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College of Agriculture,
Food & Rural Enterprise

Practical on-farm Renewable Energy

2013/2014

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

afbi Agri-Food and Biosciences Institute

Ulster Farmers' Union

LEAF Linking Environment and Farming

Foreword

As CAFRE Director I would like to warmly welcome you to our fourth Practical On-Farm Renewable Energy event. As in previous years, the aim of the day is to provide practical information about renewable energy options for farmers, growers and the rural sector.

Since the upsurge of interest in small scale renewable energy technologies in 2010, many farmers and members of the rural community have successfully installed renewable energy technology in their businesses or homes. This has reduced their ongoing energy costs and often improved the sustainability of the business by providing an additional source of income. As well as the immediate economic benefits, the food produced has a lower carbon footprint which can give it a competitive advantage in the marketplace.

There is still potential for further investment in a range of renewable energy technologies. 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 staff from across DARD, AFBI, the UFU and CAFRE.

I hope you have an informative and worthwhile day.

John Fay
CAFRE Director

Contents

Efficient farming cuts Greenhouse Gases

Peter Scott, Climate Change and Renewable Energy Branch, DARD

This Practical On-farm Renewable Energy (POFRE) event continues to be a key action in the implementation of the DARD Renewable Energy Action Plan (REAP) and also within the wider actions on resource efficiency leading to lower greenhouse gases.

Earlier this year the Renewable Energy External Stakeholder Group (REESG), who were tasked to review the REAP, reported to Minister O'Neill. Overall, their conclusion was that the plan has had a positive impact on the development of renewable energy within the land based sector.

The Group made a number of recommendations to improve and further develop actions. These included the need for more input (to DETI's lead) on renewable energy policy, stimulating behavioural change and advising on potential innovative technologies.

My team are currently working on how to develop these recommendations and our intention is to incorporate renewable energy actions into Phase 2 of the wider industry and DARD "Efficient Farming Cuts Greenhouse Gases" Strategy and Action Plan.

Optimising renewable energy generation in support of agricultural activities and encouraging fuel efficiency on farms will remain an important and integral part of the way forward alongside better nutrient and fertilizer management, better livestock management and locking carbon in soils, peatland, woodland and grass.

I also see positive indicators of continued investment and interest in renewable energy in the £22 million investment that the DARD and EU Co-funded Biomass Processing Grant Scheme is supporting, with over £3 million capital grant offered and in the 8,000kW of biomass based capacity applied for under the Renewable Heat Incentive.

Renewable energy will continue to be an option that land owners will need to consider to maximise their own resources and produce food in the most environmentally sustainable way possible.

CAFRE renewable energy training workshops

Renewable energy team, CAFRE, Greenmount Campus

CAFRE runs a series of workshops on energy efficiency and renewable energy technologies at venues throughout Northern Ireland. These workshops 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.

Workshops are available on the following subjects:

- Energy efficiency on the farm.
- Introducing renewable energy.
- Energy from wind.
- Solar power.
- Biomass production.
- Heat from biomass.
- Anaerobic digestion on the farm.
- Micro-hydro.
- Heat pumps.
- Business planning.
- Rainwater harvesting.

Details of the programme are available at http://www.dardni.gov.uk/index/farming/managing-your-business/renewables/renewable-training.htm

For further information, contact David Trimble by phone on (028) 9442 6682 or by email: david.trimble@dardni.gov.uk

Overcoming problems with farm scale renewable energy installation

Chris Osborne, Senior Policy Officer, Ulster Farmers Union

Since the inception of the CAFRE Practical On-Farm Renewable event, the Ulster Farmers Union has been highlighting the significant barriers faced by our members attempting to become involved in small-scale renewable energy generation. Through extensive lobbying, the UFU Policy team have helped play a significant role in addressing several of these barriers. Significant progress has been made in several areas though problems remain. One example of where there has been an improvement is the situation in relation to the back log of planning applications. These have started to clear, albeit slowly. On a policy level, there is room for optimism with many planners gaining a more detailed knowledge of renewable projects, giving benefits in their dealings with people on the ground.

Despite these slight improvements, there is a major structural barrier which has not diminished. In fact the situation has actually deteriorated in the last 12 months and it concerns **Grid Connection** and **Storage**.

Grid Connection

The first thing a prospective renewable generator should do before committing any money to a renewable generation project is to check the situation in relation to grid connection. Proximity to a 3-phase line should not be considered as an acceptable rule of thumb. It is only NIE who will be able to provide advice on grid connection and no decisions should be made until such time that you actually get confirmation that you will be able to connect.

In certain parts of Northern Ireland, the low voltage network is full to capacity and as a consequence, NIE are issuing "Conditional Offers" to those wishing to connect. In such cases, despite providing the developer with an offer, NIE have to make representation to the Utility Regulator seeking agreement for the reinforcement work to take place and seek confirmation as to who should pay for the work. Under current regulatory rules, the cost of this additional work cannot be included in the standard connection offer when such reinforcement work is needed. Instead, NIE must engage with the Regulator with a view to seeking agreement for this necessary reinforcement work being carried out.

The problem has been exasperated by the fact that the log-jam extends beyond the 11kV and into the 33kV network. NIE have identified that in order to address this capacity problem, significant additional reinforcement is required at locations across a wide area of the 33kV distribution network. In certain instances, this could also include a combination of work on 33kV lines and/or 33kV/11kV primary substations.

The UFU have already made their position clear on the electricity grid in Northern Ireland. There is a need for significant investment on what is an ageing infrastructure.

There are three possible solutions identified by the Ulster Farmers Union.

1. Investment in upgrading the grid

The UFU have submitted formal requests for further investment on grid enhancement of the 11kV network through the consultation on NIE plans for Regulatory Period 5 (RP5). Farmers and landowners rely upon these lines to power their homes and businesses and such is the aged nature of the lines, there could be security of supply issues should they not be upgraded. However, this has stalled as a result of the NIE RP5 submission being referred to the Competition Commission and to date, no decision has been made.

2. Procurement of additional short term capacity

On 12 June this year, the Northern Ireland Utility Regulator (NIAUR) and the Department of Enterprise, Trade and Investment (DETI) issued an information paper "Security of Electricity Supply in Northern Ireland". In this paper, they identified a risk to security of supply from 2016 onwards. This stems from the EU Emissions Directive, which is expected to result in the withdrawal of some generation capacity at Ballylumford and place restrictions on generation at the Kilroot plant from 2016 onwards.

An option was identified to procure additional short term generation capacity to address the security of supply. DETI, under the Electricity (NI) Order 1992, has the power to direct NIAUR to invite tenders or to invite tenders itself for 'further generation capacity' or the provision of such energy efficiency or demand side management measures to meet any projected shortfall.

The UFU is calling for DETI/NIAUR to consider bringing forward the option of procuring additional short term capacity to address the growing shortfall developing throughout NI.

This solution, some might say is "papering over the cracks" and instead, we should be looking at the very nature of the problem – the grid design. Embedded generation (where a number of small scale renewable generation units are attempting to connect to the grid at sporadic intervals) is not compatible with our electricity grid here in Northern Ireland. It has created capacity problems and means significant patchwork reinforcement work needs to be carried out by NIE if the electricity grid is to incorporate small scale renewable generation.

Storage

With renewable energy and heat generation, storage (or a lack of it) is an on-going problem. There are large volumes of renewable energy lost in a variety of ways leading to a loss in efficiency. There is a line of thought which says that the small scale renewables sector will not evolve without a storage solution. If the storage problem could be resolved, it will "add value" to renewable generation.

Consider a wind turbine. In the spring, the turbine may move for a consecutive period of time generating large volumes of electricity. During this time, excess generated electricity cannot be stored and simply is "lost" to the farm business or exported to the grid at low value. Through storage technology, this excess could be stored and utilised when it is needed to power the farm business.

The overarching and encompassing problem is that in Northern Ireland, the electricity grid is not designed to incorporate embedded generation (individual small scale renewable generation units accessing the grid) and is the root of the barriers identified on previous page.

The third solution addresses both grid connection and storage.

3. Matrix Sustainable Energy Horizon Panel

In April 2013, DETI Minister Arlene Foster launched a report incorporating the findings and recommendations of the Matrix Sustainable Energy Horizon Panel. The report was entitled "Foresight Study into Future Market Opportunities in Sustainable Energy Technologies" and identified how the Northern Ireland economy could grow through the development of sustainable energy technologies. Specifically, the Matrix Panel believe that through the development of integrated and sustainable energy solutions that can be replicated on a global scale, Northern Ireland will become established as a centre of excellence. To date, no individual region has established a leader position in this sector and so Northern Ireland has a unique opportunity to become an early adopter in the field.

The report highlighted what would be achieved through the adoption of "Intelligent Energy Systems". Such a system would incorporate, amongst other technological solutions, what is referred to as Distributed Generation. Distributed Generation (also known as on-site or local generation) is the generation of electricity from many small energy sources. This type of generation, allowing the collection of energy, would improve security of supply. Distributed Generation is an alternative to the centralised plant generation (transmission and distribution of bulk power) which constitutes the grid infrastructure we presently rely upon in Northern Ireland.

In short, Distributed Generation could offer a different, more practical method of managing the connection, demand and supply of the generation of renewable energy. This Intelligent Energy System would offer a collective alternative known as Local Energy Generation, Supply and Storage (LES). For example, there is the option to facilitate Demand Side Units, which play a role in managing the overall generating capacity and perhaps most radical of all, there is the possibility that small scale generators could bypass the traditional grid arrangement and set up a private network.

Overall, LES could provide a "switchable" solution to the identified problems, a seamless feed of energy will be fed into a binary grid, where traditional fossil fuels will be maintained so as to provide a base-load to cover the intermittent nature of renewable generation.

The Matrix Panel identified the need to create a resilient yet flexible solution which allows the incorporation of alternative generation sources which are integrated into the energy system thereby ensuring security of supply. The UFU believes that an Intelligent Energy System should be researched and developed in Northern Ireland and could offer a solution to the problems already identified in this energy market. Only then will we be in a position to go some way towards tackling the rigid barriers encountered with grid connection and storage of small scale renewable generation units.

This systems approach could be adopted to solve the many challenges in delivering local, robust and commercially viable renewable energy systems that are compatible with national scale infrastructure.

There is much work to be done in this area, not least to overcome the policy inertia on the part of policy makers in the energy market. Buy-in will be needed from Government, SONI, NIE, Regulatory authorities and policy makers for Intelligent Energy Systems to be considered in Northern Ireland. For example, there is currently a disproportionate amount of Regulation surrounding Distributed Generation with a lack of understanding from policy makers and this must be addressed.

What does the future hold for small scale renewables in the land-based sector in Northern Ireland?

The work of the Matrix Panel, with the support of the UFU could play a ground-breaking role in a new chapter for Energy Policy and the small scale renewables sector in Northern Ireland. The UFU is calling for cross-departmental (DARD, DETI, DOE) support in getting progress on this issue.

Yet, this does not take away from the short term problems on the ground and the urgent need for a reality check in terms of small scale renewables and the anticipation and expectations of the land-based sector.

With a multitude of sales companies and agents offering their services, would-be generators are urged to do their homework before committing to any project. An important and simple question to ask yourself is "can I afford it?" UFU analysis has shown that the more credit needed to fund a project, the less attractive a project becomes due to the longer payback. Even if you have the upfront capital, caution is needed should grid connection and hidden costs lengthen your forecasted break-even/payback period.

It should be noted that many renewable energy projects will not be successfully completed due to a combination of the grid connection, storage and other issues highlighted.

The reality check may involve taking a critical look at Renewable Energy policy in Northern Ireland. Failure to do so could mean the continuation of a frustrating experience for many and could end up being a missed opportunity for our farming industry.

For further information, contact Christopher Osborne on (028) 9037 0222 or email: christopher@ufuhq.com

Renewable Energy Technologies

Energy Efficiency on the Farm

David Trimble, Renewable Energy Technologist, CAFRE

What is energy efficiency?

The first step you take to reduce your energy bills is to work out how to use less energy. You can do this by carrying out an energy audit on your unit to identify any savings that can be made by doing things differently. Once these savings have been made then the renewable energy options can be considered.

