to generate electricity. They are experiencing extensive business benefits including lower energy costs and a sustainable supply. But organisations in Northern Ireland are not realising the maximum benefits that can be achieved from Renewables Obligation Certificates (ROCs).

A Renewables Obligation Certificate (ROC) is a green certificate issued to an accredited generator for eligible renewable electricity generated within the United Kingdom and supplied to customers within the United Kingdom by a licensed electricity supplier. ROCs are issued for each megawatt hour (MWh) of eligible renewable output generated. The average market value during a 12 month period in 2010 and 2011 was around £48.00 per ROC, and the number of ROCs issued depends on the generating capacity and type of the technology.

Newly installed wind turbines up to 250 kW or Photovoltaic panels up to 50 kW, for example, are awarded 4 ROCs per MWh generated. If each ROC were to be sold for an average of £48, then this would equate to 19.2 pence per kWh generated. However, the majority of generators are not obtaining this figure due to the nature of the Northern Ireland market for ROCs.

For example, Northern Ireland businesses that have installed a renewable technology to create electricity are making significant savings on their energy bills. However, they could use their technology to generate revenue and reduce the payback period significantly by looking further afield and selling their ROCs to licensed electricity suppliers across the UK, either directly or via auction.

To give a working example; a small business or farm with a 20 KW wind turbine, generating for example 26,200 units of electricity for use in their business each year, will generally save more than 12 pence per unit on their electricity; or over £3,000 per year. They will also receive 104 ROCs that can be sold on to a licensed electricity supplier and at the average market price this equates to almost £5,000. If limited to selling ROCs at a fixed price of £42.30 during the past year, this generator would only have obtained £4,400 from ROCs, a difference of 13.6%. The added revenue will also reduce the company's payback period by up to a year. Wind turbines up to 250 kW can now obtain 4 ROCs per MWh of electricity generated, regardless of whether this electricity is used to offset demand on the business or sold to the grid. Action Renewables is seeing an upsurge in interest in these turbines due to the revenues obtained from selling ROCs, which can provide a return on investment of around 5 years.

Most businesses will automatically think of selling their ROCs in the Northern Ireland market but could receive a 15% higher price for them if they explore all opportunities and examine selling them in England, Scotland or Wales.

Action Renewables Energy Trading Limited is one of the companies that can assist organisations in obtaining a more competitive price for ROCs by trading across Great Britain and Northern Ireland and making the ROC market work for Northern Ireland generators.

For further information contact Jonathan Buick on tel: (028) 9072 7767
or email: jonathan.buick@actionrenewables.co.uk

Developing the Renewable Heat Market in Northern Ireland

Peter Hutchinson, Renewable Heat Branch, DETI

In July 2011, the Department of Enterprise, Trade and Investment (DETI) launched a public consultation on the development of the Northern Ireland Renewable Heat Incentive (RHI). This consultation closed for comments on Monday, 3 October 2011 and DETI is now considering responses in advance of confirming a final policy position. The consultation can still be accessed at www.energy.detini.gov.uk

The launch of the consultation document followed on from significant research carried out by DETI into the current status of the Northern Ireland renewable heat market, its potential development and the appropriateness of a long term incentive scheme.

Why incentivise renewable heat technologies?

One of the catalysts for this work was the Renewable Energy Directive (RED), published in June 2009, which requires the UK to ensure that 15% of its energy consumption comes from renewable sources.

In addition to this, the development of the renewable heat market in Northern Ireland supports wider DETI energy goals in terms of increased fuel security, reduced carbon emissions and opportunities for 'green jobs'. The Strategic Energy Framework, published in September 2010, included a target of 10% renewable heat by 2020; this is a challenging target considering a starting position of 1.7%.

The GB Renewable Heat Incentive.

In July 2009, the Department of Energy and Climate Change (DECC) indicated that they were planning to introduce a Renewable Heat Incentive (RHI) in Great Britain. The GB RHI was the first of its kind with the final design of the scheme being announced in March 2011 in advance of implementation in September 2011.

