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Energy crops in Europe

Best practice in SRP biomass from Germany, Ireland, Poland, Spain, Sweden & UK

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Biomass in Europe

An overview of best practice from Germany, Ireland, Poland, Spain, Sweden & UK

Biomass is increasingly being seen as an important energy source for Europe. In 2009, the European Commission (EC) set a binding target for renewable energy to comprise a 20% share of the overall EU energy mix by 2020. In order to achieve this, one of the possible strategies put forward by the EC was to triple the amount of biomass used as fuel from the 1997 level, with the greatest potential for growth being seen to be in the use of wood chips and agricultural biomass (energy crops).

The market for energy crops shows huge variation from country to country, with take-up levels being strongly influenced by local factors such as the policy environment, the availability of financial incentives and the level of access to appropriate infrastructure. Despite this, many would-be growers and end users face common challenges, and hence there is an opportunity here to share knowledge and experience in a way that will help to support innovation in this sector and address some of the key barriers to development.

This booklet aims to contribute to this process by providing 40 case study examples from within the sector across several European countries. The 40 case studies have been selected to cover every step in the biomass supply chain, from initial business planning to the distribution and use of the heat and power produced. These examples focus specifically on woody energy crops grown on short rotation plantations (SRPs). Note that the terms SRP and SRC (short rotation coppice) are used interchangeably in this booklet.

The case studies show how organisations and individuals in the 6 Rokwood partner countries are making improvements to the fuel production cycle through the breeding and testing of new high yielding varieties, the development of methods for reducing disease and pest issues, by gaining a better understanding of the best sites for planting as well as modifications and refinements to machinery. In addition, the case studies also throw light on how SRP is being deployed to deliver a range of economic and social benefits to businesses and communities. The self supply of SRP woodfuel at Gurteen College **(case study 13)** and Berkshire College of Agriculture **(case study 38)** and district heating at Beuchte Energy Village **(case study 1)** are all highly successful projects that could and should be replicated elsewhere. Furthermore, the use of SRP as biofilters as demonstrated in Drumkee **(case study 37)** and Enköping **(case study 24)** exemplify the wider opportunities for multifunctional benefits and efficient land use.

In this context, 'best practice' is defined as the application of a method or technique that has shown successful results within a specific context. The best practice examples included here do not necessarily show 'gold standard' examples, rather they simply provide information about what is and isn't working under certain conditions so that this knowledge can be applied to other projects. It is hoped that by documenting and sharing this information, others can learn from the experiences set out here to improve the outcomes of their own projects and in doing so help steer the development of the SRP sector in the right direction.

What is a Short Rotation Plantation?

A short rotation plantation (SRP) generally describes an agricultural crop harvested at short intervals but is the term most commonly used for a form of energy crop, where fast growing trees such as willow or poplar are cultivated and then repeatedly harvested, usually on a three-year cycle. The freshly cut product can be burnt in power stations and some types of large-scale woodfuel heating plant but can also be used in smaller-scale boilers when processed into more refined forms of woodfuel.

SRP is considered to be a low carbon fuel as an equivalent amount of carbon dioxide emissions released during combustion will be re-absorbed by new growth. However, SRP is not just about sustainable woodfuel. It can also help solve a number of other environmental issues including water quality improvement (e.g. diffuse water pollution from agriculture in sensitive catchments), rebuilding bee and other pollinator populations, carbon sequestration ,reduction in soil erosion and as a flood mitigation measure.

Another characteristic of SRP is the ability to be grown on lower grades of agricultural land that are less suited to food crops, meaning that it will not overly compete with food production over land use.

This booklet is a key output of the Rokwood project. The Rokwood project is supported by the European Commission under the 7th Framework Programme for Research and Technological Development, and its overall aims are to improve research and development activities, promote market uptake and increase investment in woody energy crops grown in short rotation plantations (SRPs). These crops include willow, poplar, Robinia, Eucalyptus and Paulownia. The project is designed to support transnational cooperation between six 'clusters' of organisations across Germany, Ireland, Poland, Spain, Sweden and the UK, although the project outputs (including the contents of this booklet) are intended to be applicable on a wider scale. More information can be found at **www.rokwood.eu**

SEVENTH FRAMEWORK PROGRAMME

This project is supported by the European Commission under call FP7-REGIONS-2012-2013-1 "Regions of Knowledge" of the 7th Framework Programme for Research and Technological Development.

Case studies

The following pages contain 40 case studies of enterprises within the six Rokwood partner countries, and covering every step in the biomass supply chain, from initial business planning to the distribution and use of the heat and power produced. These examples focus specifically on woody energy crops grown in short rotation plantations (SRPs).

GERMANY

CASE STUDY 1

Title	Beuchte: a bioenergy village
Topic	District heating
Location	Beuchte, part of the Schladen-Werla in south-eastern Lower Saxony, Germany

CASE STUDY 2

Title	Setting up a contract for the provision of heat to a school in Lower Saxony
Topic	Business models; district heating
Location	Braunschweig, Lower Saxony, Germany

CASE STUDY 3

Title	ROD-PICKER: an automatic harvesting system for SRC nurseries
Topic	Harvesting
Location	Germany, Sweden, Denmark, Romania

CASE STUDY 4

Title	Biomassehof Achental: integrating and developing local supply chains
Topic	Business models
Location	Achental, Bavaria, Germany

CASE STUDY 5

Title	ProBioPa: sustainable production of biomass from poplar short rotation on marginal land
Topic	Site selection; Environmental impact
Location	Baden-Württemberg, Germany

CASE STUDY 6

Title	ProLoc: clone-site interaction of poplar and willow on agricultural sites in short-rotation
Topic	Site selection
Location	38 test sites across Germany

CASE STUDY 7

Title	Securing the growth of cuttings in dry regions in Germany
Topic	Planting and establishment
Location	Brandenburg, Germany

CASE STUDY 8

Title	A tool for the accurate estimation of yields from SRPs
Topic	Site selection
Location	University of Technology, Dresden, Germany

REPUBLIC OF IRELAND

CASE STUDY 9

Title	Setting up an SRC Plantation in the Irish Midlands region
Topic	Business models
Location	Walshestown, Co. Westmeath, Republic of Ireland

CASE STUDY 10

Title	Bord na Móna: co-firing biomass and peat
Topic	Co-firing, Business models
Location	Edenderry, Co. Offaly, Republic of Ireland

CASE STUDY 11

Title	Bioenergy Region Westmeath
Topic	Policy support, promotional activities
Location	Co. Westmeath, Republic of Ireland

CASE STUDY 12

Title	Self-supply of SRC woodfuel at Ardtarmon House
Topic	Harvesting
Location	Ballinfull, Co. Sligo, Republic of Ireland

CASE STUDY 13

Title	Self supply of SRC woodfuel at Gurteen College
Topic	District heating, self supplyl, fuel processing and quality
Location	Ballingarry, Roscrea, Co. Tipperary, Republic of Ireland

POLAND

CASE STUDY 14

Title	Updating coal-fired power stations to utilise biomass for the production of heat and power in Poland
Topic	District heating, CHP
Location	PEC Płońsk Ltd., Masovian Voivodeship and CHP Czestochowa, Silesian Voivodeship, Poland

CASE STUDY 15

Title	Zeran and Siekierki: district heating in and around Warsaw
Topic	District heating, co-firing, CHP
Location	Warsaw, Poland

CASE STUDY 16

Title	Local supply chains for district heating in rural areas
Topic	Business models
Location	High School building in Siedlin, Płońsk district, Mazovia, Poland

CASE STUDY 17

Title	Willow plantation and pellet manufacturing plant in Chlebowo
Topic	Business models, Harvesting
Location	Chlebowo , near Zielona Góra, Lubusz, Poland

SPAIN

CASE STUDY 18

Title	Assessing the field performance of Eucalyptus grown in SRPs in Andalusia
Topic	Mapping
Location	Andalusia (Sevilla, Granada, Huelva and Córdoba), Southern Spain

CASE STUDY 19

Title	The effect of density on Populus sp. SRPs in the Mediterranean area
Topic	Planting and establishment, Crop production
Location	Spain

CASE STUDY 20

Title	BIOCEN S.A. trigeneration project for L'Oreal
Topic	District heating
Location	Burgos, Spain

CASE STUDY 21

Title	Mapping biomass potential and biomass installations in Andalusia
Topic	Mapping
Location	Andalusia, Spain

CASE STUDY 22

Title	'Granada es Verde' campaign and biomass facility contract promotion
Topic	Promotional activities
Location	Andalusia, Spain

CASE STUDY 23

Title	Spanish BIOMCASA ESCO promotion scheme for biomass facilities
Topic	Promotional activities, Policy support
Location	Spain

SWEDEN

CASE STUDY 24

Title	Using willow to produce fuel and treat wastewater at Nynäs Farm
Topic	Business models, Additional areas of application of SRPs
Location	Enköping, Sweden

CASE STUDY 25

Title	Investigating the impact and control of weeds in biomass willow clones
Topic	Weed control
Location	Lund, Sweden

CASE STUDY 26

Title	Researching the effects of different storage and drying methods for Salix
Topic	Fuel processing and quality
Location	Sweden

CASE STUDY 27

Title	Locally produced Salix - a model for increased cooperation
Topic	Business models
Location	Ystad, Sweden

CASE STUDY 28

Title	Developing a new model of billet harvester for SRPs
Topic	Harvesting
Location	Sweden

CASE STUDY 29

Title	Developing a fully hydraulic head for SRC harvesting
Topic	Harvesting
Location	Sweden

CASE STUDY 30

Title	Successful use of SRP as a fuel through long lasting three-party collaboration
Topic	District heating; Business models
Location	Sweden

CASE STUDY 31

Title	Establishment of large scale willow plantations in Lithuania and Latvia
Topic	Planting and establishment; Business models
Location	Lithuania and Latvia (though this is a study from Sweden)

CASE STUDY 32

Title	Using Salix to encourage biodiversity in Sweden
Topic	Additional areas of application of SRPs
Location	Enköping and Vingåker, Sweden

UK

CASE STUDY 33

Title	Using willow for wastewater treatment at Fernhill Farm
Topic	Additional areas of application of SRPs
Location	Somerset, UK

CASE STUDY 34

Title	Strawson's Energy and Koolfuel
Topic	Technology development specific to the growth andharvesting of SRC
Location	Nottinghamshire, UK

CASE STUDY 35

Title	Regro: representing the interests of farmers growing energy crops in Yorkshire and the East Midlands
Topic	Business models, Policy support
Location	Yokefleet, Goole, Yorkshire, UK

CASE STUDY 36

Title	UK bred SRC willow varieties
Topic	New cultivars
Location	Markington, Harrogate, North Yorkshire, UK

CASE STUDY 37

Title	Small-scale municipal wastewater treatment using SRC
Topic	Additional areas of application of SRPs
Location	Drumkee, Co. Tyrone, UK

CASE STUDY 38

Title	Self supply of SRC woodfuel at Berkshire College of Agriculture
Topic	District heating, self-supply, fuel processing and quality
Location	Maidenhead, West Berkshire, UK

CASE STUDY 39

Title	Self supply of woodfuel at Umberleigh Barton Farm
Topic	District heating, self-supply, fuel processing and quality
Location	Umberleigh, North Devon, UK

CASE STUDY 40

Title	SRC mixture research at the Agri-Food and Biosciences Institute
Topic	Disease and pest control
Location	Loughgall, Co. Armagh, UK

CASE STUDY

Topic District heating

Beuchte: a bioenergy village

Location

Beuchte, part of Schladen-Werla in south-eastern Lower Saxony, Germany

Description of project or activity

A district heating system was established in the small village of Beuchte in 2008. The heat is produced in two 250 kW furnaces using woodchips which are produced in nearby poplar SRPs, mainly on small fields and marginal lands, by a local farmer. Backup heating is supplied by an oil heater.

The first SRPs were established in 2009. Today more than 30 hectares of SRP are grown within a 10km radius of the village. Currently, 65 households in the village, around half of the total households, are supplied with heat from the district heating system. The heating network has been planned so that additional households can easily be connected. The heat is transported to the households in the form of hot water through a network of underground pipes.

Long-term contracts of 12 years exist between the operator of the heating system and the participating households, as well as between the operator and the woodchip producing farmer, enabling stable prices for the whole contract duration.

Background/objectives

The idea behind Beuchte was to establish a district heating system based on the waste heat of a biogas plant. However, although several households had already adapted to this new kind of heat supply, the biogas plant was never built.

The local farmer, Clemens von König, took over responsibility and planned a district heating system for the village based on woodchips. He made contacts with the inhabitants of Beuchte and the local SRP operator, Hans-Georg von Engelbrechten, to further develop this idea. The existing district heating concept was adapted, heat prices were calculated and contracts were formed, all within 16 months of project conception. The project was financially supported by the KfW (Reconstruction Credit Institute – a German government owned development bank).

