REPORT ON THE BIOMASS FOR ENERGY STUDY TOUR TO NORTHERN IRELAND 26TH October – 30th October

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Executive Summary

This report outlines what was found out and learnt from a study tour of Northern Ireland, to investigate how biomass was used in Northern Ireland to produce renewable heat energy in buildings and whether such systems could be introduced in the Northern Isles. On the study tour were representatives from the Agronomy Institute, Orkney College, Orkney Island Council, Orkney Woodlands Group, Community Energy Scotland, Shetland Amenity Trust and Shetland Heat Energy and Power together with a member of the farming community.

A number of places and institutes were visited including Cookstown Leisure Centre the Northern Ireland Agri-Food and Biosciences Institute and Rural Generation Limited. This enabled us to get a complete picture of the biomass for energy industry in Northern Ireland from the issues surrounding growing biomass, through to the logistics and economics of its use in buildings.

The main biomass crop was Short Rotation Coppice (SRC), mainly willow for woodchip chip and wood pellet production. There was some straw crops grown such as Reed Canary grass and Miscanthus but these had been less successful in Northern Ireland and there were issues with sulphur content

The tour also looked at the possibilities of getting added value from SRC by using it to reduce pollution in water by using at as a filter.

Overall the study tour showed that it is feasible to set up biomass heat systems if there is a will but the economics have to be right. It seems that to be economically feasible for farmers and customers then the price of woodchips needs to be at least £90 per tonne and probably closer to £110 per tonne.

In Orkney there have been positive moves to potentially install a biomass heating system at Orkney College but it is unlikely that Orkney would be able supply in the near term more than 30% of the annual fuel requirements. There needs to be a greater incentive for farmers to use land currently utilised for cattle production (where the margins are currently good) for biomass production.

In Shetland there are other considerations. For example, there are no existing biomass plantations as there are in Orkney and the there is a greater pressure on quality land to be put to other uses because, relatively speaking, suitable land for growing any type of crop is at a premium. This suggests that while biomass systems on a larger scale are potentially feasible they will have to be supplied from imported biomass, a situation similar to the importation of oil.

Where there is scope for expansion of biomass for energy in both Orkney and Shetland is in the area of small scale production for own use. It takes about 1 ha to produces enough fuel annually for a three bedroom house and this is not beyond the realms of possibility for farms and smallholdings in Orkney and Shetland

This report contains a number of appendices

- Appendix 1 is a supplementary report by the Orkney Woodlands Group.
- Appendix 2 outlines the situation in Shetland in more detail.
- Appendix 3 is a list of the SRDP grants available together with relevant web links for the implementation of biomass for energy schemes.
- Appendix 4 is the transport costs to Orkney and the quoted price of pellets to OIC.
- Appendix 5 is estimated costs of producing willow and minimum price that a farmer would need to charge.

Contents

The purpose of the study tour to Northern Ireland (NI)

The purpose of this study tour was to take a group of stakeholders from the Orkney and Shetland biomass for energy sector to Northern Ireland and see how the Local Authorities, Government and producers in Northern Ireland have created a locally based biomass energy sector. However this has taken time and there has been some challenges which Orkney and Shetland could learn from. In conclusion: the study tour aims to investigate the viability of developing such schemes in Orkney /Shetland.

Specifically the aims of the visit were:

- To see whether SRC in Northern Ireland is mutually financially beneficial to growers/end users
- To see if/how they have achieved a balance between supply and demand
- To see what economies of scale are necessary to enable economic production
- To see what equipment and costs are necessary
- To see growing methods, varieties, any problems and compare yields
- To see which aspects can be related to the Orkney and Shetland conditions

The economic case for willow SRC biomass energy in Orkney

With the help of our NI Colleagues we have been able to put together the economic case for biomass for energy in Orkney and Shetland

The economic value of woodchip compared to oil

10 t willow woodchip is equal to 4000 l of heating oil

→ 1 t willow chip = 400 l heating oil

The price of heating oil in NI is about 50p / l (it is more in Orkney)

So the true cost of willow woodchip if it to replace oil like for like = 400 * 0.5

<u>= £200 / tonne</u>

In Northern Ireland they are selling woodchip at £80-90 per tonne which gives the Local Authorities an overall saving of £70 - £80 per tonne compared to oil. However it was considered that some adjustment may have to be made to this margin to cover the increased cleaning and maintenance that was experienced with the biomass wood-chip boilers.

This gives a good working long term profit for the farmers who, in cooperation with the Local Authorities have committed to local long term production of woodchip.

The financial agreement based on £80 – 90 per tonne was calculated using the economic analysis undertaken for the NI government by AFBI. This is laid out in

Table 1. The 2010 Agronomy Institute figures for typical yields in Orkney are about 5-6 ODT (DM) so the breakeven point where a reasonable return is had by the farmer is **around £80 per tonne** (Shown by the circle in Table 1). However it should be pointed out that in Northern Ireland yields from research plots were a little lower than was found at the field scale although still comparable.

Table 1: Projected Gross margins from willow

Yield (t/ha DM)			Price (£/ t of DM)	
	£43	**£58**	**£72**	**£87**
6	-£145	-£74	-£3	£68
8	- £123	-£28	£67	£163
10	-£100	£19	£138	£257
12	-£78	£65	£207	£350
14	-£55	£110	£253	£444

t = tonne
DM = Dry matter

However it should be pointed out that according to the SAC report carried out in 2008 the most important factor predicting whether farmers would accept willow was whether it matched the long term price of cattle, if the willow was to replace cattle grazing land. This is much more difficult to predict and will fluctuate over time. A costing for the profitable production of willow in Orkney for a farmer moving out of willow is shown in Appendix 5.

Technical aspects of biomass heat generation

Advantages

1. Provides a sustainable energy source which can be locally grown, so no issues with depleting the worlds fossil fuel supplies.
2. Supports the Orkney Island Council's (OIC) vision of promoting sustainability, working together and with communities.
3. Reduces emissions of CO_2 and resultant local benefit.
4. Technology that has been tried and tested and introduced through out the world (although not necessarily in the Northern Isles).
5. Grant funding is available which would not otherwise be available on a replacement oil boiler system. Since the trip, England has begun operating a domestic boiler scrappage scheme and it is likely that something similar will be rolled out in Scotland.
6. Reduced fire risk compared with oil storage.
7. No possibility of environment impact due to fuel spillages compared with oil, resulting in a low probability of an insurance claim.
8. Biomass is good for decentralised energy generation for heat and it's the most efficient means of producing heat energy, especially in peripheral areas.

Disadvantages

1. Increased maintenance of the boiler plant and fuel store.
2. Disposal of waste ash by product.
3. Limited local marked for installation and maintenance of the equipment.

4. Increased storage capacity compared with oil, but not necessarily resulting in increased capital outlay. This could be a limiting factor on confined or difficult sites. Woodchip and pellet storage take up much mores space than the equivalent amount in oil and woodchips take up more space than pellets. For example: Pellets occupy 30% less volume compared to chips (based on the same heat produced).
5. Fuel quality issues, and resultant impact upon heat delivery to the property.
6. Boiler operating inefficiencies due changes in demand, and resultant additional equipment required such as buffer tanks, to even out the peaks and troughs in demand.
7. Biomass boilers are very expensive in capital outlay, especially within the domestic market.
8. Security of supply could become a problem within the Northern Isles with limited land available for biomass growth.
9. Harvesting of willows for biomass production could be a significant problem within the Northern Isles due to the isolated location and ground topography.

Other important benefits that occurred in Northern Ireland

- Most money stays within the community (apart from perhaps hiring equipment from outside the community etc.). This does not happen when you buy your energy, be it oil or wood pellets from elsewhere.
- It gives local security of supply.
- Long term contracts offered price stability.
- Local jobs were created for local people.
- Farming in Northern Ireland given the security of a long term contract.

The situation in Orkney

At present there is no commercial wood chip operation in Orkney.

There are potentially a number of reasons for this. Amongst these are

- Uncertain return to farmer.
- Poor grants.
- Unknown/unfamiliar growing system with high labour, maintenance input.
- Long term crop as opposed to e.g. barley which can follow the market demands quickly.
- Unwillingness to put large areas of farms into SRC when they are already productive in other ways.
- Uncertain demand, which can be competed with by waste wood /pellets from mainland Scotland.
- Need for expensive specialist machinery.
- In the past the local large scale consumers in Orkney have used poor quality, unscreened wood waste for example in district heating projects where money was not spent on reducing moisture content to required levels of around 30%. In retrospect this strategy has not been as successful as expected but they did get the wood for £40 per tonne. This figure was also similar to the cost of

chip at the large Longannet Power station where it is used for co-firing. This station uses enormous boilers compared to those used in small district heating systems and local municipal buildings which mean they require no woodchip quality control and moisture content criteria in the way that the smaller boilers in a district heating system or a municipal building would require. For smaller scale boilers what is needed is high quality, guaranteed delivery woodchip of a guaranteed moisture content of no more than 30%. This is what the local authorities in NI have set up.

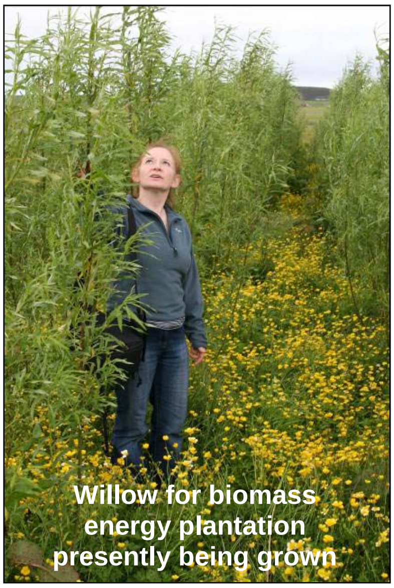
- There are no forest wastes or indigenous forestry that can be utilised for woodchip. The only wood being produced on any scale is the SRC willow at Orkney College. This means that if woodchip was to suddenly become popular through tax breaks for example, it would take about 4.5 years for the locally produced woodchip to become widely available if farmers could be persuaded to convert some of their land to SRC. This is less likely while the market for beef in buoyant and the price of beef cattle relatively high.

Locally produced SRC, however, has the advantage over imported timber supplies in that it is unlikely to be affected by competing requirements for wood such as the building trade because it is not suited for use in construction. This competition for other uses of the timber in Scotland could produce a lack of energy pellet supply when there is major demand from the building industry for example.

The result of previous low prices for woodchip in Orkney and the relatively profitable beef farming industry has meant that instead of willow being grown and seen as a valuable, renewable and locally produced fuel no such supply chain has developed in Orkney compared to similar sized economic and municipal areas in NI. What needs to happen is that the local potential large scale consumers in Orkney need to set up a mutually beneficial working relationship at a price that works for all parties. Then all the benefits of a locally supplied and produced energy source as set out above can be realised at a price that is still half that of oil

The situation may very well change should the market be stimulated by OIC who are currently investigating the viability of biomass boiler replacement for old oil systems. Initially pellets will be the main fuel source, but with careful selection of equipment which allows conversion to chips, should the wood chip market become viable and develop, there may well be local opportunities for local producers.

The Potential for Orkney


Willow for biomass energy plantation presently being grown

OIC, one of the potential local large scale consumers does have obligation to meet a proportion of its energy needs through Renewable energy

The council is now exploring the use of biomass pellets and willow to meet these targets. The current thinking, if newly installed infrastructure such as duel and multifuel boilers will allow, is to see pellets being the short term solution to initially allow a biomass system to be established, followed by willow when a sustainable guaranteed source has been established. The costs of importing pellets is shown and the cost of pellets from Balcas the main supplier, delivered to Scrabster, are shown in Appendix 4.

The advantage of pellets is that they are more energy dense and easier to handle. This makes them ideal for domestic dwellings. There has been private interest of late in biomass pellet boilers for domestic dwellings and this is to be welcomed.

The problem for OIC is that the infrastructure for biomass for energy may be installed before the willow chip can be produced, which takes about 4.5 years from scratch (less if shorter rotations are used or no cutback is used in the first year). However, for medium sized buildings such as swimming pools, leisure centres, schools, office building etc., the biomass fuel of choice is generally accepted to be woodchip from a local source (up to 40 miles away). This is because:

1. The cost of pellets delivered to Orkney is in the region of £160 per tonne in bulk: This is slightly less than the fuel oil costs (However there are financial incentives to be gained by meeting local authority renewable energy targets).
2. The pellets are made outside Orkney so money leaves the Orkney economy leaving little economic benefit for the local economy.