The GB RHI applies across England, Scotland and Wales, rewarding those who install eligible renewable heat technologies with payments made on a quarterly basis. The level of payment and length of tariff varies depending on the size and type of technology installed. Full details of the proposed tariffs and eligibility requirements can be found on the DECC website (www.decc.gov.uk).

The Northern Ireland Heat Market

The reason why the GB RHI does not apply in Northern Ireland is because there are significant differences between the heat markets in GB and Northern Ireland. Northern Ireland is largely dependent on oil with a developing natural gas market, whereas in GB the gas market is well established and is the predominant fuel source. There are also differences in fuel prices between GB and Northern Ireland and the amount of our income that goes towards heating our homes and businesses. As a consequence the levels of fuel poverty tend to be higher in Northern Ireland. Finally, the geography of Northern Ireland is very different to GB, with Northern Ireland being more rural with fewer larger cities and therefore has a very different heat density.

These factors meant that it was appropriate for separate consideration to be given to how the heat market here might be encouraged and incentivised. A study carried out demonstrated that Northern Ireland has the potential to reach 10% renewable heat by 2020, but only with significant support from the Executive, in regards to policy, finance and cross-departmental working.

A significant element of this study was gathering up to date, reliable information on the Northern Ireland heat market. It was determined that the total heat demand for Northern Ireland is around 17,362 GWh per year. The breakdown of heating, by fuel type and sector, is detailed below.

Fuel/Energy Type	Domestic (GWh)	Industrial Commercial and Public (GWh)	Total (GWh)	Percentage of total
Oil	9,241	4,103	13,344	77%
Gas	973	1,991	2,964	17%
Economy 7 Electricity	176	41	217	1.2%
Renewables	No Information on split	No Information on split	290	1.7%
Coal	110	438	547	3.1%
Total			17,362	

Looking forward to 2020, Northern Ireland's overall heat demand is predicted to drop from 17.4 TWh per year to 16.7 TWh per year with rises in demand from new developments being outweighed by reductions in demand with efficiency improvements in the existing sector. The 10% for renewable heat therefore equates to 1.6 TWh.

A Renewable Heat Incentive for Northern Ireland

For the renewable heat market to reach a level of 10% by 2020, DETI has proposed to introduce a RHI specifically tailored and designed for Northern Ireland. The Northern Ireland RHI represents investment of £25m in renewable heat over the next 4 years.

The scheme designed by DETI has many similarities to the GB RHI in terms of administration, eligibility and the design of tariffs. The Northern Ireland RHI is intended to incentivise the uptake of a range of renewable heating technologies through long term tariffs paid on a quarterly basis for actual renewable heat generated.

Tariffs are detailed below:

Tariff name	Eligible technologies	Size	Tariff duration (years)	Northern Ireland recommended levels (pence per kWh)
Air Source Heat Pumps		Less than 45 kWth	20	3.3
Ground Source Heat Pumps	Including water source heat pumps and deep geothermal	Less than 45 kWth	20	4.0
		Above 45 kWth but excluding large industrial sites		0.9
Bioliquids		Less than 45 kWth	20	1.5
Biomass	Solid biomass Muncipal solid waste[3] (inc. CHP)	Less than 45 kWth	20	4.5
		Above 45 kWth but excluding large industrial sites	20	1.3
Biomethane	Biomethane injection and biogas combustion, except from landfill gas	Biomethane all scales, biogas combustion less than 200 kWth	20	2.5
Solar Thermal		Less than 200 kWth	20	8.5

It is proposed that the Northern Ireland RHI will be available to non-domestic customers first (with some additional eligibility standards for heavy industrial sites). This is similar to the GB RHI. It is expected that the RHI will be extended to domestic customers by October 2012. In the interim, DETI has proposed to make available **Renewable Heat Premium Payments** to support the capital installations in domestic dwellings. Those customers availing of these payments will remain eligible for the RHI in October 2012.