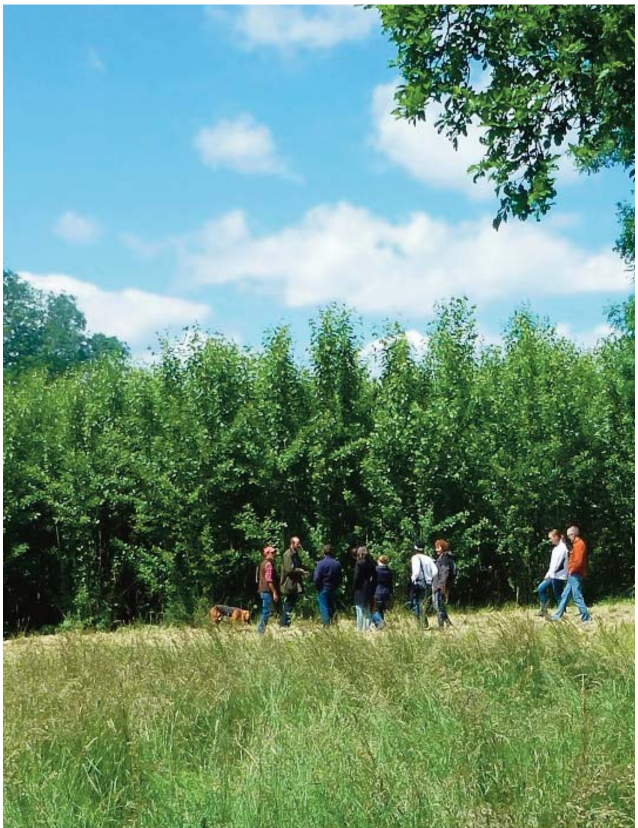
Successes

The project is working well. The operator of the district heating system, the supplied households and the SRP operating farmer are all happy with the economic and ecological benefits. The operator is getting good returns (see section costs and benefits), the households have 20% reduced heating costs and the SRP farmer profits from his marginal lands.

Challenges

The original plan was to supply the village with the heat from a biogas plant. Problems with the operator of this biogas plant, however, meant that a biomass heating system was implemented instead, which required a large number of adaptations in the system.

The support of various households not participating in the project was necessary as their gardens were required for the underground heat pipe network.



Short rotation plantation for woodchip production

Costs and benefits

With an estimated operating life of 20 years, the annual operation costs of the district heating system are €62,000, including investment costs (€700,000, of which €300,000 were publicly funded), interest costs, operating costs and fuel costs (€80 per oven-dry tonne of woodchips or €16/MWh). These costs correspond to €47.69 per MWh. The contracted price for the energy of 6.5 cents/kWh leads to revenues of €84,500 for the whole district heating system or €65 per MWh, leaving an overall profit of €22,000 per year or €17 per MWh for the operator of the district heating system.

The SRP operating farmer can sell more than 300 tonnes of oven-dry woodchips at €80 per tonne for at least 20 years, leading to a total profit of €1,700 per hectare per year or €34,000 for the required 20 hectares.

The 65 households have savings of 20% on their energy, compared to fossil energy: 10% from the guaranteed reduced energy price and 10% from the saved maintenance costs of the conventional boilers they used before.

Lessons learnt and recommendations for future projects

All projects are different and each project has its own specific challenges and problems. However, there are some rules that apply to every project. The most important thing is a close cooperation between all the participants. If the project manager and the participants all know and trust each other then the basis for success is there.

One of two 250 kW woodchip furnaces

Contact details and/or further information

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CASE STUDY

Topic Business models; District heating

Setting up a contract for the provision of heat to a school in Lower Saxony

Location

Braunschweig, Lower Saxony, Germany

Description of project or activity

The project began in 2007 with the aim of supplying a local school with 1,200 MWh of heat per year. This was based on the use of a woodchip burner, using wood from short rotation plantations which were to be established from 2009 onwards. The project includes the establishment of 400 meters of heat network pipework connecting the main school building, a second building for classrooms, and the gym. After the contract period ends the network will become the property of the Waldorfschool.

As the heating central plant was built close to the Rudolf-Steiner-Street the delivery of woodchips has little impact on the school's activities and disturbance by noise and dust can be kept to a minimum.

The central plant room contains two 250 kW woodchip heaters, and the system is also connected to gas burners situated in the basement of the main building of the Waldorfschool. The basement is very close to the woodchip heating system (approximately 30 metres) so the backup system can compensate very quickly should the temperature of the woodchip heaters fall due to mechanical reasons or pump damage.

Apart from delivering woodchips, the contract also covers the maintenance of the heat exchangers, the removal of ash and the checking of the mechanical parts including the pumps.

Background/objectives

The Rudolf-Steiner School was heated by gas until 2007 when, in order to better align with their principles, the board of parents decided to switch heat supply to make use of renewable sources. Thus, the school can combine its teaching aims with its environmental aims by switching from a fossil-based fuel to a climate-neutral supply.

The board of parents decided to sign a contract with DEHO Dt. Holzenergie GmbH on a 10-year basis with an option to extend the supply by another five years at the end of the period. It took three months to establish the heat network, and to construct the building for the burners and the storage building for the woodchips. The connection to the backup gas burners was realized in 2008. The gas burners were initially the responsibility of the school, however after the first year of supply this task was handed over to the contractor.

Successes

The supply has been successfully in place for 8 years to date and the school is satisfied with the degree of reliability that it provides. The costs for renewable heat supply have been found to be more or less equal to the use of fossil fuels.

Each year the project needs roughly 1400-1500m^3 of woodchip and, due to the volume of the silo, it is possible to reduce the deliveries to twice a week in winter time. The amount of gas needed for the backup is below 5% of the total amount of energy consumed by the school.

The woodchips come mainly from short rotation plantations established in the region of Braunschweig. Due to the climatic factors (fairly regular rainfall with a total of around 700mm per year) each hectare produces 70m^3 of poplar woodchips which are harvested every three years. The total energy output per hectare is 60MWh per year, based on 12 tonnes of absolute dry mass as harvested.

The school board are very satisfied with day to day operation of the project including little pollution and no interruption of the teaching lessons (delivery is done before or after school lessons). There is a high degree of satisfaction from the Waldorfschool's point of view.

The board of parents responsible for fixing new contracts has shown interest in extending the contract up to 2017. Waldorfschool plans to expand their activities by renovating one further building and including one building which is still heated by gas. This extension would need some further works on the existing heat network but this amount of additional work is easy to execute. Once the decision for this extension has been made, enough woodchip from short rotation coppice will be available from fields that have been planted in the past years.

Challenges

To establish a woodchip heater, the school buildings had to be linked by a heating network of 400 metres so that the total amount of heat justified the investment in the woodchip heater infrastructure.

The combination of the existing gas burner as a redundant burner with the woodchip burner has been a challenge which was finally realised.

The building for the burners had to be placed in an area with many office buildings and so the number of criteria for building permission at the site was quite high. Due to good technology and the high quality burning materials, emissions were kept to a minimum.

The woodchips get dried on drying stations which use the heat from anaerobic digesters (biogas plants) in the region of Braunschweig where the heat would not be used for other reasons. The close distances from the short rotation plantations to the drying stations and from there to the storage facilities of Waldorfschool also ensure there are only minimal emissions during transport.

Costs and benefits

The cost of the whole system was roughly €350,000. The components of the system include two "Ala Talkkari" woodchip burners of 250 kW each, the storage and woodchip transport machinery and 400m of heat pipe and transmission stations, as the system is not directly linked to the heating system of each building.

The operational costs are €4,000 p.a. and consist of chimney sweeping service, insurance and maintenance (cleaning) of the heat exchangers and disposal of the ash.

The costs for woodchips are €25,000 p.a. on a base of €100/tonne absolute dry mass with an equivalent of €20 per MWh or €23 per m^3 of dried woodchips, including delivery to the school. This means that the farmers income for producing wooden biomass in form of short rotation plantations is roughly €400 per hectare per year, thus equalling the price for other agricultural products produced in the region (wheat, oil seed rape, sugar beet or corn).

The carbon savings are roughly 400 tonnes per year and 300 hours are necessary to run the system (creating local jobs through maintenance and delivery).

Lessons learnt and recommendations for future projects

The most important factor in deciding whether a system can be established or not is the amount of heat produced. If the heat consumption is not large enough to match the heat production of a woodchip heater, than this can be dealt with by linking several consumers. It is also important to know the quality and energy content of the woodchips being used to allow for accurate estimation of the quantity of fuel that is required to be kept in storage. For instance, in this project the woodchips being used are produced from poplar which has a low density and low energy content. This means that a fairly large storage capacity is required to ensure there is never a shortage of fuel. This helps to avoid the need for additional deliveries which would increase the operational costs. It is important to remember that the higher investment costs at the beginning of the project are negligible compared to the savings as once these systems are established, they last for usually around ten years.

Another important lesson is that automatic cleaning of the heat exchangers in the burner is very important. This is because ash produced during the heat production constantly reduces the efficiency of the heat transmissions, and means that a greater volume of woodchip is required to produce the same temperature. In order to optimise the performance of the burner and reduce the amount of fuel required, the surface of the heat exchanger should be cleaned periodically, as much as several times per day. If there is no automatic cleaning system and this has to be done manually, the costs would be increased greatly and efficiency reduced. This highlights the point that the economic success of a project is heavily dependent on the quality of the technology being used.

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CASE STUDY

Topic Harvesting

ROD-PICKER: an automatic harvesting system for SRC nurseries

Location

Germany, Sweden, Denmark, Romania

Description of project or activity

The methods used in planting material for short rotation plantations (SRPs) are still largely dominated by manual work and are underdeveloped and thus not very efficient. Depending on the planting density, the costs for planting can make up more than 75% of the total establishment costs of SRPs. Clearly, an improved efficiency in the production of SRP planting material could have a large impact on the profitability of SRPs in general. The production capacity for planting material needs to be expanded significantly in order to meet the demand which is expected to further grow in the future.

As a consequence, ROD-PICKER, an “automatic harvesting system for SRC nurseries”, was developed in an EU funded research project. ROD-PICKER cuts, sorts and bundles the rods produced in SRP tree nurseries fully automatically. Compared to traditional production methods for planting material, the productivity could be increased by 300%, while the overall costs could be reduced by 46%. ROD-PICKER will therefore increase the profitability of SRPs in general and ensure the availability of sufficient amounts of cheap and high quality planting material.

Background/objectives

During the last few years, substantial progress was made in the harvesting and processing of the wood produced in SRPs meaning that today it is usually conducted fully automatically. However, the production of wood cuttings for the establishment of new SRPs or the re-establishment of existing SRPs in tree nurseries is still dominated by manual labour and is thus very inefficient. The project ROD-PICKER is funded by the European Commission under its 7th Framework Programme in the Scheme “Research for SMEs.” It gathers 6 partners (consisting of 3 researchers and 3 SMEs) from 4 different countries (Germany, Sweden, Denmark and Romania) for the development of an “automatic harvesting system for SRC nurseries”. It was planned to develop a mobile system for the harvesting and processing of SRP planting material, consisting of a cutting module, a sorting module and a bundling module, between October 2012 and September 2014. The main aims were a significant cost reduction (up to 60%) in the production of SRP cuttings and an increase in the productivity of the process (up to 500%).

ROD-PICKER harversting unit in the field

Successes

During the preparation of the project ambitious aims were set for ROD-PICKER. All these aims have been achieved, some with minor restrictions.

A complete system for the automatic harvesting, sorting and bundling of rods produced in SRP tree nurseries was developed. In contrast to the original plans, however, the processing of the rods had to be divided into 2 steps: cutting in the field and sorting and bundling in the workshop (see challenges section). The productivity in the production of SRP planting material was increased by 300% (aim 500%) and the costs for the planting material were reduced by 46% (aim 60%). More information on the successes of the project (e.g. in terms of economic growth of the partners) will be available after the market introduction, which is planned for 2015.

Further important parts of the project were the calculation of the expected profitability of ROD-PICKER for the producer and the customers as well as the detailed analyses of the expected social and environmental impacts. The positive results of these analyses indicate that ROD-PICKER can not only increase the productivity and reduce the costs of the production of SRP planting material but can also be economically, socially and environmentally sustainable. Therefore, it is superior to all existing production systems for SRP planting material.

Challenges

The original plan was to develop a completely mobile system, consisting of only one machine to cut the rods, sort and bundle them fully automatically in the field, making any further processing of the rods in a workshop or something similar unnecessary. However, it was deemed impractical and technically unfavourable to bring the processing speeds of the different modules into accordance, which would have slowed down ROD-PICKER significantly. Moreover the necessary maintenance (e.g. removal of stuck rods) would probably lead to regular interruptions of the harvesting process.

Therefore, it was decided to develop a system consisting of 2 parts: a harvesting module to cut the rods in the field and a sorting and bundling module to further process the rods in a workshop. This is seen as the main reason why the original aims of the project in terms of cost reduction and productivity increase could not be achieved.

Costs and benefits

The project was funded under the 7th Framework Programme for Research and Technological Development (FP7) of the European Union. The total costs of the project amounted to €1,693,364, and €1,284,000 came from EU funding.

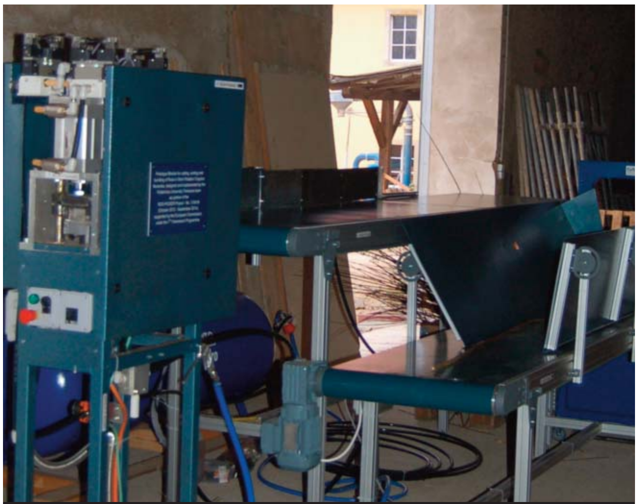
The benefits for the project partners cannot be stated exactly yet, as the market introduction of ROD-PICKER is ongoing. Egedal Maskinfabrik, a manufacturer of agricultural machines, will exclusively produce and sell ROD-PICKER, while Salixenergi and Lempe, both mainly agricultural service providers, will receive fixed shares of the profits. All 3 SMEs will significantly grow in terms of turnover, profit and employment. The researchers, on the other hand, will mainly profit non-monetarily, e.g. from the extension of their knowledge bases.

