cafre
College of Agriculture,
Food & Rural Enterprise

Practical on-farm Renewable Energy

2014/2015

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

afbi
Agri-Food and Biosciences Institute

Ulster Farmers' Union

Linking Environment and Farming

Foreword

As CAFRE Director I wish to extend a warm welcome to all our visitors to this, our fifth, Practical On-farm Renewable Energy event at Greenmount Campus. The day has become established as an excellent source of practical information about renewable energy options for farmers and the rural sector.

At the present time with the uncertainties in world affairs, we need to improve our energy security by reducing our dependence on imported fossil fuels. In the longer term we need to tackle global warming by reducing the level of greenhouse gases in the earth's atmosphere. At an individual farm level an investment in renewable energy will reduce the high cost of energy inputs and can also provide an additional source of income for the business. It will also give a green image to our production that is of increasing importance in the market-place.

I trust today will provide you with useful information on how to benefit from renewable energy technologies in your business and that contacts and links made here will help you to develop your business in the future.

Finally, I wish to express my sincere appreciation to the organising committee for the event, comprising staff from across CAFRE, DARD, AFBI and the UFU.

I hope you have an informative and beneficial day

John Fay
CAFRE Director

Contents

Efficient farming cuts Greenhouse Gases

Peter Scott, Climate Change and Renewable Energy Branch, DARD

"In the agriculture sector, we face two defining global issues; the need to produce more food to sustain a burgeoning world population and the imperative to avoid global warming reaching dangerous levels. I am determined that the local agriculture sector should rise to these dual challenges."

Michelle O'Neill, Minister of Department Of Agriculture and Rural Development

There is increased pressure on all sectors of the economy, including agriculture, to reduce Greenhouse Gas (GHG) emissions. The EU has enacted legislation to reduce GHG emissions by 20% by 2020 (taking 1990 as the base), while the UK has set the legally binding (non-sectoral) target of reducing emissions by 34% by 2020 and at least 80% by 2050. In Northern Ireland, we are committed to reduce our GHG emissions by 35% by 2025. Meanwhile food demand is predicted to double globally by 2050. As a region that exports almost 70% of its agricultural produce, Northern Ireland is well placed to meet this demand but it is important that we do so in an environmentally sustainable way, producing as few emissions as possible.

Farming involves complex natural cycles so reducing greenhouse gases is not always straightforward. Three main greenhouse gases are emitted by the agri-food industry:

- Carbon dioxide (CO_2) emissions from fossil fuel usage and soil disturbance when cultivating;
- Methane (CH_4) emissions from ruminant livestock and manure storage;
- Nitrous Oxide (N_20) emissions from Nitrogen (N) fertiliser, manure applications and turnover of Nitrogen (N) in the soil when cultivated.

Agricultural production within Northern Ireland is relatively efficient, when considered on a global scale, and emissions from agriculture have fallen since 1990. However we can always do more to achieve further reductions. It is also the case that agriculture and forestry play an important and unique role in removing carbon dioxide from the atmosphere through the process of sequestration, when carbon is absorbed by living biomass (vegetation) and soil. Given agri-food's central role in the local economy and society, GHG emissions from agriculture still comprise a significant proportion of overall emissions in Northern Ireland (30% compared to the UK and EU average of 10%). As the sector that produces most GHGs in Northern Ireland, it is vital that farmers continue to work towards reducing emissions.

The Greenhouse Gas Implementation Partnership is a local voluntary partnership between the agri-food sector, government, scientists and environmentalists, set up to address the issue of climate change and greenhouse gas emissions relating to agriculture. It issued its "Efficient Farming Cuts Greenhouse Gases" strategy in 2011 which demonstrates that lowering the carbon footprint of local food production is good for the farmer and good for the environment. The main objective is to encourage farmers to adopt technical efficiency measures on-farm, known to enhance both economic performance and reduce GHG emissions per unit of output ie: a litre of milk, a tonne of cereals/potatoes/vegetables or a kilogram of beef, pork or lamb. This is known as reducing 'carbon intensity'. The central principle of the "Efficient Farming" strategy is that good farming practice, implemented on a voluntary basis with industry support, can make a significant contribution to reducing the carbon footprint of local agriculture. Faced with the need to reduce GHG emissions, it makes sense to do so in a cost-effective way.

DARD recognises the efforts made by the industry in reducing emissions. By working in partnership to meet the GHG challenge we can map our own future, increase efficiency and profitability, decrease our carbon intensity and grow production in a sustainable way to meet demand.

Copies of the Efficient Farming cuts Greenhouse Gases can be seen at:
www.dardni.gov.uk/efficient-farming-cuts-greenhouse-gases-summary.pdf

For further information, contact Julianne Bailie on (028) 9052 4130 or email: julianne.bailie@dardni.gov.uk

Profitable farming in a changing climate

Lynne O'Neill, Climate Change and Renewable Energy Branch, DARD

While climate change presents a challenge for agriculture, reducing the amount of greenhouse gases produced on your farm can help save money as well as helping the environment. Small changes can make a big difference.

- An efficient farm is a more profitable farm and produces less greenhouse gases than an inefficient farm
- As we saw in March 2013, changing and extreme weather conditions hit farmers hard. We need to take appropriate steps to prepare for more severe weather events in the future and therefore reduce associated losses
- Market signals show that retailers and consumers are increasingly aware of sustainability concerns and are choosing products produced in an environmentally responsible way

The 'Efficient Farming Cuts Greenhouse Gas Strategy' sets out a range of measures that can be adopted across different types and sizes of farming enterprises, ranging from small, low cost improvements to larger scale investments, all of which can increase efficiency and profitability and reduce greenhouse gas emissions. The key message is that every farm in Northern Ireland can take action to reduce their carbon footprint, and by doing so, they will also enhance their profitability. Examples of these measures include:

- Energy audits to identify potential energy savings and improvements, such as insulation and cheaper energy tariffs
- Regular maintenance of tractors and other machinery can improve overall fuel efficiency and reduce fuel use. For example a 20% under-inflation of tyre pressure can reduce fuel efficiency by up to 30%
- Installing renewable energy technologies can reduce energy costs and has the potential to provide additional income streams, while reducing emissions
- Improving the structure of farmland soils by reducing compaction can increase productivity and efficiency and prevent greenhouse gas emissions
- Implementing a Nutrient Management Planning regime can cut costs and emissions by ensuring nutrients are utilised efficiently, often reducing the quantity of chemical fertiliser needed

- Spreading slurry by trailing shoe or shallow injection can increase grass growth by up to 25% compared to splash plate application, reducing fertiliser requirement and the associated cost and emissions
- Applying slurry 4-5 days before Nitrogen fertiliser can reduce emissions by up to 80% compared to applying both on the same day
- Using the latest list of higher performing cereal and potato varieties with better disease resistance, suitable to local climatic conditions, will reduce greenhouse gas emissions and increase profitability
- Planting and management of woodland and hedges can lock carbon in thereby reducing the carbon footprint of agricultural production
- Better quality grass and silage can increase milk yield in dairy cattle or reduce concentrate feed use, reducing both the cost of the diet and emissions per litre of milk with potential savings of up to £100 per cow per year
- Sowing clover provides a natural source of nitrogen for crops and can reduce fertiliser costs and prevent Nitrous Oxide emissions from chemical fertiliser use
- Improving animal health will reduce the number of expensive herd replacements and therefore prevent excess greenhouse gas emissions

To find out more about the 'Efficient Farming cuts Greenhouse Gases' strategy and how it can benefit your farm, please visit:
http://www.dardni.gov.uk/index/farming/climate-change-farming

For further information, contact Julianne Bailie on (028) 9052 4130 or email: julianne.bailie@dardni.gov.uk

CAFRE training workshops

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
www.dardni.gov.uk/index/farming/managing-your-business/renewables

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

Is the policy landscape changing for small scale renewable energy projects in Northern Ireland?

Chris Osborne - Senior Policy Officer, Ulster Farmers Union

Policy background

In 2010, the Department of Enterprise Trade and Investment (DETI) announced that should a landowner produce renewable electricity via a wind turbine up to 250kW, they would receive four ROCs. This created a rush of enthusiasm in renewable energy projects and, to some, this was wrongly viewed as 'a get rich quick' option.

The rush to avail of the four ROCs incentivised some to plan for turbines bigger than their actual needs. Would-be developers believed that the bigger the capacity, the bigger the financial pay out. But wind turbines do not work that way, with many only operating at 15 to 20% efficiency. Instead of being viewed as a way of saving on-farm energy costs or improving on-farm energy efficiency, many landowners committed to significant capital investments in the belief that they would earn large amounts of money from exporting 100% of the electricity generated onto the grid.

The UFU advice during this time was always to do as much research as possible before agreeing to build a turbine, have a detailed business plan and realise that a turbine project is a long term commitment. Where the breakeven period approaches the lifespan of the turbine for example, the figures were not adding up and costly grid connection quotes meant that many projects were not viable. The UFU advised that using the energy on-farm would lead to savings and excess left over could be exported to the grid.

In drawing up their business plans, landowners along with third party companies did not envisage any problems connecting their generation units to the electricity grid. However difficulties have been experienced in the last few years with grid connection costs. Installing a large turbine with no way of storing generated renewable electricity when it is not needed adds to the inefficiency of the whole project.

Grid connection process

When wanting to connect a turbine to the electricity grid via G59 connection, a developer had to go through a nine-step application process, including payment of a feasibility study fee. It often took over twelve months after planning permission was applied for and granted to receive a grid connection offer. Note that in GB, a developer is able to apply for planning permission and grid connection in parallel, unlike here in Northern Ireland.

After this drawn out process, some developers were receiving 'conditional' grid connection offers. Conditionality meant that grid connection would be conditional upon 33kV investment taking place and despite entering the NIE grid application queue there was no guarantee to a landowner/developer applying to connect that their renewable project would even go ahead.

NIE and Conditional Offers

On 15 August this year, NIE announced that conditional grid connection offers for small scale renewable electricity generation would have to be withdrawn. This announcement followed a determination by the Utility Regulator, which was linked to a Competition Commission ruling on RP5 which was published in April 2014. The Competition Commission's determination in relation to RP5 confirmed that it was not in the public interest to allow NIE to make any further investment in the 33kV network. This impacted upon the integration of small scale renewables to the grid and NIE subsequently withdrew conditional grid connection offers.