3. Defined under the Waste and Emissions Trading Act 2003, Section 21

Renewable Heat Premium Payments

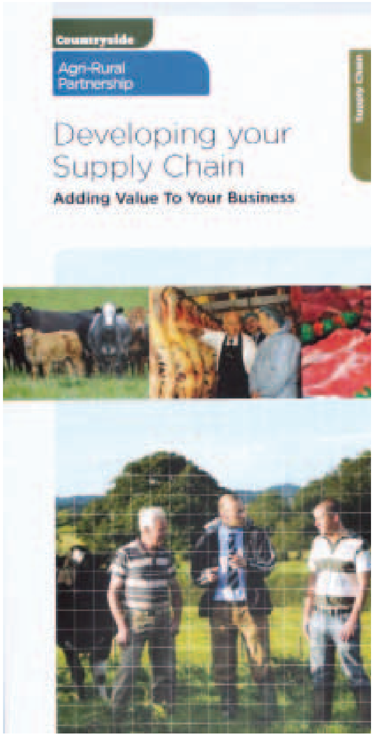
Technology	Support per unit (£) in a detached dwelling	Support per unit (£) in any other dwelling
Air Source Heat Pump	1860	1170
Biomass boiler	2580	1620
Ground Source Heat Pump	2250	1410
Solar Thermal	480	480

The proposed RHI will support the uptake of renewable heating technologies in a range of sectors across Northern Ireland and presents an opportunity to reduce fossil fuel consumption and as a result increase fuel security and cut carbon emissions. The RHI also presents opportunities for new 'green jobs'.

Further information can be found at www.energy.detini.gov.uk or by contacting email: Ni.rhi@detini.gov.uk

Can you develop a renewable energy supply chain?

Gareth Gormley, Senior Rural Enterprise Adviser, DARD



Events such as the Practical On-farm Renewable Energy 2011 event at Greenmount Campus will encourage farmers to consider the production of renewable energy crops on their farm. It will also prompt the question 'How can I work with others to add value and create a sustainable business opportunity within the renewable energy sector?'

One group that illustrates the potential of working together in this way is the North Antrim Environmental Systems (NAES) supply chain group. This was established several years ago due to a common interest in renewable energy and environmental issues. In 2010, with potential enhancement to the Renewable Obligations Certificates (ROCs) available in Northern Ireland, the Group decided to develop its own Anaerobic Digestion plan. To do so they needed both expert assistance and financial resources. The Group was successful in its application to the Supply Chain Development (SCD) programme. This is funded under the Northern Ireland Rural Development Programme (NIRDP) and administered by Countryside Agri-Rural Partnership.

The main steps in the development of the project were:

- The application for the programme by submitting a Declaration of Interest which outlined the proposal. The group secretary, Bob Richmond says, "This initial step was quite straightforward".
- A facilitator was assigned to the group who helped them obtain the available assistance from the programme.
- An Action Plan was prepared stating the aims and objectives of the group.
- The programme makes available a wide package of support to assist the group in researching their project and to give them the skills and knowledge to bring their plans to fruition. Three members of the group attended a week-long biogas training course in England. This not only increased their knowledge of the bio-digestion process but allowed them to network widely with other people considering the same issues as themselves.
- Group members made an independent trip to Denmark and Germany to visit a wide range of biogas plants, particularly those using similar inputs to ourselves. Bob Richmond says "We found this visit extremely useful as we had the opportunity to discuss matters openly with the owners/managers without always having a company representative taking the lead."
- Firm decisions have been made on the design of the plant and rapid progress is envisaged on their business plan.

Bob Richmond comments, "We would like to thank the funders of the Supply Chain Development Programme – Axis 1 of the Rural Development Programme for all the support to date. With up to a maximum of £15,500 of funding available per group, not to mention the facilitation and specialist mentoring support available, this is a very worthwhile programme and we would encourage other groups considering the programme to apply."