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

Dairying

- Check your tariff. The CAFRE electricity benchmarking study indicates that up to one in eight of the dairy farms in the country are on the wrong tariff. This is a loss of around £8 per cow each year.
- Have a plate cooler to help cool the milk. These should be supplied with the correct volume of water. Indications are that many plate coolers are working well below their potential, due to not enough cold water flowing through them. The plate cooler also needs a time delay on the water solenoid. If operating properly a plate cooler can save 60% on your milk cooling costs.
- Save on water heating by good insulation of water heaters and associated pipe-work. An un-insulated tank will lose 50% of its heat in 17 hours, compared to just 5% losses with good insulation.
- Watch those lights. Make the best use of low energy bulbs and appropriate use of timers, sensors and proximity switches.
- Large units of over 200 cows should consider installing vacuum-on-demand pumps and heat recovery systems to capture waste heat from the milk cooling condensers.

Heat Recovery Unit

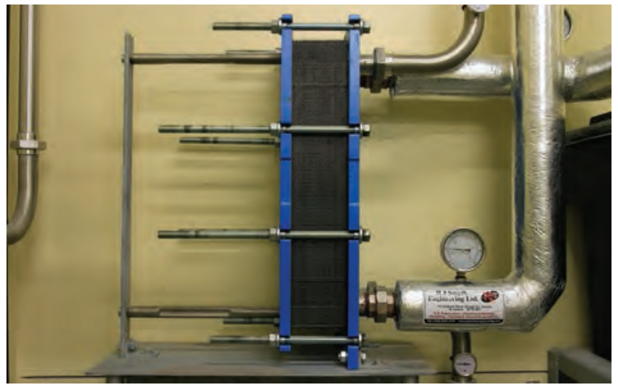


Plate Cooler

Pigs

- Check your tariff. Larger units should regularly negotiate the price they pay with the electricity supply companies.
- Have a good control system for heating and air movement.
- Savings with low energy lighting can be very significant.
- Insulation and draft proofing are critical.

Mushrooms

Energy audits carried out by CAFRE on a number of mushroom units identified areas requiring action.

- Improve insulation of the hot water distribution pipe-work.
- Change the tariff to benefit from the cheaper night rate.
- Ensure more efficient air movement by the removal of unnecessary louvres and increasing the size of air inlets.
- Install low energy lighting.
- Install and manage an integrated environmental control system.

Beef and Sheep

Beef and sheep enterprises have a relatively low usage of electricity. The main efficiency measure is the installation of high efficiency light bulbs in sheds and work areas.

Field work and arable

Fuel efficiency on tractors and harvesters can be improved in several ways:

- Regular maintenance – excessive dust on radiators can waste as much as 5% of the fuel.
- Maintain the correct tyre pressure – 20% over-inflation can reduce fuel efficiency by up to 30%.
- Use the electronic engine management technology. This improves fuel efficiency by giving a rapid response to changing load demands.

What's new in energy saving on the farm?

In the past few years voltage optimisation devices have been actively promoted for energy saving on the farm. These have the potential to cut 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); and
   - 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.

For further information, contact David Trimble at (028) 9442 6682 or email: david.trimble@dardni.gov.uk

Biogas production at Greenville Energy

Dr William Moore, Development Director, Greenville Energy

Terry and Jason Mitchell farm around 320Ha just outside Ardstraw in Co. Tyrone where they now milk 600 cows three times daily. The decision was made to increase cow numbers in the farms dairy herd from 300 to 600 about seven years ago after the installation of a 50 point rotary parlour. An inevitable by-product of milk production is manure which is expensive to store and spread. In addition, milking 600 cows and then cooling the milk is an energy intensive operation and is a cost that is rising annually, way above normal inflation rates. Also, the volatility of the world dairy markets and the poor returns from milk production for some years led the family to seek methods of diversification. It was evident that a technology to produce energy from the cow manure would be a perfect solution and provide a secondary source of income for the farm.

After extensive research and many visits to operating Anaerobic Digestion (AD) facilities in Europe it was decided to construct an AD facility on the family farm. Whilst researching AD facilities throughout Europe it became evident that the majority of the facilities utilised maize silage as an energy crop to boost gas yields from the digesters. Although maize is grown in small quantities in Northern Ireland, in most areas the weather conditions are not suited to maize production and poor yields are commonplace. Northern Ireland farmers have traditionally chosen grass as forage for their livestock as the mild, wet climate is ideally suited to grass production. Consequently it was decided that the Anaerobic Digestion facility would have to be able to utilise grass silage as its energy crop. However, it soon became evident that German AD facilities were designed specifically for maize silage and few utilised large quantities of grass silage. As a result, it was decided to work with Williams Industrial Services from Mallusk to design an AD facility that would operate on high quantities of grass silage.

The facility utilises two digesters that are 26m in diameter and 5m high with an operating volume of about 2,200m^3 each. A wet feeding system is utilised that blends solid feedstock such as grass silage with digestate before being macerated and then pumped into the digester. The blending and maceration of the solid feedstock prior to entering the digester is vital for grass silage. Mixing of the digesters is carried out by impeller mixers similar to the propeller of a boat.

These mixers can be positioned at any level or angle in the tank to enable effective mixing of the substrate. Grass silage is widely recognised to be a difficult feedstock to utilise for anaerobic digestion. One major issue is floating layers of silage in the digester which can cause 'gas capping' whereby the floating layer becomes gas tight and prevents the gas escaping from the liquid. If this occurs the floating layer is forced upwards by the pressure of the gas and can block the gas pipes for transferring the gas to the generators. In extreme situations it can actually lift the concrete roof of the digester. As such, effective mixing is required to prevent floating layers occurring. In addition, effective mixing is required to utilise the operating volume of the digester and generate higher levels of gas production and effective heat distribution.

The system operates in the mesophilic region at a temperature of about 41°C and has a long hydraulic retention capability suited to grass digestion. Feedstock is fed directly into the primary digester and an overflow system leads to the same quantity being forced out of the primary digester into the secondary digester. Subsequently, the same quantity is forced from the secondary digester into the final storage tank. Gas is produced in both digesters and then stored in a gas dome above the secondary digester; from there it is fed to either of the two generators.

The electricity produced by the two generators is utilised by the farm and replaces electricity purchased at full retail price, whilst the excess is exported onto the national grid to generate an additional income. Heat energy is also produced by the generators and this is utilised to keep the digesters at a steady 41°C and any excess heat is used by the drying floor to dry grain and other produce.

Digestate from the system is spread back on the land to reduce expenditure on inorganic fertilisers and provide a valuable source of nutrients.

Capital grant support towards the cost of the installation was provided though the DARD Biomass Processing Challenge Fund under the supervision of the European Sustainable Competiveness Programme for Northern Ireland.

Challenges Faced

The key challenges faced by the installation of the facility were:

- Development of a facility that operates on grass silage.
- Finding an equipment supplier who would provide:
  - Warranties
  - Production Guarantees
  - Local Service and Support.
- Funding – NI banks are not experienced with AD.
- Grid connection – NIE were not set up to deal with generator connections.
- OFGEM accreditation – complex application procedure.
- Insurance – insurance companies did not understand the process.

Benefits of the AD Facility

Benefits to the farm are:

- Reduced energy costs.
- Reduced expenditure on inorganic fertilisers.
- Increased crop yields.
- Increased revenues.
- Reduction in use of fossil fuels.
- Reduction in carbon dioxide and methane emissions.

The AD facility has been integrated with the existing farm business through utilisation of cow manure and excess grass silage. Existing farm staff and equipment are utilised thereby helping to maintain the viability of the farm and employment.

For further information, contact Willie Moore at (028) 8167 8664
or by email: willie@greenvilleenergy.com

Biomass production and associated waste treatment

Alistair McCracken, Chris Johnston, Agri-Food & Biosciences Institute, Newforge Lane and Hillsborough

The uptake of biomass heating has been slow over the last number of years. However, the recently launched Renewable Heat Incentive (RHI) run by the Department of Enterprise, Trade and Industry (DETI) is encouraging progress towards obtaining 10% of heat from renewable sources, the challenging target set within the Strategic Energy Framework for Northern Ireland. The increasing numbers of biomass heat systems now being installed will require an increased supply of good quality wood fuel which is likely to come from a mixture of sources including energy crops such as short rotation coppice willow. This, together with increasing publicity around large-scale biomass electricity production, may serve to grow public concerns about the potential drawbacks of agricultural diversification to energy production. However, there is no evidence that this will adversely impact on food production.

Planting and Crop Management

After site selection (soil, pH, slope, elevation, access, market), it is important that a good seed bed is prepared and cultivated to 25cm depth. Insecticide and herbicide treatment then follows according to the SRC willow Best Practice Guidelines. It is essential to use high quality genotypes with characteristics such as high yield and disease resistance. It is important to remember that the planting material is protected by Plant Breeders’ Rights (obtain from specialist supplier). The preferred planting machinery is a Swedish Step Planter which plants in double rows 0.75m apart with 1.5m between rows, 0.5m spacing between plants within each row (18,000 cuttings/ ha). Management of the crop post-planting up to cutback is crucially important as newly planted willow cannot effectively complete against most weeds. An application of pre-emergent herbicide within 14 days of planting is recommended as per the SRC willow Best Practice Guidelines. At the end of the establishment year, the crop is cut back which encourages production of multiple shoots and prior to bud burst, an application of herbicide is recommended to control weeds.

Healthy green willow cuttings

Willow Step Planter

Method of Harvesting

Various options are available for harvesting willows; some of which make it possible for the material to dry over time without the need for forced drying. Options include Chip Harvesting (Self propelled or tractor mounted), Rod Harvester, Biobaler or Billet harvester.

Chip harvesting by self propelled and tractor mounted harvesters give rise to a chip which requires forced drying otherwise the following may occur: rapid temperature rise, risk of high dry matter loss, risk of allergy-inducing spore production, risk of spontaneous combustion and value depreciation due to a reduction in calorific value.

Tractor mounted harvester

Whole stem harvesting will give rise to whole rods which can be piled at the side of a field or brought to a yard for natural seasoning. This drying method can reduce the water content to below 30%. An advantage of whole stem harvesting is that any limitations in the availability of drying infrastructure in the area need not dictate whether harvesting goes ahead or not. The rods have subsequently to be chipped for automatic feed boilers.

Whole stem harvester

The Bio-bale harvester will give rise to bales which can be left at the side of a field or brought to a yard for natural seasoning. AFBI data revealed water content can reduce to below 20% in ambient conditions. It is then advisable to store the bales under cover. Bales can be used whole in a big bale boiler or will need to be subsequently chipped for automatic feed boilers. However, to date this system has resulted in significant in-field losses at harvest.

Bio-bale harvester

Biofiltration and the AFBI led EU ANSWER Project (Agricultural Need for Sustainable Willow Effluent Recycling)

ANSWER is a cross-border project examining the potential of using Short Rotation Coppice (SRC) willow for the bioremediation of effluents and leachates. This project is part financed by the European Union’s European Regional Development Fund through the Intereg IVA cross border programme managed by the Special EU Programmes Body. There are six other partners (NI Water, South West College, Teagasc, Sligo IT, Monaghan County Council and Donegal County Council). The total funding is £2.1m over four years.