The grid connection problems were attributed to two distinct issues;

i. Urgently needed investment in 11kV reinforcement (and the subsequent very high grid connection cost)

ii. Problems created by 'conditionality' which came about due to inadequate 33kV network capacity.

In reality, the grid connection cost for some developers had reached such high levels that it meant many renewable energy projects had become financially unviable. Coupled with the growing uncertainty created by conditionality, many landowners were growing increasingly frustrated and the situation on the ground was not as that envisaged when the policies were implemented in 2010.

Prior to the NIE announcement, the UFU had lobbied all parties to resolve the problems experienced by landowners attempting to connect small scale renewable generators to the grid, expensive quotations, uncertainty, lack of transparency and poor customer assistance in relation to the grid connection.

NIE are dealing with the management of the affected applications, with the likelihood that some projects will never see the light of day, namely those where significant capital expenditure is required for an upgrade, i.e. transformer changes at sub-station level. However, we have an issue where the land based sector in Northern Ireland is unable to reap the benefits from small scale renewable generation on account of the problems above.

Security of supply

There are also concerns over security of supply on the local grid. Last year, the Northern Ireland Utility Regulator (NIAUR) and DETI issued an information paper 'Security of Electricity Supply in Northern Ireland'. They identified a risk to security of supply from 2016 onwards. This stems from the EU Emissions Directives, 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.

Time for change

Despite the decision by NIE creating much needed certainty and transparency for some, the grid connection problems remain. Consequently there is a need for a change of policy thinking when it comes to how we connect small scale generators to the grid. Small scale renewables grid connection policy is changing on two fronts, both with UFU involvement. The idea is that these solutions will work side-by-side and offer viable alternatives going forward.

1. Managed Connections (known as Project 40)

NIE, in conjunction with the UFU and other industry representatives are looking into a solution whereby generator output could be curtailed in order to ensure that 33kV capacity limits are not reached. This will not only reduce connection costs (by removing the requirement to reinforce the 11kV network) but will allow the generator to connect to the grid where before conditionality would have been likely. This is one example where the policy landscape will change as it will involve a move from a shallow (or firm) to a deeper (non-firm) grid connection. The curtailment process will be set out by NIE when they review your grid connection.

Since this has not been done before in Northern Ireland, it will involve changes to the Statement of Charges/and or the Distribution Code. It will also be subject to a formal consultation process with the Utility Regulator needing to approve any changes.

When implemented this will change the way many people work with small scale renewables. The idea would be that where capacity is limited, the output of a generator to the grid could be curtailed via a managed connection. The developer will need to factor this into their business plan and estimate in advance how much electricity they can produce and what impact the curtailment might have. This will change how landowners plan their projects and utilise the energy they produce.

Whilst the UFU acknowledge that NIE are making progress on a managed solution, it should be noted that Project 40 will not provide a viable alternative for everyone and other grid alternatives need to be considered in parallel.

2. Microgrid

A Micro-grid is a group of interconnected loads and distributed energy resources within clearly defined electrical boundaries that acts as a single controllable entity with respect to the grid. The Lecale area near Ardglass, where grid capacity has been reached, has been identified as an area where the local community could benefit from an alternative way of connecting small scale renewable energy projects to the grid.

Down Area Farmers for Renewable Energy (DAFRE) has been formed to look at a micro-grid/ storage solution in the area. This is an innovative community initiative involving local farmers, businesses and community groups. The Micro-grid will utilise local renewable generation provided by a structured mix of renewable technologies; small scale wind, solar PV, on-farm AD and the Sea-gen tidal test site at Portaferry.

The idea of a micro-grid is not as eccentric an idea as it first sounds. In the US there is 1,051 MW of micro-grids, including the Central Hudson Utility Company in upstate New York. Here they have a generator and islandable micro-grid in the Frost Valley, providing reliable power since it was set up in 2010. It has led to an improvement in security of supply, having survived a dozen major storms since 2010 including Hurricane Sandy.

Micro-grids such as the Frost Valley are backed up by conventional energy generation. You have to look further west to California, to see micro-grids utilising renewable energy and heat. The California Energy Commission (CEC) has identified 'high penetration renewable based microgrids'. These are defined as projects which can incorporate 'high amounts (up to 100%) of renewable energy to meet the community load whilst avoiding adverse grid impacts, through the use of a microgrid controller/energy management system'. These are seen in action at several of the University of California campuses, including San Diego where they are managing 42MW of CHP, solar PV and back-up on-site generation capacity with a campus-wide energy management and load control platform.

Advantages of a microgrid;

- Increased efficiency and consequent environmental benefit
- Security of supply – mitigate against any black outs
- Wealth and job creation for the local rural community
- Smart solution available to end users
- Improve market intelligence
- Improved reliability
- Security of supply to load customers is improved
- Possible financial savings

Storage

Central to the Lecale micro-grid project will be a storage solution in the form of IAES (Isothermal Compressed Air Energy Storage). Storage will address the load management complications associated with embedded generation. Storage is a way of managing the load, mitigating against the need for curtailment. Storage facilities will be based at the Northern Ireland Energy Storage Demonstration Park located in the local area. This will be the first of its kind outside USA.

The UFU believe that smaller farm scale storage could address many of the problems identified with small scale renewables and the grid. Sited on-farm, the idea is that the electricity or heat which is generated at a time when it is not needed could be stored for use at a later date. Storage could come in the form of second life traction batteries (used in electric cars etc). However, a change of thinking is needed for this to occur.

When the Lecale project is implemented and is successful, it could be rolled out to other areas in Northern Ireland and potentially ease the grid connection problems, working alongside Project 40. Lecale is an "intelligent" solution but for it to be rolled out it will require many policy makers to think outside the box.

Change of thinking

- **What is the role of ROCs going forward?**

Under the Project 40 proposals, the likelihood is that by choosing a smaller sized generator, both capital and grid connection costs will be greatly reduced. The landowner could still export to the grid (and avail of the financial incentive) and make both cost and efficiency savings using renewable energy on farm. With the ROC system due to come to an end in 2017 and be replaced by a Feed-in Tariff for small scale renewables, the UFU are calling for DETI to consider a banded approach where smaller size generation units will receive greater incentives such as those described under Project 40.

- **Need for policy support on storage**

It is the view of the UFU that not enough policy consideration and support has been given to storage in the small scale renewables policy environment. For small scale renewables to be sustainable in Northern Ireland this will need to change. The storage policy debate needs to be progressed if small scale renewables are to be a sustainable part of our industry in the future. With the introduction of a small scale FIT still being designed, there is an ideal opportunity for storage support to be included and the UFU will be lobbying for this to happen.

- **Grid outlook and changing expectations**

There is no quick fix to help those experiencing problems connecting small scale renewable generators to the grid, but the UFU can commend NIE for actions taken to address these and will continue to work on Project 40. However, this will not help everyone. Managed connections, Micro-grid and storage are integral parts of a sustainable solution going forward. For these to work it will need a change in expectations amongst land owners and how they plan their renewables project. It may be wise to considering the mantra "big is not necessarily best".

Renewable Energy Technologies

Energy Efficiency on the Farm

David Trimble, Renewable Energy Technologist, CAFRE

Not every farm business will invest in renewable energy but every business can benefit from improving its energy efficiency. There are a wide range of energy efficiency measures that can be taken on farms, including:

- Selecting the most cost effective energy supplier and energy tariffs
- Insulation of buildings and hot water systems
- Installing effective control systems in intensive production units
- Basic maintenance activities such as removing dust from radiators of the fins of chilling units
- Replacing old, inefficient equipment such as pumps and electric motors

This article highlights three energy efficient technologies that can give both financial savings and carbon footprint reductions.

LED lighting

When faced with a high electricity bill on the farm the tendency is to 'put the blame' on some of the larger appliances and perhaps overlook the cost of the lighting. This can be a mistake because, while each light bulb has a relatively low usage of electricity the total usage can be high due to the number of hours that they are burning.

There are a range of lighting options available from fluorescent tubes, compact fluorescents, high pressure sodium, metal halide and light emitting diodes (LED). These vary in initial price, length of life and electricity usage.

To reduce the overall cost of lighting on the farm the key is to get the right balance between the initial cost and the running costs.

LED lighting has developed rapidly over the past few years, making their use in commercial situations an option. They have a long life and a high efficiency, both of which help to offset the high purchase price. LED lighting was installed on the pig farm of Jonathan Cuddy in Co Tyrone, with five foot LED tubes replacing five foot double fluorescent tubes. The financial figures for this change are:

Cost of LED light and fitting (£68 + £3)	£71
Energy used by LED lights	25 W
Energy used by double fluorescent tubes	116 W
Hours of light per day	14
Saving in electricity (116W – 25W)	91 W

At 14 hours per day (14 x 91W)	1274 W
For 365 days	465 kW
At 15 pence/unit of electricity (465 x 0.15)	£69.75
Tax relief on renewable energy investment (£68 x 20%)	£13.60

This gave a payback of **less than one year** in this intensive livestock enterprise.

In the right circumstances LED lights are proving to be a good choice for use on farms.

High volume plate coolers

On dairy farms milk is typically pre-cooled by means of a contra flow of water through a plate cooler. This reduces the energy needed to lower the milk temperature to 3°C for storage. A problem has arisen as dairy units have increased in size as often there is an insufficient volume of water to effectively cool the milk. This means the potential of the plate cooler is not realised and the chill unit is using extra electricity to cool the milk.

One solution to this is to have a high volume of water in a storage tank. Water from this tank circulates through the plate cooler, and then returns to the storage tank for further use. This means that the plate cooler can operate with the optimum volume of water and extract the maximum amount of heat possible from the milk. In CAFRE's Greenmount Campus dairy unit this system is in use with 30,000 litres of water in the storage tank.

The temperature in the storage tank rises slightly during milking as warmer water returns to it from the plate cooler circuit. While this is a disadvantage for cooling milk it is outweighed by the benefit of a high water flow rate compared to the milk flow rate. This is anticipated to be a 3:1 or 4:1 water flow to milk flow ratio. Studies of the Greenmount system to date indicate that the milk is cooled to within 3°C of the water temperature. Each 1000 litres of milk increases the water temperature in the storage tank by 0.5°C. The system is being fine tuned to get the milk reaching the bulk tank to as low a temperature as possible.