Opportunities exist for biomass production, woodchip and pellet manufacture in addition to energy supply, distribution and marketing from anaerobic digestion, wind generation and micro-hydro sources. Farmers and growers need to consider:

- What are the opportunities to supply the Northern Ireland energy market.
- What renewable energy systems and technologies are available.
- How they can overcome the challenges to entering the market.

The Northern Ireland Rural Development programme is funded by the European Agricultural Fund for Rural Development (EAFRD) and the Department of Agriculture and Rural Development (DARD).

For further information on the Supply Chain Development programme contact Gareth Gormley on tel: (028) 3025 5912 or the Countryside Agri-Rural Partnership on tel: 0845 0267538, or email: supplychain@countrysiderural.co.uk, or visit www.countrysiderural.co.uk

Renewable Energy Funding for the Agricultural and Rural Sector

Gareth Gormley, Senior Rural Enterprise Adviser, DARD

There are a range of grants and funding available to support the adoption of renewable energy technologies within the agricultural and rural sector. These are summarised below:

NI Rural Development Programme – Axis 3

Measure 3.1 - Farm Diversification

A stand alone renewable energy project can be funded at up to 50% grant aid to a maximum grant level of £50,000 providing the diversification project is for the farm owner or farm family member to become an energy producer and 100% of the output is sold to a third party eg PowerNI. Under Axis 3 energy cannot be used to reduce the running costs of a farm business and can only be used to supplement the income of the farm family. Renewable energy applications from farm owners or farm family members that are intended to increase the profitability of a new or existing farm diversification business may be accepted. All the energy generated must either be used by the diversified business and/or sold to a third party eg PowerNI.

Measure 3.2 - 3.6

Private Promoter - A renewable energy project can be funded at up to 50% grant aid to a maximum grant level of £50,000 to increase the profitability of the business.

Social Economy Enterprise - A renewable project can be funded at up to 75% grant aid to a maximum grant level of £170,000 to increase the profitability of the business.

Farm Modernisation Programme

Future tranches of the farm modernisation programme will provide funding for some on-farm energy efficiency equipment at grant rates up to 40% or a maximum of £4500.

Short Rotation Coppice (SRC) Scheme

The SRC Scheme supports the planting of SRC crops for renewable energy purposes. Applications should be made preferably in the autumn prior to the intended planting date, but at the latest by 31 January each year for planting in the following spring. Applicants must also be able to show they can use the crop themselves for energy production or that they have a market for their crop. The maximum grant rate for establishment is £1,000/ha and the minimum grant aided area is 3 Ha. **For more information** contact the Scheme Manager, Birnie Brown on tel: (028) 9037 8502.

NIE Farm Solar Water Heating Scheme

Farmers in Northern Ireland can avail of the NIE SMART Programme which offers a grant towards the cost of installing a solar water heating system on the farm. Grant levels are detailed below.

1. £900 or a maximum of 25% for a system providing up to and including 300 litres of hot water.

2. £1,100 or a maximum of 25% for a system providing over 300 litres of hot water.

NIE Solar Water Heating Scheme for the B & B and Self Catering sector

The NIE SMART programme is launching a further grant scheme to support solar water heating for the B&B and Self Catering sector which tends to have a high demand for hot water. Hotels will also be considered on a case by case basis. The grant rate is 25% of the installed cost excluding VAT, capped at £2,500 per property.

Power NI Household Solar PV Scheme

Power NI is offering support to householders who would like to install solar photovoltaics (PV). Funding from the Northern Ireland Sustainable Energy Programme (NISEP) is limited and will be administered on a 'first come, first served' basis. The grant rate is £1,105 per kWp or 20% of the relevant eligible costs, whichever is the lesser amount (Max. £5,000). Please note that farmers who are on a domestic tariff will be eligible to apply for the grant but farmers who are on a business tariff are not eligible.

NIE Household Grant for Wind

Support is now available for householders who would like to install wind turbines. The grant rate is £900 per kWp or 30% of the relevant eligible costs, whichever is the lesser amount (Max. £4,500). Please note that farmers who are on a domestic tariff will be eligible to apply for the grant but farmers who are on a business tariff are not eligible. **For further information** contact Delta Hamilton, delta.hamilton@powerni.co.uk Power NI, Woodchester House, 50 Newforge Lane, Belfast, BT9 5NW.