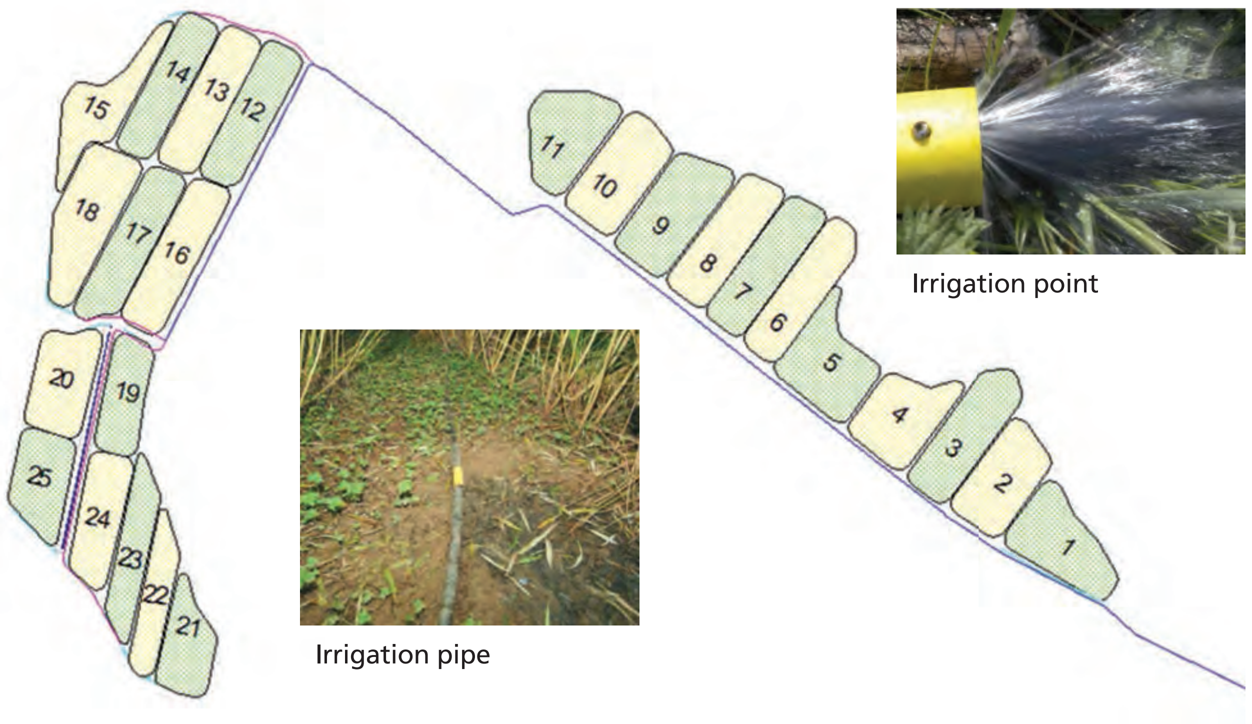
This is an innovative project forged on strong links between scientists, local authorities, water utilities and educational establishments. This project is built on DARD funded work currently being conducted by AFBI on growing SRC willow and its use as a multi-functional crop, particularly for bioremediation of wastewater treatment effluents (sewage treatment wastewater), farmyard dirty water and land fill leachates.

Lysimeters at Co Donegal landfill site

By the end of the project (October 2014), ANSWER will have succeeded in establishing four operational large scale proof of concept (approx 40ha), as well as a trial landfill leachate irrigation project comprising of 12 lysimeters examining different application rates on biofiltration efficacy and willow growth.

ANSWER also incorporates four post-graduate students whose studies include the identification of the best SRC willow genotypes for bioremediation, the effect of effluents and leachates on willow plants and their ability to take up nutrients, changes in soil following long-term irrigation, survival of human pathogenic bacteria (coliforms, Campylobacter, Salmonella spp.) in the soil and the impact on biodiversity e.g. earthworms.

Example Field Irrigation Layout – 14ha (3 fields)



Irrigation point

Irrigation pipe

Example of a 14ha Irrigation area split into 25 different independently controlled irrigation zones

Automated valve construction

Pipe lay out under construction

Also associated with the ANSWER project are resource and suitability mapping using GIS technologies where information on possible opportunities to use bioremediation for the management of wastewaters will be categorised. Studies of overland flow of water will also be conducted aiding our understanding of factors which might lead to runoff and pollution, in particular with phosphorus.

There is real potential that these solutions to local problems will have national and international applications. This has already started to be realised in N Ireland with the recent launch of the first NI Water awarded SME contract to treat waste water using willow biofiltration technology. Other countries including the US and Canada have shown interest in these technologies.

For further information on this subject, please contact:

Christopher Johnston on (028) 9268 2484 or email: chris.johnston@afbini.gov.uk

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answer

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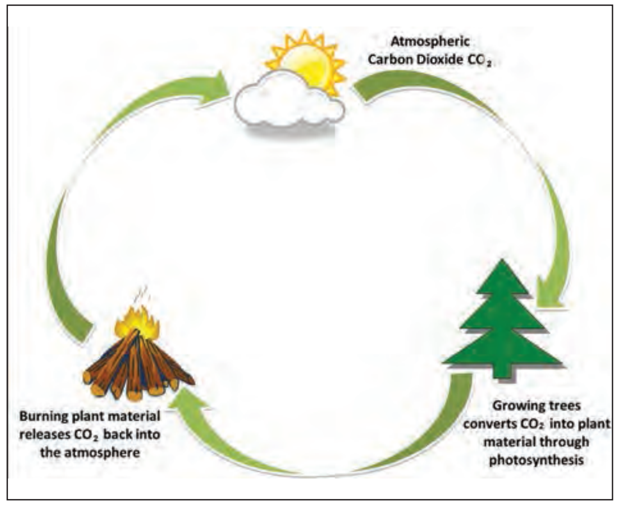
Heat from Biomass

Cathal Ellis, Renewable Energy Technologist, CAFRE

Heat from biomass refers to the use of organic matter such as wood, straw or energy crops for the production of heat. Biomass heating systems can be utilised for space heating of buildings, hot water or steam production or any combination of these. Systems can be installed for domestic applications from around 10kWth, light commercial applications from 20kWth to 1MWth, industrial applications above 1MWth and district heating systems.

Biomass as a renewable low carbon fuel

The sun is the main source of energy held within all biomass fuels. This energy is captured and stored through the process of photosynthesis, and released when the material is burnt. This then releases CO_2 and other by-products of combustion. This CO_2 release is offset by that absorbed in the original growth of the biomass, or that will be absorbed by the growth of new plant material planted to replace that being used. As a result of this process, it is considered to be a low carbon material where it has been derived from sustainable sources.



Biomass Fuel

The most common biomass fuel is woodchips or wood pellets but can include other materials such as logs, miscanthus, or even straw bales. The most important characteristic of wood used for heat production is the moisture content. At a moisture content above 30%, woodchip cannot be stored safely as it will rapidly start to degrade. Wood chip is generally dried to between 15% and 20% moisture content. At this level, it can be safely stored, giving good energy production when burnt. Wood pellets are supplied with moisture content below 10%.

Biomass Heating Systems

The biomass boiler is at the centre of any biomass heating system. There are many types and models ranging from simple room heaters, log boilers, pellet stoves, multi-fuel heaters to pellet and woodchip boilers.

Boilers can provide a combination of space heating for buildings, hot water for various processes and steam. Boiler sizes range from 10kW to 50kW for domestic use, 50kW up to several MW for commercial use and district heating systems.

As well as the boiler a biomass heating system will require:

- A flue.
- An accumulator for heat storage.
- Pipe work.
- A system for storing and transferring the wood fuel to the boiler.
- A system for removal of ash.
- Control and safety mechanisms.

A biomass heating system should be sized to operate at its optimum where it is running continuously between around 60% and 100% of its rated capacity. In this instance the heat store is used to meet peak loads.

Renewable Heat Incentive (RHI)

This support mechanism is dealt with more fully elsewhere in the booklet. The key points are:

- an ongoing payment is available for using renewable heat technologies;
- biomass heating is included;
- it is open from 1st November 2012 for commercial applications and planned for domestic users in 2014; and
- Commercial tariffs paid for 20 years with a proposed 7 year domestic tariff.

Case Study – Paul Hobson's poultry unit, Moygashel

Aim: To design and install a 'wet' biomass heating system to satisfy the full heating demand of a 12 house poultry unit.

Solution: Install 12 individual biomass boilers each with independent heating loop and heat meters to each house. This allows an RHI application for the twelve house unit at the higher tariff of 6.1 pence. Phase 1 and 2 have been completed providing heating to the first four houses. The full install will contain a mixture of 99kW and 60kW boilers and is expected to be completed by Autumn 2014.

Fuel: Wood pellets.

Benefits of phase 1 and 2:

- Lower fuel costs.
- Replacing existing direct fired gas blowers provides a healthier environment for the birds, as biomass boilers are not dependant on oxygen from within the sheds for combustion. In addition, they do not give off carbon dioxide directly into the sheds as with direct fired gas blow heaters.
- This reduction in carbon dioxide means that the shed requires less ventilation and consequently less heat is lost.
- A carbon saving of over 200 tonnes carbon dioxide per year.
- An annual saving of £29,800 compared to the original gas system.
- The payback will be less than 3 years (with the renewable heat incentive).

For further information, contact Cathal Ellis on (028) 9442 6793 or by email: cathal.ellis@dardni.gov.uk

Heat pumps on the farm

Garrett O'Sullivan, 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.

Mr Robert McKeown, a farmer from Co. Tyrone, had previously installed an under floor heating system for a 2100 sq ft farmhouse. The under-floor heating was supplied with hot water from a large 400 litre immersion tank, which was circulated via an under floor heating distribution system to provide space heating throughout the house. The well insulated immersion tank was heated with a 24kW electric immersion heater and was operated using night rate electricity, which reduced the cost of the heating.

Due to the increasing cost of electricity, alternative forms of heating were investigated. As the dwelling already had an under floor heating system installed, it was determined that an air source heat pump would provide the optimum alternative for heating the building and at the same time employ a renewable energy technology to reduce the annual energy costs.

A 16kW (thermal) output air source heat pump system was installed and coupled to the existing under-floor heating loop in the house, to provide the heating instead of the electric immersion heater.

Air Source Heat Pump Unit at Co. Tyrone Farmhouse

The heat pump unit was installed and commissioned in August 2012. Since then the costs of heating the house have been monitored and a saving of around £1,100, a 40% reduction in house heating costs, has been achieved.

The installation of the heat pump cost £8,000. This installation received a Renewable Heat Premium Payment (RHPP) grant of £1,700 for installing an air source heat pump into a domestic dwelling.

The overall payback period for this installation is calculated to be less than six years. A heat pump has an anticipated lifespan of at least 20 years.

Gary Anderson a pig farmer with a 400 sow unit in Co. Tyrone, installed a ground source heat pump system to replace an oil boiler system, which provides heat for pig rearing unit. The overall operating savings were £6,500 per annum and a payback of less than 2 years. A more detailed article from last year's POFRE 2012/13 booklet can be found at:

http://www.dardni.gov.uk/5-ground-source-heat-pump-on-a-co-tyrone-farm.pdf

Pig Pen with Heating Pads

CREAM Herd Dairy Water Heater at Greenmount.

CREAM Dairy Air Source Heat Pump Installation

The CREAM dairy unit at Greenmount Campus consists of a herd of 30 cows used to train students in the management of a dairy herd. The dairy washing system was previously supplied with hot water for plant cleaning by an electrically heated immersion tank. An air source heat pump has been running there since August 2011 and continues to reduce the electricity requirement for heating the dairy hot water by around 25%.

What about the economics of heat pumps?

The economics of using heat pumps is influenced by the introduction of the Renewable Heat Incentive (RHI). Under this scheme a payment is made for each unit (kWh) of renewable heat produced by a heat pump used in a business setting. The scheme was introduced in 2012 for commercial ground source heat pump systems. For ground source heat pumps up to 20kW(th) output, the tariff is 8.7p per kWh(th) and is payable for 20 years.

Further details of the RHI tariffs for commercial ground source heat pumps and the RHI scheme can be found in the RHI article later in this booklet.

For domestic dwellings the Renewable Heat Premium Payment scheme (RHPP) applies at present. This provides an up-front payment to help with the installation of a heat pump. The payments are:

Air Source Heat Pump	£1,700
Ground Source Heat Pump	£3,500

More details on the Premium Payment can be found in the RHI article later in this booklet.

It is also proposed to introduce a second phase of the Renewable Heat Incentive (RHI) scheme to include payments for both ground and air source heat pumps used in both commercial and domestic applications. The rates and periods for which the tariffs will be paid will vary depending on the technology used (i.e. air or ground source) and type (i.e. domestic or commercial). More details can be found in the RHI article in this booklet.

What to think about when considering using a heat pump?

This is a typically a higher cost technology to install than oil heating, so it will be most relevant where:

i. Energy costs are high.

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

As heat pumps typically produce water at temperatures of between 40°C and 55°C, they will be most cost effective if the final water temperature required is in this range. However, where significant electric immersion heating is employed, a heat pump can still significantly reduce the overall electricity required, where it is installed in conjunction with electric immersion heating.

Ground source heat pump systems are more efficient than air source heat pump systems. However, they are significantly more expensive to install and where they are being considered, the ground availability and soil condition are critical to ensure that the unit removes heat from the ground efficiently and cost effectively. Heat pump installers will assess the suitability of any site being considered for ground source heat systems.

If suitable ground is not available, an air source heating system can be considered instead. As this type of heat pump extracts heat from the air, they can be installed in more situations than ground source systems and only require an available electrical supply to operate.

For further information, contact Garrett O'Sullivan at (028) 9442 6869
or email: garrett.osullivan@dardni.gov.uk

Solar water heating on the farm

David Trimble, Renewable Energy Technologist, CAFRE

Solar water heating systems are becoming more common in Britain and Ireland due to the increasing energy prices. In the agricultural sector they have more relevance in the high energy using enterprises. For example, a dairy cow uses around 350 kilowatt hours (kWh) of electricity per year, of which around 40% is used for heating water.