An important potential problem is security of supply. It may seem that being supplied pellets from a factory by one supplier is the obvious route to go for security of supply. Balcas, the pellet maker in NI, has just opened in Invergordon. The problem is that if by creating a monopoly supplier (Some would say that this is what has happened in NI) then they could have the ability to control the market price for biomass pellets so a potentially good lead-in deal might not be so a little down the line. Furthermore, potentially, if they see a more economic proposal for pellets than supplying outlying areas then they could easily cease trading in the out-lying areas and supply the more economic proposal. This is in essence the position in the Northern Isles .If one dominant pellet manufacturer decides that these are not an economic proposition then it could easily cease supplying them.

Orkney and potentially Shetland would rapidly, at high cost have to try and find another supplier. This could also happen if local farmers decided to stop supplying a consumer because, for example arable or livestock suddenly become more economic. Alternatively the Northern Isles are positioned such that they could investigate suppliers of wood pellets from the Scandinavian Markets. The over-riding risk with this venture is that the communities could find itself trading long-term energy security offered by locally grown woodchip for energy insecurity through the pellet market.

Perhaps, the answer is that when the infrastructure for a biomass energy system is installed, it should be a system that can be multifuel (as shown in this report) so that when woodchip becomes available, it can be used. The system could also include storage areas that can hold the larger volume of chips, and not the lower higher calorific content of pellets needed to heat a building, not just built to hold enough wood pellets to heat the building. This would increase capital expenditure in the short term but in the medium and longer term the savings would more than cover the cost of the multi fuel use system to the benefit of all concerned.

Summary

Woodchip for biomass energy is a potentially economically viable, quality controlled and guaranteed fuel source. Systems have been created at a number of NI councils such as Cookstown and Armagh that could be adapted for Orkney. It will take time and perhaps Potential Local Large Scale Consumers should begin a dialogue with local producers now so that the woodchip can come on-stream as soon as possible.

In the meantime, to meet renewable energy targets, the answer is to use pellets in multi fuel systems that can be easily adapted for the more economic woodchip at a later date.

The situation in Shetland

The situation in Shetland differs from Orkney as the climate is a little colder and windier and more importantly, there is substantially fewer areas where reasonable soil can be found to grow crops. This means that what there is, is in high demand for feed for animals. The situation in Shetland is developed further in Appendix 2.

Background to Northern Ireland and biomass for energy

Northern Ireland (NI) has latitude of 54 N – 56 N and is very similar to Orkney especially and to some extent Shetland. Essentially it is part of an island where the Irish Sea meets the North Atlantic. Just like Orkney and Shetland, it has a maritime climate which means that:

- It has a generally wet climate. The west is wetter than the east (2000 mm rain a year around Londonderry compared to 850 mm around Belfast).
- Temperature ranges between 6^{o}C in winter and 18^{o}C in summer so the winters are mild and the summers are cool compared to continental climates of the same latitude. This is due to the moderating effects of the Gulf Stream and the surrounding sea. These are very similar temperature conditions to Orkney.
- Wind can be strong and frequent but not to the same degree as in the Northern Isles. In Northern Ireland they have 10-15 days of gales which contain less salt than the Northern Isles where as Orkney has around 30 days of gales and Shetland, around 35.

However there are some considerable climatic differences:

- Northern Ireland is part of a large land mass and has a temperate maritime climate, like most of Britain whereas Orkney's climate is hyper-oceanic like Shetland, Western isles, extreme west and north coasts of Scotland. It is exposed to gales from all directions.

- NI has no western coastline exposed to prevailing south-westerly's.
- In Orkney and Shetland any gale, from any direction is salt laden and can carry salt to almost every part of the islands.

With regards to landscape and growth potential there are other similarities and differences to the Northern Isles. Similarities include:

- Farms are smaller, around 35 – 70 Ha in size, and farmers tend to be part time with most having a local second job.
- The main farming is livestock farming and pasture although the livestock are predominantly for dairy production rather than beef.
- NI has the lowest percentage of land covered by trees, at 5%, than any other region in Europe. This is still higher than in Orkney but there are few woods. The trees tend to be used for hedging.

Differences include:

- N. Ireland has 5 % tree cover whereas the tree cover in Orkney has a very open landscape with only 0.2% tree cover.
- NI has abundant hedgerows which include hedgerow trees. These give good initial shelter to SRC and also enable it to be absorbed into landscape very easily whereas Orkney and Shetland has few hedgerows no initial shelter and large areas may fit poorly into open landscape with valued views.
- The range of tree species, their height and form was significantly better than in Orkney and Shetland where as the range of trees that can be grown is greatly reduced.
- At the end of October, the trees were in fine autumn colour. Whereas in Orkney and Shetland trees turn brown and lose their leaves in September.

The last two points indicate poorer growing conditions and a shorter growing season in the Northern Isles.

In Northern Ireland, the Assembly government and the local government have a commitment to biomass as a real, workable source of renewable energy for the Province that will help it meet it's climate change commitments and reduce it's reliance on fossil fuels. This has led to a number of infrastructure developments and an improvement in biomass production to meet these requirements. These include

- 1000 ha src planted in NI
- 8 MW heat installations needing 7/8000 tonnes per year
- 55000 tonne pellets produced by Balcas
- 400 ha forest harvest giving 40,000 tonnes per year
- 3, 10 MW plants planned

At the Assembly level, there is a financial commitment to ongoing research into biomass through their biomass programme at the government's Agriculture, Food and Biosciences Institute (AFBI), which is researching into aspects of biomass for energy which ranges from the best crops to grow in NI to how to efficiently utilise the energy produced for domestic, municipal and light industrial purposes. There are also advice and financial support mechanisms available at the Assembly level for those wishing to convert to biomass for energy.

At the Local government level they are committed to, and are installing on an impressive scale, biomass for energy systems in schools, leisure centres and other municipal buildings. They are also encouraging the take up of biomass for energy in the domestic sphere.
This has meant that from the light industrial and municipal level through to the small domestic level, NI is by far the furthest ahead in implementing a biomass for energy economy that is sustainable, reliable and economic for all the partners in the biomass for energy chain from the farmers who are producers to house owners and councils who are the users. Most importantly for the Northern Isles it is able to show us how to set up small scale economically viable biomass for energy schemes that are ideally suited for the communities of the Northern Isles.

In summary, NI is relatively similar to Orkney in climate and farming which makes it a good place to study growing biomass crops for biomass for heat schemes. It shows how commitment from all levels of government can make biomass for energy a viable, profitable and local industry that brings environmental benefits for all sectors of the economy and community.

For all these reasons it was decided that we should take a group of people that covered all the stakeholders in the biomass for energy community in the Northern Isles to NI to study their achievements, experiences and challenges, how the schemes could be introduced into the Northern Isles and the potential pitfalls that we might have to confront in building a viable, locally based biomass for energy industry in the Northern Isles.

Participants

Participant	Origin	Representation or work role
Dr Geoff Sellers	Agronomy Institute Orkney College: Orkney	Agronomy Institute Research Fellow (Tour leader)
Ms Fay M[c]Kenzie	Agronomy Institute Orkney College Orkney	Agronomy Institute PhD student
Dr Mark Hull	Community Energy Scotland Orkney	CES representative
Mr Clifford Bichan	Orkney	Farmer
Mr Gwyn Evans	Orkney Islands Council Orkney	Facilities Manager Orkney Islands Council
Ms Jenny Taylor	Orkney Woodland Project Officer	Orkney Woodland Group
Mr James Mackenzie	Shetland Amenity Trust Shetland	Woodlands Officer: Shetland Amenity Trust
Mr Steven Peterson	Shetland Heat Energy and Power Ltd Shetland	Assistant Manager
Study Tour Tutors		
Dr Alistair McCracken	ABFI Northern Ireland	Senior Scientist (Biomass)
Paul Muir	AFBI Northern Ireland	Research Scientist
Linda Walsh	AFBI Northern Ireland	PhD student and Research Scientist

Places visited on the tour

Time	Place visited	Topics covered
Tuesday am	NI Horticulture and Plant Breeding Institute (NIHPBI)	Willow Agronomy. Other potential energy crops
Tuesday pm	Cookstown Leisure Centre	Biomass hot water and heating system
Tuesday pm	College of Agriculture, Food and Rural Enterprise (CAFRE)	Discussion on the general biomass situation and economics of production in NI
Wednesday am	Culmore Effluent treatment trial	Learn about the potential for biomass for energy production to be combined with effluent treatment regimes
Wednesday pm	Rural Generation Ltd	To learn about the commercial potential for a biomass supply chain operation from growing to installing heating systems
Thursday am	Hillsborough AFBI	Environment and Renewable Energy Centre showcasing biomass renewables research in NI
Thursday pm	AFBI HQ	Wrap up session

Tuesday am: NI Horticulture and Plant Breeding Institute (Loughgall)

Introduction

The NIHPBI is part of AFBI which has been set up by the Northern Ireland Government as its Agricultural Research and statutory testing body. Loughgall is about 200 ha in size of which 70 ha is woodland or planted with trees. AFBI concentrates on Biomass, potato, apple and mushroom research at Loughgall

The willow biomass for energy research programme is based at Loughgall and was begun in 1976. It has a broad range of willow research areas including:

- Genotype Selection
- Clone mixture research
- Biological water polishing and cleansing using biomass crops
- Planting configuration
- The effect of sewage sludge application
- Mechanisms and interaction between mixtures

A few of the overall findings from the research programmes are that willow grows well in NI because it is present naturally in NI with it's relatively wet with mild winters, and it propagates easily. However, unlike (it seems so far) in Orkney, the willow in Northern Ireland does seem to suffer from rust disease which has led to a major research programme looking at mixing clones with different disease resistant genes etc. to try and reduce the loss of growth due to rust.

Genotype trial

Although NI is part of the European breeding programme it does not actually breed willow. It is a testing station for different clones of willow from Europe and America. It tests clones for their suitability for use in Northern Ireland and maritime areas of the U.K. What was immediately apparent when visiting the clone testing trials was that they were very similar to the trials that the Agronomy Institute are conducting in Orkney. However, given our more northern position, yields from research trials in Orkney are around 5-6 ODT/y (oven dry tonnes/ year) compared to NI at around 7-9 ODT/y and this was highlighted by the generally taller nature of the stands. One of the major differences was that there were more clones in the NI trials from more countries. In Orkney we only have clones from the Swedish and British research programmes whereas NI also include clones from their collaboration with Syracuse University in the USA.


AFBI willow breeding trials

In general the results suggested that the American genotypes did not fare well in NI (interestingly the British genotypes given to Syracuse did not do well in the US). Ashton Stott was the least productive, in contrast to Orkney where it looks to be the highest yielding, and that the Swedish clones performed the best. This difference in clones between Orkney and NI highlights the importance of the Orkney testing programme for biomass suitable for our conditions. Potentially, the main reason for the difference is that Swedish clones grow tall and thin whereas the British clones tend to be stockier with mores stems. It can be surmised that the taller Swedish clones do not grow as well as the shorter British clones where the winter winds are high and frequent which is the situation in Orkney compared to NI (although winds are comparatively high and frequent in NI compared to the U.K. in general).

Rust was a major problem in NI. This, in contrast with Sweden and the US, where rust is not a problem, is thought to be because in the US and Sweden, rust is climatically controlled by the hard winter frosts and cold which does not occur in NI (nor Orkney). Ashton Stott resistance has particularly broken down and is no long recommended in NI. Rust is not a problem in Orkney at the moment but it is perhaps something we should look out for if willow production becomes more widespread

Fertiliser trials

The fertiliser trial were only recently planted in 2008 using 7 genotypes and one mixture from the British and Swedish breeding programme so have not yielded any results. The treatments were:

100 kg/ha N
200 kg/ha N
300 kg/ha N

The aim of the trials was to see how N impacts on the willow as a whole rather than come up with Fertiliser recommendations for willow

Commercial trial of a number of mixtures to assess disease reduction and interactions

The aim of this trial, which had been set up in 2005 so had been through 1 harvest cycle, was to investigate whether growing mixtures of the ten best clones improved disease resistance and growth compared to mono cultures. There were also two types of mixtures: random mixtures where the willow mix was completely randomised, and mixtures of blocks of same type clones so that blocks of individual clones were randomised rather than the individual plants. These were called short run mixtures.