Heat recovery units

The recovery of heat from the cooling compressor is widely practiced in various industries and is becoming more common in our larger dairy units. The economic benefit will be greater in larger herds where greater amounts of heat can be recovered from the larger volume of milk.

With a heat recovery unit, heat is recovered from the second phase of milk cooling by circulating the hot gas from the compressor through a tank of water. This gives two benefits. It marginally cuts the milk cooling costs but, more significantly, the heat recovered produces partially heated water which with further heating can be used for the daily hot circulation cleaning of the milking plant.

The Greenmount Campus dairy unit system will be investigated to determine the electricity savings and financial benefits achieved.

For further information, contact David Trimble on (028) 9442 6682 or

email: david.trimble@dardni.gov.uk

Biomass production and associated waste treatment

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

Introduction

The Kyoto protocol resulted in outlining legally binding obligations for industrialised nations to reduce their greenhouse gas (GHG) emissions. An EU target of 20% reductions by 2020 based on 2005 levels, corresponds to a UK reduction of 34%. Substituting fossil fuels with sustainable, renewable sources is an effective method by which we can decarbonise our society and help achieve these reductions. It is recognised (Dept of Energy and Climate Change Bioenergy strategy) that Bioenergy has an important role to play in order to meet these renewable energy objectives and its exclusion could increase the overall cost of decarbonising our future energy supply and security of supply.

In Northern Ireland our climate is well suited to growing woody biomass energy crops such as short rotation coppice willow (SRC willow) and this is seen as a real opportunity for the agriculture sector to reduce and secure farm energy costs and GHG emissions as well as feed into the Bioenergy market. The uptake of biomass heating has been slow over the last number of years. However, the Renewable Heat Incentive (RHI) run by DETI is helping progress towards the extremely challenging target of obtaining 10% of heat from renewable sources. This target is set within the Strategic Energy Framework for Northern Ireland.

In some cases, Bioenergy is seen as an economically uncompetitive crop to produce and so its multi-functionality is an attribute which could offer farmers, landowners, agri-food processors and water utilities solutions to current problems by providing sustainable, cost effective and compliant waste water management options. To this end research sponsored by DARD and the EU ANSWER (Agricultural need for sustainable willow effluent recycling) project have explored solutions for real waste water problems as outlined in the following sections.

Overview

Throughout Ireland there are many small rural Waste Water Treatment Works (WWTWs) which are serving populations beyond their design capacity or which have been overtaken by more stringent discharge requirements demanded by tightening EU water quality regulations. The following 'proof of concept' schemes have been recently commissioned using Short Rotation Coppice Willow (SRC) willow to treat WWTW effluents.

Irrigation protocol

Climate controlled zoned area irrigation systems have been designed, constructed and commissioned and are currently operating to approximate irrigation levels up to 1 mm/day, (10 cubic metre/ha/ day, up to approx 3,500 cubic metre/ha/yr). A system of environmental controls, water monitoring and data acquisition software has also been incorporated to ensure appropriate weather related irrigation and ongoing monitoring of system loading. Each zone is irrigated for a pre-set length of time before the micro-controller automatically opens another valve commencing the irrigation of another zone. The length of irrigated time in conjunction with the flow rate for that section has been calculated in order to apply the desired hydraulic loading (and the associated Nitrogen and Phosphorus levels) to ensure sustainable and environmentally sound waste water application and SRC willow fertilisation.

Proof of Concept site - Bridgend, County Donegal

The WWTWs at Bridgend, Co. Donegal serves a population of approximately 500 and produces an effluent inflow volume averaging approximately 80 cubic metres/day. This exceeds the original design capacity and as such a 14ha SRC willow and irrigation site was constructed to facilitate the treatment of this effluent [Figure 1]. A 400 cubic metre storage tank was also constructed to act as an effluent buffer to smooth out irrigation to land opportunities with prevailing climate and its suitability for irrigation.

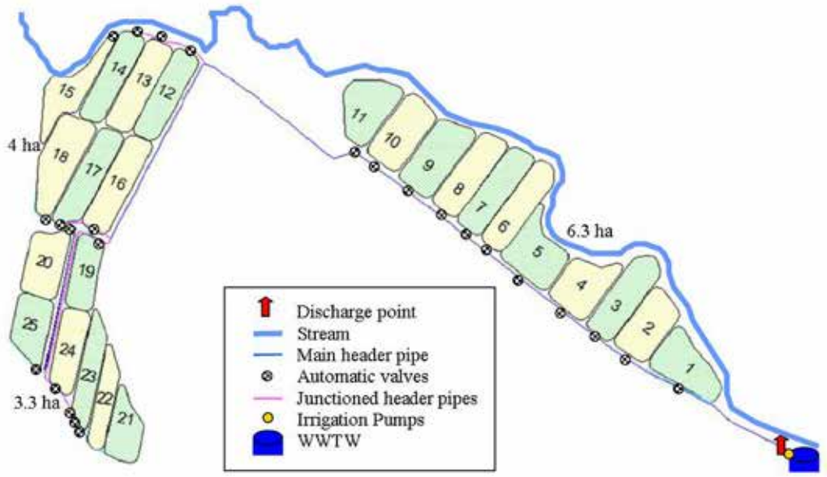

Figure 1. The 14 ha field layout indicating the main pipeline, 25 zones and valves.

Current data

The irrigation system was commissioned at the beginning of May 2014 and the irrigated total to 5th August 2014 was 6,512 cubic metres (over a period of 97 days). The data in the graph below indicates irrigation in the early part of this period at approx 30 cubic metres/day up to the 1st week June and the subsequent readjusting of the irrigation rate to manage the inflow to the WWTW [Figure 2]. The total irrigated volume to the plantation since commissioning is 5,129 cubic metres and the total inflow into the treatment works during this period has been 5,816 cubic metres. Therefore it can be concluded that 12% of the inflow into the treatment works has been discharged with the remaining 88% being recycled in order to fertilise a renewable energy crop. The average irrigation volume per day during this recent phase has been 84 cubic metres/day giving an average application rate of 6 cubic metres/ha/day.

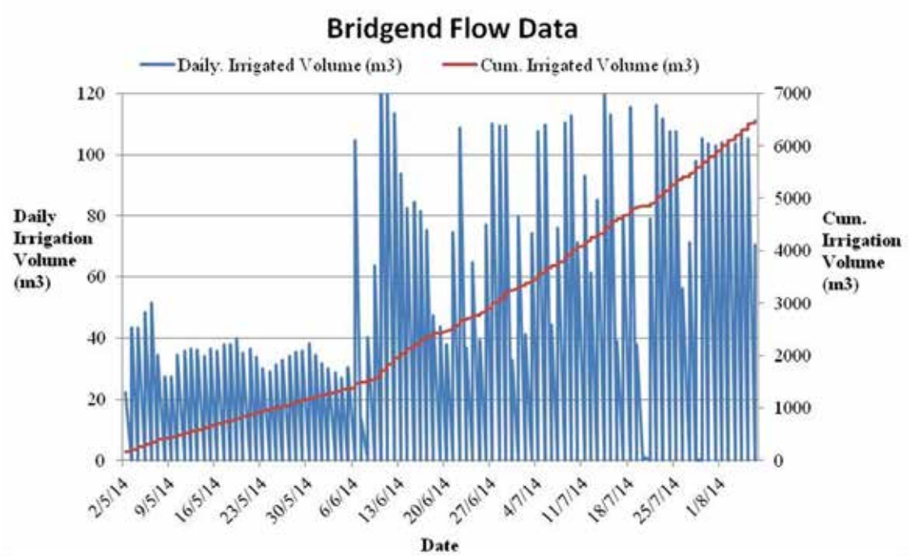

Figure 2. Daily and cumulative irrigation pattern (Bridgend)

Proof of Concept site - Clontibret, County Monaghan

The WWTWs at Clontibret, Co. Monaghan serves a population of approximately 200 people and produces an effluent inflow volume averaging approximately 30 cubic metres/day. This exceeds the original design capacity and as such a 7ha SRC willow and irrigation site was constructed to facilitate the treatment of this effluent. A 205 cubic metre storage tank was also constructed to act as an effluent buffer to smooth out irrigation to land opportunities with prevailing climate and its suitability for irrigation.

Current data

The irrigation system was commissioned in the middle of May 2014 and the irrigated total to 5th August 2014 was 2,261 cubic metres (over a period of 83 days). The irrigation regime averages 27 cubic metres/day up to 5th August 2014 giving an average application rate of 4 cubic metres/ha/day. The total inflow into the treatment works during this period has been 2,367 cubic metres. Therefore it can be concluded that less than 4% of the inflow into the treatment works has been discharged to the waterway with the remaining 96% being recycled in order to fertilise the SRC willow renewable energy crop.

Figure 3. Showing irrigation pipes running through willows

Future applications

As well as SRC willow plantations providing the opportunities for the sustainable management of potentially polluting effluents from waste water treatment works, other applications of these energy crop plantations are currently being investigated throughout Ireland, such as the use of SRC willow to manage diffuse pollution from fields likely to assist runoff of nutrients (livestock or chemical fertilisers) into environmental waters (riparian strips) and the ability for SRC willow to Bio(phyto)remediate polluting leachates from landfill sites. Within the EU ANSWER project, a landfill site has been engineered to allow the planting of SRC willow and appropriate drainage to be installed to allow true proof of concept investigation of the role these technologies can play in helping manage these very costly and environmentally damaging scenarios [Figure 4].

Figure 4. Churchtown landfill site surface engineering

For further information on this subject contact:

Chris Johnston on **(028) 9268 1540** or email **chris.johnston@afbini.gov.uk**

Alistair McCracken on **(028) 9025 5244** or email **alistair.mccracken@afbini.gov.uk**

ANSWER (Agricultural Need for Sustainable Willow Effluent Recycling) project, part-financed by the European Union's European Regional Development Fund through the INTERREG IVA Cross-border Programme managed by the Special EU Programmes Body.

answer

European Union
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Investing in your future

Heat from biomass at Liscausey Hall, Stewartstown

Andrew McCrea, Stewartstown, Co Tyrone

Andrew McCrea operates a large sow breeding unit with all progeny reared to approximately 30kg, before being transferred to off-site finishing units to be finished to slaughter weight. He produces 17,000 pigs each year to the British Quality-assured Red Tractor standard. Andrew continually achieves excellent levels of performance from this breeding unit and he was a DARD Focus Farmer and the 2010 Farmers Weekly National Pig Farmer of the Year.