Moreover, the European SRP sector in general will strongly profit from ROD-PICKER. The costs for planting material, which is the main cost factor in SRPs, can be reduced by 46%. Therefore, the profitability of SRPs will significantly increase, contributing to a further fast growth of the European SRP sector.

Lessons learnt and recommendations for future projects

When it was realised that it was impossible to bring the processing speed of the cutting module and that of the sorting and bundling module into accordance, a decision had to be made: either continue with the original plan and develop a complete solution consisting of only one mobile system but with reduced productivity, or develop a 2-part-solution with full productivity but an interruption in the production process. It was the right decision to react flexibly to the new findings to reach the main aims (increased productivity, reduced costs) as well as possible. All partners had time reserves left which enabled them to finish the project within time despite the unforeseen problem.

A lesson learnt from previous projects was taken into account in ROD-PICKER: many projects make great developments but do not use them. They do not achieve the market introduction of their product as their main aim was the development of a prototype instead of a marketable product and all the work ends after the end of the project. ROD-PICKER is ready for the market, and will be released in 2015 after all required approvals and certifications have been obtained.



ROD-PICKER sorting and bundling unit

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Topic Business models

Developing local supply chains

Location

Biomassehof Achental, Bavaria, Germany

Description of project or activity

Biomassehof Achental produces biomass from different wood-based sources. The material is sourced locally from forests in the Achental region. The venture mainly uses wood which can no longer be processed for other purposes. It is an outstanding project that supports the integration and development of supply chains of regional value. Since 2005, Biomassehof Achental has served as a reliable energy supplier for the region.

Background/objectives

The company was established in 2005 as a result of the findings of RES-Integration ('Rural sustainable development through integration of renewable energy technologies in poor European regions') which identified the potential for the production of biomass and a sufficient customer base. All that was missing was the local suppliers of processed biomass, and so Biomassehof Achental was established to meet this requirement.

The region is now able to cover its energy needs using renewable energy resources from wood, solar energy and water power. Achental is one of 21 federal bioenergy regions, "Bioenergie-Regionen", in Germany.

The biomass power plant produces, and advises on, various biomass types. The venture produces wood chips, pellets, split logs, round timber briquettes and litter. Biomassehof Achental has already served as a best practice example for the project "SRC plus".

The enterprise is supported by the "Intelligent Energy Europe" programme which focuses on encouraging organisations' activities relating to sustainable energy.

Successes

The establishment of the Biomassehof hub created a successful enterprise for wooden biomass supply. The success of the venture lies in the creation of regional value and the reduction of carbon dioxide emissions through reduced procurement of oil and gas for heating purposes from abroad. Furthermore, a big regional network of heating installers and plumbers was created after the establishment of the enterprise.

On the webpage "bioregions.eu" the region is given as a best practice model. The enterprise is supporting and initiating regional projects utilising bioenergy. Moreover, the Biomassehof established an innovative organisational structure supported by communities, regional actors and green investors.

Challenges

Biomassehof Achental is a partner of the EU-project "SRC plus" and is developing short rotation plantations in Achental, which is traditionally a wood producing region. It is hard to convince farmers in the region to produce short rotation crops (SRCs), as their growth is only valuable in marginal farming areas, though they add both economic and ecological value where grown.

Costs and benefits

A regional heating supply chain has been developed using wood from SRCs. This is carbon neutral. Another benefit of the biomass power plant is the processing of wood which cannot be used for other purposes, such as manufacturing furniture. If the biomass power plant is mainly using waste wood from the forest, then less ecologically valuable SRC is planted in fields.

Lessons learnt and recommendations for future projects

Biomasshof Achental was established due to the increasing demand for wood from the region. It represents a central location to coordinate offers of, and demands for, woody biomass. There is a high demand for woody biomass and this can be met through the use of both regional, traditional wood from the forest and also through establishment of SRPs.

The cultivation of SRC on conventional maize sites is one option to increase production in the region. This would also increase the production of the Biomassehof and would improve the ground quality of the SRP sites.

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CASE STUDY

Topic Site selection; Environmental impact

ProBioPa: production of biomass from poplar short rotation on marginal land

Location

Baden-Württemberg, Germany

Description of project or activity

In Germany, the social and ecological effects of energy crops are discussed very intensively. Short Rotation Plantations (SRPs) have favourable ecological effects in comparison to annual crops, and so the discussion is focused on the competition for land between food and energy production. ProBioPa aims to provide a solution to this by cultivating SRPs on marginal land (land with low yields). The main topics of the project were:

- Optimization of plant hybrids (poplar and willow) with respect to water and nutrient demands
- Optimization of poplar cultivation on marginal land with respect to water and nutrients
- Estimation of available land, economics and woodchip quality
- Ecological evaluation

Background/objectives

ProBioPa was a joint research project performed from 2009-2014 by the following partners with the following focuses:

- University of Freiburg/Breisgau, Freiburg Institute of Advanced Studies; Prof. Dr. Klaus Palme, Dr. Franck Ditengou; Systems biological analysis of Poplar and Arabidopsis roots
- KIT (Karlsruhe Institute of Technology), IMK-IFU Institute of Meteorology and Climate Science, and since October 2010: Helmholtz Center München, EUS Research Unit Environmental Simulation; Prof. Dr. Jörg-Peter Schnitzler, Dr. Katja Block; Optimization of water utilization and evaluation of VOC emissions by Poplar plantations
- University of Freiburg, Institute of Forest Botany; Prof. Dr. Heinz Rennenberg, PD Dr. Jürgen Kreuzwieser; Improvement of nitrogen-uptake-efficiency and analysis of poplar fitness
- KIT (Karlsruhe Institute of Technology), IMK-IFU Institute of Meteorology and Climate Science; Prof. Dr. Klaus Butterbach-Bahl, Prof. Dr. Hans Papen; Evaluation of climate and atmosphere protection by poplar SRPs
- University of Freiburg, Institute of Forest Exploitation and Ergonomics; Prof. Dr. Dr. h.c. Gero Becker; Optimization of harvesting and logistics for poplar SRPs
- Forestal Research Institute Baden-Württemberg, Freiburg, Department of Forest Exploitation; Dr. Frank Brodbeck, Dr. Udo Hans Sauter; Availability of land and economic analysis of poplar SRPs on marginal land
- NETAFIM Deutschland GmbH; Benjamin Zahn; Poplar SRP irrigation on marginal land

Poplar plantation in Bingen-Hornstein, Summer 2011. Image: JP Schnitzler

Successes

The joint research project has contributed to the implementation of SRPs in Germany by delivering important data concerning the availability of land, the achievable yields and the economic results. Details on the main findings of ProBioPa are stated in the section “Lessons learnt and recommendations for future projects”.

Challenges

Since standard technologies could be applied and the ecological evaluation showed positive results in comparison to annual crops, the main challenge is the economic results of SRPs on marginal land, i.e. their low profitability. This will probably not change until the prices of conventional energy sources (and, as a result, the prices for woodchips) will increase significantly.

Costs and benefits

From the socio-ecological point of view, SRPs on marginal land have significant advantages in comparison to annual crops, especially low emissions of "climate" gases and minimum utilization of land used for food production. 11 million tonnes (dry mass) of woodchips could be produced on 0.76 million ha of marginal land. Regional value addition is supported.

On the other hand, annuities of SRP cultivation are low in comparison to annual crop cultivation. The yearly annuity of a 20-year poplar-SRP cultivation is about €70/year and ha, when SRP is harvested every 4 years with a forage harvester. Annuity may be increased to €255/year and ha, if the rotation cycle is extended to 5 years. Thus, the establishment of SRP cultivation will depend on the woodchip market price and on the price of conventional energy sources as well.

Planting of poplar in Bingen-Hornstein, April 2009. Image: JP Schnitzler

Lessons learnt and recommendations for future projects

The following main results have been achieved:

1 In Germany, the conditions for cultivating SRPs are favourable on 4.6 million ha of agricultural land. 62 million tonnes (dry material) could be harvested per year.
2 Taking restrictions (cultivation of SRPs on marginal land only, surface fall, nature protection) into account, 29.6 million tonnes (dry material) could be harvested on 2.18 million ha of agricultural land.
3 Further restrictions have been defined by the EG 1782/2003 guideline, reducing available marginal land to 0.76 million ha and biomass to 11 million tonnes (dry mass).
4 The woodchip quality derived from SRPs cultivated on marginal land is comparable to the quality of average SRP woodchips.
5 The ecological evaluation clearly shows a good ecological balance compared to crops. From the ecological point of view it is favourable to use one-step harvesting techniques, not to use soil irrigation by pumping and not to use fertilisers.
6 From the economic point of view, SRPs on marginal land are not competitive with the cultivation of annual crops. The economic results may be optimized by the extension of the rotation cycle, implementation of a two-step harvesting strategy with interim-drying of the rods or technical drying of the woodchips.

The main bottleneck for establishing SRPs in Germany is the low price of conventional energy sources, especially natural gas. In comparison, other restrictions are negligible.

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Literature cited:

- **Nachhaltige PROduktion von BIOmasse mit Kurzumtriebs-plantagen der PAppel auf Marginalstandorten (PRO-BIOPA). Final Report of KIT (Karlsruhe Institute of Technology), IMK-IFU Institute of Meteorology and Climate Science (Project Coordinator: Prof. Dr. Jörg-Peter Schnitzler) for the German Ministry of Research and Education, Karlsruhe 2014**
- **Schweier J, Becker G: Economics of Poplar Short Rotation Coppice Plantations on Marginal Land in Germany. Biomass and Bioenergy 59 (2013) 494-502**

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CASE STUDY

Topic Site selection

ProLoc: clone-site interaction of poplar and willow on SRPs

Location

38 test sites, distributed all over Germany

Description of project or activity

During the last few years a lot of research has been conducted on SRPs. However, there are still large knowledge gaps regarding the correlation between climate and soil characteristics of a site and the expected yields. A research project was initiated by a consortium of different agricultural and silvicultural research institutions to investigate these correlations.

38 test sites were established all over Germany to cover as many different site conditions as possible. 5 different clones, 3 of the genera poplar and 2 of the genera salix, were planted with a spacing of 1.8 x 0.5m in each of these test sites and harvested after 3 years.

The growth parameters (diameter at 0.1m, diameter at breast height, the height and the amount of biomass produced), were compared to the climate parameters (temperature and precipitation) and the soil parameters (soil fertility, soil texture, water and air capacity, dry bulk density and general nutrient availability). Correlations between these parameters and the biomass production were identified and a location-based yield model was developed.

Background/objectives

Several German SRP growers recognized the large knowledge gap regarding the correlation between site parameters (e.g. temperature, precipitation, nutrient content and water capacity of the soil) and the biomass production rate. This made it very hard to estimate potential yields and profits before the plantations were established.

21 German research institutions, including many agricultural and silvicultural research institutes of universities and federal states as well as some private enterprises, formed a consortium to close this knowledge gap in a joint research project.

Altogether 38 SRPs of the mentioned poplar and willow varieties were established by these 21 institutions, 37 in spring 2008 and 1 in spring 2009. However, 5 of the 38 SRPs failed before the harvesting, which was conducted after 3 years, and were not taken into account for the development of the yield model.

The aim of the project was the identification of site parameters influencing the biomass production of poplar and willow SRPs and, based on these results, to develop a location-based yield model.

Successes

Climate, soil and (with restrictions) growth parameters were successfully investigated for all 38 test sites. However, as described in the “Challenges” section below, not all the obtained data could be included in the yield model developments. Clear correlations between the biomass production and the following site characteristics were found:

- Precipitation (a high precipitation during the vegetation period leads to a higher productivity, especially on sandy soils)
- Aridity index according to de Martonne (a low aridity during the vegetation period leads to a higher productivity, especially on sandy soils)
- Soil fertility (a high soil fertility leads to a higher productivity)
- Soil texture (various positive and negative correlations)
- Field capacity, air capacity, dry bulk density (various positive and negative correlations)
- General nutrient availability (several positive and negative correlations)

On the other hand no correlations were found between the temperature and the biomass production.

Most of the observed correlations could be explained and conclusions were drawn. The aim of the project was achieved and the influence of all investigated site characteristics on the biomass production of the different poplar and willow varieties was successfully determined.

Short rotation plantation test site

Challenges

Altogether 38 test plantations were established. However, only 33 of these plantations were taken into account for the development of the yield model; 2 plantations failed due to massive disturbances in the first year and another 3 plantations failed due to management and other problems in the second year.

Moreover, many single plants failed during the first year after establishment, due to problems such as insufficient weeding or watering. Depending on the species, between 11 and 18 of the 33 plantations had failure rates of up to 50% and between 3 and 9 had failure rates of even more than 50%. All these plants had to be replaced in the second year, leading to different plant ages at the time of harvesting. However, the newly planted plants were marked and the different ages taken into account in the evaluation.

Further plantations that did not fail had to be excluded from the yield model developments, as they were established on acidic soils, organic soils or in post-mining landscapes.

Costs and benefits

The project was funded by the German Federal Ministry of Food and Agriculture's funding programme "Renewable Resources". The total funding was almost €700,000.

The project's benefits are hard to quantify in monetary units. However, it can be assumed that money would be saved or additional income generated if the results of the project were transferred into practice, e.g. by avoiding the establishment of SRPs in conditions that have been found unsuitable or by improving the site conditions in a way suggested by the project's results. Farmers now have a reliable data basis for the estimation of yields depending on the specific site conditions. This is especially important when the high investment costs and the comparably long duration before the first harvest are taken into account.