Commercial willow trial for disease

The initial results after one harvest were that random mixtures and short run mixtures both reduced disease levels compared to mono cultures.

Testing mixtures is also a component of the Orkney willow research programme but random mixtures especially do have drawbacks which may be important in the absence of a disease risk. For example

- The shape and thickness of the stems can vary between clones which makes harvesting mixes difficult.
- Fertiliser requirements may be different for each clone leading to runoff if over applied or reduced growth in some of the clones.

These problems can be partially overcome by carefully choosing your mix so that you have clones that have a similar shape and requirements and so that they grow at a similar rate etc. The problem with this is that the clones are therefore likely to have a similar parentage and so likely to contain closely related resistance genes. This means that the protection against disease may be reduced due to the potential for resistance against disease to break down when you only have a small variety of resistance genes.

Target Trial

The results from the Commercial Trial suggested that individual clones can affect positively different vulnerable clones around them and improve disease resistance that way.
The Target Trial was designed to investigate the mechanisms behind increased disease resistance in mixtures rather than mono cultures. It was planted in 2005 and so is only yielding initial results at the moment. The plots consisted of 6 'target' clones, which were to be assessed for diseases surrounded by one of eight other clones (Figure 1). The disease results of the 'target clones' were then measured. The basic plot design was repeated for the other 8 'surrounding' clones.

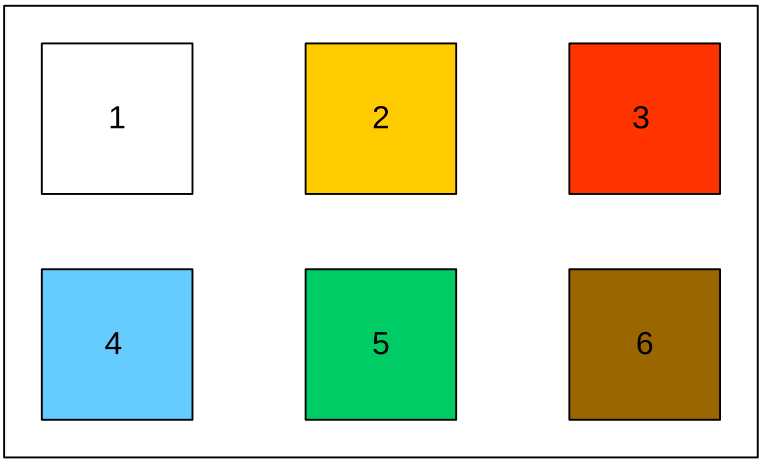


Figure 1: Diagram of one of the 'Target' trial plots. Six different selected clone types (coloured squares) are surrounded by 1 different clone type (diagonal infill). This was repeated 8 times for each of the different 'surrounding 'clone types.

Initial results indicated that there were some differences between the same 'target' clones in disease resistance depending on what clone surrounded them. The aim of the trial now is to determine how the surrounding clone is affecting the 'target' clone so that the 'target clone becomes more resistant.

Poplar Trials

The aim of this 20 year old trial was to provide information on productivity, disease resistance and growth characteristics of hybrid poplar grown for pulp production rather than biomass. They were not coppiced in this trial but coppiced poplar is the other main tree species used in Britain for short rotation coppice. Poplar has not been successful in Orkney but we only used one variety: 'Trichobel' which may not have been suited to Orkney. It was interesting to see how they were doing in NI.

Overall they were getting reasonable yields after 14 years (cut 2005) but they were very vulnerable to disease especially the varieties Boelare and Beaupre. Rust had killed outright 90% of the trees in the trial. The result of this was that farmers would not touch poplar in NI what ever the variety was on offer, even modern disease resistance varieties.


20 year old poplar stands

Other information about willow agronomy

During this visit to the trials work we were able to pick up a number of other pieces of information about willow growing

1. Planting: Trials that were planted with a 'lie flat' planter which places the rods flat into rows rather than a vertical planter were not very successful.

2. Harvesting for scientific measurement was done by hand cutting. 7 ha took ten people 2 weeks to achieve but there is no equipment small enough that will do the job mechanically. This is the same problem that we are finding with our trials in Orkney.

3. Removing a stand of willows proved not as difficult as expected. After treating a cut stool with herbicide the ground was then cultivated with a heavy duty rotavator which left the ground in a condition to be planted with other crops.

4. Willow beetles: These are not currently present in Orkney. However they can defoliate a plant in spring and severely decrease growth and yield. If they attack in the first year they can severely limit root growth through lack of nutrients from the leaves. Even if the willow is subsequently protected, attack in the first year stunts the tree for years after.

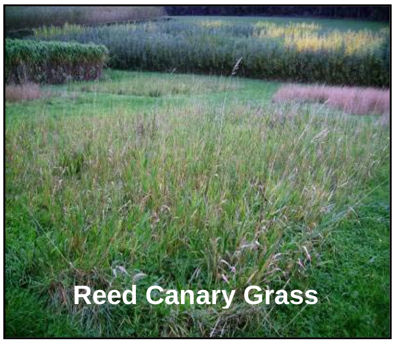
Other biomass crops

At Loughgall there was a set of trials that were investigating the potential for a number of other crops for Biomass. These were

- Reed Canary grass (RCG)
- Miscanthus
- Switch grass
- Paulowinia

The first three are grasses and the last is a semi-tropical broadleaf plant with high biomass potential.

Overall the Miscanthus showed the most potential with Switch grass and RCG not growing well at all. Miscanthus does not grow well in the Orkney climate but RCG certainly does so it was surprising to see it doing so poorly in NI. We speculated that NI may have received poor seed. The seed rate for RCG at 5 kg / ha is very low so a poor batch of seed could have a significant



impact on emergence and subsequent survival where only small areas are sown such as in trial plots. Switchgrass does not seem to do well in either area of the U.K. The Paulowinia was doing fairly well but as a semi tropical plant is unlikely to be suitable for Orkney.

What was consistent with all the grasses was that they contained high levels of chlorine that becomes hydrochloric acid when burned in boilers. This is obviously highly corrosive and has caused problems in NI. This chlorine issue has been reported elsewhere in Finland and Sweden. However some research suggests that if you harvest in February – March rather than October – November then the chlorine content of the grasses is much reduced by a ‘washing out ‘action by rain over the winter. This is something that we are actively investigating with our PelleTIME energy grass trials in Orkney.

Summary and Conclusion

The trip to Loughgall taught us a great deal about the agronomy of willow and what was possible in Orkney. The work on mixtures was particularly interesting, perhaps for the future if rust becomes a significant problem in Orkney.

The results for the other biomass for energy crops were less clear and differed from Orkney’s results especially with respect to the Miscanthus and RCG.

Tuesday pm: Cookstown Leisure Centre

Introduction

For the first half of the afternoon the party visited Cookstown Leisure Centre which is run and owned by Cookstown District Council.

The original centre was opened in 1976 but in 1998, with European Interreg III funding the leisure centre was extended and refurbished. It now has over 25 000 visitors a year.

Cookstown Leisure Centre

As part of this package a new heating system and Building Management System (BMS) was installed based on oil. However in December 2007 the heating system was upgraded. The heart of this new heating system was a Froling Turbomat 500 kW woodchip boiler together with 2 back up oil burners. The biomass boiler provides the base load and accounts for 40% of the heat over a year and the two oil burners provide the other 60%, particularly in winter. Before the woodchip boiler was installed the average oil consumption for heating at Cookstown Leisure Centre was 6000 L per week at an annual cost of £120 000 per year for oil and electricity.

The heating system has to provide for the:

- Main pool (25 m x 12.5m)
- Learner pool
- Air handling units for the pool and main sports hall
- Radiators
- Domestic hot water

Most heat is provided by the wood burner which is controlled by the BMS which switches off the boiler at 9.30 each night and switches it on in the mornings. Peak loads in the early evening are topped up by the oil burners which also provide power when the wood fuelled boiler is out of action for maintenance and repair.

The wood fuel operation

Froling Woodchip boiler

The Froling biomass boiler is connected by an Auger to a store which can hold up to 12 tonnes of wood chip. The feed and the store are also controlled by the BMS. The boiler can take chip with up to 30% moisture content. On average, it burns around 2 tonnes of woodchip per day (14 tonnes a week) at the winter peak and this averages over the year at around 21 tonnes every 2 weeks. At 2 tonnes per day the boiler produces 240 L of ash which is disposed of to landfill.

Financial background to the Cookstown Leisure Centre

Below is set out the Cooks town Leisure Centre costs and savings by converting to a willow burning boiler per annum. This was obtained from David Richardson at Cookstown District Council. It includes expenditure for installing the equipment and building the store and fuel delivery mechanism to the boiler.

Oil Deliveries

Year (Jan – Dec)	Volume (l)	Average p per l	Total Cost
2006	320 900	34.75p	£111 519.60
2007	354 014	36.45p	£129 021.90
2008	240 021	51.53p	£123 675.40

Willow deliveries

Year (Feb – Dec)	Weight (tonnes)	Average Price	Total Cost
2008	388.95	**£86.92 per tonne**	£33 806.75

Average annual oil usage (from 2006 and 2007 figures) 337 457 litres
Actual deliveries during 2008 240 021 litres
Difference **97 436** litres

(**97 436 l of oil = 260 tonnes of Carbon)**

97 436 l @ 2008 average price of 51.53p per litre £50 208.77
Willow chip fuel at average **£86** per tonne during 2008 £33 806.75

Saving **£16 402.02**

The willow biomass project costs are laid out below

Interreg IIIa grant (EU funding) £122 500
CEEF grant (NI Government Funding) £110 000
Total Grant assistance £232 500

Approximate installation costs £278 000

Approximate cost to Cookstown District Council **£45 500**

Conclusions

Cookstown district Council is substantially smaller than Orkney Island Council but has developed a model suitable for Orkney or Shetland if certain parameters can be achieved. The Council wanted a guaranteed supply of wood and local farmers wanted a guaranteed long term contract that produced excellent savings in fuel costs for the Council and a reasonable and guaranteed return for the farmer based on market rates.

The local farmers formed a consortium with the council and a supply merchant who acted as the ‘middleman’ who made sure that at least one member out of the farmers cooperative could supply the leisure centre when needed, One of the key benefits of this consortium was that all the growers and subsequent suppliers were within a 5 mile radius which reduced transport costs significantly.

However there are a number of limitations to achieving this level of production in Orkney and Shetland. Cookstown Leisure Centre uses 21 tonnes per fortnight, which would be 546 tonnes per annum, based on Orkney yields of 5-6 Tonnes per hectare., This would equate to 109 hectares per annum. Even the Northern Ireland estimates of figures of 388 tonnes would be 78 hectares required each year. That’s a lot of plantation surface area to keep supplied on a yearly basis. It would be difficult for the Northern Isles to find that level of commitment. And this only applies to one leisure centre.

Tuesday pm: Visit to College of Agriculture, Food and Rural Enterprise (CFRE).

CAFRE is the education and learning extension institution in Northern Ireland for the agriculture, rural and environmental sector.

It has campuses at Enniskillen, Antrim and Loughry, which is the campus we visited. It runs Further education to post graduate level courses as well as an extension service that runs short courses and demonstrations for practitioners within the agriculture, environment and rural sectors.

At CAFRE we met Nigel Moore who was the Renewable Energy Technologist. We had a wide ranging presentation and discussion covering aspects of agronomy and harvesting of willow in Northern Ireland. However, the main focus turned on the pricing structure in Northern Ireland that has achieved a biomass market in willow in an area that has in comparison with the rest of the U.K. few trees and how this can be used to create a biomass for energy industry in similar areas such as Orkney.

Harvesting techniques

There are two harvesting techniques both of which are used in Northern Ireland. These are:

- Cut, chip and dry

This is where the plantation is cut and chipped in one operation. The chip is then taken to a drier and dried ready for use down to about 25% moisture. It is screened and graded before it is sold for commercial purposes so that a certain quality can be offered (however there is no national quality standard regime as there is with pellets).