He writes about a wood pellet boiler installed in his farrowing unit in January 2014.

I had been using water heat pads in my farrowing houses to provide supplementary heat for small pigs for many years, with warm water heated by an oil boiler. This had worked well though the oil was a significant cost to my business. I began investigating the use of biomass heating last year and finally installed my 99 kW pellet burner this January. This was a major decision due to the high capital cost of the boiler and heat store. However after nearly a year in operation the system has worked satisfactorily and the projected economic benefits are being realised.

This was a first for both myself and the installers (on a pig farm) so we had a number of issues to work through together. Firstly, positioning the boiler system close to my existing oil boiler was a challenge but this was essential as I wanted to use the existing water pipe network. However as the new boiler system was developed within a 'pod' we were able to set it in place using a crane.

As the boiler is in the centre of my pig unit and the storage bin for the pellets is at the edge of the unit to aid delivery, the pellets have to be augered over 25m. This is further than recommended as the pellets may break during transfer and create more dust. However in practice this has not been a problem.

Initially I was informed that I would have to install heat meters on pipes entering and leaving each house to determine heat loss. However I employed a consultant to produce a 'heat loss calculation' for my unit which was accepted by Ofgem so this additional expense was avoided.

The paperwork for claiming the Renewable Heat Incentive was challenging, and delayed my payments considerably. I would recommend the use of a consultant to assist with this aspect as it saves much time and effort. My first payment was delivered in August and was gratefully received!

The potential savings from this project are set out below:

Cost of oil per year (at 57 pence/litre)	£25,000
Cost of wood pellets per year (£200/tonne + VAT)	£19,495
Saving on fuel costs per year	£5,505
Value of the Renewable Heat Incentive per year (6.3 pence per kWh of heat)	£21,097
Overall saving compared to oil heating	£26,602
Capital cost of the boiler system	£34,500
Payback time in years	1.3

The pellet boiler requires slightly more effort for its operation and maintenance compared to an equivalent oil boiler. Ash has to be removed approximately every two weeks but even after this period it only amounts to a large bucket full. The boiler is stopped once every six weeks and brushed down and it is serviced every six months. The supplier has been proactive with component upgrades and at the last service they replaced the compressor so that they were sure that the boiler was cleaning properly and that the burner tube was completely clear of ash after each run cycle.

Overview of biomass heating

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 20% and 30% moisture. At this level, it can be safely stored, giving good energy production when burnt. Wood pellets are normally supplied with moisture content between 7% and 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, to pellet and woodchip boilers. Boilers can provide a combination of space heating of buildings, hot water for various processes and steam. Boiler sizes range from 10kWth to 45kWth for domestic use, 50kWth up to several MWth for commercial use.

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 30% and 100% of its rated capacity. In this instance the heat store is used to meet peak loads.

Renewable Heat Incentive

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

- Payments are made for using renewable heat technologies
- Biomass heating is included
- Open from 1st November 2012 for commercial applications and for domestic users by late 2014/early 2015
- Commercial tariffs paid for 20 years with a proposed seven year domestic tariff.
- If heat demand is very high, payback periods can be very short, as in the case study above. If demand is low and capital replacement costs are high, then biomass heating may not be suitable.
- Use the biomass payback calculator to evaluate your own situation.

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

Solar photovoltaic monitor farm case studies

David Trimble, Renewable Energy Technologist, CAFRE

The potential of photovoltaic panels to produce electricity has been well known for many years. However they were previously an expensive technology to produce. With new production methods and economies of scale the cost of production began to fall. By early 2012 the price had fallen sufficiently for them to be more widely considered for use on farms and some of the first installations appeared on farm businesses in Northern Ireland.

It was a new and unknown technology for most local farmers and there was uncertainty about the output of the panels and the associated financial return on the investment. As part of a CAFRE technology project, a number of farms where PV systems had already been installed were identified, and agreement was obtained with the farmer to monitor the output of electricity from the system.

Five farms were chosen in a range of locations – Buckna, Kilrea, Strabane, Dungannon and Lurgan. There was a range of installation sizes involved, from 6.5 kW to 50 kW. Some installations were on agricultural sheds and others on the roof of intensive livestock houses. The electrical output data was obtained from the farms on a regular basis and the table below gives a full year's data for each installation.

Farm	System size	Orientation & angle	Time period	Output (kWh/kW)
Buckna	6.5 kW	South, at 30 degrees	Sept 2012 to Aug 2013	925
Strabane	20 kW	Almost due South and good pitch	Mid-Dec 2012 to Mid- Dec 2013	861
Lurgan	20 kW	10 degrees off South and about 15 degrees angle	2013	830
Kilrea	50 kW	Slightly off South and at 22degrees	April 2013 to March 2014	846
Dungannon	20 kW	SE and low pitch	2013	920

The main point of interest was that all of the systems gave a greater output than that predicted by the Standard Assessment Procedure (SAP) calculation. This is a calculation that installers are required to undertake for a potential client as an indication of the output of their system. In the best case the system produced 16% more that that predicted by the SAP calculation.

The project was not an attempt to measure the output of a particular make of panel or the efficiency of a particular make of inverter. This was not possible as each of the installations had a different orientation and pitch and also there was variation in the level of shading from the terrain or from adjacent buildings.

The data showed the seasonality of electricity production. For the two systems that had electronic recording and on-line data monitoring, 70% of the electricity output occurred between1st April and 31st August. This has implications for the payback on the investment. There will be a quicker payback where there is a high electricity demand on the farm in the warmer summer months, for example in an intensive livestock house that requires ventilation.

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 German 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%.

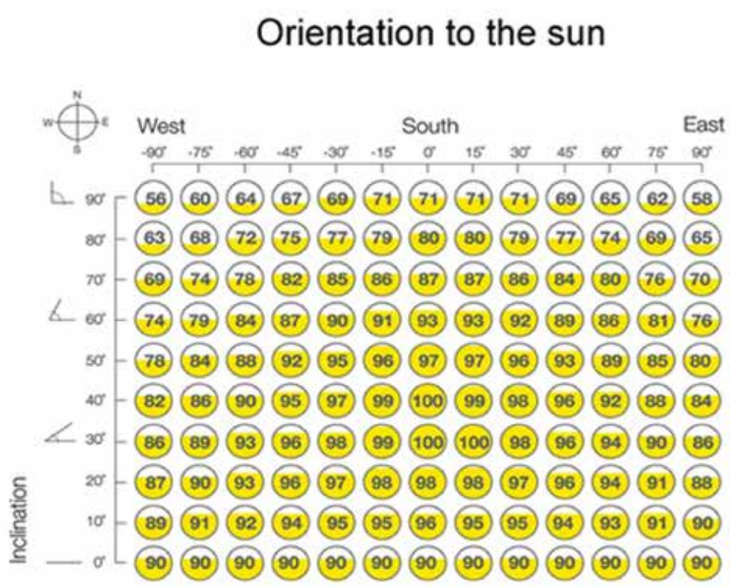
Influences on power output

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 to the south and also the angle to the horizontal.

The figure below gives a guide to how the output changes at different orientations to south and different angles to the horizontal. The maximum output of 100 is 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.



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 0.52 kg of carbon dioxide released to the atmosphere. This additional gas contributes to global warming and climate change.

A typical farm scale 20 kW PV system will generate around 16,000 kWh each year, saving 8.32 tonnes of 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). The ROCs are explained elsewhere in this 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.

For each kW of installed capacity at 30° to the horizontal and either SE or SW the electrical output is estimated to be 822 kWh. Allowing for a decline of 0.7% each year over 20 years this gives an average output over the lifetime of the system of 764.5 kWh.

Tilt of collector	South	SE/SW	North
30^0	858	822	584
60^0	791	742	400
Vertical	597	564	297

Daytime farm electricity costs around 16 pence per kWh, the ROCs are currently worth 16.3 pence per kWh, and electricity sold to the grid is worth 5.1 pence per kWh.

Using 100% on the farm each unit is worth (16 + 16.3) pence totalling £247

Selling 100% each unit is worth (5.1 + 16.3) pence totalling £164

A typical farm scale 20 kW capacity system will cost £25,000 or £1,250 per kW. With the annual output range from £164 to £247 the simple payback times will range from 5 to 7.6 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 calculator which can be used to work out the payback in changing circumstances. This is available on request by e mailing David Trimble at the address below.

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

Micro-hydro at Terrydoo, Limavady

Nigel Moore, Senior Renewable Energy Technologist, CAFRE

John Oliver Snr and his son John run a traditional hill beef and sheep farm at Terrydoo, Limavady in the shadow of Binevenagh. For many years, John Snr has had an interest in hydro power, stimulated by a friend and neighbour whose family used to run a mill powered by a water wheel fed from a river which runs through John's farm.

With the advent of support for microgeneration through Renewable Obligation Certificates (ROCs), and the increase to four ROCs for micro-hydro under 20kW in April 2010, John was spurred into action and he commissioned a feasibility study. A potential site was identified on a burn, running off the western slopes of Tibaran mountain, through the farm from where it emerges from Cam forest down to the Terrydoo Road. The burn ran down a ravine through unimproved grassland, and initial measurements indicated a height differential from source to potential outfall of around 114m (gross head). While the amount of water in the burn was not large, except after heavy rain, the large head available made this a viable site.

John employed the services of HydroNI to develop the scheme and they looked after most of the administration of the project which can be substantial. Planning permission was obtained and an early application was made for a grid connection. This was available at the time for a reasonable amount and progress continued with the necessary licensing arrangements.

An application was made for grant funding under the Rural Development Fund through ARC NW in August 2011, and a positive award was made 12 months later.

Following identification of the site, a temporary measurement weir was installed close to the proposed intake point and daily measurements were recorded to ascertain the actual flow in the system. The potential power output of a site is a function of the head and the flow. The abstraction licence from NIEA dictates the residual flow that must remain at all times and the resulting calculations indicated that a 20kW system would be best for the site.

Work on installing the 1200m of pipeline and the turbine house were completed by January 2014.