Lessons learnt and recommendations for future projects

There were several things in the initial stage of the project that did not go well and negatively influenced the project over its full duration:

- Some sites were not carefully chosen in terms of environmental conditions so their results could not be used for the yield model development
- Some plantations were established too late so the full growth potential of the first vegetation period could not be used
- Some plantations were managed insufficiently in the first year which led to various failures of trees due to drought and strong competition from weeds
- The duration of the project, only one rotation of 3 years, was too short for reliable estimations of the biomass production

These lessons were immediately taken aboard and the mistakes were not made again when a second stage of the project with an enhanced scope was initiated in 2012. In the second stage at least three rotations will be taken into account for the development of the yield model; new plantations with rotation periods of 10 years will be established; the test sites will be selected carefully and special care will be taken of the plantations after their establishment.

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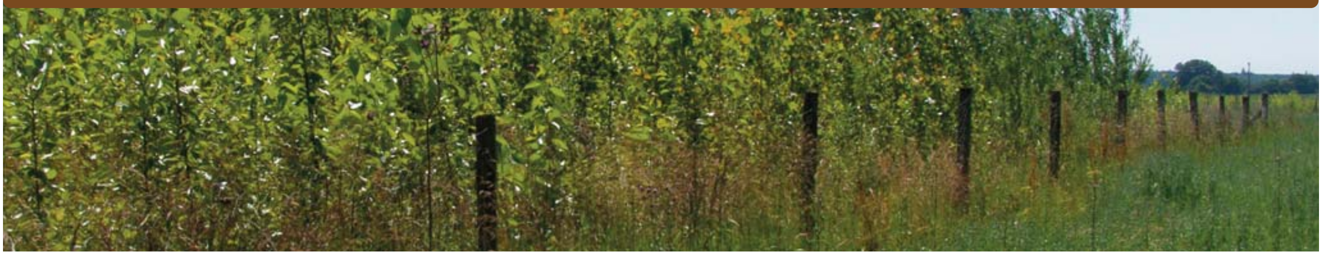

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CASE STUDY

Topic Planting and establishment

Securing the growth of cuttings in dry regions in Germany

Location

Brandenburg, Germany

Description of project or activity

Some regions in Germany, especially in the east, have poor soils and a dry climate, which lead to very low yields for traditional crops (e.g. rye 2.5 t/ha/a). In these dry regions, long-term crops in SRPs are optimal as they can reach the groundwater with their long roots. However, SRPs have high establishment costs and a comparably high risk of failure in the establishment phase. Poplar varieties adapted to dry climates were used in this project. A drip irrigation system was still needed in the first year of growth in the large field, as during the establishment phase the poplar plants were not long enough to reach the water. Extra long cuttings with a length of 40cm were also used to help reach the moist regions in the deeper soil in several smaller fields where irrigation was not economical.

Background/objectives

A farmer in the dry climatic area southeast of Berlin, Germany, had very poor soils and a large share of his agricultural area was not in use because of the low yields of traditional crops. The farmer tried to establish SRPs on his poor quality fields, but they failed due to drought. To help the plants establish, the farmer installed a drip irrigation system to use in the first years of growth, which gave the plants the resources they needed to develop roots sufficiently long to reach the groundwater at a depth of 1.5m.

For the installation of the drip irrigation system (which included the boring of a well) to be economically viable, a minimum field area was needed; the system was set up in a 30ha field. The irrigation tubes were laid in parallel to the planted cuttings.

In the following year further SRPs were established with extra-long cuttings of 40cm length to better reach the moist regions in the deeper soil on various small areas where irrigation was not economical.

Successes

Irrigation allowed the newly planted trees to survive the dry spring. A drip irrigation system directly applies water to the trees' roots, resulting in efficient water use and preventing the application of water to the surrounding weeds. The yield of the SRP was increased during the following years by providing the trees with water during dry periods.

Extra-long cuttings used in the small-sized SRPs were also successful. They surived periods of 3-4 weeks of hot and dry weather without significant losses. In the second year of growth the roots reached the groundwater.

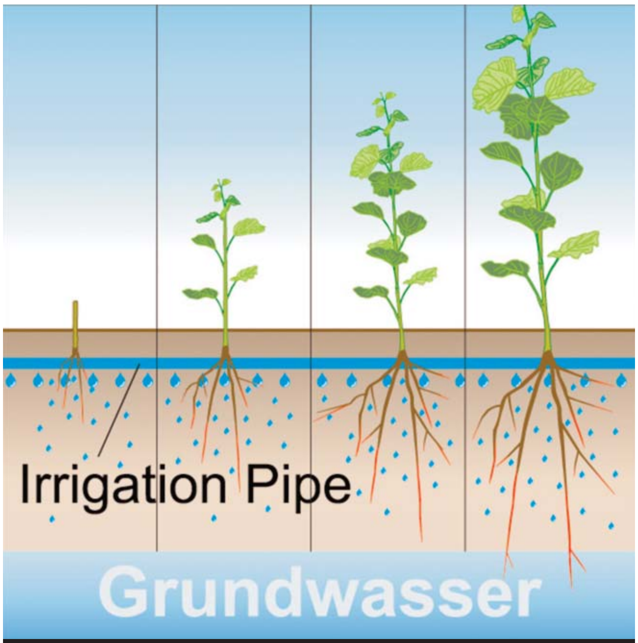
In both cases (drip irrigation and extra-long cuttings) periods of drought did not affect the SRP from the second year on. The poplars grew up to 3m in the first year.

Challenges

The installation of the drip irrigation system increased the establishment costs of the SRP by €900/ha. This was a big risk considering the comparably low expected yields of the SRP on the poor soils in this dry region. There were some problems with the drip irrigation system, such as the roots of weeds growing into, and clogging the tubes. A drip irrigation system can be difficult to plan, install and maintain for non-experts and so intensive guidance was necessary.

The use of extra-long cuttings is cheaper than drip irrigation, but failures of plants due to drought may still occur in certain environmental conditions.

Planting poplar varieties adapted to dry climates



Root system development of SRP trees in irrigated fields

Costs and benefits

For a 30ha plantation the cost of the drip irrigation system was €900/ha. Although this is a lot, it is much less than the cost of complete failure of the SRP which can amount to €2,500 to €3,000/ha. Furthermore, the drip irrigation system is only needed during the first one or two years after planting and can be reused in other newly established SRPs. Alternatively the irrigation system can be left in the plantation during its whole lifetime to increase the biomass production by irrigating the trees during periods of drought. In conclusion, the use of the drip irrigation system enables the economical use of poor soils in dry areas.

The extra-long cuttings cost 60% more than standard cuttings but still less than the drip irrigation system. They are particularly useful on small fields where drip irrigation is not economical. However, plant protection from drought cannot be guaranteed.

Lessons learnt and recommendations for future projects

- It is important to explain all activities and installations to the customer (farmer)
- SRPs cannot be established everywhere without additional efforts and costs
- Weed control is an important factor (they may cause clogging of the irrigation system otherwise)
- Thoroughly investigate how much water to apply to the SRPs
- It pays off to invest in high quality irrigation tubes which can later be reused for the establishment of other plantations

Scheme of the planting machine with integrated drip irrigation tubes

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CASE STUDY

Topic Yield estimation

A tool for the accurate estimation of yields from SRPs

Location

Dresden University of Technology (TU Dresden), Institute of Forest Growth and Forest Computer Sciences, Germany

Description of project or activity

The TU Dresden developed an innovative tool to estimate the yield of woody biomass from willow and poplar SRC. The software can be downloaded from the institute's website along with a short description of how to use it.

Background/objectives

Cultivation of woody energy crops using SRC is a process that has not yet been fully established in Germany and so potential producers of SRC still need support. One problem is that long cultivation periods are required in SRC farming which result in a higher risk for producers. To reduce the risk for farmers, the TU Dresden developed a system to help inexperienced producers reliably estimate the possible gain from SRC. A previous estimation system that existed for SRC couldn't be adapted for willow since it takes into account particular characteristics of poplar. Other estimation methods could predict gains but were time consuming and costly as they used complex sampling and calculation methods.

Successes

The yield estimator, along with guidance for use, can be found on the Institute of Forest Growth and Forest Computer Sciences' website. Both are available for free and accessible by anyone. The guide is easy to use and also has the advantage of being able to estimate yields without having to destroy or harvest any plants. Knowledge on the economic feasibility of SRC is essential for farmers when it comes to introducing the cultivation method.

Challenges

Making the software available for everyone is a great step towards reliable return estimation. The challenge is now it to spread the word on the existence of this measurement method. The biggest challenge in the development of the yield estimator was to obtain a large and reliable dataset of willow growth parameters in relation to their age.

Lessons learnt and recommendations for future projects

Farmers and other producers of biomass need a reliable and easy tool to estimate the gains from SRC. The method of the TU Dresden is innovative and easy to use. Further time is needed to see whether the tool is used and the problems that may arise.

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CASE STUDY

Topic Business models

Setting up an SRC Plantation in the Irish Midlands region

Location

Walshestown, Co Westmeath, Ireland

Description of project or activity

The project involves the planting of SRC willow on a former circa 20 ha farm that was previously grassland, as contracted by Bord Na Mona – a semi state power company who run a peat burning power plant in Edenderry with a capacity of 128 MW.

Under the Energy White Paper 2007, such power plants were required to transition to be co-fired with biomass. This was facilitated by the Renewable Energy Feed in Tariff for co-fired biomass established in 2010.

To assist in generating local biomass supply, BnM have developed an SRC contract to support farmers to plant SRC and directly supply the power station based on fixed purchase price for material (based on calorific value / moisture content) with an additional subsidy for transport costs.

Background/objectives

The farmer was seeking alternative low intensive farming opportunities. Following SRC research and discussions with BnM advisors about their contract and support, the owner / farmer decided to dedicate the entire holding to SRC willow, and planted 19 ha (16.5 on good viable land and 2.5 on marginal) in 2011.

The planting was carried out in 2011 using a mix of Swedish varieties. It cost around €1000/acre (50% of which was a state aid grant from the Department of Agriculture). Importantly the plantation was well managed and was weeded and topped after the first year, however the farmer reported additional costs not included in the establishment grant, e.g. gapping costs, additional weeding.

The first harvest was in 2013 and yielded 553 tonnes (wet), equating to 29 tonnes/ha (11.7 tonnes/acre) average with better yields on the good land. The material was sold under contract price to Bord na Mona based on calorific value – related to moisture content.

Willow harvested from the plantation

The farmer is now preparing a 'nutrient management plan' for council approval for sludge spreading as additional fertiliser. He is hopeful for an improved harvest in 2014.

Successes

Based on typical harvest patterns and the fertiliser plan, the yield is predicted to increase further. The plantation has been a relative success, especially in comparison to other poorer plantations in the region where significant problems with weeds, pests, and yields as low as 8 and 6 tonnes/acre have been reported.

Financial returns, while modest, have been comparable to other alternative incomes for this particular farmer, leasing and grass.

The farmer also manufactured his own inter-row sprayer for weed control.

Challenges

The plantation has been well managed, with appropriate weed control and cut back. The principle challenge has been to get low cost or free fertiliser onto the plantation and in particular sludge. While the administrative, licensing and planning implications of this have been difficult, progress has been made, with soil testing and nutritional plans developed. Applications are in progress for use of sludge.

Costs and benefits

The material was sold under contract price to Bord na Mona based on calorific value related to moisture content (based on a contract price of €38.15/tonne at 55% moisture content, with an additional transport subsidy) and gave a return of circa €360 per acre, an annual equivalent of €182 per acre (which was in line with BnM predication). The farmer considered this favourable compared to option of leasing the land at €100 to €120 per acre.

The farmer is now preparing a 'nutrient management plan' for council approval for sludge spreading as additional fertiliser. He is hopeful for an improved harvest in 2014 and is expecting returns in region of €220 to €240 per acre.

Lessons learnt and recommendations for future projects

The project highlights the need for ongoing management and care of the crop and in particular that land quality, weeding, and fertiliser all impact on yields.

While the returns are modest and based on current low grade biomass prices to power plants, greater returns could be achieved via supply of wood chip to the heat market.


Rows of young willow crop

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CASE STUDY

Topic Co-firing; Business models

Bord na Móna: co-firing biomass and peat

Location

Edenderry, Co Offaly, Ireland

Description of project or activity

Edenderry power station was built and commissioned in 2000, and was owned by E.ON before being purchased by Bord na Mona in December 2006. This power station has a bubbling fluidised bed boiler which consumes one million tonnes of milled peat per annum and has an annual energy input requirement of 7.7 peta joules. The fluidised bed has a fairly wide tolerance for moisture content and particle size of the biomass material. The normal bed temperature is 910°C. There is a two cylinder, triple pressure condensing turbine and seven forced draft cooling towers.

The governments white paper on energy 'Delivering a Sustainable Energy Future for Ireland' released in March 2007, set a target for 30% co-firing for peat stations. In 2002, trials on co-firing with wood chips began and in 2008 co-firing commenced commercially.

It was anticipated that 300,000 energy tonnes of peat or 2.3 peta joules would be replaced by biomass as fuel for Edenderry power station. Bord na Mona is now the biggest consumer of biomass in the Republic of Ireland (ROI), and almost all the willow and miscanthus grown in the ROI used by Bord na Mona.

Background/objectives

The 2007 Energy White Paper set out a co firing target of 30% by 2015 for peat burning power plants in Ireland, and the action was incuded as a key aspect of Ireland National Climate Change Strategy targets. It was also included as a key action, the saving of up to 900,000 tonnes of CO_2 per annum. The overall objective was to reduce the intensity of greehouse gas emissions from power generation while maintaining diversity in the fuel mix. In July 2010 REFIT (Renewable Energy Fit In Tariff) was established for co-fired biomass. The REFIT prices for biomass are €8.5c/kWh for other biomass, and €9.5c/kWh for energy crops.