Cut and chip

- Whole rod harvesting

This is where the stems are cut as a whole rod and then automatically stacked at the side of the road or plantation and left to dry outside or under cover of a barn. When a need arises part of the stack is chipped and then, if need be, dried further in a drier before grading and use.

Cut, chip and dry in NI is the preferred method for commercial operations because there are large heated drying areas available to dry the chip, such as grain stores, immediately and because chip takes up less space due to reduced volume. Other advantages include being able to mix the drier chips in the pile with wetter chips to achieve a consistent 25% moisture per load sent out. These features are important for commercial operations.


Whole rod harvester

Whole rod harvesting and storage tends to be used by the grower-user, perhaps a farmer who is growing the willow to heat his farm operation. He often has the space to store outside rather than inside but not the economic justification for a large under floor heated drier. He also has the option of coming along every two weeks perhaps and removing a few rods to chip as and when he needs it to fuel his boiler. It also gives the user the option of making billets instead of chips for example. However for commercial operations to customers it is not considered as good in Northern Ireland as Cut chip and dry because the moisture consistency of the rods is not as good as drying chips and there is less control over quality assurance because you do not have as much at any one time to mix in together to average out wetter chips. This is important as customers can send back loads that don’t meet the required specification.

In a Shetland context, if a suitable drying store could be found within the industrial zones of Lerwick, waste heat from the local Energy Recovery Plant could be utilised throughout the summer months to dry out chips for winter use. At the present time, the local Energy Recovery Plant dumps a significant proportion of the generated heat throughout the summer period due to sporadic demands for space heating. In this situation if suitable facilities could be utilised the whole process could be made more economically viable and the current plant more energy efficient.

Whole rod harvesting is also the preferred option in Northern Ireland where drying facilities are not close at hand as transporting chips to a drier is expensive. This is the situation in Orkney where we have no drying facilities. Furthermore in Orkney, repeatable drying results at experiments carried out at the Agronomy Institute show that in our winds we can actually dry whole rods consistently down to 25% so that can be delivered reliably to customers.

When to harvest

The accepted method for harvesting is to harvest in the spring when the willow is dormant before new leaves begin to grow. This reduces the amount of unwanted material on the willow and does not remove nutrients from the plant which occurs if you remove the rods before the leaves have fallen. However the draw back to this is that the land is wet after the winter rain and cannot take much weight. Furthermore, the willow cutting machinery whether cut and chip or the rod harvester is heavy at around 18 tonnes so in wet conditions there is a strong possibility of compaction to the soil, rutting and damage to the stools that remain through disease.

This has meant that in wetter areas of the country, such as NI, research is being undertaken into the consequences of cutting when the ground is dry: i.e. in the autumn, which would mean that the willow would still have its leaves. The results are still being collected but one of the consequences may be that extra fertiliser will be needed to compensate for the leaves that are being removed from the system when the rods are removed. . In this instance, this would increase your production costs through the additional fertilizer use, accruing from material purchase and application costs. Furthermore, leaves are a waste product like bark that really need to be removed from the chip before it is sold as it affects the quality of the chip. This is for two reasons, first they add to the ash content which has to be disposed of and the chip pile takes longer to dry so the drying process is more expensive. However these extra costs of fertiliser and of removing the leaves or added drying costs might be offset by easier and quicker harvesting and the fertiliser could be added in the form of waste organic matter such as sludge or animal wastes.

How often should harvesting take place?

There has is an increasing amount of research into how often SRC willow should be harvested. In NI they have been looking at harvesting at 2, 3 and 4 year intervals. The advantages and disadvantages of harvesting as identified by CAFRE are explained in Table 2.

In Orkney harvesting is a major economic factor with willow because, unlike NI, we don't have the harvesting machinery. John Gilliland (see below) estimates that to justify a harvester and a planter then around 500 ha of willow would need to be sown in Orkney.

The alternative is to bring it in (at high cost). So a two year cut regime might involve bringing the machinery up more often. However with the stems much thinner it might be possible to adapt machinery we have here to cutting which would very significantly reduced costs.

Moving to a four year harvest regime will significantly reduce the number of harvests but the current machinery struggles with the thickness of the stems and the harvest will take longer. It is also not clear in the Orkney climate of strong winds whether after 3 years there is an economic gain in yield by leaving the stand for a fourth year because of dieback at the top of the stand due to wind.

Table2: The advantages and disadvantages of harvesting at between 2 and 4 years

Years between harvest	Advantages	Disadvantages
2	There are more harvests to sell so cash flow is smoothed as there is a more frequent income	This does not mean to say that overall income is more because the greatest yield increase may come in year 3 and 4
	Fertiliser such as slurry can be applied every 2 years instead of	Increased harvesting costs (up to 50%) may reduce potential profits

	every 3 or 4 years Cutting is easier and fester because stems are thinner	Increased proportion of Bark (which is essentially ash waste) compared to useable wood
3	Results suggest that greatest yield increase may occur in year 3	Reduced cashflow compared to 2 year harvest (but overall income may be higher)
	Harvesting still relatively easy by machinery because stems of reasonable diameter and rods not too tall	
4	Four years of stem growth may produce a higher yield	Stems very thick and machinery can struggle and is slow at harvesting so although there are less harvests the cost of each harvest is greater
	Potentially reduced harvesting costs	Cashflow halved compared to 2 year cutting
	Proportionally less bark to useable wood so much lower ash production and more useable wood in the boiler	

Harvesting costs for each farmer could be reduced substantially if all farmers harvested at the same time so reducing the individual cost of the machinery through sharing the cost. The wood could then be stored in stacks until it was needed when it would be chipped. This is possible in Orkney at the moment because most of the willow was planted at the same time so is at the same stage of development.

Alternatively, individual stands of willow in Orkney may be of a size (say 1/3 ha per year, 1 Ha in total on a three year cutting cycle) that cutting by hand with a chainsaw is economically possible; especially as the cut could take place over the whole winter in stages rather than in one go. This is not economically viable for on a commercial basis but should be possible on a small scale where the aim is to grow for own use.

Wednesday am: Culmore SRC willow effluent treatment plant, Londonderry

Northern Ireland has a particular problem with excess soil Phosphorus (P) and it is also a nitrate sensitive zone, which means there is significant interest in reducing pollution from runoff using biological means such as phyto-remediation and scrubbing using plants. This is especially important in NI as the water industry uses 2% of all electricity produced in NI just to treat waste water.

The site at Culmore is next to the sewage treatment plant which serves a nearby bacon factory as well as the local community. It was set up as part of the Water Renew programme in 2005 and consists of replicated blocks of willow, single strand poplar and grass treatments.

Waste water treatments were applied in 2007 (July – Oct) and 2008 (June – September). The aim was to apply 150 kg/ha of N in 2007 and 200 kg/ha in 2008. This did not lead to elevated N or P in the discharge channels but water volume was sometimes so high that the irrigation had to be switched off. One of the problems with this site is that the soil is a wet, heavy clay type coupled with the fact that Londonderry is a high precipitation area receiving up to 2000 mm a year.

It also led to an interesting question of where the N and P were going? Willow takes about 90 kg/ha N and about 20 kg/ha P which is low because it is not a particularly nutrient hungry plant compared to grass. The P is probably absorbed onto the soil matrix whereas the extra N is probably broken down microbiologically. For the N this is not a problem but for the P it might be because the amount of P that a soil can hold is limited by low pH and the pH of the soil is dropping to around 5.5 which is getting low for willow and poplar.


Willow plots showing one clone that has died out

We also saw that some of the willow clones had died off. Whether this was due to the effluent loading was unclear.

The conclusion from this trial was that willow can be used as an effluent treatment system. However it is probably better used on a smaller, farm scale or municipal building scale perhaps where the effluent loading is not too high and the heavy metal content is lower (willow selectively absorbs heavy metals like Cd). It would also add value to the willow plantation which would improve the economic case .for planting willow for woodchip. Its main advantage over other phyto-remediators such as reed beds is that it lasts a long time without having to be replaced. Reed beds need replacing every few years whereas willow will last 20 years or so.

Wednesday pm: Rural Generation ltd, (To meet John Gilliland)

Introduction

John Gilliland formed Rural Generation Ltd in 1996 with the aim of making biomass for energy a workable solution to renewable energy needs in NI. It is a fully commercial company with no government or European funding. It is one stop solution to the biomass for energy sector providing advice on growing willow through to installation, maintenance and supply of woodchip boilers. It has a global reputation having worked in Canada and the USA and its aims are to provide solutions that can be used throughout the world.

Woodchip verses wood pellets.

The main advantages to pellets supplied by companies such as Balcas are that they are easier to handle than woodchip, and they will flow like oil which makes them very suitable for use in small domestic boilers. They can also be blown into hoppers and come with a quality control guarantee for moisture content (10%) and contaminants. Balcas will deliver the pellets for £130 per tonne in NI. Furthermore, the smallest woodchip boiler is about 30 kW however pellet biomass boilers can be 20 kW or less


Willow plantation at Rural Generation Ltd

Woodchip is for larger boilers that can handle material with higher moisture contents (25%). They also have a 9% lower calorific value than the pellets and a higher fly ash content because of the bark. However they are much cheaper to make and Rural Generation sells their chips at a guaranteed minimum of £20 per tonne cheaper than the equivalent weight in pellets. Bearing in mind the 9% calorific difference, this roughly equates to a £10 saving per tonne compared to pellets at £130 per tonne. This leaves woodchips being sold for around £80 – £100 per tonne, quality controlled and delivered in NI. In Orkney, woodchips could potentially be delivered at half the price of pellets if the projected figure of £160 per tonne of pellets is used.

Incentivising farmers

According to John Gilliland, in NI the cost of harvesting willow is about £25 per tonne and drying is another £25 per tonne. There is then a cost of about £10 for transport. This makes the woodchip production cost about £60 from mature plantations. It was unclear whether these costs included maintenance and labour for machinery etc. There is also of course the cost of establishing the plantation which can be expensive in Orkney on a larger scale without grants. For example the cost of planting at the Agronomy Institute was around £6000 for two ha. However, this would come down significantly if the demand grew and thus the cost of hiring equipment dropped through farmers cooperating on machinery hire etc., or it becomes economic to purchase some equipment such as small scale harvesting equipment. The same applies for harvesting and this seems a role that perhaps the Orkney Machinery ring could become involved in.

In Northern Ireland, to make it financially viable for farmers to grow willow compared to other crops then the farmer needs to make around £200 / ha. The farmer can get £100 / ha in single farm payment and there may be other grants for planting willow or in Renewable Heat Incentives together with SRDP grants (see Appendix 3). Together with a sale price of around £80 / tonne of woodchip supplied to a medium sized user then the farmer will make £200 per tonne per ha. The figure would however have to be initially a little higher in Orkney and Shetland to cover the costs of planting new areas but still would not be in the region of £160 per tonne of pellets or oil delivered.

Woodchip quality control

The main problem that Rural Generation found was that consumers needed to be guaranteed a supply, at a reasonable price and quality. In the beginning, the quality of the chip being supplied was very poor because the forestry industry was not used to quality control regimes. Furthermore, there was less knowledge about how wet wood combusted. This meant that consumers were trying to burn contaminated wood at high moisture content, causing many problems including:

- Poor emission controls
- Poor heat production because too much energy was taken up drying out the wood chip and trying to get it to ignite
- Tarring up the boiler
- Mechanical failure due to contaminated woodchip.

Quality control relies on three aspects:

- The moisture of the chips
- The contamination level and
- Uniform size of the chips that are delivered

These criteria are the basis on which Rural Generation used to set up it's own guaranteed quality control regime.

Woodchip drying

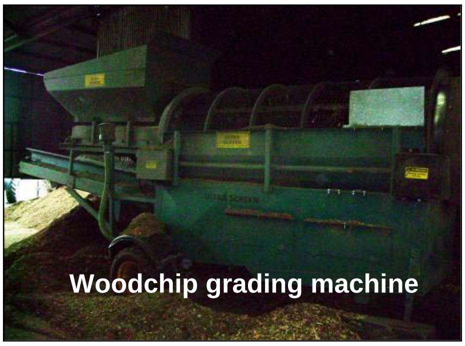
The preferred level of moisture in woodchip is around 20%. Below this, according to John Gilliland, too much dust is created. Above about 25%, the chip is too wet and the problems mentioned above begin to occur in the boilers. Furthermore, above 20% the woodchip is unstable and fungal breakdown etc., begins to occur.