Further works continued to create a small reservoir of water, sufficient to hold enough water to run the turbine at full capacity for 24 hours, just above the intake point. This allows the system to capture more water following heavy rain, and enables it to be

utilised by the turbine for a longer period, smoothing out the level of production, maximising the use of a smaller turbine at lower capital cost.

The turbine chosen for the system is a 20kW Peleton type turbine, which is best suited to high head sites such as this one. It is highly efficient (85-90%) and achieves rotation speeds high enough to enable direct connection to a generator. It is housed in a turbine house built in a small clearing between the farm lane, some new dwellings and the river to which the water is returned. With the proximity to the new houses, the building was soundproofed, and it is difficult to detect when the plant is running from outside the building.

In addition, due to the landscaping it is difficult to see from the houses as well. Space has been left in the building for a second turbine, should another system be developed on the adjacent river, but this project is currently on hold due to a very high potential grid connection cost.

To date the plant has run at a very satisfactory level, with payback anticipated within the budgeted five year period.

For further information, contact John Oliver Jr on 07820145349 or email: johnoliver20@live.co.uk

Energy from Wind at Lisnagault Farms, Coleraine

David Curry, Dairy, Pig and Arable Farmer, Coleraine

David Curry farms at Coleraine where enterprises include 130 dairy cows, fattening 1,200 pigs and growing a substantial acreage of grain. He writes about the recent installation of a 225 kW Vestas V27 turbine.

I had been interested in the possibility of installing a wind turbine as far back as 2007. I knew from discussing my project with a family member, who had already installed a turbine, of the importance of having a good windy site for the success of a wind turbine project. My land is flat and open to the south west, and so I was fairly confident that we had enough wind for a turbine to be successful. It was attractive to think that it could generate an income for the business without needing any major labour input.

I approached the Planning Service in 2007 for initial discussions, though at this stage, I was concerned that the project would be rejected on the basis of visual impact. I eventually had the courage to apply for planning permission in July 2010 and received this in February 2012.

With this in place a number of things began to be progressed, more or less in parallel. I applied to NIE for grid connection in the same month and began investigating the options for finance. Until I received planning permission, I had not been overly active in researching turbine technology up to this point or the supply options available locally. All of these issues needed a substantial amount of effort and determination to work through to a satisfactory conclusion.

I received NIE approval for the grid connection in September 2012, and paid them a 25% deposit in December 2012. After this there were still several stages to go through, including an earth test to determine the amount of earth cable that was needed, the easement down to the site of the turbine and finally the commissioning of work on a new pole, new sub-station, control house and all the associated wiring.

My hopes of having an operating turbine by June 2013 proved to be too optimistic and the commissioning date was the 10th August 2014.

Obtaining finance was another journey and set of experiences. In summary local banks did not appear too interested in funding renewable energy projects despite their initial good indications. The HSBC, after some discussions and detailed business plans, were supportive of the project and have been very good to work with to date.

Turbine choice was the biggest decision that had to be made. I looked at the option of installing a new turbine and was very tempted by this approach. However, the price was high and uncertainties existed at the time about financial support. In addition, a number of the new models on the market were newly developed and it was very difficult to judge if they were going to be reliable and successful machines.

In the end I settled for a second hand refurbished machine. I bought a 20 year old 225 kW V27 out of Germany. The nacelle was taken to Denmark for refurbishment and the tower and blades came here directly. I became more and more convinced that the people I was involved with knew how to successfully refurbish a turbine. The technical expert in Virogen set exacting standards for all the work and in particular he understood the electronics required for a successfully operating turbine. Virogen arranged all the necessary work, including a specialist fibreglass technician to work on refurbishing the blades and they also worked on refurbishing the external surface of the tower and specifying the design of the control panel for the switch room.

Some advice to prospective people who wish to install a wind turbine is not to set fixed deadlines for the work. I had purchased my turbine a year before it was up and working. This was through no fault of the Virogen installation team, but instead was down to the number of hoops we had to jump through and the time it took the relevant bodies to give their permission and to carry out their work. It is also crucial to have full confidence in the technical team that carries out the refurbishment and installation work. To date I have only praise for the company that carried out my work. All I need now is for a good strong breeze to prevail and hopefully all the effort to date will be worthwhile!

For further information contact David Curry on 07720573637 or
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Biogas Production at Holly Park Farm

Reuben McFarland, Holly Park Farm, Fintona

The farming industry has been a way of life for many generations across Northern Ireland. Farmers have faced many ups and downs particularly since the BSE crisis in 1996. The insecurity of income and rising costs in recent years has forced farmers to look for an alternative to their normal farming activity.

Holly Park Farm outside the small town of Fintona is no different. After working as young boy for many after- school hours on the farm, I spent some time at Greenmount Agricultural College. Ambitions and plans of the bunch of students when they graduated were numerous! With eagerness and youth on my side, I came home to farm in 1991, aiming to make my fortune with an endless number of years ahead! Sheep and some arable crops were the main enterprise on the farm and, in later years, beef cattle were added. Like most farmers, if we were honest, we tended to get in a rut and do the same thing day in day out whether we made a profit or not. Sometimes it takes a shock to make us refocus our energy.

In 2006, along with a good friend, Ian Bradley, we decided we would diversify toward renewable energy. We considered wind energy, installing wind meters to see if we had suitable sites. The windspeed results obtained revealed that this may be only marginally profitable.

In April 2008 we spent five days in Austria on a study of Biogas plants. This changed our focus completely. We came home fired up about the concept and felt it was the way to go but were totally unaware of the many hurdles along the way! This would mean we could farm as normal and reap energy, albeit in a different form.

Initially we planned on two small scale plants approx 250kW, to suit the size of our farms. This plan was quickly 'thrown in the bin' by the finance companies due to poor return on investment. We were left with the option of a 500kW plant. It brought new problems such as more land required and greater investment. The advantage was that it would be a shorter return on the investment.

Other aspects we had to consider when choosing the technology at that time were:

- Biogas plant efficiency
- Will it work on the feedstock here in NI (e.g. grass silage)
- Plant simplicity
- Maintenance backup

In January 2009, we applied for planning permission and 12 months later it was granted. Next step was grid connection where we received our offer in October 2010. These were both reasonably straightforward. Unfortunately, the next steps were not as straightforward, causing more grey hairs than anticipated! Obtaining finance proved to be the most difficult aspect of the whole project.

Plant construction finally began at the end of 2011 and on 5th December 2012, the 500kW Hochreiter biogas plant at Holly Park Farm was commissioned. After all the time and effort spent in getting to this stage, hearing the engines roll into life is a day that will not be forgotten for quite a while.

After the start-up of the AD plant, there is the job of applying to Ofgem for accreditation to receive the all-important Renewable Obligation Certificates (ROCs). This can be a long drawn out complex process. For Holly Park Farm Energy, it took three and a half months for accreditation to be obtained.

Plant operation post commissioning

At the time of writing the plant has been running for over 18 months and generally it has performed well. Of course, like any new venture, there is always plenty to learn and in this case you have to learn fast. After commissioning, the aim was to get it to full output as quickly as possible. We discovered that you do not rush an AD plant with extra feed to increase gas yields quickly. Over-feeding can create major problems. Feed consistency is also a major factor

on how an AD plant performs, as major changes in diet are not appreciated by the biology. Our AD plant consists of a primary and a secondary tank both of which operate at a thermophilic temperature of (52˚C).

The main feedstock for the Holly Park Farm Energy plant is grass silage as it is the most available and cost efficient feed to grow in Northern Ireland. We have fed quantities of fodder beet, maize silage, maize meal and wholecrop along with the silage, but are currently undecided on one that really excels in efficiency when the cost of growing these crops are taken into consideration.

A proportion of the heat generated is utilised in maintaining the plant operating temperature and our own dwelling house is heated using a very neat heat exchanger.

Conclusion

The planning and building of an AD plant has been a challenge and definitely not for the faint hearted. However, it is rewarding when all the time and effort invested ends with a successful outcome. It is quite satisfying to know that the renewable electricity we produce every day will provide enough on average to power 700 houses.

For further information contact Reuben McFarland on 07786375727 or email: reuben.mcf@btinternet.com

Developments in energy storage for small scale renewable energy

David Surplus, Director, B9 Energy Storage Ltd

Ambitious targets and support mechanisms for renewable energy in Northern Ireland have prompted planning applications for over 3000 small scale wind turbines, 200 farm scale Anaerobic Digestion plants (AD) and a smaller number of larger scale solar PV installations. However only a small number of these will obtain cost effective grid connection offers. This is because the 11kV network is not monitored or controlled by the network operator, so that a lack of load at times of peak wind can cause system voltage to rise above statutory limits. Assuming that the trend towards decentralised embedded generation continues to be held up in this way, then entrepreneurial farmers and landowners will be constrained to go down the route of self generation and collective microgrids. The extent to which this can deliver a successful outcome depends on the type and amount of load that is nearby and whether effective energy storage devices can be deployed.

Wind and solar PV provide the easiest method of generating power with 250kW and 50kW respectively being the maximum installed capacity to receive the quadruple ROCs support. Energy storage provides controllable load to balance the output from the generator in real time. This ensures that the voltage remains steady and that the generator does not need to be switched off (self curtailment). The energy storage **load** in kW needs to be matched with the instantaneous power output from the generators and the energy storage **capacity** needs to be available for the duration of generation events, which ranges from a few minutes to several days at a time.

