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Bioenergy Proliferation and Deployment

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John Gilliland's farm: Energy Opportunities when using Energy crops

Introduction:

The Brook Hall Estate is located in Derry in Northern Ireland and has been owned by the Gilliland Family for the last five generations. The farm is 200ha in size, which includes: 120 ha willow coppice, 40 ha Cereals, 20 ha Grass and 20 ha Arboretum, Walled Garden and Woodlands. The award winning farm is now operated by Dr John Gilliland who has an holistic approach to his farm's bioenergy production.

In the year 1988 Brook Hall Estate installed its first renewable heating system, which was a 300kW boiler. It cost £20,000 to install and generated savings of £6000 per year. The system was installed without any grant aid or RHI (Renewable Heating Incentive) and the payback time was just over three and a half years. After this success there was greater interest in green energy, resulting in a further 5 biomass installations and a solar thermal hybrid installation. The key to success in this scenario has been the critical project selection along with the right time and type of consultancy. Currently there is only one worker employed to look after farm related issues while four are employed to look after the heating aspect. During harvesting season, outside contractors are employed to look after this aspect.

Raw Material:

The willow which is used for energy production on this farm is the fastest growing species in Ireland. Brook Hall grows their own fuel so that they don't need to compete in the raw material market. The only issues related to the availability of this source are; the amount of available land for growing the willow, currently 120ha, and the geographical location of this site for growing. Saw mill off cuttings and dust are also used in their boilers, with the optimal moisture content of the G30 chips at 20% after drying.
Willow is quite dusty after chipping so screening is needed. They dry their own raw material, using the heat which they get from their boilers. The lower quality raw material can be combusted in the oldest and simplest boiler, the bale boiler. Willow was chosen as the raw material because it is fast growing, resulting in quicker possibilities to use and produce income.

Through their experience they believe that Northern Ireland and the UK have not maximised their potential for willow. Some of the reasons for this include:

- Lack of specialist planting/harvesting equipment
- Poor understanding of correct establishment and management practices by growers.
- Not economically viable for farmers.
- High up front establishment costs.
- Lack of promotion of the Energy Crops Scheme to potential growers, agents, consultants or advisors.
- Lack of specialist local supply infrastructure.

- Lack of land for energy crops due to increase in grazing land for animal and food sector

Procurement

The Willow supply chain is consists of planting the willow coppice, fertilizing, coppice management, harvesting, chipping, handling and storage of willow chips.

Planting:

Planting season extends from early spring – February/March – when weather conditions allow soil preparation, to late May and even June using cold stored cuttings. Current commercial practice is to plant 16,500 cuttings per hectare to give a final established crop of 15,000 per hectare. To facilitate mechanical harvesting and machinery access, the crop is planted in double rows 0.75m apart with double rows spaced at 1.5m. An in-row spacing of 0.6m gives an initial planting density of approximately 16500 per hectare. After planting the willow it is able to produce coppice/regenerate for 18-25 years.

Fertilisation and coppice management:

In John Gillilands farm sewage water is used as a fertilizer. Willow is able to filtrate nitrogen away from the water which makes it suitable for dirty water treatment. Fertilization using dirty water is only allowed during the growing period, meaning that it is normally restricted between the 15th of October and February

Harvesting:

The harvesting window for the SRC Willow is from leaf fall, to bud burst/flushing in the spring. In normal conditions, this gives a three to three and a half month period from December to mid March.

Willow can be harvested in many ways, but the direct chip harvesting method is used on this site. Here the crop is cut and chipped in a single pass and the resulting material must be artificially dried immediately following harvest to prevent deterioration. Most of the machinery developed for this type of operation has been designed to harvest the double row in a single pass, and are essentially modified harvesting heads fixed to standard forage harvesters. A modified Claas forage harvester is used on this site.

Handling and Chipping:

Once the standing crop is cut and chipped it is blown into trailers for removal. Because the harvested crop is chipped fresh, the quality of the chip will be maximised and the power requirement for the chipping operation minimised. This trailer then carries the chip to loading bays where they are dried to lower their very high moisture content. This lowers the moisture content to an adequate level for combustion.