In the past few years at least 35 farms have installed solar hot water systems in their business. Most of these are dairy farms that have received funding from either the Farm Modernisation Scheme or Northern Ireland Electricity (now PowerNI).

Case studies of on-farm solar heating

On the dairy farm of Denis Minford the solar system consists of 20 vacuum tubes and heats both the plant wash water and the bulk tank wash water. The heat goes preferentially to the plant wash tank and thereafter to the bulk tank wash water. This system allows the maximum benefit from the solar power on a sunny day during the long summer days.

Solar tubes mounted on the dairy roof

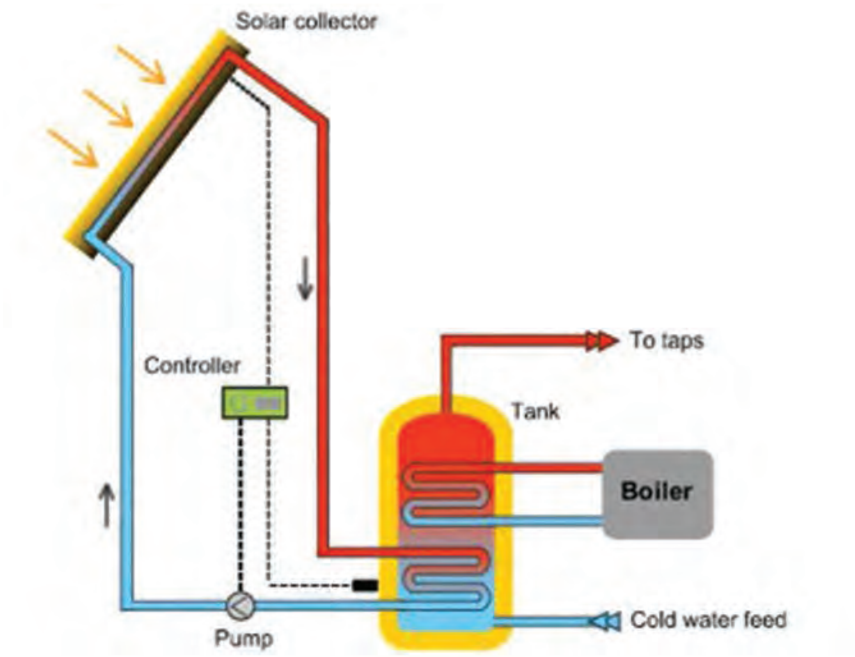
Solar controls and heat distribution system

On the dairy farm of Denis Blelock the solar collector consists of 30 solar tubes totalling about 5 square meters. The solar fluid supplies heat to the plant wash water by flowing through the heat exchange coil in the bottom of the water tank for the plant wash. In good summer days the water temperature was raised to 80°C.

A solar hot water system was installed in the Greenmount dairy unit in 2009. This provided almost half the hot water requirements for the parlour wash and has a payback time of around 8 years.

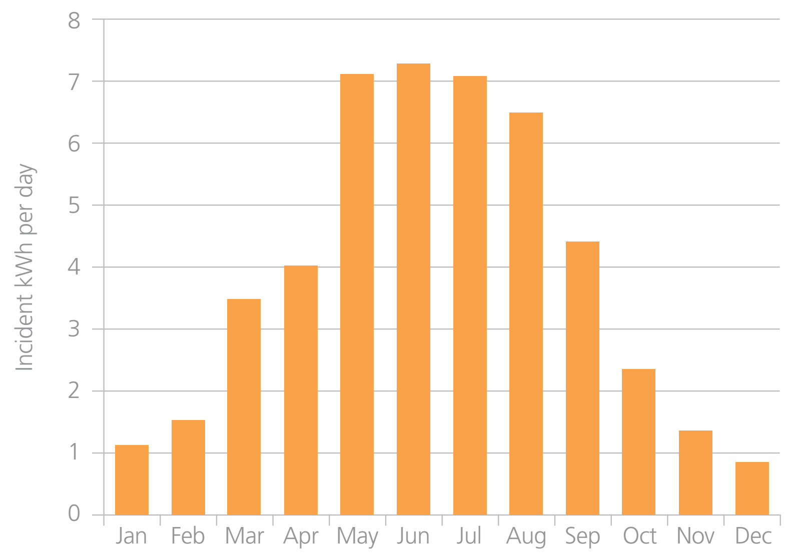
Background to solar hot water systems

The most common system in use here 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.

Systems are designed to give a high proportion of the hot water 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.



Annual distribution pattern of solar radiation in kWh per m2

What about running costs and maintenance?

Solar heating systems have a long life with low maintenance.

A 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.

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

For a fuller discussion of the options available in a solar hot water system see www.dardni.gov.uk/ruralni/renewables

Should I install solar on my farm?

1. For any process requiring energy the first step is to cut costs by improving the efficiency of the existing system. Use of solar should only be considered after achieving the maximum benefit from energy efficiency measures. These include making the maximum use of the cheap night electricity tariff, insulation and good monitoring and control systems.
2. The payback on the system is influenced by a number of factors. These include:
   - Obtaining grant aid for the initial set-up.
   - Potential tax write-off on the investment.
   - Increasing energy prices.
   - The Renewable Heat Incentive (RHI) payments (see separate article in this Booklet). The RHI will improve the payback and makes solar hot water systems a viable option in many circumstances.
3. A solar hot water system will reduce the carbon footprint of the farm, typically by two tonnes of CO_2 each year.
4. The suitability of a farm for solar technology depends on having an area to mount the collectors facing southward, at an angle of around 35° to the horizontal and without any shading from buildings or trees. This area needs to be within a few metres of the hot water tank.

For further information, contact David Trimble at (028) 9442 6682 or email: david.trimble@dardni.gov.uk

Wind Energy at Redhouse Holsteins

Alan Irwin, Benburb and David Trimble, CAFRE

Alan Irwin and his son David farm in the townland of Derrycreevy, near Benburb, Co. Tyrone, in Northern Ireland with the help of father William and family members Ida, Sylvia and Jayne.

The land comprises of approximately 240 acres of grassland and cereals, with a lot of the land being too steep or too wet for cutting silage or growing cereals. Most of the land is heavy soil over red clay.

Approximately 120 acres of silage is made in each of 3 cuts to supply the stock with forage all year round and approximately 50 acres of spring barley is grown each year to supply whole grain cereals and straw for feeding to stock.

The farm was initially a mixed dairy, beef and arable farm. The dairy herd was increased and beef gradually phased out, until the present day herd of 180 cows plus replacements. The cows are milked 3 times a day.

On farm all the work is carried out by the Irwin family and 2 full time employees. The work undertaken on farm includes all silage making, slurry spreading, cereal growing and everything in between, without any contractors being brought in.

The aim for the farm is not to expand cow numbers, as land is not available to do so, but to become as efficient and cost effective as possible, whilst taking the most out of the cows and making the best of every cubicle space.

Ongoing on farm, the plan will be to automate mundane tasks, where possible with the introduction of robot scrapers and feed pushers, but definitely not robot milkers.

In September 2011, the farm installed a wind turbine. It is a 50kW Endurance E-3120. The main purpose of the installation was to offset ever rising energy costs, and reduce the farms carbon footprint. Currently it is meeting these demands and has been a worthwhile investment.

The turbine was purchased from and installed by Silverford Renewables.

Overview of wind generation

Northern Ireland has one of the best wind resources in Europe and, as a result, installing a wind turbine here has the potential to provide a good return on investment. However, this doesn't mean that putting up a wind turbine in just any location will deliver a successful project. There are a number of key factors that need to be taken into consideration.

Wind resource

It may sound obvious, but one of the first things to determine is exactly how windy your site is. The best sites are usually in coastal areas, at the top of rounded hills, on open plains or in gaps in mountains. When a wind project fails to deliver, it is more often a fault of the site selection than the technology.

The power output of a wind turbine is related to the cube of the wind speed. An average wind speed of 5 metres/sec will give 125 units of power, whereas an average wind speed of 6 metres/sec will give 216 units of power, almost twice as much. If the wind speed on your site is not satisfactory then don't invest in this renewable energy option.

Wind maps can be used to give an initial indication of the wind speed at your site. Visit, for example, www.actionrenewables.co.uk/services/wind-measurements/ or www.decc.gov.uk/en/windspeed/default.aspx)

However, wind maps do not take account of localized landscape features that could have a considerable affect on windspeed. The windspeeds 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.

Site selection

Selecting just the right spot to place your turbine will often be a compromise between several factors. The main ones are:

- Proximity to the point of electricity use but at least 40m from any buildings.
- Ease of access to the site. If, for example, a road needs to be built to transport the turbine from a main road, this will have a significant impact on final costs.
- Grid connection can also have big cost implications. If the electricity grid is not close to the site and needs extending, or if it needs upgrading to take the amount of electricity generated, then these costs can sometimes make the project prohibitively expensive.

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.

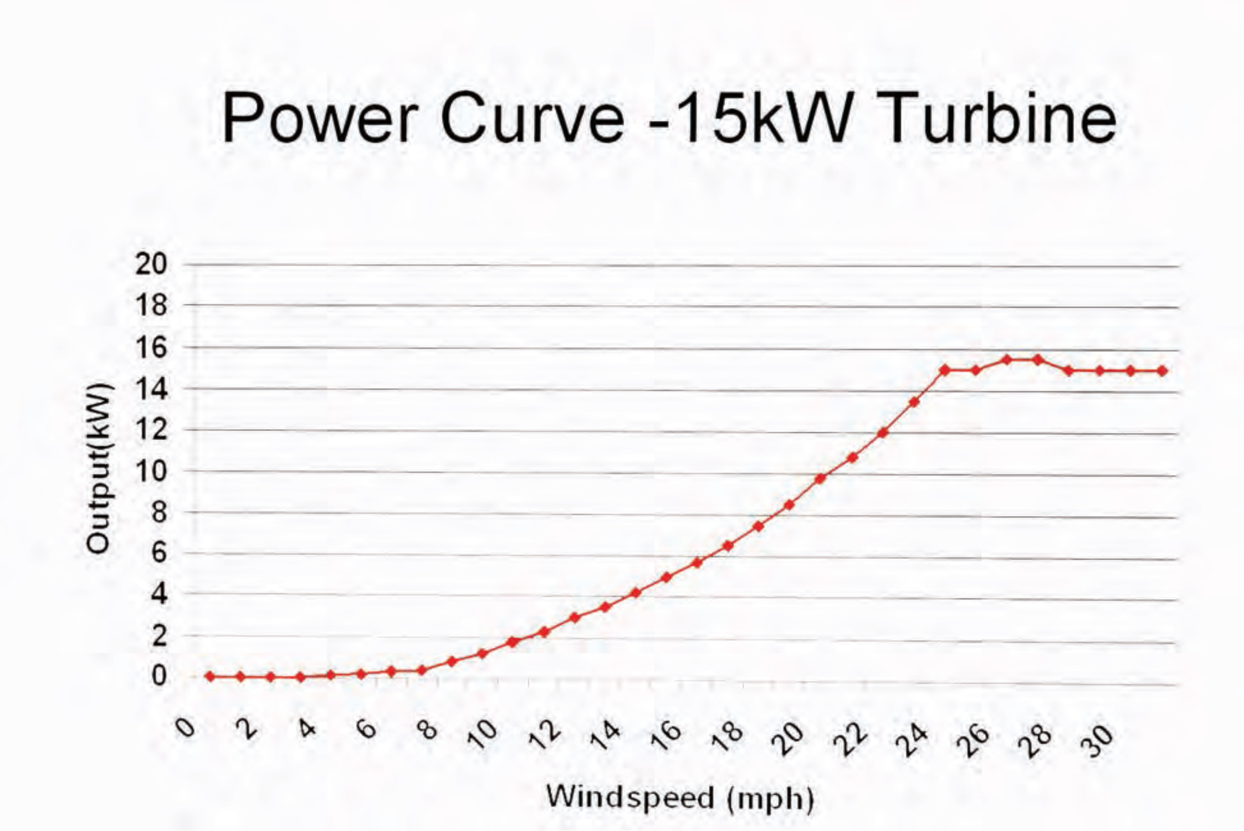
Consideration at this stage should also be given to access for maintenance.

Turbine selection

There are a number of factors to consider when selecting your turbine.