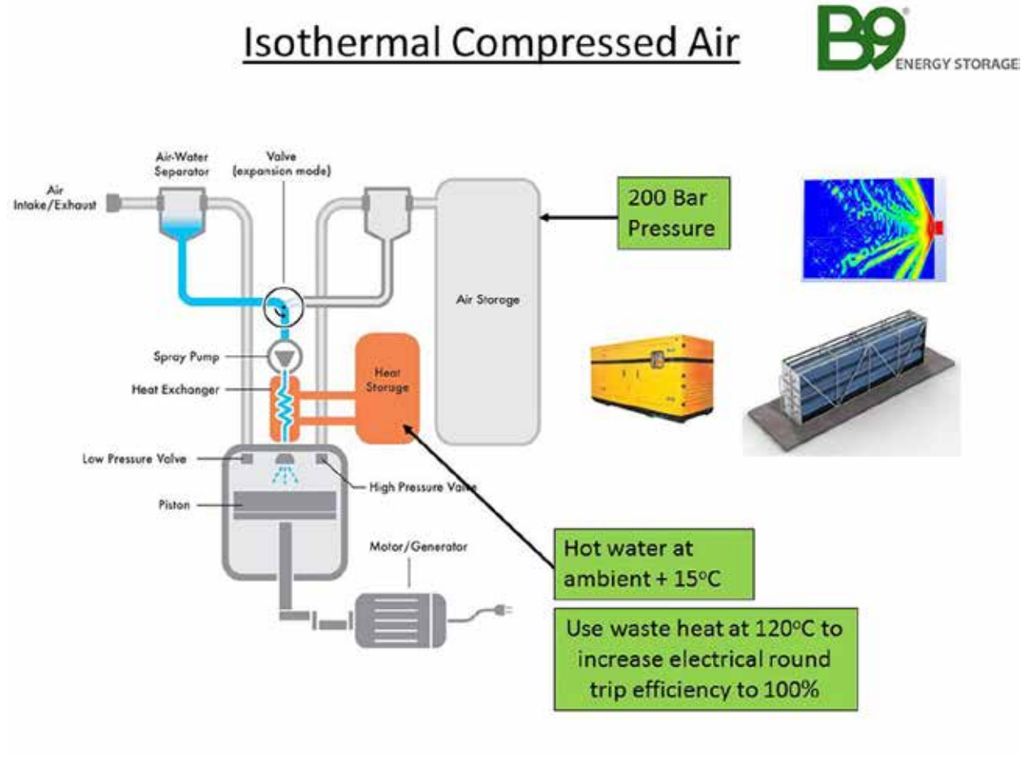
Half of all electricity generated is ultimately converted to hot water and space heating. Assuming that this ratio holds true for the rural community then water heating and the storage of the hot water in large insulated tanks is a low cost place to start with energy storage. From immersion heaters in domestic scale tanks to electrode boilers coupled with mega tanks containing hundreds of tons of hot water, there is a full range of products on the market to suit the scale of operation being considered. Heat loss from buildings increases when it is windy so that the output from wind turbines is provided at the opportune moment.

Batteries have their uses in every energy storage applications because they have fast response and good levels of efficiency. However, they are limited by storage capacity and cost so that they cannot generally provide a total economic solution by themselves.

Refrigeration and chilling are very good controllable loads because the temperature of cool spaces can be modulated within limits to follow the pattern of available wind and sun. Refrigeration load increases when it is sunny so that the output from solar PV is provided at the opportune moment.

New low cost energy storage technologies are emerging that will help to transform the capability of this industry sector. In particular, B9 Energy is of the opinion that Adiabatic and Isothermal Compressed Air systems are set to provide very significant contributions. Both technologies store the heat of compression in addition to the mechanical energy. Heat is fed back into the processes during the expansion cycle which ensures that the overall return trip efficiencies are greatly improved as compared to earlier compressed air storage designs. The products are modular, scalable, can be located anywhere, have separate devices for power and energy storage, contain no hazardous or rare earth materials, produce no emissions, have a long life and are projected to be half the price of batteries.

Generation projects which are isolated from the grid and which do not have suitable controllable load nearby require another option. The only real solution is to bring new loads into the area by establishing new businesses such as poultry farms, fish farms, mushroom farms or hydroponic vegetable houses that have significant loads for heating and cooling, pumping, ventilation and lighting.



Another promising storage technology involves the production of Ammonia as an alternative fuel for engines in tractors, fishing boats, cross channel ferries and stationary gen-sets. Ammonia is also a common feedstock for a diverse range of products such as fertiliser, cleaners, antibacterial agents, fermentation agents, refrigerants and scrubbing agents (for NOx and SOx emissions from power plants). Controllable loads are found in the machinery components that drive the following systems:

- Electrolysis of water to produce Hydrogen gas (H_2)
- Scrubbing of air to produce Nitrogen gas (N_2)
- Haber Bosch catalytic reaction of N_2 and H_2 to produce Ammonia gas (NH_3)
- Compression of NH_3 gas at 12 bar to form liquid NH_3

The electrolyser would have a much larger capacity than the other components and would only be operated part time at peak wind, peak sun and/or peak tide. Much development work is being carried out on this technology in Minnesota, USA where there is a strong wind resource and very low background electrical load. Their 1.5MW wind turbine provides power to a 40ft container located at the base of the tower which produces liquid ammonia for fertiliser and tractor fuel.

Like most things in life, the devil is in the detail and careful consideration would need to be undertaken through a properly structured feasibility study before the best solution for any particular project could be ascertained.

For further information, contact David Surplus on (028) 2826 3925 or email: d.surplus@b9energy.co.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.

The high level of demand for renewable energy connections has led to very high levels of applications since 2010 with considerable congestion now arising on the distribution network, particularly in the west of the province. A view of the level of congestion in various locations is reflected on a Heat Map accessible on the NIE Website. Capacity matters are dealt with in more detail below. The NIE Website Connections section also provides information on recent press releases and other communications relating to renewable energy generation.

If a developer wishes to proceed with an application they may decide to have a feasibility study carried out first or, once planning permission for the renewable energy generator has been received, move straight to the application process. Given the congestion now arising on the network NIE considers it may be prudent for developers to review the Heat Map or consider a feasibility study prior to proceeding with an application. NIE notes however that committing to a feasibility study does not entitle a developer to a position in the generation queue for capacity on the network. Such position in the queue can only be secured with a full application.

Getting a feasibility study

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, potentially 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 application process

Where a developer decides to proceed with a renewable energy project, and has gained the relevant planning permissions (or equivalent permissions), the developer 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 fee.

Following receipt of a valid connection application, NIE will issue a connection offer within 90 days. Developers then have 90 days to accept the offer and provide a deposit of 20% of the total costs. 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.

When an offer has been accepted and the deposit paid, NIE will start the necessary pre-construction works to facilitate the connection e.g. wayleaves, earthing, legalities. A typical connection may require a new line, transformer and equipment cubicle. Planning permission may be required for the connection. Some connections may even require NIE to provide equipment which is not readily available and these items may have a significant order time.

When all the pre-construction works are complete the job will be handed over to a construction team to build and connect your generator. 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.

Capacity issues

The unprecedented level of applications from small scale generation developers has resulted in the saturation of the distribution network in a number of locations across Northern Ireland, particularly in the North and West. The impact on connection offers has been twofold.

Firstly, costs for connection associated with work on the 11,000 volt (11kV) network have risen markedly since 2012 due to additional reinforcement required in congested areas. These costs are directly chargeable to developers leading to escalating costs within offers.

Secondly, capacity limits on the 33kV network have been reached in a number of locations. Under NIE's current Statement of Charges for Connection to the Distribution System (the 'Statement of Charges' as approved by the Utility Regulator) the costs of 33kV investment to resolve these issues would fall to the general body of customers.

While continuing to engage with the Utility Regulator regarding this investment, NIE proceeded to issue offers conditional on 33kV investment being agreed by the Utility Regulator. The Utility Regulator approved some 40 discrete lower cost 33kV investments totalling £2.3m in October 2013. This led to conditional status being removed from over 80 offers to date, enabling work on these connections to proceed, and it will facilitate further non-conditional offers being made.

However, approval for the remaining higher cost investments has not progressed. In its final determination of the RP5 price control, the Competition Commission decided that levying further costs of 33kV investment on the general customer base to support small scale renewable energy was not in the public interest. Furthermore, following a dispute in respect

of a conditional connection offer, the Utility Regulator's recent determination (Determination DET-522) has concluded that "Accordingly the Connection Agreement cannot include the Conditional Terms".

Consequently, NIE has now withdrawn all connection offers with conditional terms relating to the 33kV network, which have already been issued to developers, as provided for in Article 21(1) (c) of the Electricity (NI) Order 1992 and, in respect of safety considerations, as provided for in Condition 30(5) (a) of the NIE Electricity Distribution Licence.

NIE will also be unable to make any further connection offer at this time for those which have been withdrawn. In addition, NIE will be unable to make connection offers for applicants seeking export capacity in such locations. To date there have been over 200 applicants who have had offers withdrawn/not made.

Further work around matters relating to renewable energy generation - Project 40

In May 2014, 'Project 40' (the '40' referencing the 40% target) was established to assess industry best practice and consider a range of technical and commercial approaches for connection of large scale, small scale and micro renewable generation. This was to optimise network access and delivery to the NIE network.

The focus is to engage industry Distribution Network Operators to: assess best practice, consider the range of connection methodologies/ approaches, develop the most effective commercial and technical models, engage and consult with renewable energy industry to agree the most effective approaches and protocols.

Specific challenges will be considered through working sub-groups comprising technical, commercial, financial and legal representation from NIE, together with representation from Industry, NIRIG, the Utility Regulator, Ulster Farmers Union, DETI, DARD and other stakeholders where appropriate.

In relation to the issues regarding capacity restrictions outlined above, NIE will now undertake a review of the Statement of Charges. This review will consider various options to deal with the 33kV capacity issue. These options will include whether 33kV investment might be passed to developers and/or whether alternative connection arrangements might be offered.

With regard specifically to alternative connection arrangements, work has been ongoing to develop an approach whereby the output of the generator is controlled to avoid 33kV network capacity limits being reached, and to reduce connection costs associated with 11kV network reinforcement. Similar approaches have been adopted by other network operators in GB, albeit there are inherent differences between the NIE network and those in GB which may impact the viability of this scheme.

NIE expects to bring forward proposals for consultation shortly. However, taking account of the comprehensive nature of the Statement of Charges review and the detailed technical work required before any alternative connection method could be finalised, it is likely to take to the later part of 2015 before changes could be implemented.

NIE will continue to provide renewable developers with relevant information regarding the level of congestion across the electricity network.

For further information, contact NIE on 08457643643 or visit www.nie.co.uk/Connections

Planning permission for wind turbines, solar collectors and anaerobic digesters

Planning guidance team, Strategic Planning Division DOE

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, single or multi-turbine, 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 metric scaled drawings and fee. Full details are available on the NI Planning Portal at www.planningni.gov.uk or from your local Area Planning Office (http://www.planningni.gov.uk/index/about/local_area_planning_offices.htm).