There are three regional peat burning electrical power plants in the Midlands region, Lough Ree ESB Power Station with a capacity of 100 MW, West Offaly ESB Power Station with a capacity of 150 MW and Edenderry Power owned by Bord na Mona with a capacity of 128 MW. Of these only the Bord Na Mona plant in Edenderry had already started the process of co-firing and set a target of 300,000 tonnes per annum of biomass by 2015 at Edenderry (30% co-firing), with up to 500,000 tonnes by 2020.

In terms of peat displacement, between 2008 and 2012, c. 329,000 energy tonnes (where one energy tonne = 7.7 giga joule) were displaced, representing 12% of the raw material in 2011. This was the equivalent of the annual output from a typical 35 MW wind farm. In 2012, 200,000 tonnes of biomass was consumed in the Edenderry plant, about 20% of the total fuel consumed.

Successes

The project has been an overall successs, commencing in 2009 with under 20,000 energy tonnes of biomass being used, growing to an estimated 200,000 energy tonnes (1.38 PJ) being used in 2012 and on target for 300,000 energy tonnes by 2015.

The project has promoted the growth of SRC under contract by local farmers. Bord na Mona has developed the supply chain with SRC growers. Bord na Mona is involved in establishing the crop and the grower is responsible for growth, maintenance, harvesting, processing and transportation of the crop to the plant. Bord na Mona are then responsible for the intake, handling, burning and ultimately the generation of energy.

However this local supply chain has had limited success in part due to a price cap (proportional to the REFIT cap) and the capacity of the plant to cater for low grade high moisture content material. As such a signficiant portion of the biomass material is coming from outside the region and from overseas imports.

Challenges

The main challenges for Bord na Mona were to create a sustainable biomass supply to replace peat to reach 300kt by 2015. This supply stream needs to have the capability of being expanded to 500kt by 2020. Bord na Mona sourced their biomass raw materials from three areas:

- Irish Forests: Both sawmill residues, such as woodchips and sawdust, and pulpwood from forestry thinnings in both log and chip forms are currently consumed in the plant. In addition quantities of wood pellets from local producers are also being used. To reach the 2015 targets, 150kt will be sourced from forest materials with the intention to increase this to 200kt in 2020.

- Energy Crops: Perennial crops such as willow and Miscanthus. Miscanthus, however, can only be utilised in limited quantities (based on a 5% dilution factor with peat) owing to its higher chlorine content. At present, 50kt will be sourced from energy crops. Bord na Mona aim to increase this to 110kt by 2020.
- Imported Agri-residues: Palm kernel shells (PKS), almond shells, cocoa shells and olive stones form the remainder of Bord na Monas requirements. 100kt of imported biomass is used at present, and the aim is to increase this to 190kt in 2020.

Costs and benefits

The reported purchase price of Edenderry Power Limited by Bord na Mona in 2006 was estimated at €80 million. At present there are 45 people directly employed in the station, mostly from the local Offaly/Kildare area and 215 (FTE) directly employed in the fuel supply (peat and biomass). It is estimated that there are 75 people indirectly employed in the materials and service provision for the plant.

Bord na Mona agree short and long term contracts with biomass growers, generally for a minimum of eight years. Price per tonne at the farmer's gate is €5.50/Gj or €38.15/tonne at 55% moisture content. Transport contribution by Bord na Móna per Gj up to 25km from the power plant is €1.50/Gj or €10 per tonne. For distances greater than 25km transport contribution is €1.75/Gj or €11.50 per tonne. Therefore total price per tonne delivered is €48.15 per tonne at 55% moisture up to 25km from the power plant and €49.65 for distances greater than 25km. All pricing is index linked with the Consumer Price Index (CPI) and guaranteed.

The return on willow per acre p.a. is €200 or €494 per hectare p.a. This is net return after all costs have been met using current agricultural contracting prices and includes the "fallow years" i.e. the first three years to the first harvest and every second year thereafter. The first three years with no income is a "problem" for some growers. To offset this problem Bord na Mona is willing to advance a maximum of €450/ha for the first three years as an advance payment on the harvested willow chip. This maximum figure of €450 x 3 or €1,350 is repayable with interest to Bord na Mona out of the first three harvests of willow; hence the grower is in a contract with Bord na Mona for a minimum of 8 years. In this scenario the net return per acre per annum is €194 or €478/ha per annum. The REFIT price received by Bord na Mona for using energy crops is €95/MWh.

Lessons learnt and recommendations for future projects

As Bord na Mona is the major end user of energy crops in the Republic of Ireland, this case study shows the need for strong links within the supply chain. Good relationships with growers are essential and Bord na Mona have supported the industry by providing advance payments to growers during the 'fallow years' and by providing agronomy services free of charge. This includes the cost of soil sampling etc. Should new competitors enter the market for the fuel stock, the contracts in place and good business relationships will protect Bord na Mona's fuel supply.

For this reason, contracts are required with more suppliers of biomass to enable them to secure their supply and achieve the 30% co-firing targets.

As security of supply is the main challenge to Bord na Mona, they have opportunities to look at different sources of biomass and how these can be used to achieve higher efficiency.

Bord na Mona also plan to examine the unloading, handling and storage facilities required for large volumes of biomass and make the system currently in place more efficient, and get planning consent to install these facilities.

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CASE STUDY

Topic Policy support; Promotional activities

Bioenergy Region Westmeath

Location

Co Westmeath / Midlands, Ireland

Description of project or activity

Westmeath County, via Westmeath Community Development, participated in the EU IEE Bioregions project promoting the development of 'bioenergy regions' across Europe, the work of which incorporated the wider Midlands region.

The project involved developing a network of key stakeholders and influencers in the sector, learning from the 'best practice' European regions of Achental in Bavaria, Germany and Jonkoping in Sweden and applying relevant success factors to the Irish Midlands context. It facilitated important knowledge development, learning and information dissemination, via case study visits, workshops and seminars, and publications in local and national media.

A county energy profile was undertaken for Westmeath, which was the first of its kind in the Midlands and included a bioenergy resource study, which facilitated important understanding and discussion in relation to target setting but also indicated the poor levels of energy efficiency and fossil fuel energy dependency in the County.

A significant output of the project was the development and adoption of a 'Bioenergy Action Plan' for the county and region with concrete targets and actions for each stakeholder to promote the sector.

Background/objectives

'Bio-Regions' was a three year European project, funded by the European Commission under the Intelligent Energy Europe programme. It sought to promote the development of 'bioenergy regions' across Europe, which are regions where a significant portion of the energy demand is met by sustainable bioenergy sources, and is defined in this project as being a region with at least a third of its heating and electricity needs from regional and sustainable bioenergy sources, with a main focus on solid biomass.

Typical Westmeath pasture landscape. Image: Patrick Daly

Woodchip and solar water communal heating system: Jonkoping, Sweden. Image: Patrick Daly

The background to the project was the exemplary region of Achental in the south of Bavaria (Germany) and involvement with the German National Bioenergy network.

Achental has 30,000 inhabitants and a total area of 474km². Almost 50% of the area is forest and it has a strong agricultural sector including cattle and dairy. Critically, the bioenergy potential in the region is 274,000 MWh, out of which 43% is from forestry residue and 13% from saw mill residue. The area is implementing a plan for achieving within 5 years over 50% of electricity and 60% of heat supply from local and renewable sources, most of it being bioenergy. A key component of the regions bioenergy success is the local stakeholder engagement and ownership of the Bioenergy Centre (BAT), a public-private partnership that trades local biomass, bringing stability and a long term perspective to the market, and providing district heating to hundreds of homes. Achental was part of a German Government initiative to support the establishment of 25 bioenergy regions, which involved the development of a local stakeholder network in every region within the IEE Bioregions project (www.bioenergie-regionen.de).

The objectives of the project were to support the development of bioenergy regions on a European level by building on the work of the most advanced areas and specifically to:

- Support the development of efficient and reliable markets for solid biomass in five target regions, including Co Westmeath/Midlands
- Stimulate investment into bioenergy projects and trading businesses by local stakeholders.
- Inspire other rural areas to follow the example of the target regions.

Successes

On a European basis the project had important successes, including:

- The identification of success factors in “best practice” regions
- Developing key stakeholder networks in each target region
- Developing Bioenergy/Biomass Action Plans for establishing five new bioenergy regions
- Support the early implementation of the Action Plans in the target regions
- Dissemination and support for other regions to replicate the project activities

In the Irish Midlands context the project helped to develop multi-stakeholder engagement in the sector and there was significant learning and dissemination in the region as a result of the project. Over 100 stakeholders and interested persons attended the launch workshop in the region and there was continued high participation amongst key stakeholders during the project, with numerous workshops arranged.

A number of study tours were undertaken with Irish delegates visiting the key regions of Achental in Germany and Jonkoping in Sweden, which were reported on widely, including dissemination in national farmers’ papers.

There was key activity and interest in the Irish context on i) the concept of biomass trading and logistics centres, which facilitated some commercial interest and a later proposal for development of a Biomass Trade Centre; ii) interest in a small scale low cost on farm bio-digester that could be replicated in Ireland; iii) community scale group heating systems.

In order to assess current benchmarks and develop targets it was necessary to undertake a county/regional energy analysis and also to undertake an assessment of the bioenergy potential of the agricultural and forestry sectors. This was the first of its kind in the region and provided important insights into energy inefficiency, our minimal biomass penetration into the heat market and showed that the dominant agricultural resource and waste in the region was grass and slurry.

An action plan was developed with input and commitments from all key stakeholders to assist in promoting the sector. Importantly this action plan was unique amongst the other partners where an emphasis was placed on utilisation of the key agricultural waste-streams of grass and slurry.

Challenges

The project presented and encountered a number of challenges in the Irish context, most notably the relatively poor policy context and the absence of financial support for on the ground projects, which was principally due to the following factors:

i) the project coinciding with a significant recession in the Irish economy with the state needing financial assistance – and as such all state agencies were cutting back on their programmes and supports.
ii) the LEADER budget was frozen and all project applications ceased.

The role and financial capacity of the Irish Local Authorities compared to their continental and Scandinavian equivalents (who were actively engaged in and financially supporting key bioenergy facilities in their regions) was a huge limiting factor. The Irish Local Authorities (County Councils) were principally service providers for water, waste and roads and their 'development' remit was that of planning control rather than strategic or investment. The local authorities were also in financial difficulty.

The absence of an active Energy Agency in the region was also a limiting factor, in particular in terms of continuance of the activity beyond the project lifetime. A Midlands Energy Agency exists in name but in operational terms its core remit and part time staff re-sourcing is to provide energy efficiency advice to the council's own staff, projects and facilities.

A key challenge of the project was in finding a suitable person, agency or promoter to take the bioregions concept forward beyond the project lifetime.

Costs and benefits

Costs: The project was supported via the awarded IEE project budget, which in the Irish context was circa €100,000 mainly for staff and associated travel and admin costs over a three year period. There was no capital budget available.

Benefits: These were significant in terms of the promotion of bioenergy in the region and the awareness raising, learning and multi-stakeholder engagement in the project.

Lessons learnt and recommendations for future projects

Some key lessons and recommendations from the Irish project are as follows:

Policy and Supports: the project could have achieved more if it could have i) influenced policy and development supports or ii) been co-ordinated with the launch of new supports. Policy influence or development should be part of the projects remit, if these factors are inhibiting or essential to the mission of the project.

Funding: The absence of funding, (financing, supports, grants etc) or capital budget within the project was a limiting factor. Including capital budget for projects or a post-project mechanism for the same would be welcome. Alternatively, it might have been useful to align the project with another funding mechanism so that actual projects could commence in the project lifetime.

Local Authority: The nature and remit of Irish Local Authorities is a significant limiting factor in the under-development of renewable energy at a local or regional level. There is pressing need for wider role and leadership from Irish Local Authorities in local renewable energy.

Project Promoter and Timeframe: There is a need for a dedicated and committed agency or actor to take ownership of the bioregions concept and continue the work post project lifetime. The project could also have a phase down or post project activities perhaps with a budget. The sudden project end needs to be reviewed and mechanisms put in place for phase down, handover, and alternative financing of the activities.

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Irish Project Partner | Westmeath Community Development Limited

Fuelling dialogue between biomass research, industry, policy & business
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CASE STUDY

Topic Harvesting

Self-supply of SRC woodfuel at Ardtarmon House

Location

Ardtarmon House, Ballinfull, Co Sligo, Ireland

Description of project or activity

Ardtarmon House is a 19th century B&B with five self-catering cottages which is owned and managed by Charles and Christa Henry. Ardtarmon House also has the only SRC Willow plantation in County Sligo and is c.100km from other growers with a limited end use for the crop.

The site includes approximately 3ha of short rotation coppice willow plantation, which was planted in 2007 and forms part of the fuel stock for a Froling 48 kW woodchip boiler (the rest of the fuel is composed of other woodchip types). This heats a guesthouse and five holiday cottages on a short district heating network. The buildings serviced by the district heating network have a floor area of around 1,000m² (guesthouse 400m², 5 holiday cottages c. 600m²) and have poor insulation.

Background/objectives

The willow was planted as a pilot project under the cross border European Commission RENEW willow research group from 2004 to 2007 when willow growing and usage were being investigated. A variety of harvesting methods including the stemster rod harvester from Northern Bio Energy in Tyrone have been used to harvest the crop. Lighter machinery with less wheel impact is needed.

Under the CREST project, the Sligo IT engineering school developed a small rod harvester similar to one developed by Orkney College in Scotland which will be available for harvesting some time in 2015. The challenges experienced for willow growers in the west of Ireland are similar to that on the Orkney Islands, where access to harvesting and chipping machinery is difficult and expensive to hire.