Wind turbines are classified by their **rated power**. This is the maximum level of electricity the turbine can generate when working at full power.

More importantly, every turbine has its 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.



Power Curve

The **annual energy output** of the turbine is generally the most important measure for evaluating the worth of a turbine at a given site. The economic return on the investment depends on the number of kilowatt-hours (kWh) produced in a given time period.

CAFRE has developed a Wind Payback Calculator which is available on request to the address below. Data can be added for a particular site on aspects such as power output, support levels, borrowings and electricity prices. The calculator will give the payback time and allow the impact of the various economic factors to be assessed before committing to the project.

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

Photovoltaic power on Culmore Organic Farm

David Laughlin, organic farmer, Kilrea

Case study of Culmore farm

Culmore organic farm is owned and run by David Laughlin and his family. With its ethos of sustainable production and the aim of a low carbon footprint, the farm already had a medium sized wind turbine and 20 acres of hardwood forest. Early in 2013 the decision was made to enhance their green credentials by installing a 50kW capacity PV system on the roof of the dairy cow shed. The 100 plus herd is milked by a robot, giving a better spread of electricity use throughout the day compared to traditional twice a day milking.

The shed roof is orientated just a few degrees off south and the pitch of the roof is 22°. The 50kW of Solarwatt panels cover about 350 square metres and feed into three 17kW SMA inverters.

Installation took place in March using Solarwatt panels, Hilti mounting kit and SMA inverters. In addition, the SMA Sunny Web Box and Online Sunny Portal were installed to monitor the performance of the system. This means that all the data about the electricity production of the system can be accessed on-line on a live basis. The most encouraging aspect of this installation is that the output of the system to date is exceeding the level calculated using the Standard Assessment Procedure (SAP) calculations.

The PV system will significantly reduce the carbon footprint of the farm. Assuming the electricity production is 40 MWh each year this will save 20.8 tonnes of carbon dioxide emissions compared to generating the electricity by using fossil fuels.

The financial payback on the investment of £70,000 is influenced by the electricity output, the level of the ROC payments and the percentage that is used on the farm. In the first six months of operation, 40% of the electricity generated was used on the farm.

Background to PV technology

The photovoltaic phenomenon is the ability of certain materials to produce electricity when sunlight falls on them. The light energy is absorbed by some of the electrons enabling them to flow freely through the material. The light energy turns the material from a semi-conductor into a conductor.

The first modern cells were made in the 1950's and one of their uses was to power the transmission systems of satellites. As costs came down they were more widely used in small appliances such as pocket calculators. With improvement in the cell performance and cheaper production methods they began to be used for larger scale power generation in the 1990's. This was mainly in western European countries with Germany taking the lead.

The output of photovoltaic systems

The performance of PV panels is described in terms of its efficiency. The efficiency is the ratio of the electrical output of the panel compared to the solar energy falling on it. For example, if a panel produces 15 Watts of electricity from 100 Watts of solar power then its efficiency is 15%. In reality most of the light falling on the panel is not absorbed to produce electricity. Panels of 33% efficiency have been produced in laboratory conditions but most commercial panels have an efficiency of between 10 and 15%.

Influences on power output

There are several factors that will influence the amount of electricity that a panel will produce in a year. These include:

1. The intensity of the sunlight. In a given location this is influenced by the panel's orientation and also the angle to the horizontal.

   The figure below gives a guide as to how the output changes at different orientations and different angles to the horizontal. The maximum output of 100 is achieved when the panel is facing due south and between 30° and 40° to the horizontal.

   As a general rule of thumb panels can be mounted facing from SE round to SW without too much decline in production.

Inclination	West						South						East
	-90°	-75°	-60°	-45°	-30°	-15°	0°	15°	30°	45°	60°	75°	90°
90°	56	60	64	67	69	71	71	71	71	69	65	62	58
80°	63	68	72	75	77	79	80	80	79	77	74	69	65
70°	69	74	78	82	85	86	87	87	86	84	80	76	70
60°	74	79	84	87	90	91	93	93	92	89	86	81	76
50°	78	84	88	92	95	96	97	97	96	93	89	85	80
40°	82	86	90	95	97	99	100	99	98	96	92	88	84
30°	86	89	93	96	98	99	100	100	98	96	94	90	86
20°	87	90	93	96	97	98	98	98	97	96	94	91	88
10°	89	91	92	94	95	95	96	95	95	94	93	91	90
0°	90	90	90	90	90	90	90	90	90	90	90	90	90

2. The type of panel. Broadly there are three distinct types of panel produced; mono-crystalline, poly-crystalline and thin film. Mono-crystalline have the highest efficiency and the longest productive life, poly-crystalline are intermediate in output and life span and the thin film has the lowest efficiency and the shortest lifespan.

3. The operating temperature. Power output falls considerably as the panel heats up.

4. Shading has a very detrimental effect on the electricity output and normally panels should be mounted in areas that are not affected by shadows.

The carbon footprint benefits of PV

For each kWh of electricity generated by conventional power stations using fossil fuels, there is on average 0.52kg of carbon dioxide released to the atmosphere. These emissions contribute to global warming and climate change. A typical farm scale 20kW PV system will generate around 16,000kWh each year, saving around 8.32 tonnes of CO_2 emissions to the atmosphere.

The economics of PV

An investment in PV technology is a realistic option due to the reduction in the price of systems in the last two years and the good support given by the Renewable Obligation Certificates (ROCs). More detail on ROCs can be found later in the booklet.

The output of a system is usually calculated by the Standard Assessment Procedure (SAP), a government approved system. This estimates the output of electricity depending on the southwards orientation, angle to the horizontal and other factors. The table below gives a few examples of the SAP output figures in kWh per year for each kW of installed capacity.

Tilt of collector	South	SE/SW	North
30°	858	822	584
60°	791	742	400
Vertical	597	564	297

For each kW of installed capacity at 30° to the horizontal and either SE or SW, the electrical output is estimated to be 822kWh. Allowing for a decline of 0.7% each year over 20 years this gives an average output over the lifetime of the system of 764.5kWh. Daytime farm electricity costs 16 pence per kWh, the ROCs are currently worth over 17 pence per kWh and electricity sold to the grid is worth at most 5.5 pence per kWh.

Using 100% on the farm each unit is worth (16 + 17) pence totalling **£252**.

Selling 100 % each unit is worth (5.5 + 17) pence totalling **£172**.

A typical farm scale 20 kW capacity system will cost £25,000 or £1,250 per kW. With the annual output range from £172 to £252 the simple payback times will range from 5 to 7.3 years.

This calculation does not take account of factors such as the cost of borrowing money, any increases in the price of electricity or grant aid for the installation. CAFRE has developed a PV payback calculator which can be used to work out the payback in changing circumstances. This calculator and instructions on its use can be obtained by contacting the address below.

For further information, contact David Trimble by phone on (028) 9442 6682
or by email: david.trimble@dardni.gov.uk

Micro-hydro generation at Carncairn

Richard Reade, Broughshane

Some years ago a friend of mine embarked on a project to refurbish and get operational a hydro electric scheme that had been powering a family mill business. Like a number of his friends I was fascinated to see the old turbines installed in the 1880's come to life again. As the Braid River runs through our ground I asked him to look at it to see if there was any possibility of installing a turbine on it. I have an existing weir which was almost in ruins and planned to divert the existing headrace across our land back into the river. The original headrace left our land and went approximately 1Km into Broughshane where it re-joined the Artogues river. The geography was complicated by the fact that the river split around an island with our weir on one branch and the remaining river down the other branch before re-joining 100m below our weir. After looking at the site it was perfectly obvious that it was uneconomic and so I did not pursue it.

In April 2010, Government support for developing renewable energy technology was increased and I immediately realised that the increased level of Northern Ireland Renewable Obligation Certificates (NIROCs) available would make a big difference to the economic viability of a scheme. I began to conduct research on the possible project starting with establishing the following:

1. How much flow did I have?
2. What was the potential head?
3. Did I own all the land involved?
4. Did I own the water rights?
5. How far away was the electricity connection?

The answers to all these questions proved satisfactory so I moved on to establishing what sort of turbine would be most suitable for my site. I realised that with my head and flow and with the need to protect fish stocks, the Archimedean Screw would be the best option. Two important reasons for this were that the Archimedean screw is fish friendly in that fish can swim through it uninjured and, secondly, it does not require fine screens to prevent small fish from getting access to the turbine. I had seen the amount of time spent clearing screens several times a day by those generators using them and was determined that as far as possible my turbine would be user friendly.

Although automatic screen cleaners are available, they are expensive and are just another piece of machinery that can go wrong. At this point I approached the local fishing club to explain what I was intending to do and they have been friendly and positive throughout the building and commissioning of this scheme.

Initially my thoughts were that I might be able to build this scheme myself and I started to research Archimedean Screw Systems. I established that there were three options (i) Ritz-Atro (ii) Reehart and (iii) Spaans-Babcock. I went down to Offaly to see a 30kW Ritz-Atro scheme operating there. I soon realised that the actual screw technology between the three firms was quite similar as physics would dictate. However, the control systems had different levels of refinement. I commissioned a feasibility study from the agent for Reehart in the South which was very positive. However, after long consideration I decided to approach HydroNI who were agents for Spaans Babcock based in Northern Ireland.

The reason for this decision was that I began to hear horror stories of how long it would take from the bureaucratic point of view to get the various permissions required. I felt that someone based locally would be better placed to actively move this along and in this I have been proved correct. I went over to see a couple of Spaans installations in England and was impressed with the control systems. I also liked the fact that they had an extensive network of sewage installations throughout Ireland and, as a result, have service teams regularly on the road here, unlike both Ritz and Reehart who are based in Germany. The fact that I had commissioned a feasibility study from another firm did cause a few problems, but at this stage I presented HydroNI with a plan of the scheme that I had drawn up and told them that it was more or less what I desired. That original drawing looks very similar to what I now have.

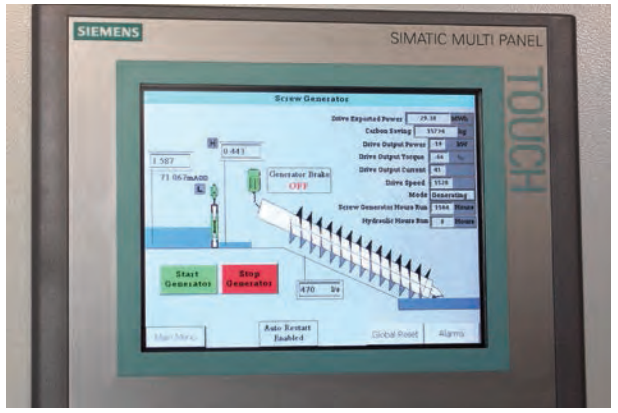
After discussions with HydroNI, it was determined that although there was the potential to build a scheme of 50kW, the load factor would be very low (at below 40%) and a better size would be about 30kW. The NIROCs scheme offers four NIROCs per kWh for schemes up to 20kW compared with three NIROCs for schemes from 20 to 250kW. We worked out that we would need to generate at 28kW with three NIROCs to produce the same income as at 20kW with four NIROCs. A number of people in the industry had suggested to me that when it comes to hydro schemes it often pays not to be too greedy and so I decided to go for the smaller 20kW Scheme.

I applied for and received a farm diversification grant under the NI Rural Development Programme. I was most grateful for this support as hydro schemes are expensive due to the amount of structural works required. Without this support, the economics of my scheme would have started to look more difficult.

This is the point when the fun began! I think it is just as well that I did not know before I started about all the hoops that I would have to jump through. Suffice it to say that I had to obtain planning permission, an electricity connection, an abstraction licence, environmental surveys for NIEA and accreditation from Ofgem. I did my research through the summer of 2010, as well as measuring river flows every day from early August.

This included establishing what sort of split I could expect from around the island down our branch of the river. We were ready to get everything assembled for planning permission by autumn 2010, including completing plans for the "civils" and hydrological reports. These were more or less complete when we applied for planning permission in April 2011 and, after a number of hiccups, planning approval was finally obtained at the end of April 2012, having been granted an Abstraction Licence in January 2012. The builders moved onto the site at the end of May and experienced one of the wettest summers on record. On several occasions the coffer dam designed to keep the weir protected during building was swept away and while excavating for the turbine house, on more than one occasion water came over the side and flooded everything.