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

Material considerations

The range of factors that DOE take into account in determining any individual application for a single wind turbine 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 at www.planningni.gov.uk), and comments that relate to planning issues from the general public and statutory consultees. They also include the impact of the proposed development on:

- public safety; human health; or residential amenity
- visual amenity and landscape character
- biodiversity, nature conservation or built heritage interests
- local natural resources, including air and water quality
- public access to the countryside

Fees

The fee for a planning application for a wind turbine(s) or wind farm falls within Category 5 of the Scales of Fees within the Planning (Fees) Regulations (NI) 2005 as amended (the Fees Regulations) and where the site area does not exceed five hectares the fee is £357 for each 0.1 hectare of the site area. Where the site area exceeds five hectares, the fee is £17,824 and an additional £106 for each 0.1 hectare in excess of five hectares, subject to a maximum of £265,806.

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 Area 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 the requirement for additional information will depend on the individual circumstances of each particular case.

Streamlined application process

A planning application for a single **domestic** wind turbine may fall within the Department's streamlined application scheme, where 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 local Area Planning Manager, thus enabling faster decision-making on this type of planning application.

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, a building within the curtilage of a dwelling-house or to a building(s) other than a dwelling house, subject to meeting certain limitations and conditions. However, if your dwelling is located within a Conservation Area you should discuss your proposals with your local Area Planning Office. Full details of the application requirements and fees are available at www.planningni.gov.uk or from your local Area Planning Office (http://www.planningni.gov.uk/index/about/local_area_planning_offices.htm).

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

- the design of the module or array
- photographs of the existing built environment
- detail of the roof mounting arrangement, if applicable
- indicative drawings of the module or array in place
- connection details to the building or grid if relevant
- if the application involves a listed building, a photomontage of the proposed collector array could be useful

Material considerations

The range of factors that DOE take into account in determining any individual application for a 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 at www.planningni.gov.uk), and comments that relate to planning issues from

the general public and statutory consultees. They also include the impact of the proposed development on:

- public safety; human health; or residential amenity
- visual amenity and landscape character
- biodiversity, nature conservation or built heritage interests
- local natural resources, including air and water quality
- public access to the countryside.

Fees

The fee for a planning application for solar collectors (panels) falls within Category 5 of the Scales of Fees within the Planning (Fees) Regulations (NI) 2005 as amended (the Fees Regulations) and where the site area does not exceed five hectares the fee is £357 for each 0.1 hectare of the site area. Where the site area exceeds five hectares, the fee is £17,824 and an additional £106 for each 0.1 hectare in excess of five hectares, subject to a maximum of £265,806.

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.

Streamlined application process

A planning application for solar panels is likely to fall within the Department's streamlined application scheme, where 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 local Area Planning Manager, thus enabling faster decision-making on this type of planning application.

Anaerobic Digesters

Planning permission is not always required for anaerobic digester plant (AD).

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 meeting certain limitations. More information is available on the NI Planning portal at www.planningni.gov.uk or from your local Area Planning Office (http://www.planningni.gov.uk/index/about/local_area_planning_offices.htm).

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, Causeway Exchange,1-7 Bedford Street, Town Parks, Belfast BT2 7EG.

Enquiries about specific planning applications and local planning issues should be addressed to the relevant local Area Planning Office, unless it is being processed by the Strategic Planning Division.

Planning applications for anaerobic digesters should be submitted on a P1 form along with the appropriate metric scaled drawings and fee.

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
- Community consultation plans

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
- 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.

Fees

The fee for a planning application for an anaerobic digester in tanks **on an open site** falls within Category 8(d) of the Scales of Fees within the Planning (Fees) Regulations (NI) 2005 as amended (the Fees Regulations) and the fee is £365 per 0.1 hectare of the site area subject to a maximum of £40,828.

The fee for a planning application for an anaerobic digester in tanks **within a building(s)** falls within Category 4 of the Scales of Fees within the Fee Regulations, which is

(a) Where no floor space is to be created by the development, £181

(b) Where the area of gross floor space to be created by the development does not exceed 40 sqm, £181

(c) Where the area of the gross floor space to be created by the development exceeds 40 sqm, but does not exceed 75 sqm, £357

(d) Where the area of the gross floor space to be created by the development exceeds 75 sqm, but does not exceed 3750 sqm, £357 for each 75 sqm, of that area

(e) Where the area of gross floor space to be created by the development exceeds 3750 sqm, £17,930; and an additional £106 for each 75 sqm in excess of 3750 sqm, subject to a maximum in total of £265,806.

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.

Should an application be EIA development then an Environmental Statement has to be submitted to the Department and under the Fees Regulations an additional fee of £10,632 will be payable, subject to the maximum for the category of development specified in the Scales of Fees.

Advance notice of change to planning in Northern Ireland

Please note that on 1 April 2015 planning in Northern Ireland will change from a unitary (single planning authority) to a two-tier system (two planning authorities), which will involve a number of reforms to the planning system. This means that most planning functions will transfer from the Department of the Environment to the new eleven local District Councils, who as the local planning authority will be responsible for preparing local development plans, determining most planning applications and taking planning enforcement action in their respective administrative areas. The Department of the Environment as a planning authority will determine planning applications for regionally significant development and applications that are the subject of call-in from the councils.

Most planning applications submitted to the Department prior to 1 April 2014 and not yet decided, including many for wind turbines, solar collectors and anaerobic digesters, will on that date transfer to the relevant new council to make the planning decision.

From 1st April 2015 and onwards, most planning applications will have to be submitted to the relevant local District Council for determination.

Further details about the change to planning will become available from various sources in due course, including the Department of Environment's website, council websites and the media/press.

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

Michael Harris, Renewable Electricity Branch, Department of Enterprise, Trade and Investment

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 megawatt hours (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 tradable across the UK.

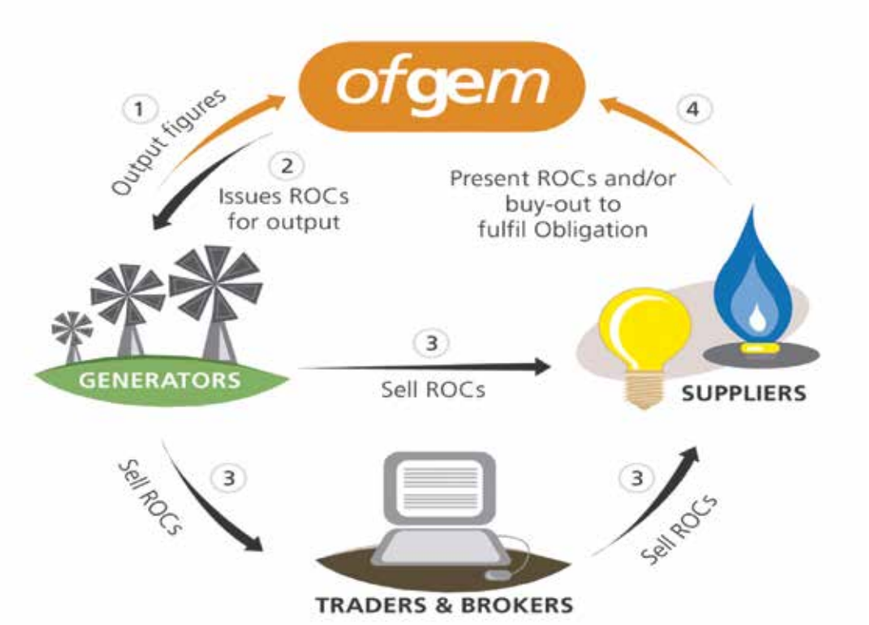
As an alternative to presenting ROCs, suppliers may pay a 'buy-out' fee to Ofgem for each MWh of the specified quantity of electricity that is not covered by presenting ROCs. Suppliers can therefore comply by either presenting ROCs, or paying the buyout (or a combination of the two). At the end of each 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. The Obligation will be set at a level intended to be higher than the anticipated level of eligible renewables generation. 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 is approximately £40.

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.

Diagram: How the NIRO works



Source: Ofgem

Changes to ROC banding levels

A consultation on proposed changes to ROC banding levels for a range of small scale technologies was held during July – September (the consultation closed on 25 September 2014). The consultation sought comments on proposals arising from a study undertaken on behalf of DETI which considered changes to technology costs since higher ROC levels were introduced for small scale onshore wind, hydro and solar photovoltaic (PV) in 2010 and anaerobic digestion in 2011. Based on technology cost changes to date and forecast change to 2017, the study also included recommendations for banding changes.

In summary, the study, and subsequent consultation, proposed no changes to existing ROC levels for onshore wind, hydro and anaerobic digestion as technology costs have not reduced and are not expected to reduce before 2017. However, there have been significant reductions in the technology costs for solar PV and a reduced ROC support has been proposed for this technology. The consultation document can be viewed at http://www.detini.gov.uk/deti-energy-index/deti-energy-sustainable/northern_ireland_renewables_obligation

A government response to the consultation will be published shortly. Any changes to ROC banding levels are subject to approval by the Northern Ireland Assembly before introduction in 2015.

Support for small scale from 2017

Under UK-wide Electricity Market Reform measures, the Renewables Obligation will close to **new** generation and additional capacity 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 continue to incentivise small scale renewable electricity generation from 1 April 2017 by means of a small scale Feed-In Tariff mechanism.

Useful contacts:

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/Sustainability/Environment/RenewablObl

NORTHERN IRELAND RENEWABLES OBLIGATION (NIRO) BANDING LEVELS

Technology	ROC banding levels		
	2014/15	2015/16	2016/17
Anaerobic digestion (≤ 500kW)	4	4*	4*
Anaerobic digestion (500kW – 5MW)	3	3*	3*
Anaerobic digestion (above 5MW)	2	1.9	1.8
Hydro (≤ 20kW)	4	4*	4*
Hydro (>20kW – 250kW)	3	3*	3*
Hydro (>250kW – 1MW)	2	2*	2*
Hydro (>1MW – 5MW)	1	1*	1*
Hydro (>5MW)	0.7	0.7	0.7
Onshore wind (≤ 250kW)	4	4*	4*
Onshore wind (>250kW – 5MW)	1	1*	1*
Onshore wind (Above 5MW)	0.9	0.9	0.9
Solar PV (up to 50kW)	4	1.6*	1.6*
Solar PV (>50kW to 250kW)	2	1.6*	1.6*
Solar PV >250kW Ground or building mounted	1.6	1.5	1.4

* Subject to outcome of consultation process

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

The Northern Ireland Renewable Heat Incentive

Stuart Wightman Renewable Heat Branch, DETI

The Renewable Heat Incentive and Renewable Heat Premium

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 1300 GWh 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 realises 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 applications to be made. As at 4 September 2014, there were 264 applications for support under the RHI and 225 of those had received full accreditation.