Successes

The owners of Ardtarmon House, have planted around 3 ha of willow on their land to supply their guesthouse and five self-catering cottages with heat, therefore reducing their dependence on fossil fuels.

The owners have worked with the CREST (Centre for Renewable Energy Technology) project in IT Sligo to develop a small scale willow harvester. CREST engages a Mechanical Engineering Level 7 student group from the Institute of Technology to design and build a small scale harvester suitable for use on Ardtarmon House and other small willow plantations in the west of

Growing, harvested and chipped willow

Ireland. The CREST co-ordinators, IT Sligo students and property owners worked with engineers from the Agronomy Institute on the Orkney Islands in Scotland, who developed a similar harvester to address the challenges they also faced. Challenges still continue in the development of this harvester and at present it is not suitable for the Ardtarmon House plantation. Trials of this harvester will take place in 2015 at another willow plantation.

The IT Sligo students won a prestigious Engineers Ireland Innovative Student Engineer of the Year Award for the design and build of the harvester. This provides a cost effective harvesting solution for smaller, dispersed willow growers. They demonstated that the intention of the willow harvester project was to provide a vital link in the biomass supply chain.

Challenges

The greatest challenge faced by the owners of Ardtarmon House concerns the harvesting of the willow. Harvesting on larger plantations is usually carried out by cutting, chipping and collecting at the same time. This generally involves the use of large machinery, which is suited to large plantations, not small plantations as in this case. As this is the only willow plantation in Co. Sligo, with the nearest being over 100km away, the use of large contractors and machinery is very expensive and not practical for use in smaller fields.

For smaller plantations, the use of whole stem harvesting is preferable, as this can be done without the use of very large machinery and the willow can be taken off the fields and dried off-field to be chipped at a later date. In this case, the willow was harvested in a labour-intensive manner and with the use of hazardous manual devices such as adapted chainsaws and strimmers.

As the willow is in the north west of Ireland, which has a damp climate, drying of the crop is difficult. When cut, the crop has around 55% moisture content. The boiler can take biomass with a moisture content of around 40%, and the owner generally tries to get the moisture content to around 27% for greater efficiency.

Costs and benefits

The largest costs involved relate to the harvesting of the willow. Until now, this has been carried out in a labour-intensive manner using manual devices (adapted chainsaws and strimmers). 1 hectare of willow contains c.18,000 plants and takes on average 45 hours to cut. This works out at c.10 seconds per plant. The owners do this manually and use WWOOFers to do this. The whole stems are then collected in the field using a buck rake. For 2015, it is planned that this will be harvested using the small scale whole rod harvesters developed by the CREST project in IT Sligo. If not successful, the manual harvesting methods will continue.

The willow is chipped using a contractor from Omagh in Northern Ireland (c.100km away). There is no closer facility available. The dried willow is chipped in two sessions, depending on the weather. The charge rate for chipping is €55 per hour. This could cost c. €600 per annum. This is less than half of the equivalent oil costs for a year (based on April 2014 oil prices). The initial cost of the 48kW Froling boiler was €48,000 in 2007. This was 50% granted aided.

Lessons learnt and recommendations for future projects

The owners of Ardtarmon House have made excellent efforts in becoming more energy efficient and environmentally friendly and are now able to power their central heating system using fossil-free fuel. This has been a difficult path and they have been innovative in adapting machinery and tools to enable them to harvest their crop in a way that is as cost effective way as possible. Due to the work with the CREST project in IT Sligo, the engineering students have developed a whole stem harvester which will reduce the manual intensivity of the harvesting process. This harvester will be trialled with other willow growers in the region as it is not suitable to the requirements of Ardtarmon House.

This project has been challenging for the mechanical engineering students, who have managed to design and build a small scale harvester to suit the conditions and the challenges faced by small growers in damp climates where lighter machinery with less wheel impact is required.

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CASE STUDY

Topic District heating; self supply; Fuel processing and quality

Self supply of SRC woodfuel at Gurteen Agricultural College

Location

Ballingarry, Roscrea, Co Tipperary, Ireland

Description of project or activity

Gurteen College is one of the first agricultural Colleges in Europe to grow short rotation coppice (SRC) and use the fuel to heat their buildings. The college installed two 300 kilowatt (kW) KWB biomass boilers in 2010 to supply space and water heating to the various buildings on site via a district heating scheme.

The college is well subscribed with 200 agricultural students, 100 equine students, 40 night class students and 100 distance learners.

The college farm covers 414 hectares and there are 130 Friesian cows, 270 beef cattle, 600 sheep and 24 horses. The farm has over 80 hectares of tillage land and of this, 32 hectares of SRC willow was planted in 2010-11. This single large plantation is situated less than 1 km from the boilers. When the SRC crop is fully mature the college will be completely self-sufficient and no longer dependent on bought in fuels. The annual woodfuel requirement is around 320 tonnes per year. As well as heating the buildings, the biomass boilers are connected to a drying shed which is used to reduce the moisture content of the SRC chip from 55% to 25%.

Background/objectives

The Gurteen College biomass project was the brainchild of the principal Mike Pearson who joined the college in 2000. During the early years of his tenure Mr Pearson saw the heating costs of the college spiral. By 2009 the college was spending €60,000 on peat briquettes and €10,000 on oil. At this time the peat and oil boiler was also coming to the end of its life.

The College underwent an extensive energy audit as part of Sustainable Energy for the Rural Village Environment (SERVE) Project. Eight energy efficiency and renewable energy measures were recommended with the objective of reducing energy usage by at least 50%. The college began implementing these recommendations in 2010. As well as the 300 kW biomass boilers the college also installed a 50 kW wind turbine.

When Mr Pearson proposed the installation of the biomass system to the board of trustees, there was concern expressed that bought in wood chip would track the price of oil. Mr Pearson saw SRC as an ideal fit to keep future fuel costs low. He also looked at miscanthus as an option but decided there were too many issues involved. 32 hectares of SRC was planted (as two plots of 16 hectares in the springs of 2010 and 2011). Whilst the SRC plantations were maturing the college bought in cord wood and chipped this themselves to keep costs low.

Successes

The land now occupied by SRC was previously used to grow spring barley, a venture that consistently lost the college money. By contrast the production of wood chip fuel has considerably reduced the college's overheads.

The project used one contractor (Rural Generation Ltd) to do everything – to plant the SRC, install the boiler and the drying floor. This was a very good decision as the company understood the complexities of the fuel and how to process it and had a very good track record of successful projects. Also, the turnkey offer meant that one person was responsible for managing the entire project. This was particularly attractive as it enabled Mr Pearson to spend more time on his day to day college activities.

The land preparation was exemplary and as a result the SRC achieved an excellent establishment. A mix of UK and Swedish varieties were planted and grown in mixtures in order to guard against future disease and pest issues. Mr Pearson did some post planting surveys, counting the number of established plants per 100 and the plantation regularly achieved 95%.

The SRC is harvested in late February and early March. 50% of the plot is harvested every two years and this takes around two days. The harvester is situated 45 miles away. Wood chip material is moved directly to the drying shed measuring 16 x 14m. The total floor area is

Principal Mike Pearson with the SRC willow crop

255m^2 and the chip is stacked at 4-5m high. The drying period is 10-12 weeks. It is possible to get 200 tonnes of dry product in the shed so surplus needs to be kept elsewhere until space is available. After harvest, the field is fertilised with slurry from the farm animals.

Challenges

Mr Pearson initially had to put in a lot of effort to get stakeholders (Trustee and governors) on board. This was partly due to the fact that the college's previous experience of a straw burning boiler in the 1980s had been an expensive investment that didn't work. However, the success of the current project means that most are now keen converts.

Mr Pearson says "You have to love your boiler to make a project like this work for you. The fuel does have more stringy bits and a higher ash content. The management of the boiler is not particularly onerous but it helps to keep an eye on the system every day". Both Mr Pearson and the technician Richard Hamilton live on site and drop into the boiler house daily. Typical tasks involve a 10 minute de-ashing every week and 3 hours cleaning required every 3 weeks. An auger jam takes 10-15 minutes to unblock. Sometimes there are no blockages for five weeks and other times there may be four in a week.

Although a good establishment was achieved the soil is a bit light. Water may be limited in dry summers and this could affect yields.

Part of the field had a weed issue in its establishment year and the necessary actions to deal with this meant that the harvesting schedule was altered although this is back on track now.

Costs and benefits

The turnkey installation costs for the district heating scheme was €300,000, although 50% of this was grant funded through a European energy efficiency grant. The cost of establishing the SRC was €2,500 per ha, a total outlay of €80,000 minus a 50% grant. The drying floor cost €80,000. This utilised an existing shed that had once been used to house straw for the straw boiler project. If a new shed had been required this would have cost an additional €40,000.

The college currently requires 1,000 MWh of heat per annum. This would cost in the region of €80,000/yr if they used oil or €50,000 if they were buying in wood chip. By contrast the system using SRC is much cheaper with a total cost of €13,000/yr.

This is broken down as follows:
SRC harvest = €5,000/yr
SRC chip drying €8000/yr

This is based on:
a) 22,400 kWh of electricity going through the fans at a cost of €9 cents per unit - €2,000/year
b) 150,000 kWh of heat going into the drying floor charged at €4 cents per kWh = €6,000.

Of course the costs involved in the lost income from food production should also be considered, but Mr Pearson says "We still receive our single farm payment on the land and I've tried hard but I can't find anyone in Ireland who can make much money from growing spring barley." Nevertheless, even if the economics allow for €10,000 per year opportunity costs and €10,000 depreciation, the project still enables massive savings. It is at least €17,000 per year cheaper than bought in woodfuel and €47,000 per year cheaper than oil. The project paid back the outward investment in 4-5 years.

Lessons learnt and recommendations for future projects

Mr Pearson says "I can't understand why more agricultural colleges aren't doing this".

The college would like to further explore the potential to use the SRC for phytoremediation of all the waste liquids produced on site such as parlour washings, yard run off, septic tank run off etc. This would require an investment of €180,000 in a lagoon and irrigation system. This would boost the SRC yields and reduce water treatment costs.

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The Sustainable Energy for the Rural Village Environment (SERVE) Project ran from 2007-2012. This was co-funded by the European Commission as part of the CONCERTO programme | www.servecommunity.ie

Fuelling dialogue between biomass research, industry, policy & business
www.rokwood.eu

This project is supported by the European Commission under call FP7-REGIONS-2012-2013-1 "Regions of Knowledge" of the 7th Framework Programme for Research and Technological Development.

CASE STUDY

Topic District heating; CHP

Updating coal-fired power stations to produce heat and power using biomass

Location

(1) Płońsk, Masovian Voivodeship (2) Czestochowa, Silesian Voivodeship; Poland

Description of project or activity

These two projects in Poland make use of Circulating Fluidized Bed (CFB) boilers to allow simultaneous combustion of coal and biomass in district heating plants. Beginning in 2006 in Plonsk, an existing heating system was modernized from a traditional set-up which ran on coal dust, to one running on biomass wood chips and producing 'green' heat and electricity. The biomass used in the CHP boiler will be primarily from SRP (Short Rotation Plantation) crops, mostly willow, with experiments being done with topinamour, the Jerusalem artichoke. The project involved not only replacing the coal boiler with a biomass boiler, but also establishing the cogeneration system and carrying out thermo-modernization of the existing heat distribution system. Annual production of green energy will be about 11 thousand MWh which will come from burning around 25,000 tonnes a year of biomass.

The other project in Czestochowa involved the building of a CHP plant designed to utilize biomass alongside hard coal as a fuel. Heat from this plant provides more than 80% of the district heating demand in the city and the electricity from the system is exported to the national grid.

Background/objectives

In Poland a large proportion of power generation is currently based on fossil fuels, however, national energy policy is currently seeking to promote the production of renewable energy sources. As such there has been a recent rise in interest in Circulating Fluidized Bed (CFB) boilers which are capable of co-firing coal and biomass for energy production.

Two projects in Poland using CFB are of interest:

In Płońsk a district heating system, traditionally based upon the use of coal, was upgraded to be able to co-fire biomass. The objective of the project was to reduce the emissions of greenhouse gases and other particulate pollutants from the district heating system, whilst still producing enough energy for the city of Płońsk. The transmission networks and substations had to be upgraded in order to try and limit energy losses during the generation and distribution processes. To ensure the sustainability of this system, another aim was to increase the availability of local sources of SRC to fuel the boiler.

In Czestochowa a cogeneration plant was built on a green-field site. This plant aimed to be one of the most efficient and modern in Poland, and to provide a reliable supply of heat to the local population and also to ensure cleaner air and a less polluted environment.

Successes

Successes attributable to the project in Płońsk include a reduction in the consumption of fuel and also a reduced production of emissions. After installation of the biomass boiler, the district heating system was able to run off of 70% less coal and produced 35,000 tonnes a year less CO_2 emissions.

There were also substantial reductions in the generation of various particle matters and a 51% decrease in the volume of solid waste, such as slag and ash, produced. This was achieved whilst still supplying 67% of the total heat demand for the city from the co-generation plant.

In Czestochowa there were also reduced emissions of nitrogen oxides, sulfur oxides and harmful dusts. These reductions ensure the plant is already conforming with stringent EU requirements in regard to nitrogen oxides, sulfur and particulates which will come into force in 2016.

Another success was that the contractor GROS-POL who dealt with the modernization of the heating systems in Płońsk was awarded the Energy Globe Award 2006 at the national level, which celebrates best practice in sustainability. The work of GROS-POL involved the reconstruction of the existing heating system in Płońsk city. This moved the system away from using coal as a heat source towards the combined production of heat and electricity from the combustion of wood-chips.