The construction proceeded in three phases. The first was to lay a concrete pipe 1.2m in diameter internally (1.5m externally at its widest) for 500m connecting the weir and turbine house. Each section of pipe was 2.5m long and weighed 3.5 tons with a maximum deviation in each pipe of only half of a degree. Fortunately the pipeline was dead straight except at one point where there was a very slight bend. The diggers started the pipe laying at the end of May and were finished by mid July. The second phase was the construction of the weir. This involved removing the old weir entirely and building a new weir, intake and silt trap using shuttered concrete with provision for intake grilles and sluice gates. This was more or less complete by the end of September and the turbine house, tanks and tailrace by the end of December. After this, Spaans took over the site until commissioning on 31 Jan 2013.



The simplicity of the operation of the Archimedean Screw is a constant source of delight and I am hoping that maintenance will be minimal. Our budgets were based on a load factor of 72%. Up to the end of June it was 92.5% and even with nearly two and a half months when there was very little rainfall, the annualised load factor is 75%. With reasonable rainfall between September and the end of January, I expect the annual load factor to be in the region of 85%.

Hydro is one of the most effective and reliable renewable energy technologies and although at times expensive to build, it has high efficiencies, high load factors, and a long lifespan when compared with other types such as wind and solar. There is no reason why my scheme should not be still generating green electricity in 50-100 years with minimal repairs to the screw and systems.

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

Issues with Renewable Energy Installations

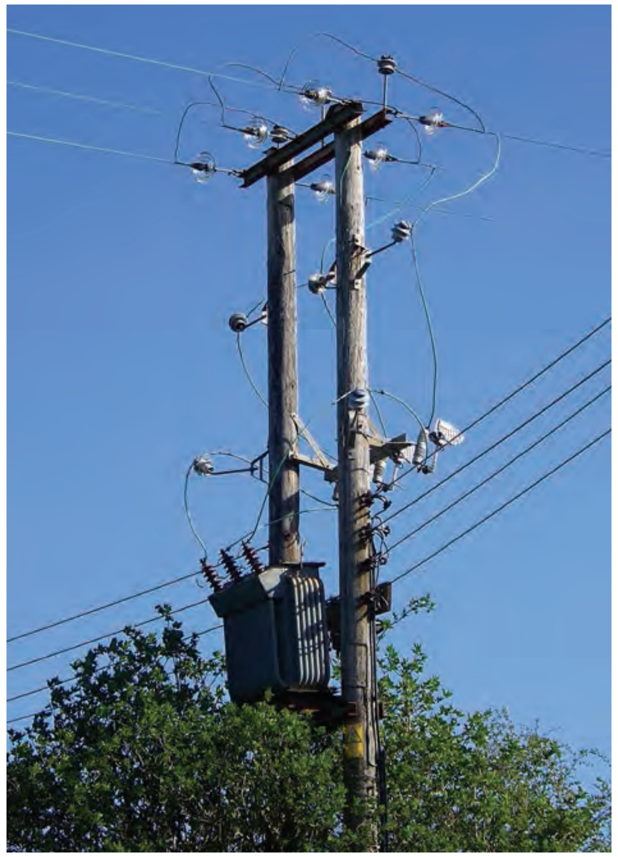
Grid connection for small scale renewable generation

Michael Atkinson, Head of Generation Connections, NIE

One of the key factors when considering a renewable energy project is connection to the electricity system or grid.

Northern Ireland Electricity (NIE), the network company, is committed to providing a fair connections process for all small scale renewable developers and offers a range of advice and expertise to assist in the connections process.

Due to the significant increase in small scale generation, access to some areas of the network has become limited, resulting in high connection costs. NIE is exploring all options which may reduce costs in these instances for small scale developers, but there is no expectation, at this stage, that any viable alternative will be available in the short term. In certain locations, further connection of small scale generation will be largely dependent on Regulatory decisions around the funding of certain network reinforcement investments.


NIE pole and transformer

In order to assist decision making at an early stage, NIE offers a feasibility study option for developers. This study will highlight if there is any already existing network congestion in the specified location, which could result in a high connection cost, thus rendering the project economically unviable.

The study will provide an indicative cost for the connection at the proposed connection point and details of the work required to provide the connection for the requested capacity. The analysis will be relevant at the time the study is carried out but does not reserve any capacity for a subsequent full application.

Please note: that there are significant technical issues to be considered and studied in order to design the connection of generators to the network. These include Network voltage and design, conductor size, earthing conditions and quality of supply.

The Renewables Obligation (RO) is the main support mechanism for renewable electricity projects in the UK. A Renewable Obligation Certificate (ROC) is a green certificate issued by Ofgem to an accredited renewable energy generator for eligible renewable electricity generated within the United Kingdom and supplied to customers within the United Kingdom by a licensed electricity supplier. In Northern Ireland, Ofgem manage the ROC administration process on behalf of the NI Utility Regulator. For further information go to www.uregni.gov.uk

If you decide to go ahead with a renewables project and have gained any relevant planning permissions (or equivalent permissions), you may then submit a formal application to NIE. This includes details of the full electrical technical specification of the generator being connected, together with the appropriate non-refundable fee.

Following receipt of the connection application, NIE will issue a connection offer within 90 days, provided all the information is available. Developers then have 90 days to accept the offer. This means that if a developer does not accept NIE's connection offer within 90 days, their application will not proceed and they will lose their place in the process.

A typical connection may require a new line, transformer and equipment cubicle. Planning permission may be required for the connection. Some connections may require NIE to provide equipment which is not readily available and these items may have a significant order time. The time to complete the connection process typically can take from six months to one year, from acceptance of the offer and payment. In some cases, for example where there are difficulties with wayleaves/planning permission or earthing, significantly more time may be required.

NIE will continue to provide renewable developers with relevant information regarding the level of congestion across the electricity network. Visit NIE's website nie.co.uk/Connections/Generation-connections for more information.

For further information, contact NIE on 08457 643643 or visit nie.co.uk/Connections

Planning Permission for Renewable Energy

Judith Winters, Senior Planning Officer, DETI

Biogas Plants

Planning permission is not always required for anaerobic digesters.

In August 2013, new legislation came into force to provide permitted development rights for small-scale anaerobic digestion plant on an agricultural unit subject to certain limitations. More information is available at www.planningni.gov.uk or from your local Area Planning Office.

Where planning permission is required, applications for anaerobic digesters are normally dealt with by Local Area Planning Offices. However, applications for commercial/off farm AD plants of significant scale, e.g. in excess of 50,000 tonnes throughput per annum may be dealt with by Strategic Planning Division.

Enquiries about specific planning applications and local planning issues should be addressed to the relevant Local Area Planning Office.

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 construction phase;
- Model of emissions dispersion; and
- Community consultation plans.

Fees

The fee for an application for an anaerobic digester in tanks on an open site is £1,863 for each 0.5 hectare of the site area subject to a maximum of £40,304.

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, £179;

(b) Where the area of gross floor space to be created by the development does not exceed 40 sq.m., £179;

(c) Where the area of the gross floor space to be created by the development exceeds is between 40 sq.m. and 75 sq.m., £352;

(d) Where the area of the gross floor space to be created by the development is between 75 sq.m. and 3750 sq.m., £352 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., £17,700; and an additional £105 for each 75 sq.m. in excess of 3750 sq.m., subject to a maximum in total of £262,395.

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.

In June 2013, the Department published a Draft Supplementary Guidance document on Anaerobic Digestion, which provides additional advice and guidance specific to AD to complement the background information already set out in the Best Practice Guidance to PPS 18.

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. Furthermore, 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) 2012.

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 to a dwelling house or a building within the curtilage of 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; and
- 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) 2012 and are therefore not likely to require an Environmental Impact Assessment.

Material Considerations

The range of factors that 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; and
- public access to the countryside.

Streamlined Application Process

A planning application for solar panels 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.

Wind Turbines

Single turbine development can range from building mounted turbines to larger stand alone turbines mounted on towers or masts. 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, accompanied by a P1W 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.

Addressing issues before submitting your application will help to speed up your planning application. Important considerations include:

- Impact on communications installations; emergency services communication or other telecommunications – OFCOM.
- Impact on nearby dwellings – Environmental Health.
- Impact on Natural Heritage – NI Environment Agency.

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) 2012. 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 particular case.

Streamlined Application Process

A planning application for 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 your local Area Planning Office at www.planning.gov.uk/index/about/localareaplanningoffices

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 incentivising renewable electricity generation.

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.

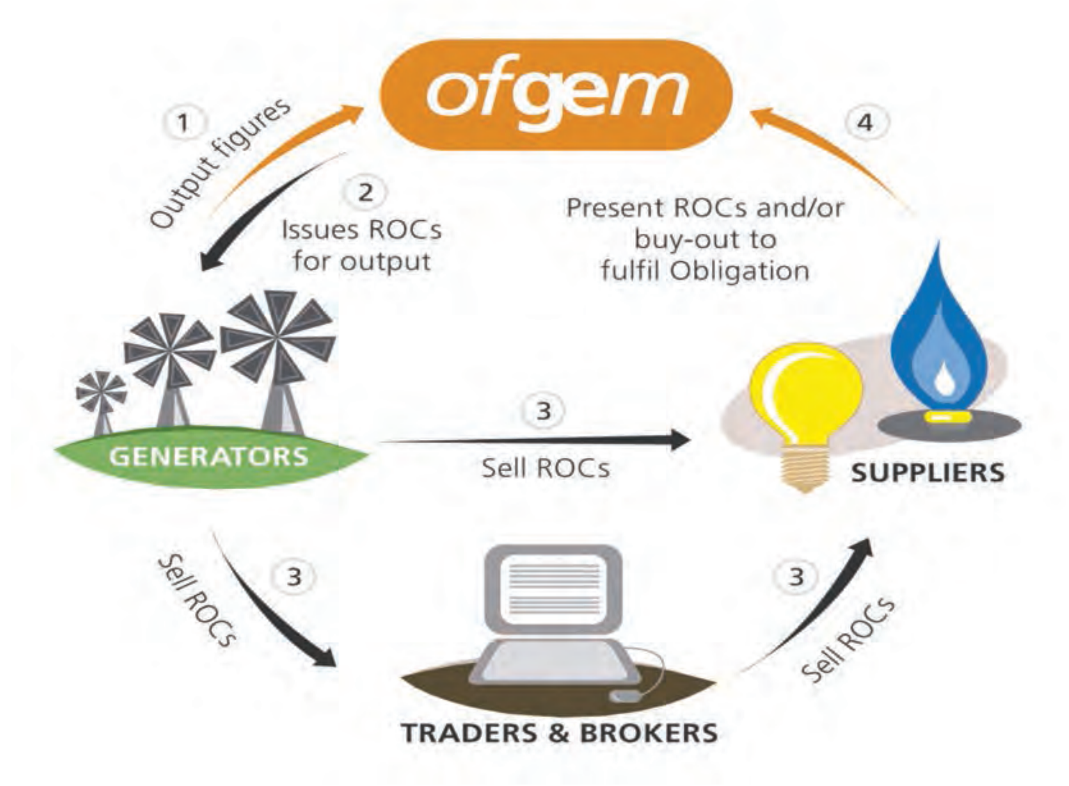
As an alternative to presenting ROCs, suppliers may pay a 'buy-out' fee to Ofgem for each MWh of the specified quantity of electricity that is not covered by presenting ROCs. Suppliers can therefore comply by either presenting ROCs, or paying the buyout (or a combination of the two). At the end of each 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 £40-45) can be expected to be at least the 'buy-out' fee (£42.02 for 2013/14) 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 based on the amount of electricity generated.

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 generated. 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 2037, whichever is sooner.

How the NIRO works



Source: Ofgem

Changes to ROC banding levels

Following a DETI consultation during 2011/12 on proposed ROC banding changes to the NIRO and a further supplementary consultation on solar PV and biomass in late 2012, a number of changes to ROC banding support levels were introduced on 1 May 2013 by the Renewables Obligation (Amendment) Order (Northern Ireland) 2013. The changes focused on large scale technologies i.e. those with an installed capacity over 5 megawatts (above 250kW for solar PV) and these are detailed on the attached NIRO banding table. In terms of small scale ROC banding levels, the Department had previously indicated its intention to carry out a review in 2013. However, in the government response to the large scale solar PV and biomass affordability and sustainability consultation published on 24 January 2013, DETI confirmed that it would not be introducing new banding levels for small scale renewables until 1 April 2015 with a view to consulting on any proposed changes in mid-2014. All of the DETI consultation documents, government responses and legislation can be accessed on the DETI website at: www.detini.gov.uk/deti-energy-index/sustainable_energy/northern_ireland_renewables_obligation_.htm

Small Scale Feed-In Tariff

The Department is developing an Energy Bill which will be introduced to the Northern Ireland Assembly in 2014. It is proposed that this Bill will include the enabling powers for the future introduction of a small-scale feed-in tariff similar to that already in operation in Great Britain since 2010. Under UK-wide Electricity Market Reform measures, the Renewables Obligation will close to new generation from 1 April 2017. Generators already accredited under the NIRO before this date will continue to receive ROCs for the full 20 year duration. It is the Department's intention to introduce a small scale FIT before 1 April 2017 to ensure that small scale renewable electricity continues to be incentivised after the NIRO's closure.