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or email: gareth.gormley@dardni.gov.uk

Take a Fresh Look at the Taxation of Business Profits

Anne Douglas, Senior Manager, Cavanagh Kelly Chartered Accountants

We are all familiar with the different types of trading vehicles - sole trader, partnership, limited liability partnership, limited company - but do you know what the advantages and disadvantages of trading under each are?

The main differences arise in the taxation of profits and protection of the business owners. Choosing the right trading vehicle can mean more money in your pocket so you should consider your options carefully.

As a **sole trader** you will pay income tax and national insurance (NIC) on profits as follows:

Profit from	To	Tax & NIC Payable
0	7,475	0%
7,476	42,475	29%
42,476	150,000	42%
> 150,000		52%

Trading through a **partnership** has a multiplier effect on these bands, so in a husband and wife partnership for instance, you will pay income tax and NIC on profits as follows:

Profit from	To	Tax & NIC Payable
0	14,950	0%
14,951	84,950	29%
84,951	300,000	42%
> 300,000		52%

A **Limited Liability Partnership (LLP)** shares many of the features of a normal partnership - but it also offers reduced personal responsibility for business debts. Unlike members of ordinary partnerships, the LLP itself is responsible for any debts that it runs up, not the individual partners. In relation to tax, however, an LLP is taxed in the same manner as a normal partnership.

One tax advantage of these unlimited entities is that if the business generates a trading loss, for instance when significant investment is made into Plant & Machinery, the loss can be offset against other income of the business owners in the same & previous year. Where the loss is made in a new business these losses can be carried back for 3 years and offset against other income earned, possibly triggering a tax refund (subject to appropriate drafting of the partnership agreement in relation to capital funding).

Another advantage is that there is no restriction or additional tax charges on the extraction of profit via drawings for the owners once the tax on the profits has been paid.

A **limited company** is a company in which the liability of its shareholders is limited to the extent of what they have invested in it in share capital. A limited company pays corporation tax on its profits as follows:

Profit from	To	CT Payable
0	300,000	20%
300,000	1,500,000	27.5% ERT
>1,500,000		26%

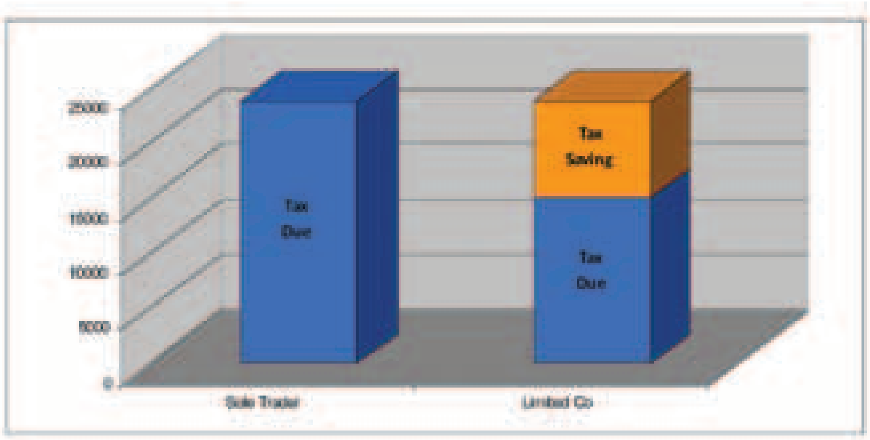
As you will see, profits between 0 and £300,000 are taxed at a rate of 20% as opposed to rates of 29%, 42% & 52% in a sole trade or partnership, giving rise to an obvious tax saving. However, you must also consider the tax implications of extracting these profits from the company. The profits generated belong to the company and where a shareholder wants to draw out these funds he must do so via a salary, dividend etc., all of which could attract additional taxes.