Rural Generation harvests using cut and chip in the winter at around 52 – 55% moisture. The chips are then stored on a heated, ventilated cover floor area for about 5 weeks where hot air is blown though the pile. This brings chips down to about 12% moisture at the bottom and about 25% at the top. The pile is then moved to an unheated store where it is mixed and left for 2 weeks allowing the pile to stabilise at around 20% moisture. The chips can then be stored indefinitely.

One of the features of this system is that there is continuous checking of the moisture levels and the consumer can be guaranteed a supply at around 20% moisture. Furthermore, by mixing, the entire chip pile does not have to be dried down to 20% which brings a saving on drying costs.

Woodchip size grading

After drying the woodchip is then graded by processing through a screen consisting of 2 sieves, an 8 mm sieve that removes fines and dust, which are then combusted to produce heat for the drying area, and a 35 mm sieve that removes large chips leaving the middle fraction for sale to the consumer.


Woodchip grading machine

Fines are not liked in urban areas because they create dust and emissions problems. nor do they burn particularly well leaving a quantity of fly ash. This requires the boiler to be cleaned out more often.

The larger debris consists mainly of leaves and larger bits of wood which could block equipment such as augers etc and causes a build up of clinker. The leaves are removed and mulched to be put back on the land and the woody material is burned.

The final result is a graded product that is at the right moisture content.

Weed control

Weed control in a commercial operation is a compromise between protecting the willow and achieving economic control. It can be difficult to achieve in willow and is the most important factor affecting growth and survival after planting and cut back.

At present Rural Generation uses the herbicides Stomp (pendimethalin) and Flexidor (isoxaben) as a pre-emergence herbicide after sowing and cutback. These chemicals are not very effective in organic soils as they breakdown quickly. So Rural Generation have developed two methods of weed control that are a combination of mechanical and chemical control.

The first device they have put together is an inter-row cultivator where the tines have been removed and replaced with spray nozzles. This is in effect a guarded inter-row sprayer so the machine carries out a spraying operation between the main rows of willow without spraying the cut stools. Rural generation favour Diquat for this operation rather than Roundup as they feel that willow is vulnerable to splash by Roundup. Diquat may only burn off the top of the weeds but it is cheap and the action is enough to give the willow stumps / saplings a head start.


The inter-row

After 3-4 cutting cycles, fields begin to get rutted and soil is pushed towards the stools. So Rural Generation has developed an inter-row disc cultivator. This carries out four operations:

1. It pushes soil back from the stools and into the ruts and furrows
2. It mulches the weeds
3. The discs prune the lower sides of the willow as by the 3rd – 4th cut the willow has become very branched and it can be difficult to do any inter-row operations
4. The disking aerates the soil around the willow


The inter-row cultivator

However there are some drawbacks. The discs cause damage to some of the willow such as root damage and there are some stem losses. However this is considered commercially acceptable given the overall weed control. The second problem is that the inter-row cultivator cannot cultivate between the individual rows of willow plants, only between the main rows between individual stands. John Gilliland did say however does control about 70% of the weeds and brings economically worthwhile increases in yield.

Background to biomass heating systems

Compared to oil fuelled heating systems, woodchip systems are considerably more expensive. The simplest boiler, where everything from loading the boiler with 1 m cut rods to removing ash, will cost around £4000 whereas a fully automated boiler could cost up to £15 000 for a reasonable sized building including installation costs. This can be compared to an oil system where a reasonable sized domestic system may cost around £6000. However with lower maintenance and fuel costs the biomass boiler should pay for itself in 5 Years according to John Gilliland.

The other important factor with biomass boilers is that they work most efficiently with lowest maintenance costs when they are working at a steady rate permanently. This is in contrast to oil powered systems. It means that they do not like being switched on for a few hours in the morning and evening at full peak and not being used in between. They do not cope well with peaks and troughs in demand. However this can easily be solved by having a hot water heat accumulator incorporated into the system so that the water is heated during the troughs and is released into the system during the peak periods, thus leaving the biomass boiler to work at a steady rate throughout. One draw back is that the accumulator adds to the cost of the system and is one of the reasons for the initial price difference between an oil and a wood heat system.

The 100 kW woodchip fuelled system

We were shown a 100 kW boiler, manufactured by KWB in Austria, which is designed to heat the main house on the Rural Generation estate, a large Georgian Mansion with no insulation (for historical purposes and preservation of the listed house). The whole system was automated and housed in a purpose built building. This cost around £22 000 for everything including building costs and had paid back its capital expenditure


The KWB 100 kW system

within 5 years. Apart from the heating system the grate was also automatically cleaned and the ash removed from the grate into a box. Also, importantly, there was quite rigorous air flow control using an automatic flue control because in windy conditions the boiler system can work too fast with problems for emissions and efficiency.

What was surprising was the cleanliness of the chimney compared to an oil fuelled system. The chimney had not been cleaned in the three years that the boiler had been in operation. One of the reasons for this is that the boiler system has been built to rigorous Austrian emission standards that are higher than those in Britain.

The other waste product apart from flue gases is ash. This system was producing good, inert grey ash that was applied straight to land. The ash content was about 2% which meant that the ash bucket on the system had to be changed about once every 10 days (In comparison, a pellet system produces about 0.5% ash).

In conclusion, we observed a woodchip system that was ideal for small-medium sized buildings such as shops or larger domestic dwellings. It was reliable, clean and the fuel cheap. The main drawback was the initial capital expenditure.

The energy cabin

Customers want a 12 month heat energy solution that will handle summer and winter conditions. Biomass boilers are efficient in winter because they can be kept active continuously. The more challenging period is summer where the need for space heating is sporadic and water heating is not constant. The boiler is likely to be idle or at best working at 20% capacity which is not good for maintenance or emissions. There was felt to be a gap in the market for a small, totally portable, self contained heating system unit that could serve a shop or dwelling, that almost 'plugged in' to the building which over came these challenges to biomass heat systems.


The energy cabin

The concept developed in to the pellet fuelled *Energy Cabin* designed to service around 3000 square feet (350 m^2) of space). It is about the size of a large garden shed and contains all the components needed for a biomass system, containing a hopper for the pellets, boiler, flue gas cleaning and extraction system, a water heat accumulator controlled by an automated energy management system. The summer heating requirement is met by using photo thermal panels on the side of the cabin. The management system uses the photo thermal panels in preference to biomass but it does mean that the boiler remains on in winter for most of the time but inactive during the summer.

The strength of the system is that it is entirely portable so an owner can take it with them when they move. It could be rented out by a central supplier and people could pay rent on it for as long as they needed it, parts are easy to replace and you don't need to build a separate building to house your heating system components.

The main draw back is cost. The Energy Cabin is a premium product retailing at £18 000 installed. This is a lot more than even the most advanced conventional biomass heating systems (without building costs) of around £15 000. This means that this system is really only for specialist high value domestic situations if a rental market for the product cannot be developed to remove the individual capital outlay.

Overall summary of the visit to Rural Generation Ltd

This was a very interesting visit to someone who offers a non stop complete service to the biomass for energy sector. It seems that the message was that you need to offer a complete service that is guaranteed with regards to delivery and quality, whether it is boiler installation or woodchip delivery. We gathered very helpful information on the size of sector we would likely to need to make it feasible to mechanise operations in Orkney (about 500 ha). There was a lot of interesting advice on how to incentivise farmers into entering woodchip production and how to create an enthusiastic consumer market, mainly based on medium sized boilers such as the ones at Cookstown and Armagh leisure centres.

On the agronomy side the operation was very mechanised because it was so much larger in scale. Individual plant losses were expected but accepted because of the reduced costs produced by mechanisation.

Finally, it was very useful to see a number of boilers of different sizes in operation to get a better idea of what space and capital outlay would be needed to install biomass heating systems in small to medium sized building.

Thursday am: Environment and Renewable Energy Centre (EREC), AFBI Hillsborough

Introduction:

AFBI Hillsborough is a 300 ha research farm specialising mainly in livestock research but they also do arable, forestry and energy crop research. In particular they have 300 cattle which produce 20 m^3 of slurry a day and there is also a lot of agricultural and forestry waste produced. EREC was set up to investigate and develop ways of using these waste products to create renewable energy in a one stop showcase environment.

At EREC there were several renewable energy heating systems on show, all of which were being used to provide heat for the estate. We visited the woodchip manufacturing facilities, the Combined Heat and Power plant (CHP), and the anaerobic digester facilities. The different energy sources are ranked in order of priority that they are used.

1. Biogas CHP plant
2. Biogas boiler
3. Biomass boiler (both willow and grasses)
4. Oil fired boiler

One of the interesting aspects of the biomass system here was that grasses (in this case Miscanthus) were being used alongside wood chip. Miscanthus is an important energy crop which hadn't been made clear up till now on the trip. In Northern Ireland in 2007, 9 516 ha of land was growing energy crops and ⅔ of this land was down to renewable energy grass crops for co-firing. Only ⅓ was down to willow for willow chip. The advantage with co-firing is that you can put whole bales of straw into the system which is cheaper than chipping it or pelleting the resource. Of the willow, pellet production at Balcas ltd and woodchip production for municipal buildings such as Cookstown and Armagh leisure centres takes up 7000 tonnes per annum. However, they were not using RCG which would have been of more interest to Orkney as the conditions in the Northern Isles are really too harsh for the successful growth of Miscanthus

Woodchip drying facilities

Rural generation had installed a under floor heated drying bay for wood chip from willow and forest brash. The heat for the drying came from their own biomass production and heating systems. They used the whole rod harvesting system and so they were chipping rods that they had stored as and when they needed them. While in outside storage the rods had reduced from 50% moisture to 30% moisture before drying removed an extra 5 %.

The drying takes about 4 weeks to achieve and cost £30 per tonne. This cost was too high and was making the production of willow too expensive. However, they hoped through fine tuning the newly installed heating system to reduce drying costs to more like the £25 per tonne that Rural Generation had achieved.

Chipping forest brash, consisting mainly of lodge pole pine and spruce produced a darker chip and because the brash came wrapped with polythene twine there was a higher degree of contamination with up to 1 kg / tonne of twine being mixed in with the woodchip. The fines content is also 2 times greater than willow chips because of all the side shoots and needles etc. However they had not found any problems in just burning the fines in their own biomass boilers.

Because of the relatively high cost of screening woodchip, none of their woodchip was screened except for some partial screening by the chipper itself.

Energy producing systems at the EREC

EREC have installed a number of different systems, partly as demonstrators and partly because they had so many different forms of feed stock. The heat is distributed amongst the various EREC buildings via a local district heating system.

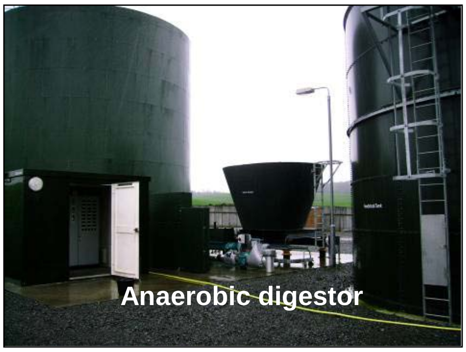
The main heating system for EREC was the biogas CHP system. This is because the gas was being produced 24 hours a day and there was little ability to store it. If there is too much gas for the system then the excess gas was diverted to the gas boiler which produced heat only from the gas. The CHP unit generated 81Kw of biogas, 69Kw after factoring in efficiency losses, 43Kw for heating and 26Kw of electricity. The gas system produces 81Kw of heat, 69Kw after factoring in efficiency losses. If more heat is needed then the 2^{nd} system cut in which was a Froling Turbomat 320 kWh stepped moving grate biomass boiler run on wood chips but which is capable of utilising a range of biomass fuels including woodchip, pellets and Miscanthus.

Another type of boiler they had installed was a 120kWh multifuel boiler which was used to evaluate different types of biomass feedstocks such as sugar beet waste and straws of different kinds. Because of the problem with chlorine in these types of fuels the multifuel boiler had a number of innovative features. The flue was ceramic lined and the boiler had extra corrosion resistance. Lime was also added automatically depending on the type of fuel used to neutralise any hydrochloric acid produced.