Image Sourced from http://www.biofuelstp.eu/

Storage:

Screening and drying of willow is done in the storage of John Gilliland's farm. A screening machine grades the chip, depending on the different category of the chip. In the chipped willow storage facility there is a flow system with wind tunnels installed in order to help with the drying process. The drying process takes a long period of time to ensure that as much moisture as possible is evaporated. In order to ensure that the whole chip is dried to the optimal level, the drying process is carried out in several phases.

Bioenergy production: Combustion

The Brook Hall Estate has five biomass installations and one hybrid solar thermal system installed.

All heat for the farm, the farm houses, and driers now comes from a 300kW big bale boiler and 100kW KWB boiler, using the under and over sized woodchip, from the woodchip grading process. All electricity is wind electricity. Work continues with AFBI assistance to reduce the heat and electricity inputs.

Development of Renewable Heat in the farm in brief:

1988, First Experience of Renewable Heat

- Brook Hall Estate: Installed 300kW boiler
- Cost £20,000 Savings £6,000 per year Payback 3.6 years
- No grant aid or RHI

2012, Renewable Energy at Brook Hall

- Five Biomass Installations & hybrid with Solar Thermal
- 2006, 100 kW KWB Installation, cost £25,000
- Savings £4,800 per year, payback 5.2 years (No RHI)

Policy case: Renewable Heat Incentive

Renewable Heat Incentive (RHI) is the main driver for Biomass to Heat -systems. The aim of RHI is to increase renewable heating to 10% by 2020. In (2012, this figure was at 1.8 %). RHI is funded by Central Taxation and gives 20 years payments, on eligible metered heat consumption. RHI incentifies a wide range of technologies, but boilers less than 45kW need to be certified and installers have to be accredited. Tariff levels bridge the cost between conventional and renewable heat. Financial support can be simply calculated by multiplying metered heat units with tariff. Annual proof of service and maintenance as well as performance is required.

In Northern Ireland, RHI depends on the type and size of technology used. Smaller (less than 100 kW) boilers have a bigger tariff than the 100 kW and bigger boilers. When installing a bigger boiler you will get a smaller tariff (1,5 p/kWh versus 6,1 p/kWh). This encourages people to choose smaller boilers, as the payback time will be much shorter. The carbon reduction will be higher when using bigger boilers, when you displace more oil in your old heating system.

Fuel Supply Case: Fuel Security

According to the CCC view, the UK will be struggling to reach the target of solid biomass use for bioenergy if they only want to increase wood energy. The aim is to produce around 40 TWh electricity and around 30 TWh heat using solid biomass. Power and Heat sectors may require around 30 Million tonnes of solid biomass in 2020. This is the same equivalent used by all wood consuming sectors today (primarily construction, wood panels, pulp and paper). The shortfall from forest energy (over 60 TWh) will need to be met via imports or other sources, such as dedicated plantations and agricultural residues. In Ireland’s case,

the potential supply in 2020 will be just about enough to cover the potential demand in 2011, but won't even be close to the demand in 2020.

The solution for fuel security could be similar to the approach used in Gilliland's farm. These approaches include; increasing the use of under utilized woodland for bioenergy production, producing conventional forestry thinnings, making farmland accessible to increase the food production by stimulating lowland to grow willow coppice and increasing the use of wood pellets. The benefits of growing willow include; reducing livestock diseases, cleaning water through sewage treatment, increasing carbon capture, producing indigenous renewable fuels and improving biodiversity. John Gilliland's farm has been successful in the use of biofiltration of dirty water, using energy crops (willow).

Fuel combustion and Conversion Case: Quality management

When using biomass, quality management plays an important role in successful and efficient energy production. Too wet, mouldy, dusty or oversized fuel can lead to the unreliability of the boiler, environmental hazards and problems with efficiencies.

In the case of John Gilliland's farm they have managed to solve some of the problems related to the quality. First of all, they have built a successful storage terminal which can also be used for drying the raw material. In their studies they realized that the boiler efficiency decreases when the moisture content was over 20 %. With help of their drying storage and its intelligent structure, they are able to handle the moisture content of their raw material. In order to get rid of improper fuel size, they have bought a screener which grades the woodchip. Lower quality fuel can be still combusted in their simplest boiler which is also the most inefficient.