You can, however, withdraw a combination of salary and dividends up to £42,475 per annum per shareholder completely tax free.

Where losses are generated by a limited company they are ring fenced within that company and can only be carried forward until such times as the company makes a profit when they will be offset and relief gained.

Example

A business generates taxable profits of £75,000 – what would the tax charge be to a sole trader versus a limited company?



As you will see, there is a potential tax saving of almost £9,000, provided the shareholder in the company scenario only requires to extract £42,475 of the profits generated as remuneration. This tax saving is depleted as the requirement for cash extraction grows.

If you do not want to incorporate your business you may consider the introduction of a corporate partner into your partnership – this has the advantage of offering a limited company to shelter some of the business profits at the lower corporate rate of tax.

You can see it could be well worth your while taking some time out to consider the most appropriate trading vehicle for your business and at Cavanagh/Kelly we have a team of experienced professionals who can help you make this decision.

For further information contact Anne Douglas on tel: (028) 8775 2990.

Financing Northern Ireland Renewables

Trevor Finlay, Managing Director, Vision Asset Finance

Introduction

For many farmers and landowners 2011 has been the year of decision regarding whether or not to invest into a renewables venture. For most, this has involved submitting a planning application for their preferred technology. Typically this will be a mid-scale Wind Turbine (up to 250 kW) or an Anaerobic Digestion (AD) / Biogas plant (up to 500 kW). The 2010 and 2011 amendments to the Northern Ireland Renewables Obligation have given both technologies the required level of NIROC support to make them commercially viable on a farm scale.

So, you've got your planning approved, and you want to progress with a G59 application for grid connection of your project. Almost simultaneously you will need to firm up how you are going to finance your entire project. Grid connection offers for projects of this scale can range from £70k to £500k depending on distance from sub stations and the level of additional infrastructure required. Grid connection offers will require you to pay 20% of the amount to reserve the connection within 90 days.

Banking your Project

You'd think that with the enhanced levels of NIROCs available that securing finance for your project would be relatively straightforward? Well, as many are now finding out – you'd be wrong.

The banking crisis of 2008 has resulted in many of our local banks having to recapitalise, and as such they have been unable to meaningfully support the renewables sector. While most of them have long term commitments to the Northern Ireland farming sector, they have struggled to convince their credit departments to provide additional facilities for what are essentially 'new' technologies, particularly when there are so few local examples of the technology up and running.

The present reality is that the early projects already commissioned or under construction are 100% self-funded or have a modest level of bank debt secured against land based security and alternative income streams. For many prospective projects in the pipeline, this funding scenario is not an option.

Funding Alternatives

Thankfully, as with any gap in a market, other financial players have moved to pick up the slack left by the banks. There are currently a number of private and public funds active in the local market that may be interested in helping with specific projects. This takes us into the world of 'Project Financing' which carries a whole new set of funding parameters compared with the regular secured loan facilities that farmers will be most familiar with.

Project Finance for Anaerobic Digestion

If we take an AD project as an example; a Project Finance facility from an investment fund will offer up to 100% funding for your project. Funding is currently available from several funds between a minimum of 5 to a maximum of 10 years. The Fund will typically cover all the primary costs of construction and technology plus costs of grid connection, feedstock storage, tractors, trailers and other necessary items for effective operation of the plant.

The following is an outline of the likely investment criteria required to secure project financing for an AD plant.

1. **Planning Approval**

2. **Feedstock Supply Security:** The funds need to be convinced over the security of feedstock supply for a minimum period of 7 years.

3. **Technology Approval:** A full due diligence will be undertaken on the preferred technology vendor to ensure that they are suitably experienced, credit worthy and able to contract under UK based construction terms for the project supply and associated warranties.

4. **Grid Connection:** The offer of grid connection will need to be confirmed and the costs factored into the overall financial model to ensure project viability.

5. **Funding Vehicle:** A new special purpose company (SPV) would act as the recipient of the funding. It would then enter into a supply contract for the supply of the feedstock to the plant. These contracts will be between the SPV and you and/or your primary supplier of feedstock.