The new investment occurring in Płońsk and the associated infrastructure required is also expected to create 50-70 new jobs in the local area. In particular, it is hoped that plantation grown willow trees can be used as the source of biomass in the plant, and the production of this will create work for farmers in the local area. In Czestochowa 45 people are employed by Fortum Ltd in the CHP plant.

Challenges

Using wood alongside coal as a fuel in a boiler means that special technology is required in the boilers and flue gas cleaning systems to allow them to better deal with emissions from its combustion.

The use of biomass introduces specific problems such as higher moisture content, resulting in a high gas volume during combustion. Biomass also contains alkalis which lower the softening and fusion temperature of the fuel ash and this may result in damage to the heat exchangers.

The use of a CFB mitigates some of these issues, for instance by allowing the flue gases to stay for longer in the boiler so that soot and carbon oxides can be eliminated and through the use of lambda sensor indicators to control the amount of air flow and fan speeds to control the primary and secondary air blasts.

Emissions of nitrogen oxides are also minimized by secondary air blown in which facilitates the burning of volatile combustible exhaust components. Partial recirculation of exhaust gases also helps to reduce emissions of nitrogen oxides. Multicyclone and pulse dust collectors behind the boiler help to limit dust emissions.

In Płońsk, a challenge was that the total power rating of the system decreased during the process from 50MW to 37.1 MW. The modernization works, however, were sufficient to ensure continued supply of sufficient heat to Płońsk.

There have been additional challenges related to the supply chain. It can be difficult to contract reliable suppliers of biomass. This is due to both the farmers' resistance to new solutions and an insufficient amount of appropriate equipment. In Czestochowa, Fortum (the Finnish energy company) wanted to create a 500ha biomass plantation but were unable to do this.

Costs and benefits

The total cost of the entire project in Płońsk was 33.7 million PLN approximately. The modernization of the heating system in Płońsk was funded by a 17.8 million PLN loan financed by the National Fund for Environmental Protection and Water Management (53% of investment costs) and a grant of 11.3 million PLN from EcoFund (33% of project costs). There were also smaller contributions from the City Hall of Płońsk and the PEC.

It is intended that the loans taken out will be repaid from the savings made as a result of lowered production costs due to the greater efficiency of the new boiler. Additional savings are also being made due to the reduction in losses associated with the transmission of energy, from 22% to 11-12%.

An important source of income is a fee for selling the rights to emissions (estimated at about 900.000 PLN/year).

In Czestochowa, the total value of the investment was around 135 million Euros.

Lessons learnt and recommendations for future projects

Funding is available from different institutions including the National Fund for Environmental Protection and Water Management and the Eco-Fund Foundation.

The demand for biofuel developed a use for set-aside land, including that which is periodically flooded, which had great potential for SRP but has been discounted for agricultural purposes.

In Czestochowa, they are now thinking of plans to switch to CHP plants using biomass only. This would require a significant further investment and modernization and so the lesson learnt here is in forward planning and in anticipating future ideas before investing.

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CASE STUDY

Topic District heating; Co-firing; CHP

Zeran and Siekierki: district heating in and around Warsaw

Location

Warsaw, Poland

Description of project or activity

PGNiG TERMIKA is a major Polish energy company and is responsible for meeting a large portion of the heat and power demand of the city of Warsaw. The company has begun to carry out significant work to retrofit a number of their CHP (combined heat and power) plants in order to improve both their efficiency and their environmental performance. Two of their facilities – the Zeran and the Siekierki plants – have been retrofitted with more modern equipment, which allows for the co-firing of coal and biomass to supply electricity as well as heat via a district system.

Chimney at the Zeran plant

The plants use biomass from a number of sources, one of which is willow grown in short rotation coppice plantations (SRPs), which is supplied to the plant under long term contracts with individual farmers. The remaining biomass is wood waste sourced predominantly from Polish sawmills and forestry.

Background/objectives

PGNiG TERMIKA own five co-generation plants in Poland. These plants produce approximately 401 million GJ of heat per year, which meets 70% of the heat demand in Warsaw as well as 60% of the heat demand in Pruszków, Piastów and Michałowice. At present, the primary fuel is coal, however the company is gradually adapting the boilers for co-firing with biomass in order to increase the percentage of biomass in total energy production, in line with the demands set by the EU.

The Siekierki plant is the largest co-generation plant in Poland and the second largest in Europe. The facility has been in operation since 1961, and has four main generation units. Its thermal capacity levels at 2,078.2 MW and its electrical capacity at 622 MW.

The Zeran co-generation plant has been operating since 1954 and is the second largest source of heat for the city of Warsaw. The CHP has a capacity of 1560 MW heat and 364 MW of electricity, two fluidized boilers, 5 steam boilers, 4 hot water boilers and 8 heat turbines, and could warm up to 40% of buildings in Warsaw. The fluidized bed boilers are capable of burning a range of lower grade fuels at a high efficiency without the need for extensive fuel preparation (such as pulverizing).

Willow biomass is supplied from several plantations located within 200km of Warsaw. These are selected based on a set of criteria including distance from the plant, class of land (the best and worst grades are excluded and the soil is tested for factors such as mineral content and groundwater level), appropriateness of the route for travel of heavy machinery to allow transport of harvesting machinery and fuel delivery, and size, with farms needing to have at least 15-20 hectares of suitable land. Contracts are set for a period of 15 – 17 years, and the roles and responsibilities of each party are clearly defined. The terms of the agreement include elements such as soil preparation requirements, the conditions of cultivation and care of the biomass plantation, harvesting rules, and transport and delivery to the CHP settlement on the basis of cooperation with the Operator.

Zeran district heating plant

Successes

The new boilers are some of the most eco-friendly and efficient of their type in Europe. They significantly reduce emissions of particulate matter and oxides of sulphur and nitrogen, without the need for outside plant construction. The technology is also highly flexible as it is capable of burning a range of different fuels, so it allows its operators to take advantage of changes in the cost and availability of fuel types.

Long term contracts between the plant operators and the farmers ensures a reliable supply of biomass to the plant and also provides a steady source of income for the farmers, including up-front funding to assist in the establishment of new plantations (for example to cover the cost of purchasing seedlings and planting). This has provided confidence within the sector and has helped to stimulate the local supply chain.

Challenges

Initially, the plant operators had some difficulties contracting reliable suppliers of SRPs. Most willow plantation plots were small (i.e. up to 7-8ha) and sparsely located. There was also a lack of grower experience so, for example, the rows of willows were too densely planted, with over 25-30 thousand plants per hectare. This meant that it was not possible to drive a tractor with the necessary equipment through the crop, so some of the growers had problems harvesting or entering plantations on wetlands and land that was flooded during winter or spring.

In the first half of 2012, approximately 100 thousand tonnes of biomass were used for co-firing in existing installations. This was later reduced due to the collapse in the value of the certificates of origin for renewable electricity (also known as 'green certificates') in the market managed by the Commodity Power Exchange. In 2013, due to changes in economic relations and the low profitability of co-incineration, these power plants have sometimes been operated using a reduced volume of biomass.

The modernization of the boilers and flue gas cleaning system was also particularly complex due to the age of the existing equipment.

Costs and benefits

PGNiG TERMIKA invested 31.4 million zł of EU funding in the installation of catalytic denitrification for two boilers.

CHP Siekierki and Zeran burned approximately 160,000 tonnes of biomass (willow) in 2011.

The retrofit project reduced CO_2 emissions by more than 165,000 tonnes and produced nearly 166,000 MWh of greener energy in 2011, which corresponds to approximately 5% of total electricity production by PGNiG TERMIKA.

Lessons learnt and recommendations for future projects

The importance of cooperation between the power plant operator and farmers (SRC producers) has been highlighted under this project. Long-term contracts for the production of willow, including transport to plant in Warsaw, have been found to be a successful means of instilling confidence in the industry.

There is still huge potential within Poland for the retrofit of old CHP plants in district heating systems in order to meet the country's environmental goals and improve the economic competitiveness of its heat supply.

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Fuelling dialogue between biomass research, industry, policy & business
www.rokwood.eu

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CASE STUDY

Topic Business models

Local supply chains for district heating in rural areas

Location

Siedlin, Płońsk district, Mazovian region, Poland

Description of project or activity

The straw boiler in the high school building complex in Siedlin was installed in 2005, after the modernization of the whole school complex meant that the old oil heating boiler was no longer adequate to meet the heating needs of the building. The boiler is situated in a specially raised building segment with a room for the furnace, water tank and additional equipment, and a room for the storage of straw bales (with a total storage capacity of 120 bales).

The installed EKOPAL RM 01 furnace has a rating of 300 kW, and is adapted to burn straw and hay bales with the diameter of between approximately 125cm to 170cm. The bale humidity must not surpass 20%, and the furnace is equipped with an air ventilator along with an air throttle to regulate burning. The throttle, ventilator, and the water pumps are all computer controlled. The control panel is located on the side of the furnace. On the rear of the furnace there is a special ash tank that collects ash (using the effects of gravity) from the smoke pumped out from the furnace to the chimney pipe during the burning process.


Straw furnace with the main hatch open


Ash tank at the rear of the furnace

This case study provides an example of how a local supply chain can be successfully set up in a rural agricultural area, to provide fuel for small to medium-sized district heating systems.

Background/objectives

As noted above, after the school was modernized, it became apparent that the previous oil boiler was not sufficient to meet the heating needs of the whole building complex. Given that the school's neighbourhood is a well developed farming area, and due to the price growth of coal and heating oil, the district administration (Płońsk communities' mayor) decided to invest in an innovative heating system provided by a company from Poznań. The main goal was to create a boiler that would be easy to handle and less expensive to use.

Successes

Even though the maintenance of the new boiler (in comparison to the previous construction) required at least two additional jobs to be created, the overall heating cost is much smaller than in the years before this boiler was installed. When the outside temperature oscillates between 0-10°C, the boiler uses up to 2-3 bales of straw per 24 hours. When the temperature drops to -20°C, the usage of straw bales rises up to 4-6 per 24 hours. The school has an almost inexhaustible supply of straw bales from local farmers. Even taking into account the requirement for additional working posts, this heating system has 45% lower costs than the use of oil boilers for heating, as well as providing employment for the local community.

Challenges

Although the furnace is very reliable and there have been no malfunctions registered since its installation in 2005, there are some minor drawbacks associated with this kind of installation. The furnace requires a large water tank to store warmed up water, and a large closed-off storage area for straw bales (the boiler needs straw bales with a humidity level less than 20%, hence they cannot be stored outside). Due to this drawback, this set up is too large in size for individual purposes, but works well as a district heating system or a heating system for small compounds.

Costs and benefits

As previously noted, when the outside temperature oscillates between 0-10°C, the boiler uses up to 2-3 bales of straw every 24 hours, and when the temperature drops to -20°C the usage of straw bales rises up to 4-6 every 24 hours. The school has an almost inexhaustible source of straw bales from local farmers. The cost of a single bale is around 28 zlotys, and the heating costs are working out at around 45% less than by heat production using traditional heating systems (coal, heating oil). The straw is bought directly from nearby farmers, which often transport the bales to the school storage hall. The transportation costs are so low in this case that they do not need to be considered as part of the business case. The additional benefit of this situation is that at least two new work posts have been created within the community.

Water tank next to the straw furnace

Lessons learnt and recommendations for future projects

The system is unfortunately too large for individual needs, and may also not be the most efficient option to suit particularly large scale compounds. The straw boiler heating system has however been shown to be a good choice for smaller scale compound district heating, and for heat production for average scale building complexes situated near large farming regions. This creates a situation of unlimited straw bale supplies. New workplaces are created, not only by the boiler maintenance, but also in the farms, where many of those farmers find that it provides a good source of additional profit.

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CASE STUDY

Topic Business models; Harvesting

Willow plantation and pellet manufacturing plant in Chlebowo

Location

Chlebowo , near Zielona Góra, Poland

Description of project or activity

Chlebowo is a biomass production and manufacturing complex situated near the western boarders of Poland in the Valley of the Odra River. It consists of a large 750 hectare plantation of willow and a manufacturing plant specialized in pellet and woodchip production.

The plantation was set up in 2007 and the manufacturing plant itself was built in 2009. The plantation has been seeded on a high ground water level soils, that are classed as grades III and IV organic soils. The seedlings were sown in lines separated by 50cm with a space of around 80-100cm between the lines. The number of seedlings per hectare was 25-32 thousand. The willow regrowth is cut down once every 3 years, and achieves a yield of around 50-55 tonnes per hectare.

The majority of the willow biomass produced is then made into pellets in the nearby manufacturing plant. The manufacturing plant, thanks to its high efficiency, uses not only the biomass from its own plantations, but also biomass from other sources within a radius of around 50km from the plant. In this case study, the most important innovation has been that the plantation owner has had his own willow harvester created to meet his specifications.

Background/objectives

This project was initiated with the aim of taking advantage of the positive view of renewable energy sources in Poland for the production of both heat and power.

The first crops were harvested after approximately three years, and once the manufacturing plant was constructed the whole production process began properly. The project was a private endeavor, with the aim of filling the predicted increase in demand for biomass as an energy source. At this moment in time, there is an idea to create an alliance between municipalities, which, with the help of EU financing, could initiate a programme for the roll-out of district heating systems. Alternatively, it could offer the modernization of individual heating systems using biomass. It is expected that this will be launched during the Programming Period for 2014-2020.

Successes

Unfortunately, the original plan to target individual home owners as the main pellet buying force was not successful. Instead, the manufacturing plant found a different market for its products in the form of the State CHP Plant. At present, the plant is the only recipient of the product. CHP facilities all over Poland are obliged by law to launch at least one biomass boiler in every facility. Previously, biomass was used only for co-firing with coal. For individual home owners coal still stands

Willow biomass pellet manufacturing plant

Pellet tanks at the manufacturing plant

as a cheaper and more efficient heat source. This of course may change, and biomass has great potential which is yet to be realized in Poland. At this point in time, the prediction of the Ministry of Economy for the years 2010-2020, is that the production of renewable energy will increase to almost 16% of overall energy production by the year 2020. The present Development Strategy for the years 2014-2020 includes a recommendation for each district authority to establish such an energy production system, which should be able to produce at least 1 MW of power.