The final type of heat system they had was an experimental system in partnership with the University of Ulster. It was a woodchip gasification system that produced electricity from woodchip. The theory is that gasfying the chips by combusting them in limited oxygen could produce electricity more efficiently because you would not have to heat water and power a turbine first. This system has had problems and was unreliable because inherently it is a batch system not a continuous flow system and electricity production needs to be a continuous flow system. No one so far has managed to get gasification to work efficiently as a continuous flow system. The £30 M state of the art ARBRE project in Yorkshire signally failed to work and was abandoned. A similar system installed in a district heating system for Wick has also gone silent. So there is a great deal of work to be done to get this system to work (if it ever will) and to overcome the negative feelings towards gasification.

Anaerobic digestion

The anaerobic digester at EREC takes in 20 m^3 of manure a day. Manure, however, is not energy rich containing only a ⅓ of the energy content of the original grass.



Anaerobic digestor

One answer might be to digest the vegetation and in Germany they are growing maize to do just that so that they get 3 times the energy out of a system compared to putting in animal wastes. However this has strong implications for the food verses fuel debate which is especially important in the U.K. where there is relatively less space to grow food crops.

Another problem with anaerobic digestion at EREC is that it contains relatively high levels of Hydrogen cyanide which needs to be removed by carbon scrubbing.

The electricity produced is not commercially viable if it is sold to the grid because they only pay 4p per kW. However, if you can use it to replace electricity that you would have other wise bought from the National grid then it is worth 15p / kW which makes it a much more economic proposition. This may change however, with the new Feed in Tariffs which promise up to 45p / kWh.

The final point about anaerobic digestion is the waste digestate left at the end of the process. This contains all the nutrients that the original feed stock had but the N is in a more available form so it has a higher fertiliser value. Furthermore it contains less water than manure for example so it is easier to spread and handle.

Forest Brash

Forest Brash was being collected from the woodland and stored outdoors in 300 kg bales by the side of the road. It mainly consists of lodge pole pine and spruce and this has a number of drawbacks. The main one is that the brash still comes with the needles attached but the needles contain up to 3 years of nutrient supply which would be returned to the soil around the tree if they had been allowed to naturally drop. By removing the brash for fuel, then you take away all this nutrient from the system which will have to be replaced somehow. In Wales they tried leaving the brash for a couple of months but with only limited success.

Stack of Forest brash bails

Another problem is that Lodge pole pine is not a very straight tree with lots of branching. This means that it does not stack very well when gathered up. Excessive handling of the bales can be problematic with the binding breaking causing the bales to fall apart.

In conclusion, brash is a valuable resource to be collected for use in a biomass heat system but it comes with its own challenges.

Conclusions

This was a very interesting visit to a demonstration centre run by the government. Of particular interest were the different biomass boilers and CHP equipment on show and the chance we had to get an honest view of how good each system was such as anaerobic digestion and gasification technology. It also highlighted the surprisingly high cost of trying to dry chips rather than drying whole logs which, from the Agronomy Institute results, looks to be the feasible route in Orkney.

Thursday pm: Talk on wood pellet manufacture by BALCAS

Balcas are mainly a timber company that has branched out into pellet manufacture in order to utilise their waste sawdust. They started pellet production at their Enniskillen plant in 2006. As well as domestic customers they now supply in NI:

- 9 government buildings
- 10 schools
- 2 retail outlets
- 3 hospitals
- 3 hotels

This gives some idea how far NI has gone in converting to biomass energy.

They produce 100 000 tonnes of pellets in Northern Ireland which is offered at

- £130 per tonne loose bulk delivered
- £160 per tonne in 1 tonne bags delivered
- £2 per 10 kg bag which equates to £200 per tonne

Fuel oil <---> Bio fuels (calculated from thermal values)

1 kg wood pellets (8%)	0,47 litre oil	1,62 kg wood chips (40%)	1,13 kg straw (15%)
1 litre fuel oil	3,42 kg wood chips (40%)	2,12 kg wood pellets (8%)	2,4 kg straw (15%)

One tonne of pellets are equivalent to 470 l of oil which is more than woodchip (270 l of oil / tonne). Quality control is most important and each delivery is quality checked before leaving the factory because poor quality pellets can turn to dust during storage and handling which makes them useless as a fuel.

In September 2009 Balcas began production of pellets in Scotland at Invergordon having secured 150 000 tonnes per year of lodge pole pine in Scotland for the next 15 years. This is more expensive than using their own sawdust and 1 tonne of loose pellets delivered costs £160 per tonne. They hope to produce over 100 000 tonnes of pellets a year at maximum capacity.

Balcas say the advantages of pellets as a fuel are that

- The product is reliable
- It is not new technology having been around for 20 years on the continent

- Pricing is stable compared to oil allowing long term contracts to be signed
- You can claim renewable heat incentives
- Security of supply and delivery
- More energy efficient than other biomass products so take up less storage space. this is important for domestic situations
- They are easy to handle especially at the domestic level
- They are available immediately

With regards to Orkney the Appendix 4 outlines the Balcas quoted prices for delivery of Pellets to Scrabster as well as the transport costs of delivery to depots in Orkney.

Lessons to be learned from what we studied in Northern Ireland

Agronomic aspects

There were three main conclusions that were highlighted to us:

1. ***Willow can grow well as a biomass for energy crop in maritime climates. However there are other challenges to be met in Orkney and Shetland such as the cost of planting and harvesting and whether willow can produce a long term economic alternative to other crops. This will be reliant on the creation of a commercial market of sufficient size and/or the price of oil making biomass a real domestic alternative.***

2. ***A negative result with one aspect of a project can potentially set back development of a new industry in an area for many years to come.***

3. ***The economics of the market need to be acceptable to both growers and end users and that there are many sensitivities such as yield, price offered, quality required or delivery costs that will affect the economic case.***

Genotype trials

This was the major trial at Loughgall and produced results for clones that were different from the clone trials we are running in Orkney. For example Ashton Stott was a poor performer in NI, partly because it has little resistance to rust, whereas the Swedish clones performed best. In Orkney, where rust has not been a significant problem (yet!) Ashton Stott performed well and perhaps importantly for Orkney, it's bushier lower growth habit seems to resist the winter winds in Orkney better.

- **The difference in results shows that local information on what will grow best is important and it is important to continue with willow research. Research in NI may not produce recommendations that are best for Orkney or Shetland.**

Weed control

Weed control is vitally important, particularly so in Orkney and Shetland where any willow is probably following grass. This will almost certainly mean using herbicides at least in the first couple of years to control weeds while the willow becomes established.

Rural Generation used mechanical control as well but this seemed to cause a level damage to the willow which was acceptable on a large plantation.

1. **On smaller plantations, which are more likely in the Northern Isles, losses are more important so it is debatable whether mechanical control is advisable in Orkney especially give the volume of perennial weeds we have in Orkney, particularly following grassland.**

2. **On a smaller scale there is often scope to do operations manually.**

Disease control

Northern Ireland showed us

1. **The importance of having mixes in your stand of willows to control rust rather than a one clone plantation. This is different to cereal production for example and creates its own problems such as different growth rates and plant architecture.**

2. **It is important to choose a selection of clones that has similar growth characteristics.**

3. **It is also important to be sure that the rust resistance genes present over your mix are sufficiently varied to give you good disease control. Clones derived from similar parents may not have enough variation in resistance genes to offer a high degree of rust control over the whole plantation.**

4. **It should also be possible to plant the clones in blocks rather than mix them up completely. This would help overcome the differing growth characteristics of the clone mix as you could harvest blocks individually when the time is right rather than take an average harvest and planting time when conditions may not be optimal for any of the clones**

Poplar trial

- **The main lesson for the Northern Isles is that one poor result could put back development for decades regardless of subsequent improvements made**. This has not happened yet with biomass production in Orkney but it has certainly happened with biomass for heat use in Orkney. The abandonment of biomass as the fuel for the Lynn Road district heating system and a return to oil was nothing to do with biomass per se but to do with poor quality control of the waste wood chip that was used. But the net effect has been to put back fresh woodchip biomass use in Orkney by years compared to other counties.

Planting machinery

At Loughgall they used a lie flat planter. However in Orkney the plantations were planted with a vertical planter. In Orkney we found that the large vertical planter used at Muddisdale was not particularly successful whereas the purpose built smaller planter used at Papdale was much more successful at producing a uniformly planted site and greater cutting survival rate.

This may have been due to

- The skill of the people who were involved in the planting operation at Muddisdale. This should improve with experience.
- The smaller size of the vertical planter that was more suited to the size of plantation that we were planting.

The main lessons to be learned for the Northern Isles are that:

1. **It is important to use machinery that is suited to the size of operation that is being undertaken if SRC is to be economically viable**. Most of the machinery is designed for large scale production and is simply too big for the scale of plantations that individual holding would undertake in Orkney or Shetland.

2. **It may be that at the crofting level, of say a one hectare plantation where the landholder is growing for his own energy use and there are no commercial constraints that the easiest way is to do everything manually.**

Harvesting techniques

The main lessons from NI was that

1. **The general method for dealing with willow in NI is to cut, chip and dry but Whole rod harvesting seems therefore the model to follow in Orkney given the potential size of our plantations**. In Orkney we are closer to the grower – user model. This is because we do not have large woodchip drying facilities and our extra wind and reduced rain compared to NI means that we can dry rods consistently. . In Shetland, if suitable facilities could be found, the cut-chip and drying method could be utilised, as there is currently an abundance of waste heat available within the main town of Lerwick during the summer months. Alternatively the whole rod harvesting method could also be adopted with the benefit of some artificial drying if necessary, prior to chipping for customer use.

2. **Orkney and Shetland may have to consider harvesting in autumn** which is being researched as a possibility in the wetter areas of NI.

3. **If we need to harvest in autumn then there would be a fertiliser requirement for the willow as we will be removing the leaves as well although this would add to costs.**

4. **The fertiliser requirement could be supplied from slurry for example which would reduce fertiliser costs and offer an outlet for a farm waste product.**

5. **Harvesting by machinery would only be economic at present in Orkney if farmers pooled together to bring up machinery which is expensive or machinery already on the island was adapted for use with willow by the Orkney Machinery Ring perhaps. This is possible at present because all the willow was planted at the same time** but this may not be the case in the future.

6. **For crofters the economic solution on smaller areas is almost certainly to harvest manually as and when fuel is needed**, as long as any nutrients removed in leaves are made up with fertiliser applications.

Removal of mature stands of willow

This proved easier than expected in NI. This problem of how to get rid of mature willow if the need arises has, understandably been of some concern to Orkney farmers.

- **The method used in NI of an application of Glyphosate followed by heavy duty rotavating is something that can easily be adapted in Orkney and is a method that should go someway to addressing the problem of removing stools of mature willow from a field.**

Other biomass crops

The results from Loughgall for RCG simply did not match the results from Orkney. RCG in Orkney grows well and indigenously too. Whether it will ultimately provide Orkney with an alternative biomass for energy crop is still to be seen so the main point from NI about alternative biomass crops is that

- **Local research and results may prove substantially different from research results from other areas of the country. More research needs to be done into this crop but at present it is looking like a successful grass crop that may have a whole set of uses, not just for biomass for energy.**

Creating a partnership that enables biomass for energy to become a viable option for larger scale heating systems

Cookstown District Council has successfully been running a medium sized woodchip heated municipal building for a number of years and produced tangible and real cost savings compared to oil or wood pellets. This came about through a partnership between the Council who agreed a market price that was reasonable with its local farmers who then formed a cooperative to grow the willow and guaranteed that they would supply the leisure centre with quality wood chip 365 days of the year.

The Council got large savings on their heating bills while the local farmers got a market price for their woodchip on a long term contract which enabled them to invest in the machinery needed to plant and harvest the woodchip and guarantee supply and quality to the Leisure centre.

This is an ideal model for cooperation that Orkney Islands Council, in partnership with farmers groups, could copy for use with new build municipal buildings, especially in Mainland Orkney. The net result of the Cookstown-producer partnership is that Cookstown has a greener leisure centre that makes substantial financial savings in fuel for the District Council whilst providing local jobs from the growing of the willow locally through to processing and delivery. This can be compared to oil or pellets where, apart from delivery, most money flows out of Cookstown.