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

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	6.6
	20kW$_{th}$ and above but less than 100kW$_{th}$		6.3
	100kW$_{th}$ and above but less than 1000kW$_{th}$		1.5
Biomethane	Biomethane all scales, biogas combustion less than 200kW$_{th}$	20	3.2
Ground Source Heat Pumps	Less than 20kW$_{th}$	20	8.9
	20kW$_{th}$ and above but less than 100kW$_{th}$		4.5
	100kW$_{th}$ and above		1.3
Solar Thermal	Less than 200kW$_{th}$	20	9.0

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 of 4 September 2014, DETI had received 2004 applications and issued 1409 vouchers of which1118 had been returned for payment indicating the technology had been installed.

The total combined capacity of the installed technologies is in the order of 20MW. The total committed spend is currently in the region of £2.7m, this funding represents a total investment in the sector of £9.2m.

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
Air source heat pumps	1700	167	12	128	11
Biomass boilers	2500	700	50	508	45
Ground source heat pumps	3500	158	11	119	11
Solar Thermal	320	384	27	363	32
TOTAL		**1409**		**1118**	

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.

The consultation proposes 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$_{th}$		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
	100kW$_{th}$ and above but less than 1000kW$_{th}$		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 of 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. Consideration and finalising of amendments to the non domestic scheme will be undertaken during 2015.

The Domestic Renewable Heat Incentive Scheme

Another element of phase 2 of the RHI is the introduction of a domestic RHI scheme in Northern Ireland that will 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 for a seven year period.

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 an upfront payment and ongoing tariff support.

The different support levels proposed are detailed below;

	New installations and those supported under RHPP	
	Up front support[1] (£)	**Tariff for 7 years (pence per kWh)**
Air to Water Heat Pumps	1700	3.5
Biomass	2500	5.65
Ground Source Heat Pumps	3500	8.2
Solar Thermal	320	13.5
Bioliquids (when introduced)	500	2.7

The established technologies that are currently supported under the RHPP will continue to be incentivised. Further work is required on bioliquids and will not be included in the scheme at this stage.

Initial arrangements and guidance about the Domestic scheme will be announced in due course and it is expected that the scheme will open for applications before the end of the year.

Further information can be found at:

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

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

Payback times for renewable energy investments

Charlie Kilpatrick, Senior Business Technologist, CAFRE

The introduction of Renewable Obligation Certificates(ROCs) to renewable electricity generators and Renewable Heat Incentives(RHI) for heating systems has created a tremendous interest from farmers wishing 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 as well as 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, the first 12 months forecasts 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 received. 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 (where required)
- Value of output in terms of electricity sold and used, heat generated and used, and income from ROCs & RHI. This value will be directly related to the potential efficiency of electricity or heat generation i.e.
  - For anaerobic digestion, the type and quality of feedstock
  - For a wind turbine the location and associated wind speed on your site
  - For solar photovoltaic panels, the tilt and orientation of the panel, and percentage age degradation

  - For micro-hydro power, the flow and head of the stream or river feeding the turbine
  - For a biomass boiler, the boiler efficiency and moisture content of fuel
- 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 time 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 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 budget 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 calculated based on the previous year with 50% paid on each occasion.

It is important to ensure that you plan tax affairs and manage 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 is 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)

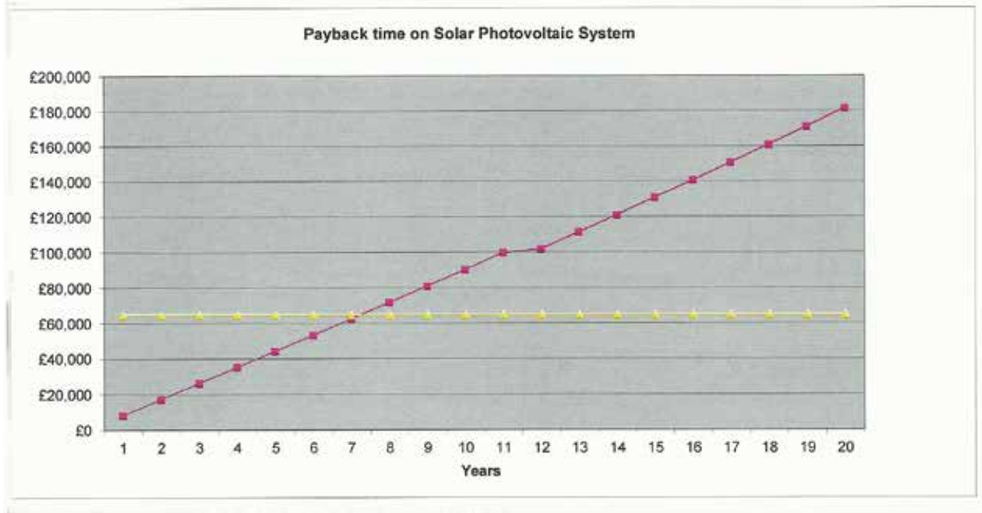
CAFRE payback calculators

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 wind turbines, micro-hydro and solar photovoltaic technologies and take into account all factors that affect cost and level of output together with the value of ROCs, electricity sold and electricity used by the business. Assuming that funding is available, you can use the calculator to apply your own specific circumstance to calculate the number of years to pay the renewable project back. A biomass cost comparison calculator has also been developed that will allow comparison of payback time with conventional oil/gas systems.

Solar Photovoltaic Payback Calculator

cafre
College of Agriculture
Food & Rural Enterprise

System type kWp	50
Installation cost	£55,000
Connection charge	£10,000
Own funding	£15,000
Grant	£0
Borrowed funds	£50,000
Investment	£65,000
Cost to renew inverter at year 12	£7,500
Annual maintenance cost	500
Bank interest	5.0%
Predicted SAP yield kWh/m²/year	1027
Actual Solar Radiation Utilised kWh/m2	822
Panel degradation per year	1%
kWh generated	41080
kWh sold to grid	21080
kWh used	20000
Value of electricity sold	£0.051
Cost of electricity	£0.140
ROC value per kWh	£0.163
Annual ROC income	£6,704
Annual electricity sales income	£1,075
Annual electricity savings	£2,800
Total value generated	£10,579
Electricity increase in value per year %	4
ROC increase in value per year %	2
Life time net cash flow	£116,803



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Financing renewable projects for land owners

Eoin Donnelly and Dominic O'Neill, First Trust Bank Agrifood Team

With the incentive of benefitting a farm business both economically and environmentally, we have seen a significant increase in interest in renewable energy projects particularly in onshore wind and anaerobic digestion. Each project will have its own varying degrees of complexity, associated capital costs and efficiencies generated from the project.

The Northern Ireland Executive's Strategic Energy Framework has a target for 40% of electricity consumption to be generated from renewable or alternative energy sources by 2020, with an interim target of 20% to be in place by 2015. With the percentage currently at approximately 19% there is likely to be continued demand for Bank funding to enable on-going investment in renewable energy projects to meet the 2020 target.

Whilst the government incentives for investing in renewable projects are among the most generous in Europe and planning permission continues to be secured for a wide variety of renewable projects the actual uptake in developing the larger projects has proved particularly slow.

One of the major challenges in delivery of renewable energy projects is the ability to secure the necessary funding particularly for larger scale projects. The main options for funding are:

- The promoter's own funds
- Traditional Bank finance
- Equity finance

With the ongoing economic uncertainty there remains a view in the marketplace that Banks are not lending and in particular are not lending for renewable energy projects. This would appear to be a misconception with most Banks once again in a position to lend to viable business propositions. In this sector, having confidence that the Government supports currently available from NIROCs and/or RHI payments will remain available during the project construction stage until completion and accreditation is one of the key risks. Having gained satisfaction around same, the key to securing funding for such projects is evidence that the project has been well planned, makes economic sense for the business and can clearly demonstrate the ability to repay the debt.

At First Trust Bank we have provided funding for renewable projects predominantly for anaerobic digestion plants ranging from 150kW to 500kW, 250kW scale wind projects and biomass projects. In particular we have experienced considerable demand for our bespoke product offering to fund Biomass installations for Moy Park broiler growers seeking to convert existing housing stock from conventional gas and also for the installation of Biomass in new poultry houses being constructed under our Moy Park Growers scheme.

As further evidence of our support for the renewables sector we have also brought to market a specialist AgriFood Energy Efficiency Loan targeting farms and agri-businesses who introduce energy efficiency measures such as lighting, solar/PV, wind, biomass and hydro projects into their overall operation. This in turn allows these businesses to directly tackle the increasing challenging of rising energy costs whilst benefiting from the current government incentives for renewables. A number of customers are already reaping the benefit of availing of this product.

The four main stages of project financing for a renewable energy project are:

1. Development: securing land, access, planning consent and grid connection

2. Pre-construction: securing funding and financial close

3. Construction: Implementing construction contracts

4. Operation: Ongoing monitoring and maintenance of the project

Banks will generally favour experienced operators with a sound business track record ideally with planning, land access, grid connection offer and a power purchase agreement.

When approaching a Bank or financial institution for finance the promoter should be able to provide the following:

- Up-to-date financial statements for their existing business

- A detailed business plan including profit and loss, balance sheet and cash flow projections to demonstrate the ability of the project to repay the proposed finance over an agreed timeframe

- Details of any equity input or security available to support the project and confirmation of the source of any funds being input

- Confirmation of the legal structure of the borrowed entity

- An outline of project timescale and contingency plans in the event of unforeseen delays e.g. grid connection or registration with Ofgem for Renewable Obligations Certificates (ROCs) or the Renewable Heat Incentive (RHI)

Access to funding and the pricing is likely to vary between Banks depending on the internal lending appetite for these types of projects in each Bank and their experience to date in providing funding for this sector.

In summary a well prepared and planned project will get careful and due consideration from a Bank and increase the likelihood of a positive response to any funding request.

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ISBN: 978-1-84807-499-6

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