The Bill will provide a framework only for small scale FIT powers. This is required to provide DETI with the legislative base to introduce a FIT incentive mechanism in the future. How the new FIT will work, including tariff details will be provided in subsequent secondary legislation and will be subject to extensive public consultation.

The policy consultation on the Energy Bill can be viewed at: www.energy.detini.gov.uk

Northern Ireland Renewables Obligation (NIRO) – Banding Levels

Technology	ROC levels			
	Current	2014/15	2015/16	2016/17
Anaerobic digestion (≤ 500kW)	4	4	4 Banding levels from 2015/16 subject to further review	4
Anaerobic digestion (500kW – 5MW)	3	3	3 Banding levels from 2015/16 subject to further review	3
Anaerobic digestion (above 5MW)	2	2	1.9	1.8
Hydro (≤ 20kW)	4	4	4 Banding levels from 2015/16 subject to further review	4
Hydro (>20kW – 250kW)	3	3	3 Banding levels from 2015/16 subject to further review	3
Hydro (>250kW – 1MW)	2	2	2 Banding levels from 2015/16 subject to further review	2
Hydro (>1MW – 5MW)	1	1	1 Banding levels from 2015/16 subject to further review	1
Hydro (>5MW)	0.7	0.7	0.7	0.7
Onshore wind (≤ 250kW)	4	4	4 Banding levels from 2015/16 subject to further review	4
Onshore wind (>250kW – 5MW)	1	1	1 Banding levels from 2015/16 subject to further review	1
Onshore wind (Above 5MW)	0.9	0.9	0.9	0.9
Solar photovoltaic (up to 50kW)	4	4	4 Banding levels from 2015/16 subject to further review	4
Solar photovoltaic (>50kW to 250kW)	2	2	2 Banding levels from 2015/16 subject to further review	2
Solar photovoltaic – Ground mounted >250kW	1.6	1.4	1.3	1.2
Solar photovoltaic – Building mounted >250kW	1.7	1.6	1.5	1.4

A complete list of ROC banding levels for all technologies can be found on the DETI website at www.detini.gov.uk/deti-energy-index/deti-energy-sustainable/northern_ireland_renewables_obligation_.htm

For further information on:

The NIRO: Department of Enterprise, Trade and Investment (DETI)
Tel: 028 9052 9428
http://www.detini.gov.uk/deti-energy-index/deti-energy-sustainable/northern_ireland_renewables_obligation_.htm

NIRO Accreditation Ofgem
Tel: 020 7901 7310
www.ofgem.gov.uk//environmental-programmes/renewables-obligation-ro

Understanding the ROC Market and the Role of Ofgem

Jonathan Buick, Project Manager, Action Renewables

Anyone considering a farm-based technology generating renewable electricity will have come across the term "ROCs". These are Renewable Obligation Certificates and provide a very important income stream. Indeed for most projects the income from ROCs is more than the income from the sale of the electricity itself.

ROCs are issued by the Office of gas and electricity markets (Ofgem) which is the gas and electricity regulator based in London. This government body also approves technologies, and projects must apply for accreditation in order to receive ROCs.

The reason ROCs have a value is because there is a legislative obligation on all licensed electricity suppliers to submit ROCs each year to Ofgem or else pay a penalty. This penalty, known as the Buy-Out, is set each year and is partly index-linked to RPI. For 2013/14, it is £42.02 per ROC. So, electricity suppliers such as Airtricity, Npower, PowerNI or Electric Ireland (and all the others) have a choice of either buying ROCs or paying the penalty. However, Ofgem collects the Buy-Out payments from those suppliers which opt to pay the penalty and gives it to those suppliers which have submitted ROCs in proportion to the number of ROCs each one has submitted. This means that electricity suppliers are generally willing to pay more for ROCs than the current Buy-Out penalty because they expect to receive a rebate per ROC (known as the Recycle payment).

ROCs are issued to generators such as wind turbines or AD plants for each megawatt hour (MWh) of eligible renewable output generated. The number of ROCs issued depends on the generating capacity and type of technology.

Landowners and project developers have been contacting Action Renewables increasingly over the past year with concerns about receiving the number of ROCs which are currently available. With project development taking up to two years, particularly now that the process of obtaining a grid connection is becoming more problematic, this is a very legitimate concern. It should be remembered that there are currently no plans to alter the number of ROCs that generators receive prior to 2015, other than what has already been set by the Department of Enterprise, Trade and Investment for Northern Ireland (DETI). It is DETI which determines energy policy for Northern Ireland. DETI also sets the obligation on suppliers and then decides on the number of ROCs which generators receive. The Renewables Obligation is therefore DETI's primary mechanism for increasing the amount of renewable electricity supplied in Northern Ireland in order to reach the target of 40% renewable electricity by 2020.

The most recent ROC banding levels were published in January 2013 and are available on DETI's website. These apply until April 2017. No new projects will be eligible for ROCs after April 2017.

However, those projects which have already been commissioned and approved will continue to receive their ROCs for twenty years from their approval date. There is a process underway to replace the support offered by ROCs for new projects after April 2017. This will be a Feed-in Tariff, similar to the Feed-in Tariff which operates for farm-scale technologies in Great Britain. Action Renewables believes that these tariffs will not be as favourable as the existing support from ROCs – governments around the world rarely increase the support they offer over time. This is understandable since support is provided to encourage the development of renewable energy supply chains, which, once developed, should result in the technology becoming cheaper. To a large extent this process is occurring and is especially noticeable in the PV sector.

For larger systems, (we don't yet know the details of size and technology), a different type of Feed-in Tariff called a Contract for Difference (CfD) will be introduced. This will affect wind farms, but may also affect larger AD plants. For example, under a Cfd, generators will bid for a strike price, the difference between the wholesale price of electricity and the strike price being subsequently delivered to the generator. CfD's are expected to provide fixed price support for generators for 20 years but at a lower price than available under the ROC system. This is because the CfD, and indeed Feed-in Tariffs for smaller technologies and farm-scale systems, are designed to provide greater certainty on pricing to new generators than that available using ROCs. However, given that Action Renewables is not alone in believing that wholesale electricity prices will continue to rise, the upside of the ROC system is that as wholesale electricity prices rise, so too does the value of the electricity generated and sold, and the Buy-Out (being index linked) continues to rise as well due to strengthened ROC values. No such upside exists under CfDs.

(Action Renewables Energy Trading Limited is an independent ROC trading organisation in Northern Ireland that can assist organisations in finding the best deal for selling ROCs and electricity and provide expert support services through the accreditation process.)

For further information, please contact Jonathan Buick, Programme Manager, Action Renewables on 028 9072 7767 or email: jonathan.buick@actionrenewables.co.uk.

The Renewable Heat Incentive and Renewable Heat Premium

Peter Hutchinson, Renewable Heat Branch, DETI

The Non-Domestic Renewable Heat Incentive Scheme

In November 2012, DETI launched the Northern Ireland Renewable Heat Incentive (RHI), a mechanism to support the deployment of renewable heat technologies within the non-domestic sector in Northern Ireland. The RHI provides non-domestic generators of eligible renewable heat and producers of biomethane with incentive payments for the lifetime of the technology (to a maximum of 20 years). The tariff payments vary depending on the size and type of technology and are calculated based on the metered heat output of the installation. The scheme is administered by the GB energy regulator, Ofgem.

The purpose of the RHI is to develop the renewable heat market to a level of 10% by 2020 (starting from a baseline position of 1.7% in 2010). To meet the target, it is assumed that an additional 1300GWh of renewable heating is required by 2020. Achieving the target will ensure that Northern Ireland contributes to wider UK and EU targets, as well as benefiting from increased energy security, reduced carbon emissions and realising the potential for new green jobs in this sector.

As the RHI requires installations to be in place before the accreditation process can begin (unless the technology is of sufficient size to warrant pre-accreditation) there can often be a long lead in time for projects and for the application process. As at 13 September 2013, there were 46 applications for support under the RHI and 30 of those had received full accreditation.

All the applications to date have been for solid biomass boilers with the average size of application being in the order of 180kW and the total combined capacity of the applications is around 8,200kW.

The existing RHI tariffs are detailed in the table below:

Tariff name	Size	Tariff duration (years)	Northern Ireland levels (pence per kWh)
Biomass	Less than 20kW$_{th}$	20	6.3
	20kW$_{th}$ and above but less than 100kW$_{th}$		6.1
	100kW$_{th}$ and above but less than 1000kW$_{th}$		1.5
Biomethane	Biomethane all scales, biogas combustion less than 200kW$_{th}$	20	3.1
Ground Source Heat Pumps	Less than 20kW$_{th}$	20	8.7
	20kW$_{th}$ and above but less than 100kW$_{th}$		4.8
	100kW$_{th}$ and above		1.3
Solar Thermal	Less than 200kW$_{th}$	20	8.8

The Renewable Heat Premium Payment Scheme

The RHPP scheme was launched on 24 May 2012 as a support measure for domestic customers wishing to utilise renewable heating. This was an interim measure that was put in place in advance of the design and implementation of the domestic RHI. The scheme has proved very popular and as at 13 September 2013, DETI had received 1175 applications and issued 909 vouchers of which 575 had been returned for payment indicating the technology had been installed.

The total combined capacity of the installed technologies is 8,300kW. The total committed spend is currently in the region of £1.7m, this funding represents a total investment in the sector of £5.5m.

The breakdown across the different technologies is shown in the table below:

	Voucher value (£)	Total Vouchers Issued		Total vouchers returned for payment	
		Number	% share of technologies	Number	% share of technologies
ASHPs	1700	89	10	51	9
Biomass boilers	2500	437	48	238	41
GSHPs	3500	92	10	52	9
Solar Thermal	320	291	32	234	41
TOTAL		**909**		**575**	

Biomass boilers are clearly the most popular technology with almost half the applications received being for either wood pellet or wood log fired boilers.

In terms of the displacement of other heating fuels the vast majority of applicants have notified that they are intending to displace heating oil (89%).

There have been a high number of applications from those carrying out self builds (38%). Less than 3% of applicants opt to install two renewable heat technologies in their home. These applicants comply with DETI's ruling that where two technologies are installed one must be a solar thermal panel.

Phase 2 of the RHI – New technologies and long term support for domestics

In July 2013, DETI published a public consultation on proposals for Phase 2 of the RHI relating to the expansion of the current scheme and the implementation of a domestic RHI mechanism.

For the non-domestic scheme, Phase 2 focuses on introducing new tariffs for more innovative renewable heat technologies, such as air source heat pumps, deep geothermal, biomass direct air and bioliquids. New support is also proposed for large scale biomass (above 1MW) and biomass and bioliquids combined heat and power systems.

The consultation proposed new tariffs for the non-domestic RHI as follows:

Tariff name	Size	Tariff duration (years)	Northern Ireland levels (pence per kWh)
Air to Air Air Source Heat Pumps	Less than 100kW$_{th}$	20	5.2
Air to Water Air Source Heat Pumps	Less than 100kW$_{th}$	20	2.5
Bioliquids	Less than 100kW$_{th}$	15	2.6
	100kW$_{th}$ and above but less than 1000kW$_{th}$	15	2.1
Biomass (heat only)	1000kW$_{th}$ and above	20	0.6
Biomass or Bioliquid Combined Heat and Power (new sites)	All sizes	20	3.5
Biomass or Bioliquid Combined Heat and Power (conversion from fossil fuel)	All sizes	20	1.7
Biomass Direct Air	Less than 100kW$_{th}$	20	5.1
	100kWth and above but less than 1000kW$_{th}$	20	1.4
Deep Geothermal	All scales	20	3.7

In addition to these new tariffs, DETI has proposed to make some changes to the administration processes with the aim to simplifying procedures relating to metering. Finally, DETI is considering the introduction of an "uplift" tariff for biomass district heating schemes, where one boiler provides heat for a high number of different buildings.