Processing the raw product

The main lesson from Northern Ireland if you are going to become a woodchip supplier in any way were:

- **The need to supply a quality controlled and consistent product if you are to ever make any impact on the market. This applies as much to woodchips as it does to pellets.**

- **If Orkney and Shetland are to set up a viable woodchip business or even growing it for home use then quality control must be there at the start of the planning not an add on at the end.**

Quality control has three main aims:

1. To provide a product that conforms to the moisture content fuel requirements of the customer's boiler. For woodchip this is between 25-30% usually depending on size of boiler. The smaller the boiler the more stringent the requirements.
2. To supply chip of a relatively uniform length. Two smaller chip and you create dust and it burns too quickly, too bigger chip and it clogs up the augers and systems. This will also depend on the size of the customer's boiler. Once again the smaller the boiler the more stringent the limits on chip size.
3. There should be mechanisms for removing contamination as this will lead to clinker build-up, excessive ash production, dirty smoke and broken equipment.

This is what happened at Lynn Road in Orkney with the chip supply. Attempts were made to use very wet wood that was highly contaminated with metal and paint which led to poor boiler performance and increased maintenance to the extent that the woodchip boiler has been taken out of commission and the development is now relying on the oil backup system. Attention to quality control would have made all the difference.

Other potential uses of willow that could improve the financial viability of a biomass for energy strategy

1. **Effluent treatment is a potential use for willow. The value of willow for this purpose in Orkney and Shetland is likely to be with the disposal of slurry wastes rather than water treatment wastes. This is an area that needs further research.**

2. **Effluent treatment is likely to be a secondary consideration rather than the planting of willow for remediation in itself because there are better, more efficient plant types available.**

3. **The financial returns to be gained from effluent treatment are difficult to assess in the Northern Isles**. This is different from where remediation for leisure and nature reasons is the prime aim, such as on or near landfill sites which produce leachate. In these circumstances willow might be chosen for its aesthetic and biodiversity value alone.

Wood pellet manufacture and the current situation for pellet use in the Northern Isles

1. **In the short to medium term, for larger installations pellets will have to be the main form of biomass in the Northern Isles** but the problem is that if Scottish manufacture of pellets becomes limited due to quality issues or manufacturing issues (as has happened recently with a manufacturer in Northern Scotland) a then there may be potential problems with total reliance of pellets in the Northern Isles. The main disadvantages of pellets should this situation arise (as it has in Northern Ireland) are that:

- They are approaching the price of Oil (but they do contain more energy per tonne).
- If it ends up their being only one mass manufacturer in Scotland then you have security of supply only as long as they decide to supply you.
- They can increase the cost of the pellets as and when they want , unless its possible to enter into long term supply contracts.

2. **For household use where a person is not growing chip for themselves then the advantages to pellets probably outweigh the disadvantages and they will become the main source of biomass fuel for household systems along perhaps with briquettes or small logs for wood stoves etc.**

3. Another significant factor to be considered with reference to the use of imported wood pellets is the storage issues of such a volume of material in order to make shipping viable. The storage of pellets is critical and possible over a long period of time, but their moisture content has to be kept down below 10 % and the potential of water ingress destroying the stored pellets are of significant concern. The bulk storage of pellets must be carefully considered with the Northern Irish example to use specially constructed watertight bunkers or silos.

4. **In Orkney and Shetland where we have not got any woodland brash or willow at the moment any project of a reasonable size will probably have to use a variety of biomass fuel sources such as chip and pellets or chip and grass crops. EREC showed us that this is a viable proposition but it would need a multifuel boiler. These are more expensive than a single fuel boiler but would maximise the resources available in the Northern Isles and would, in time, pay for itself through the reduced cost of importing oil or indeed pellets from Balcas.**

Final Conclusions

This was a full and interesting study tour and much was learned. There were a number of main points that were learned from the tour:

- **The economic model must be beneficial to both the grower and the end user for a local supply chain and wood chip market to develop**. This was made very clear in NI on a number of occasions by numbers of different people including both consumers and producers.
- **Given Orkney and Shetland's climate and scientific results for the Orkney trials, it is entirely possible to grow willow for** biomass energy in Orkney

and potentially Shetland. However we need to be aware of potential problems such as disease and ought to consider growing mixtures whether as fully mixed or in blocks. Yields may also differ from the Orkney trials depending where the site is. Although the Agronomy trial sites have been consistent over two large sites, yields will be reduced by high wind and spray exposure, use of poor or predominantly water logged soils, level of inputs etc.

- **Woodchip for heat energy is a fuel source in Orkney that** promises to keep the money spent on fuel within the Orkney economy and creating jobs. Purchasing pellets or oil means that local funds are spent elsewhere and the energy shipped to Orkney.
- **The Cookstown visit showed that setting up a wood biomass based heating** system is relatively straight forward and has been achieved successfully by a number of Councils throughout NI, some of whom are smaller than Orkney.
- **The key though was the partnership between the consumer (the Council)** and the producer (the farmer) The consumer had to be prepared to pay a fair long term price to a producer, often a consortium, and the consortium had to promise to guarantee quality and security of supply.
- **Quality control is paramount. Without it the system will break down.**
- **The infrastructure technology needed to utilise biomass as a heating fuel is** well developed and not difficult to run. It is easily incorporated into municipal developments and run and maintained on a day to day basis by municipal staff. There is no need for specialist trained staff once the systems are installed, whether this is in your domestic home or as a district heating system
- **Pellets are a good product that is available immediately. Woodchip in** Orkney will take at least 4 years to develop so there needs to be a partnership agreement between potential large local consumers and potential producers that will last over the f year lead in period.
- **Pellets for larger buildings are *very* expensive in the long run. At a** suggested bulk import price of £150 - £155 per tonne to Orkney (source OIC) they are potentially up to twice the price of woodchip.
- **After the 4 year initial growth period the Council could switch to woodchip** which should almost halve fuel costs (woodchip at £80 per tonne) compared to pellets while still gaining all the benefits of using a renewable fuel.

This would require forward planning and the installation of multi fuel boilers so that there can be an easy switch from pellets to woodchip.

Appendix 1: ORKNEY WOODLAND PROJECT (OWP) REPORT ON SRC VISIT TO NORTHERN IRELAND (October 2009) AND ITS POTENTIAL IMPLICATIONS FOR SRC PLANTING IN ORKNEY

INTRODUCTION

The visit to Northern Ireland was highly interesting and seemed of great value to all the different parties involved. This brief report does not make any attempt to summarize all the findings from the visit, but rather to take the relevant findings from the trip and consider them in terms of SRC production in Orkney. This is written totally from the perspective of the Orkney Woodland Project and addresses how the project feels that SRC can be taken forward in a manner and at a scale that could work for Orkney and how OWP could participate in that process.

OWP gives free advice and grant applications to those wanting to plant woodland in the County and have also carried out grant applications for SRC in the past. The project, therefore, has long-standing experience of tree growth in a huge variety of local conditions. OWP has a responsibility to give realistic, evidence-based advice to farmers and other landowners. To visit Northern Ireland, where SRC is relatively long established, and to meet those involved in various ways, was therefore a very useful experience and the time given to us by everyone was greatly appreciated.

MAIN RELEVANT FINDINGS FROM NORTHERN IRELAND

Varieties

It was evident that long-term study will be needed to continually assess and to keep introducing and trialling new varieties.
We were told that we need to advise planting a minimum of 6/7 varieties, half of European origin, half of Scandinavian(Swedish) origins.

Ground Preparation

It was said that the willows have to grow for five years to recover the greenhouses gases lost through ploughing and this is something to be considered. No plough systems should be investigated.

Yields

Yields quoted varied from ? 7-9 odt/ha

Economics

Even in the relatively well-established industry of Northern Ireland, the economics of SRC were acknowledged by all as fragile and borderline. Whilst some growers / suppliers were succeeding, others were less happy.

- Grants were higher a few years ago, which led to a rapid increase in areas being planted. With reduction in grant, the amount of planting seems to have diminished
- If farmers are only growing for wood chip, farmers likely to only break even at best (AMc) ie unless involved more in supply chain.
- Income to farmer £90/tonne at 25% moisture, £70 at 30% moisture, but some farmers are being left with unsold chip, presumably because market has not caught up with supply. There was therefore possibility of price fall.
- Large scale growing/supply requires large scale, expensive, fuel-guzzling infrastructure for planting, harvesting, maintenance, chipping, grading, drying and delivery. We were told that in order to be really viable, growers need to

be involved higher up the supply chain and that approximately 500 hectares is needed to justify the associated machinery / infrastructure required.

• If delivery is more than 20 miles, it can become uneconomical to grower.

Given that yields in Orkney are likely to be slightly lower (by maybe 2 or more tonnes/ha'), this would suggest even more fragile economics for a commercial grower. (We still have no yield data from a farm plot in Orkney and it was repeatedly confirmed that yields from research plots always outdid yields from farm plots.) An assessment of yields from Cliff's and Eric's sites to establish more 'real' predicted yield for Orkney would be very useful.

Northern Ireland's climate cannot be considered as 'maritime' in the same way as Orkney's and only the best sites are likely to produce high yields Unfortunately, these are likely to be sites that farmers may want to keep for other purposes.

Bioremediation

This is clearly an area that should be further investigated in Orkney.

CONSIDERATIONS FOR FUTURE OF SRC IN ORKNEY

Advice

Experience of advising on woodland works clearly shows that many people require a very high level of initial and ongoing advice. It is clear that the same, or maybe more, will be required to get many people interested in growing SRC.

OWP (and other advisors) has to be particularly careful not to imply economic benefits which may not be forthcoming.

It would clearly be helpful if the Agronomy Institute could be involved in developing this advice, since it needs to make use of the relevant research information learnt from the AI and the other local plots of SRC.

Economics and Barriers to Development

Currently grants for SRC under SRDP are as follows - minimum of 2 hectares, 50% of actual costs up to maximum of £1000 per hectare, based on receipted invoices i.e. the grant would not cover initial costs.

There is currently no market for wood chip in Orkney, although OIC are considering installing a small number of wood chip / pellet boilers in schools. It seems likely that the market for domestic wood fuel will increase, although Orkney is also well suited to domestic wind, to ground source heat pump installations, both of which seem to be being increasingly widely installed. These alternative technologies may be seen as an easier way of energy / heat production.

Orkney has potential competition of supply from wood chip and / or pellets from the north of Scotland where there is abundant waste wood and the price of this will clearly have an effect on the price paid for local willow. Orkney Islands Council has to obtain supplies from the cheapest source and this may well be from out with the County.

Orkney currently does not have any of the large scale planting harvesting, drying equipment necessary for large scale production. This machinery is extremely expensive to buy and would be heavy and expensive to transport from south if hiring it in.

Potential yields are likely to be lower than in Northern Ireland and will vary from site to site.

CONCLUSIONS

Because of the doubtful economics and need for extensive infrastructure, commercial production of SRC is unlikely, in the short or medium term, to get off the ground in any large scale way in Orkney.

If, however, we can start to promote SRC on a small, own-use, domestic/farm scale and develop low-tech, affordable, practical, simple ways for people to do this, then I am sure there are people who would want to do this.

Many individuals are keen to ensure their own security of supply and this probably involves developing a package of energy efficiency/provision for their home/farm, which may include high levels of insulation, wind, ground-source heat pumps, a wood-burning stove etc... For the many folk in Orkney who have a field or two, this could indeed include growing a patch of SRC.

This scale should not be ignored. Every individual who manages to contribute to their own heating provision, even in a small way, is helping to reduce their own expenditure on fuel and helping to reduce 'fuel miles'. There may also be other benefits e.g. providing shelter for homes or livestock, health benefits, biodiversity benefits etc.

If SRC is promoted to folk who really WANT to do it, who are time and energy rich and to whom the concept of becoming more self-sufficient in energy is highly appealing, then it will find its place in Orkney.

Bioremedation

The local SEPA office should be asked what and where the local problems are with run-off / pollution that might be addressed by willows. A research project could therefore be designed to test the effects of planting willows on a problem site. With the full support of SEPA, this should be easier for the AI to obtain some funding for.