6. **Operation:** The SPV will contract with the farmer for the day-to-day running and operation of the plant.

7. **Feed Stock Supply:** The SPV will contract with the farmer for the supply of feedstock to the plant. The SPV will pay for the supply of feedstock on a % of dry matter basis. Digestate removal will often also form part of this agreement.

8. **Power Purchase Agreement:** The SPV will also negotiate and agree terms for the supply and sale of electricity to an approved energy company. NIROC income will also be secured via the SPV.

9. **Site & Access:** The location of the plant will need to be established with full and unhindered access. A long term lease will be held by the SPV over the plant site, silos and include access rights over any lanes. The SPV will pay the landowner for the lease of the site.

10. **Costs & Structure:** The costs of funding from a Venture Capital Trust (VCT) fund will generally be higher than that generally on offer from banks. However, everything is negotiable and the precise deal structure will depend on various factors such as feedstock security and the precise percentage of funding required. Funds will retain an active and majority shareholding in the SPV until the debt is repaid whereupon equity is transferred back to the farmer/landowner.

As with anything, this funding model is not prescriptive but provides an overview of the likely process to secure Project Financing for an AD project. I'd like to be able to confirm that this model also works for mid-scale wind turbines. However, unless you've got three or more turbines to finance – it doesn't. The funds offering Project Finance for renewables generally start with transactions of £1.5m+ and hence the wind turbine projects of up to £500k need a different approach.

Wind Turbine Financing Options

While there is a level of debt available from banks to support wind turbines most of it is directed at the large wind farms with only a trickle available for small projects. The options for individual famers to raise 3rd party finance for single turbines are almost non-existent unless you are able to secure the support of your bank in the form of a secured loan facility. Lease finance or Hire Purchase type facilities are still not available from any UK based institution for wind turbines of this scale. Many farmers are therefore considering self-financing their turbine with a second-hand turbine to keep the cost as low as possible.

Alternative approaches:

1. Some farmers are teaming up with a few neighbours to put together a portfolio of sites that may be of interest to an investment fund.

2. Independent wind development companies are offering attractive lease options to landowners with suitable sites. Landowner investment options are also becoming a feature of this route.

Financing a Wind Turbine Portfolio

There are only a few investment funds currently interested in funding Northern Ireland portfolios of wind turbines. The funding criteria for Project Financing portfolios of wind turbines are stringent and must be considered before settling on a particular brand or development strategy.

Typically this will involve:

1. Planning Approval.
2. Reasonable costs for Grid Connection (up to £150k).
3. Sites should have an average wind speed greater than 6m/s, with independent verification from recognised consultants.
4. New turbines only.
5. Turbines must have a track record of performance in the sector and be able to adhere to all planning conditions.
6. Turbines must carry manufacturers warranties for at least five years.
7. Turbines must be competitively priced and be supplied by suitably qualified construction contractors.
8. Operation and Maintenance Arrangements must be established with suitably qualified contractors.

In conclusion

I hope this article has given you a useful insight into the current financing options for your AD or Wind Turbine project. An early understanding of the likely financing options is very important to ensure there are few surprises when the bills need to be paid. I've no doubt that Northern Ireland landowners are well positioned to benefit from what renewable installations offer both in terms of income and the ability to offset the high cost of farm energy bills.

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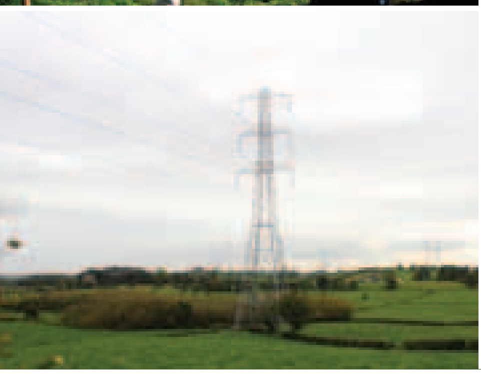

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