Fuel combustion and Conversion Case: Planning a bioenergy system

Choosing the right size of boiler and type of boiler for your bioenergy project is really essential. Some issues which affect boiler size and type include; Energy need, Energy type (heat or electricity), Ownership, Efficiency, Fluctuance, Network characteristic, Available space (buffer cylinder/tank?), Estimated payback time/Cost, Installation, Maintenance and Policy (Subsidies and Incentives)

Even more than gas and oil systems, biomass systems require a careful integration of components to make sure the whole operation runs smoothly. These components include: the fuel storage facility, any driveways necessary to provide access for large fuel-delivery trucks, a boiler room to house the combustion equipment, the boiler or combustion appliance, fuel-handling equipment to move the fuel from storage to the boiler, a chimney to exhaust the combustion gases, any necessary exhaust-gas cleaning devices, ash disposal equipment, and the controls that keep all the equipment operating optimally.

John Gilliland's farm has experience of planning different bioenergy projects. They have gained great experience in the impact of installation design on the financial payback of a 99 kW boiler to a great extent. Other issues which they have learned include how to fit installations. They have tested containerized solution, "Flat Pack" Buildings as well as different installation internally.They also have knowledge in the sizing of installations meaning that they have experience in testing different boiler sizes. In their experiences they have found that the design works well when the boiler has over 2500running hours annually.

Another important issue which can be learnt from J.Gilliland's farm is that good design of fuel storage depends on the type of fuel. It is important to know when an external hopper is needed and when you could use above ground stores and below ground stores. It is also important to realize the frequency of fills that is needed for the storage of biomass and how to deliver fuel (Access to storage, when to use blower trailers, when elevator trailers and when walking floor trailers).

Conclusion:

The future for biomass crops is encouraging, with biomass seen as a key alternative crop for farmers and the SRC willow as the crop with the most potential. The benefits of Biomass Installations can be seen in this case study as much of the processes have been carried out without any Government Incentives.

There have been recognised short comings on the viability of the potential of Willow in Northern Ireland and the UK. However this case study has highlighted the importance of willow in Ireland and what it can offer in terms of Energy Production and Cost Savings.

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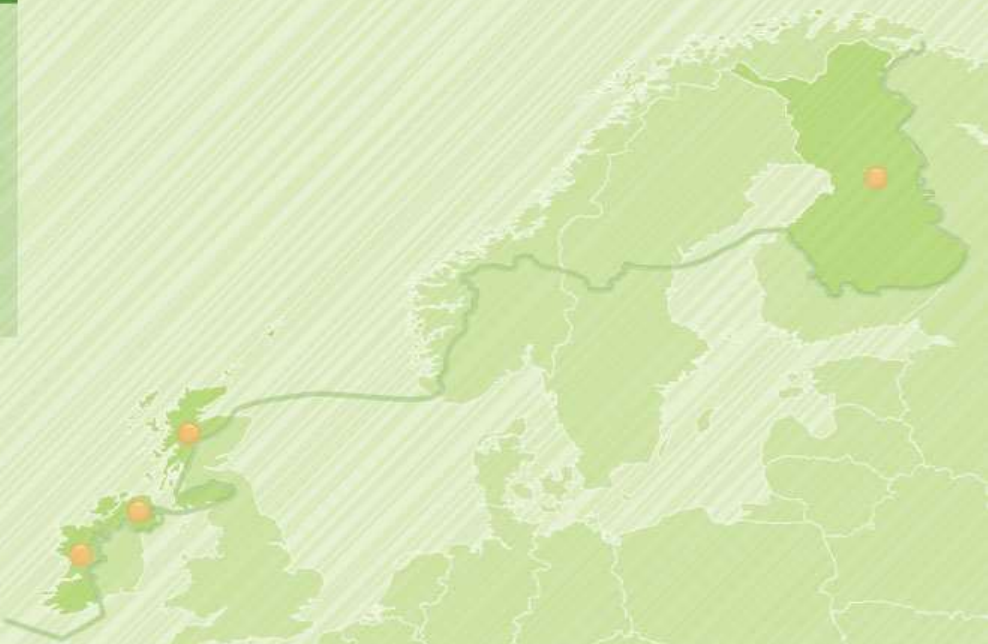

BioPAD is promoting the wider use of bioenergy and developing applications targeting the whole process from supplying fuel to producing energy.

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