Support for domestic systems

Another element of Phase 2 of the RHI is the introduction of a domestic RHI scheme in Northern Ireland that will ultimately replace the RHPP. The domestic RHI scheme proposed by DETI includes two elements. New applicants for the scheme would first receive a one-off payment once their application is approved and their installation accredited and then receive an ongoing annual payment for the heat output of the technology.

Applicants that have already received the RHPP would receive the ongoing tariff only and any applicants that installed without the support of the RHPP (between the period 1 September 2010 and the launch of the domestic RHI), would receive a higher tariff but no upfront payment.

The different domestic support levels proposed are detailed below:

	Installed after 1 September 2010 and without assistance under the RHPP	New installations and those supported under RHPP	
	Tariff for 7 yrs (pence per kWh)	Up front support[1] (£)	Tariff for 7 years (pence per kWh)
Air to Water Heat Pumps	8.1	1700	3.4
Biomass	7.9	2500	5.5
Ground Source Heat Pumps	13	3500	8
Solar Thermal	16.4	320	13.1
Air to Air Heat Pumps	5.5	1000[2]	3.5
Bioliquids	3.3	500[2]	2.7

The established technologies that are currently supported under the RHPP will continue to be incentivised and DETI is considering introducing support for air to air heat pumps and bioliquids.

The consultation document outlined proposals relating to eligibility standards, how payments will be calculated and made, the administration processes, and how domestic systems over 45kW could be treated.

The consultation process concluded on Monday 14 October 2013.

Further information can be found at;

Phase 2 of the RHI www.energy.detini.gov.uk
Information on applying for RHI or RHPP www.nidirect.gov.uk/energywise
Further guidance on the RHI scheme www.ofgem.gov.uk
Or by contacting ni.rhi@detini.gov.uk

[1] For technologies installed under RHPP this support has already been received.

[2] No support has previously been available for air to air heat pumps or bioliquids.

The Renewable Energy Supply Chain

Gareth Gormley, Senior Rural Enterprise Adviser, CAFRE

The following case studies demonstrate how groups of farmers and growers have come together to add value to their outputs and create sustainable business opportunities within the renewable energy sector.

Biomass Energy Northern Ireland

Biomass Energy Northern Ireland (BENI) recently completed the Supply Chain Development Programme delivered by the Countryside Agri Rural Partnership. The BENI group is made up of biomass producers supplying wood chip from Short Rotation Coppiced willow and forestry.

The group was assigned a facilitator, Ian Duff, who with an engineering background proved invaluable in supporting the group through the Programme. He assisted BENI through an evaluation process which clarified the aims of the group and has identified a role to promote the sector.

BENI organised several workshops for members, covering subjects such as improving the management of wood chip drying and appropriate fuel storage and handling equipment. The programme also allowed BENI to evaluate its structure as well as develop a marketing plan which included the production of promotional literature.

At the end of the process, BENI has become a more cohesive group who are actively promoting the use of wood chip to potential end users. The introduction of the Renewable Heat Incentive will encourage agricultural and other businesses to install renewable energy systems which can exploit locally produced wood chip fuel supplied by BENI members.

The Antrim – Belfast International Airport Biogas Plant Supply Chain

The Antrim – Belfast International Airport Supply Chain was formed in November 2012 to deliver a Biogas Plant fed with agricultural material: grass silage, cattle slurry and layer hen manures sourced from local farms. Having obtained full planning permission, the Supply Chain began discussions and held various meetings with neighbouring farms to secure five-year agricultural supply contracts. This five-year commitment was necessary to assure potential funders that an affordable 'energy resource supply' was readily available.

The Supply Chain and Belfast International Airport quickly established a 'Private Wire Cabling Route' from the biogas plant to sub-station within the airport along with a pricing structure agreeable to both sides. With these fundamental principles established the following months became primarily concerned with securing project funding.

A detailed Business Plan was prepared for potential funders outlining:

- the farming and entrepreneurial background of the lead promoters;
- how the Crosshill Biogas Plant would operate 8,200 hours per year;
- the management and operational controls necessary to ensure 8,200 CHP hours, every year over the next 20 years (along with 88% performance guarantee from the German biogas plant provider); and
- the Business Model that maximised returns to all the various 'investor stakeholders'.

The 'private wire arrangement' generates £140k pa premium above the standard Power Purchase Agreement on offer from PowerNI, demonstrating an 11% return on investment with the Biogas Plant, achieving payback in little more than eight years.

Since Easter, local banks have been approached. Various private investors groups and London pension backed funds have visited the site. Consequently the assignment took on more of a detailed financial engineering role, than an agricultural supply chain project. Currently the Supply Chain is reviewing two distinct £2M funding offers. A decision is imminent with construction on the site expected to start in early 2014.

Opportunities

Nineteen groups of farmers and growers have used the Supply Chain Development Programme to evaluate (i) the opportunities to supply the Northern Ireland energy market, (ii) the renewable energy systems and technologies that are available and (iii) how they can overcome the challenges to entering the market.

For further information on these and other case studies, contact Gareth Gormley, CAFRE, on (028) 3025 5912 or the Countryside Agri-Rural Partnership, on 0845 026 7538, or visit www.countrysiderural.co.uk

Payback times for renewable energy investment

Charlie Kilpatrick, Senior Business Technologist, CAFRE

The introduction of Renewable Obligation requirements to electricity suppliers has created a tremendous interest from farmers to diversify the use of their farm resource by investing in various renewable energy projects. However in most cases, the money required for investment has to be borrowed and the project must generate a sustainable surplus to meet loan repayments, private drawings and taxation.

Business planning

Planning the financial aspects of a business can be a considerable challenge, especially in respect of a new renewable energy project. Nonetheless a comprehensive business plan is a key requirement of any lender and as well as detailing projections for costs and sales the business plan must include details that take into account the production system and the marketing strategy. The business plan ideally should run for at least five years. However, forecasts for the first 12 months should have the most detail associated with them.

The foundation of the business plan is an estimation of the costs which will be incurred by a business and the income which will be generated. It is therefore important to clearly state the assumptions that lie behind the projection of figures, both in terms of costs and income, so bank lenders can clearly see the thinking behind the numbers.

For example, a good business plan for any given renewable technology project will require you to accurately estimate the following figures:

- The cost of a site survey and associated planning fees (where required).
- The cost of grid connection.
- Value of output in terms of electricity sold and used, and sale of ROCs. This value will be directly related to the potential efficiency of electricity generation i.e.
  - For a Wind Turbine, the location and associated wind speed on your site.
  - For Solar Photovoltaic, the tilt and orientation of the panel and the decline in output over time.
  - For Hydro power, the flow and head of the stream or river.
- Cost of maintenance and insurance.
- The capital cost of the investment.
- Repayment of a capital loan at a given interest rate over a number of years.
- Grant funding if available, and timing of payment.

Measuring the cost of borrowed capital

There are a number of ways that a lender can quote interest rates (e.g. nominal rate, flat rate) and it is essential that the borrower understands the basis of these calculations. All rates should be converted to a common denominator to enable comparison of the cost of finance. Legislation was enacted a few years ago to ensure consumer rights when borrowing money All interest rates must be converted to the true or Annual Percentage Rate (APR).

APR allows you to evaluate the cost of the loan in terms of a percentage:

- If your loan has a 5% rate, you'll pay £5 per £100 you borrow annually.
- APR means the interest rate only applies to the outstanding capital amount
- All other things being equal, you simply want the loan with the lowest APR.

Financial Projections/Statements used

Once all the projected costs and returns have been estimated, they can then be translated into financial projections used in the business plan. There are two main financial statements used in business planning and it is important that you have a clear understanding of the function of each.

One cannot say one is more important than the other as they each have specific task in the financial planning process.

1. Profit and Loss Budget

The Profit and Loss (P&L) forecast is a statement of sales, costs and profit (or loss) over an accounting period (usually one year). It is calculated using standard conventions such as depreciation that will give an accurate measure of business progress when projected over a number of years. Profit is not cash and should not be confused with a cash surplus. The primary function of the P&L is to estimate the net profit or loss. A business will pay tax on its net profit, before drawings.

2. Cash Flow Budget

The Cash Flow Budget is a forecast of money going into and out of a business over a specific period of time period and can be reflected in the business's monthly bank balance. It differs from profit in that it does not include notional costs such as depreciation but does include all capital payments, private drawings and tax.

Businesses fail more often from lack of cash than lack of profit. While the Profit and Loss budget tells you what you expect to spend and receive, the cash-flow marks the timing.

Tax implications

In many cases, cash flow planning fails to take into consideration the amount of income tax to be paid and the timing of payments. Remember that the tax bill for the previous trading year is due by the end of January each year.

Furthermore, an additional payment on account is also requested at the end of January and July, based on the previous year's income with 50% paid on each occasion.

It is important to ensure that you plan tax affairs and managing your tax bill in advance to avoid cash flow problems. This can be done by making regular contact with your accountant, letting them know what's happening in your business and being aware of current tax allowance options such as:

- Annual Investment allowances.
- Averaging of profits.
- Options for trading (sole trader, partner or limited company).

CAFRE Payback Calculators

In order to help with preparing a business plan, CAFRE has developed a selection of computer based payback calculators to give potential investors a guide to the number of years that it will take to pay off an individual renewable project. The calculators have been developed for anaerobic digesters, wind turbines, hydro and solar photovoltaic technologies and take into account all the factors that affect costs and the level of output. This includes the value of the ROCs as well as electricity sold and electricity used by the business.

Assuming that funding is made available, you can use the calculator to apply your own specific circumstance to calculate the number of years to pay the renewable project back.

For further information, contact Charlie Kilpatrick by phone on (028) 9442 6654 or by email: charlie.kilpatrick@dardni.gov.uk

Financing renewable energy projects for landowners

Russell Smyth, KPMG Corporate Finance

Northern Ireland has had reasonable success in developing its renewable energy market, with renewable electrical generation currently at 14% of total supply. This is above the UK average of 11%. However, there is very limited diversity, with the vast majority of this generation coming from large-scale renewable assets, primarily in the wind sector. Access to funding in this large-scale market, whilst challenging, remains possible. For example, KPMG recently led the successful £81m fundraising for the 16MW Evermore biomass plant in Derry. KPMG believes that if a project of this scale is of high quality, and structured correctly, funding can be delivered, with investors actively seeking such opportunities.

Despite this positive sentiment on large-scale assets, it is difficult to say the same for farm-scale projects. Northern Ireland has some of the most generous renewable energy support regimes in Europe, and the local rural community has strongly embraced the concept of farm-scale renewable energy. Yet, to date, less than 5% of farm-scale renewable energy planning permissions have been successfully developed into operational renewable assets. This signifies that some form of structural impediment exists, if not market failure.

KPMG believes the core problem is the absence of funders for these projects, and the structural impediment is scale.

The most common farm-scale projects being progressed are 500kW anaerobic digestion ("AD") and 250kW-scale wind. Similar to their larger-scale counterparts, these projects contain many complexities and risks. However they individually lack the scale to justify the expense of researching and contractually mitigating these risks – costs which can easily exceed £500,000 for a large-scale project. As a result, despite investors seeking involvement in this attractive renewable market, mainstream funding options appear to be absent for the farm-scale market.

Over the past year a number of alternative funding routes have attempted to fill the void. These include bank funding with recourse to other security. However this is only available to a minority of developers with the appetite and capacity to offer other assets (such as the farm) as security. Another alternative is niche asset funders, although this solution often lacks flexibility or fails to meet the developer's core objective to retain long-term ownership.

KPMG has sought to address these challenges on specific projects with some success. In small-scale wind we have successfully completed a significant fundraising by assisting a client in establishing a pipeline of 250kW projects. These have a common contractual approach, such that individual assets are combined to create the required scale.

In the AD market, KPMG is currently working with a number of industry players and funders on the creation of a dedicated fund which, if it comes to fruition, will be designed specifically to address the needs and objectives of the local farm-scale AD promoters. Key to this is the creation of a standardised approach – a suite of legal contracts, methodology and structure, which will combine to provide funders with the economies of scale required to economically fund this size of asset.

Without a structured approach such as this, there is a risk that many of the 95% of planning permissions currently sitting undeveloped will miss the fast-approaching deadline to benefit from current renewable incentives. If this were to happen, Northern Ireland will lose a significant opportunity to develop a strong portfolio of decentralised renewable energy assets.

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