What OWP can do to help promote SRC

At this time, OWP does not feel that it is responsible to encourage local commercial scale production of SRC, as the economic returns to the farmer are doubtful. However, it is clear that SRC can play its part in the array of sustainable energy sources which can be used in the County. OWP sees domestic scale and possibly bioremediation projects as the most immediate way forward for SRC. By encouraging production / use at this level, SRC growing will become part of the local culture and may increase if the demand increases, or with agricultural changes, in the future.
OWP intends to promote SRC in the following way:

- OWP will promote small (domestic / own-use) scale of SRC growing locally.
- Hopefully in consultation with AI, OWP will prepare written guidance on low-tech, domestic scale SRC growing for Orkney (This will probably also include SR Forestry and be along similar lines to the 'Orkney Woodland Design Guide')
- Hopefully in consultation with AI, OWP will provide free onsite and ongoing advice for potential small scale growers
- OWP could carry out a limited number of SRDP grant applications, but only where appropriate (and this grant does not suit small scale projects)
- OWP could investigate other, more suitable, funding for small scale projects, including bioremediation projects.

OWP intends to develop a small scale, multi sited, community-based SRC project (see appendix) and would be happy to discuss ways to achieve this with all concerned.

OWP Project Proposal for Summer 2010 / Spring 2011

- Promote small scale, domestic SRC - sort of local ‘challenge’ project to individuals with suitable land (suggest a maximum size to be agreed ? up to 1 ha max)

- Prepare advice sheets geared round low-tech, manual planting / harvesting methods

- Visit site and ensure land is suitable, give advice, calculate area and number/variety of cuttings needed

- Arrange bulk order of suitable mixture of cuttings, which growers can purchase off OWP/Agronomy Institute.

- Continue to give ongoing advice on management, maintenance, harvesting, drying etc

- Visit sites as they grow and involve site owners in measuring and monitoring growth

- This level of advice / support would definitely encourage people to get involved

Jenny Taylor, Orkney Woodland Project, 28/2/10

Appendix 2: The situation in Shetland

At present there are no SRC willow for biomass trials in Shetland, although the ability of some species and cultivars of willow to grow well here is not in dispute. Nor has there been any attempt to use biomass for energy on any institutional scale. There is however an interest; from the user point of view Hjaltland Housing Association (HHA), and from both user and operator/supplier, Shetland Heat Energy and Power (SHEAP). Shetland Amenity Trust is committed to grow willow for biomass, and there are individuals in the community who would be willing to try.

A significant difference from Orkney – let alone Northern Ireland – is, however, the availability of suitable ground suitable for cultivation. There is little arable land in the county, and although "in-bye" crofting land has been used in the past for arable crops, most of this is in small parcels. Indeed it is doubtful whether enough land might be available locally to support a small district heating scheme, such as has been investigated by HHA and SHEAP at Scalloway.

It is worth pointing out that under SRDP a minimum of 2 hectares per applicant is eligible for grant aid to SRC cultivation. This may be a barrier to crofters who wish to grow SRC but may not have sufficient suitable land to qualify. There are, however other (non-land-based) grants available under SRDP that might contribute to a project that involved agricultural or rural businesses, or rural communities. Meanwhile there are other funding sources, e.g., Carbon Trust, Community Energy Scotland, Energy Saving Trust, where an end-user may be assisted.

Harvesting on a large scale in wintertime would most likely encounter problems with wet ground given Shetland's rainfall statistics, the prevalence of water-retentive soils, and the weight of machinery.

This is not to say, however, that these negative aspects are insurmountable. Biomass using imported wood pellets is under consideration by SHEAP and HHA, and initial feasibility studies have indicated its economic viability. If security of supply and storage can be validated, we may see pellets being used. But, as has been pointed out in Orkney's case above, there are strong arguments in favour of local supply of woodchip. If wood-pellet systems are to be used in Shetland, they should also be flexible enough to convert to woodchip.

Before any of this can "get off the ground" in Shetland, the priority is to demonstrate that SRC willow can be grown, albeit on a very modest domestic, or community building, scale. Both to qualify for grant aid and to demonstrate its efficacy, this means having an end-user in place (which may be the grower). This is the only way for scepticism to be allayed, and to encourage others to try. Such a demonstration plot could produce not woodchip but billets (assuming a boiler or stove that can utilise them), and could minimise machinery dependence; indeed, if small scale machinery such as clearing saws are used for harvesting, it could be integrated with other woodland/biomass initiatives such as short rotation forestry (SRF), as more flexibility could be introduced to plot design. This might increase biodiversity value, and integrate better with both landscape and other land-use.

The priority then, from Shetland Amenity Trust's point of view, would be to demonstrate the feasibility of growing willow for biomass, and to find and help to make available the best species and cultivars for the climate and soils in Shetland. The scientific research that has been done in Orkney and in Northern Ireland, and elsewhere, does not itself have to be replicated.

As mentioned above, there are individuals in the community who have declared an interest in growing SRC, and it is to be hoped that by next year at least one trial will have been initiated.

Appendix 3: A Short list of SRDP grants that are potentially available for growing SRC and implementing biomass for energy systems in Scotland.

Grants for SRC
http://www.scotland.gov.uk/Topics/farmingrural/SRDP/RuralPriorities/Packages/renewableenergy/ShortRotationCoppice#top

Renewable Energy - Agriculture
Could include biomass boiler, purchase of supply chain or specialist equipment to harvest and process woodchips and pellets for own-use agricultural businesses.

http://www.scotland.gov.uk/Topics/farmingrural/SRDP/RuralPriorities/Packages/renewableenergy/RenewableEnergyAgri

Renewable Energy - non land based
http://www.scotland.gov.uk/Topics/farmingrural/SRDP/RuralPriorities/Packages/renewableenergy/SupportforRenewableEne
Could include biomass boiler, purchase of supply chain or specialist equipment to harvest and process woodchips and pellets for rural communities or businesses.

Appendix 4: Fuel Pellet costs delivered to Orkney and quoted price of Pellets delivered to Scrabster by Balcas

	Scrabster - Stromness 10 meter Rigid Lorry 4 < 16 tonnes							
Tonne	Pellet Cost	Total cost inc. Ferry Low - £166	Price Per Tonne Delivered	Total cost inc. ferry Mid - £194	Price Per Tonne Delivered	Total cost inc. ferry Peak - £212	Price Per Tonne Delivered	
4	£640.00	£806.00	£201.50	£834.00	£208.50	£852.00	£213.00	
5	£800.00	£966.00	£193.20	£994.00	£198.80	£1,012.00	£202.40	
6	£960.00	£1,126.00	£187.67	£1,154.00	£192.33	£1,172.00	£195.33	
7	£1,120.00	£1,286.00	£183.71	£1,314.00	£187.71	£1,332.00	£190.29	
8	£1,280.00	£1,446.00	£180.75	£1,474.00	£184.25	£1,492.00	£186.50	
9	£1,440.00	£1,606.00	£178.44	£1,634.00	£181.56	£1,652.00	£183.56	
10	£1,600.00	£1,766.00	£176.60	£1,794.00	£179.40	£1,812.00	£181.20	£160/ tonne
11	£1,760.00	£1,926.00	£175.09	£1,954.00	£177.64	£1,972.00	£179.27	
12	£1,920.00	£2,086.00	£173.83	£2,114.00	£176.17	£2,132.00	£177.67	
13	£2,080.00	£2,246.00	£172.77	£2,274.00	£174.92	£2,292.00	£176.31	
14	£2,240.00	£2,406.00	£171.86	£2,434.00	£173.86	£2,452.00	£175.14	
15	£2,400.00	£2,566.00	£171.07	£2,594.00	£172.93	£2,612.00	£174.13	
16	£2,240.00	£2,406.00	£150.38	£2,434.00	£152.13	£2,452.00	£153.25	£140/tonne
	Note: All fuel prices DO NOT include VAT							
	Scrabster - Stromness 14 meter Arctic Lorry > 16 tonnes							
Tonne	Pellet Cost	Total cost inc. ferry Low - £232.4	Price Per Tonne Delivered	Total cost inc.ferry Mid - £271.6	Price Per Tonne Delivered	Total cost inc.ferry Peak 296.8	Price Per Tonne Delivered	
17	£2,380.00	£2,612.40	£153.67	£2,651.60	£155.98	£2,676.80	£157.46	
18	£2,520.00	£2,752.40	£152.91	£2,791.60	£155.09	£2,816.80	£156.49	
19	£2,660.00	£2,892.40	£152.23	£2,931.60	£154.29	£2,956.80	£155.62	
20	£2,800.00	£3,032.40	£151.62	£3,071.60	£153.58	£3,096.80	£154.84	
21	£2,940.00	£3,172.40	£151.07	£3,211.60	£152.93	£3,236.80	£154.13	
22	£3,080.00	£3,312.40	£150.56	£3,351.60	£152.35	£3,376.80	£153.49	£140/tonne
23	£3,220.00	£3,452.40	£150.10	£3,491.60	£151.81	£3,516.80	£152.90	
24	£3,360.00	£3,592.40	£149.68	£3,631.60	£151.32	£3,656.80	£152.37	
25	£3,500.00	£3,732.40	£149.30	£3,771.60	£150.86	£3,796.80	£151.87	
26	£3,640.00	£3,872.40	£148.94	£3,911.60	£150.45	£3,936.80	£151.42	
27	£3,780.00	£4,012.40	£148.61	£4,051.60	£150.06	£4,076.80	£150.99	
28	£3,920.00	£4,152.40	£148.30	£4,191.60	£149.70	£4,216.80	£150.60	

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Biomass Pellet Prices from Balcas
Dated April 2010

Balcas Provide two types of delivery - Rigid 10m lorry (4 - 16 tonnes) *most economical for Orkney*
-Artic 14meter lorry (28 tonnes)

The minimum delivery they will provide is 4 tonnes which would require a 5 tonne fuel store requiring 7.5m³ of space.

Charges for loads are either - Domestic for loads of 4 tonnes < 16 tonnes is £160 per tonne + VAT. Up to 24m³ of storage required.

Commercial for full 16 tonne – 28 tonne loads is £140 per tonne + VAT. Approx 42m³ required.

All prices are to Scrabster only with the ferry costs being charged on top with no extra charges for driver etc providing no overnight stay is required. Pellets can be stored indefinitely provided they are kept dry. Unloading is done via a blower vehicle which can reach a maximum of 20m. This offloading system is advantageous as it gives a sealed fuel store above ground. Balcas will also offer a bulk tipper if that is advantageous to us. The same rates will apply.

Based upon a 16 tonne delivery, on a rigid lorry, costs are anticipated to be in the range of £150 - £155 per tonne delivered.

Appendix 5: Estimated costs of producing willow and minimum price that a farmer would need to charge

The following breakdown of costs and the two paragraphs after it were provided by Mike Girvan (SAC Agricultural Consultant) for a theoretical highly profitable beef business running 100 cows on100 ha, looking to change from beef to growing willows.

Beef enterprise Sales 98 fat cattle at £ 900 -			£88,000
Subsidies	SFP	£23,000	
	LFASS	£6,000	
	SBCS	£6,370	
	LMO	£3,450	
Total			**£126,820**
Costs, variable and fixed			£60,000
Profit			£66,820
Profit/Ha			£668

Willows as of this year do qualify for SFP so the figure that would have to be matched would be £ 43,820. However you would have to add on £ 11,000 / year to compensate for no income in the first 3 years of the willow production. So the figure to equal the beef enterprise would be **£ 54,820 /100/7 = £78.**

However to tempt people to move from what is at present a safe and viable enterprise the awards have to be above what the present enterprise will offer. I would suggest that this figure should be in the region of **£100 - £130/ tonne**. All costs associated with getting the willows to the end user such as harvesting drying chipping etc would be above this price.

In addition to Mike Girvan's figures above, the following should be considered:

- Costs for harvesting and chipping have been excluded. These could add at least another £30/t. However these costs are not necessarily borne by the farmer. Under some business models there is a middle party who buys, processes and sells the chip to a consumer and bears the cost of harvesting and processing and the farmer just grows the willow.
- The attractiveness of willow in Orkney will largely be determined by the cost of production of chips relative to that of beef. Beef prices are high at the moment but over the 20 year lifespan of willow the prices will fluctuate. Major determinants of the price of chips in Orkney will be i) the price of oil and ii) the price of chips or pellets imported from elsewhere. In the future, oil prices can be expected to continue to rise.
- New subsidies for renewable energy from Biomass could be come available similar to the Feed in Tariff for electricity for example or an updated Renewable Energy Obligations Certificate