Challenges

Aside from the challenges noted previously, the plantation has also experienced problems with pests. For example, in 2008 the plantation encountered an invasion of Phratora Vulgatissima, a kind of a colorado beetle (the same species). It took the pest a couple of months to eat up almost all of the leaf lamina across a 48 hectare section of the plantation. Fortunately, when the plantation owner decided to spray the plantation with PERETORID pesticides, only one treatment was needed to get rid of this bug. Other problems include beavers creating dams and lodges, which results in flooding of large parts of the plantation, and problems with the harvester. To work properly, the machinery needs a flat terrain, which is not too common in the valley of the Oder river. The harvester also has some design flaws, which are particularly felt when the harvested willow branches are too thick. The space between the belts transporting the willow to the harvester's tank is too small, and the belt is too stiff. So when the branch is thicker than average the belt does not bend and the machinery gets clogged up. There is some work currently underway to improve the construction.

Lessons learnt and recommendations for future projects

The majority of all future activities of the manufacturing plant will be set on gaining additional distribution markets for the manufacturing plant production. It is a step that needs to be carried out before further development of the plantation or manufacturing plant, due to its rather high efficiency and production reserves in comparison to the current retail figures. The owner of the complex also has a plan to create a biogas refinery on site. The refinery will use algae as the main substrate for its production.

Contact details and/or further information

Pellet plant website: www.fabrykapellet.pl/index.html#

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CASE STUDY

Topic Mapping

Assessing the field performance of Eucalyptus grown in SRPs in Andalusia

Location

Andalusia (Sevilla, Granada, Huelva, and Córdoba), Southern Spain

Description of project or activity

For EU energy targets to be met in the coming decades, it will be essential to find alternative energy sources. Woody biomass production is a promising strategy for harvesting energy. Agricultural lands, especially those that are abandoned, offer an alternative for new energy farming.

In this context, woody biomass has great advantages, particularly that which is produced under short-rotation management; i.e. it re-grows after each harvest, allowing multiple harvests without having to re-plant. Therefore, new high-yielding woody species need to be tested in potential regions such as the Mediterranean area. The success of plantations under short-rotation systems depends primarily on the type of plant material used. This largely determines the amount of biomass that can be produced in a specific region, and hence there is a need to study the performance of different eucalyptus species in situ to select the best-performing option under the site conditions of Andalusia (southern Spain).

Background/objectives

The aim of the present study was to assess the field performance of four selected eucalyptus stands (Eucalyptus camaldulensis, Eucalyptus dunnii, Eucalyptus saligna, and Eucalyptus maidenii) in a short-rotation system under site conditions of Andalusia (southern Spain), and the resulting implications for potential feedstock source for solid biofuels in an energy farming context.

This project was sponsored by a contract entitled "Agronomic and Economic Assessment of Energy Crops in Andalusia" (CAICEM-11-89) between IFAPA and Andalusian Society for Biomass Valorization.

Eucalyptus plantation in Granada

Successes

The results of the project met its objectives. The E. camaldulensis was one of the best adapted species to the south Spanish Mediterranean environment, while the E. dunnii was shown to be more efficient under intensive conditions. In general, the findings suggest the three-year coppicing cycle is the best strategy in order to maximize the biomass yield (19 tDM ha^{-1}). By contrast the E. dunnii appeared to be most productive under two-year coppicing cycle (20.5 tDM ha^{-1}). In the European Mediterranean basin, the implementation of short-rotation plantations for woody biomass production appears to offer a highly promising and sustainable option among the available renewable energy sources.

The imminent demand for woody biomass for use in the production of energy towards meeting the EU energy targets for 2020 has forced researchers and land managers to increase its productivity. Thus, under such a scenario, new high-yielding eucalyptus stands are crucial for growing in areas influenced by Mediterranean climatic conditions.

Challenges

In the framework of this study it has been identified that a suitable variety of Eucalyptus can be grown in Mediterranean environments, and therefore, that it may be used in farming systems for biomass production. However, in agronomic terms it will be crucial to improve our knowledge regarding the production techniques (irrigation, planting grid, weed control, pest and disease management, etc) so that biomass yield is maximised.

Costs and benefits

Use of short-rotation plantations for biomass production is one of the more promising options for contributing to meeting the European renewable energy targets. It has been identified as the most energy-efficient carbon conversion technology to reduce GHG emissions.

In terms of fixed carbon and nitrogen and environmental benefits and the impacts associated with new energy farming, the eucalyptus biomass in the present experiment followed the pattern:
E. camaldulensis > E. saligna > E. maidenii > E. dunnii.

Lessons learnt and recommendations for future projects

This study could be considered as the first step in improving our knowledge in regards to the importance of energy farming systems which require fewer inputs but are still able to produce a significant proportion of overall energy. The study teaches us lessons on the importance of fostering the use of biomass as a renewable energy and avoiding greenhouse gas emissions in a sustainable agricultural context. It also shows us the way such energy crops can revitalise rural economies and increase energy independence in Mediterranean environments.

In addition, the research into bioenergy systems has to be moved in a new direction by applying modern genetic, agronomic, innovative strategies for optimising energy farms by increasing yields, decreasing costs, and maximizing sustainability.

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CASE STUDY

Topic Planting and establishment; Crop production

The effect of density on Populus sp. SRPs in the Mediterranean area

Location

Spain

Description of project or activity

The effect of density on poplar short-rotation forestry plantations of the 'I-214' clone (Populus x canadensis (Dode) Guinier) was analyzed in the context of maximizing biomass production under Mediterranean conditions. Data from 12 experimental sites in Spain with densities ranging from 6,666 to 33,333 cuttings ha^{-1} (3m spacing between rows) were used.

As is common practice in SRF, the whole trial area at each site was fertilized during soil tillage according to the specific soil characteristics and Oxifluorfen (4 L ha-1) was applied immediately after the cuttings were planted to control weed establishment and competition. Irrigation was applied in all plots either by drip or flooding to site field capacity.

To study clone production performance in relation to site and plant density, basal area was used as indicator, and weed control, plant spacing, latitude, altitude and mean spring temperature were used as independent variables.

Background/objectives

This work was supported by RTA-2008-00025, On-cultivos and Lignocrop projects. Plots were established in early spring between 2005 and 2009.

The main objective of the study was to determine the effect of density on biomass production in SRF plantations for energy purposes under Mediterranean conditions. The initial hypothesis was that total biomass production would be similar over a wide range of densities and therefore the optimum density, in terms of economic viability, would be the lower limit at which maximum biomass production was attained.

The specific objectives were: i) to evaluate the effect of density on biomass production after the first (establishment) year and at the end of the first rotation (three-year old plants); ii) to evaluate the interaction between site characteristics (climate, soil and management) and density and determine the most relevant variables that could have an influence on biomass production in the study scenario.

Successes

The effect of density on the growth and production of Populus genus clones in SRF plantations was found to be significant in the first establishment year, when higher density results in greater growth. This suggests that in a hypothetical annual rotation, without taking into consideration the effects of management intensity on the vigour of regrowth, higher density would be the most advantageous during the first year. However, after three years, the differences in both biomass and basal area associated with the DENSITY factor disappeared, while differences relating to SITE factors were still present. This would imply that the location of the plantation is more important in terms of productivity than the number of plants per hectare.

Poplar plantation in Granada

Sites at more southerly locations were the most productive since the plants benefited from warmer climates and longer growth periods, as long as they were kept well-watered.

Among the variables that explain production variability, weed control (poor, medium and good) was the most influential factor. This is because the weeds compete with the poplars for resources, negatively affecting production, particularly when the poplars are young. Weed control must therefore be particularly intensive during the first growing period in SRF plantations. It is also essential to begin treatment at the soil preparation stage through the use of appropriate herbicides or tillage techniques, especially where perennial species are present since these may be difficult to control later on. Inadequate control of existing vegetation during the soil preparation work will result in a deficient plantation and cause high levels of tree mortality along with a reduction in productivity. The necessity of applying treatments during the second or third vegetative periods is more questionable.

Challenges

Weed control is one of the most important factors to be considered in SRF plantations for biomass production. A weed control protocol was clearly defined for all the trial sites. However, the efficiency of the herbicide treatment varied considerably from one site to another due to factors such as the size of the seed bank, the meteorological conditions at the time of application, the skill of the workers or specific site conditions which affect the efficiency of the herbicide. This must be taken into account when estimating real scale production since cultural treatment may be more heterogeneous over large areas.

Costs and benefits

The profitability of SRF poplar plantations will be dependent on the optimum plant density since this will affect the cost of plantation (purchase of cuttings and machinery costs), which can be as much as 40% of the total cost of production. Therefore, as regards to the economic profitability of the crop, factors such as plant material/plantation cost, weed control strategies or the operational capacity of the machinery employed must all be considered, as well as biomass yield.

Moreover, this work does not assess environmental costs, such us the high consumption of water, which is a limited resource in Spain and other Mediterranean countries. Neither does it assess the environmental or social benefits such as the positive impact on biodiversity, carbon savings, and protection from water and wind erosion or rural development.

Lessons learnt and recommendations for future projects

In order to maximize biomass production, taking into account planting costs as well as the difficulties associated with management and mechanisation of plantations, the overall results suggest that a density of 15,000 cuttings ha^{-1} should not be exceeded.

More trials are necessary to establish the effect of density on the production of plants over successive rotations. Furthermore, different clone material must be considered in order to give greater consistency to these results.

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Paper: Cañellas, I., et al., The effect of density on short rotation Populus sp plantations in the Mediterranean area. Biomass & Bioenergy, 2012. 46: p. 645-652.

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CASE STUDY

Topic District heating

BIOCEN S.A. trigeneration project for L'OREAL

Location

Burgos, Spain

Description of project or activity

Biocen, SA operate the Trigeneration CHP power plant for L'OREAL. It is a plant with a 5,000kW thermal oil boiler and a 500 kW installation of solar photovoltaic panels generating 3,310 kW of heat and electricity in the organic rankine cycle (ORC) module, steam at 12 bar, and cold water by absorption. The installation is supplied with 100% renewable energy.

The new power plant is an excellent example of energy saving and efficiency. It supplies all the electricity, heating and cooling consumed by L'Oreal in its production processes and the air conditioning of its buildings, replacing natural gas and electricity to the network. L'Oreal use 70% of the heat and 100% of the electricity produced by the power plant and the remaining 30% of the thermal energy generated becomes available to other local businesses to use through a district heating network.

The thermal energy is produced by the thermal fluid boiler assembly, generator and ORC module. The thermal energy is used to produce hot water wash, hot water osmosis, heating and hot water for sludge drying. The cold water produced by absorption is used in the industrial process for conditioning various units.

The biofuel used is forest chip, such as poplar, with a chip size of G100 W35. The expected annual consumption is estimated at 8,000 tonnes.

To ensure the process of collecting and transporting the biomass is as efficient and sustainable as possible and to minimise CO_2 emissions, the biofuel is sourced from the nearest location possible.

Background/objectives

Main objectives are to prove that it's possible to power a big L'Oreal industrial facility on 100% renewable and locally produced energy. This experience may then be replicated in the other 40 factories of the group worldwide in order to achieve zero CO_2 emissions in all its factories (with a first objective of 50% CO_2 emissions reduction in all its factories).

Successes

- The production of 100% of the energy needed by the factory at nearly zero CO_2 emissions
- The creation of an ESCO company that raised all investment through a contact with L'Oreal
- The ESCO company is a good example of a PP Partnership in which private and public companies collaborate. In this case, the private company has the know-how on the management of the power plant and the energy contract, while the public company gives security to the project, and assures the delivery of the biomass needed by means of its management of neighbouring forests

Solar PV panels on the roof of the biomass store

Costs and benefits

The total cost of this project amounts to €12 million. The economic implication for L'Oreal has been very important since it has invested €2.5 million in the factory to adapt to new supply and has given a plot of 0.5ha to grow new plants.

The plant produces 100% of L'Oreal's energy needs from the following renewable sources:

- Photovoltaic Solar Panels on the roof of the boiler with a 500 kW power rating.
- Biomass trigeneration plant with a 5,000 kW generator, saturated steam at 12 bar and production of 2.3 t/h, 3,310 kW ORC module that provides an electrical output of 617 kW and a heating capacity of 2,693 kW, and 1,200 kW cold water absorption equipment (24,000 litres and 10,000 litre machines for air conditioning).

This facility ensures that the use of energy in the L'Oreal factory produces no CO_2 and that the production for waste sludge drying is minimised.

Lessons learnt and recommendations for future projects

A project of this size takes a long period to be implemented, and legislative changes have affected the project. For instance, the no tariff-fee in force right now in Spain has considerably reduced the financial benefits of the project. The annex district heating facility for neighbouring buildings is thus crucial for the stability of the project.

Poplar chips for consumption in the biomass plant

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Fuelling dialogue between biomass research, industry, policy & business
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CASE STUDY

Topic Mapping

Maps of biomass potential and biomass installations in Andalusia

Location

Andalusia, Southern Spain

Description of project or activity

This application has been developed by the Andalusian Energy Agency. The biomass potential map compiles updated information on biomass resources, including production ratios, while the installations map shows all plants using biomass as an energy source for both electric and thermal purposes, as well as those producing biomass as a source of energy (for example pellet factories). It is also possible to check and sort the installations by municipality, sector and / or technology type.

The mapping tool is located at: bit.ly/1IAsY1E

Background/objectives

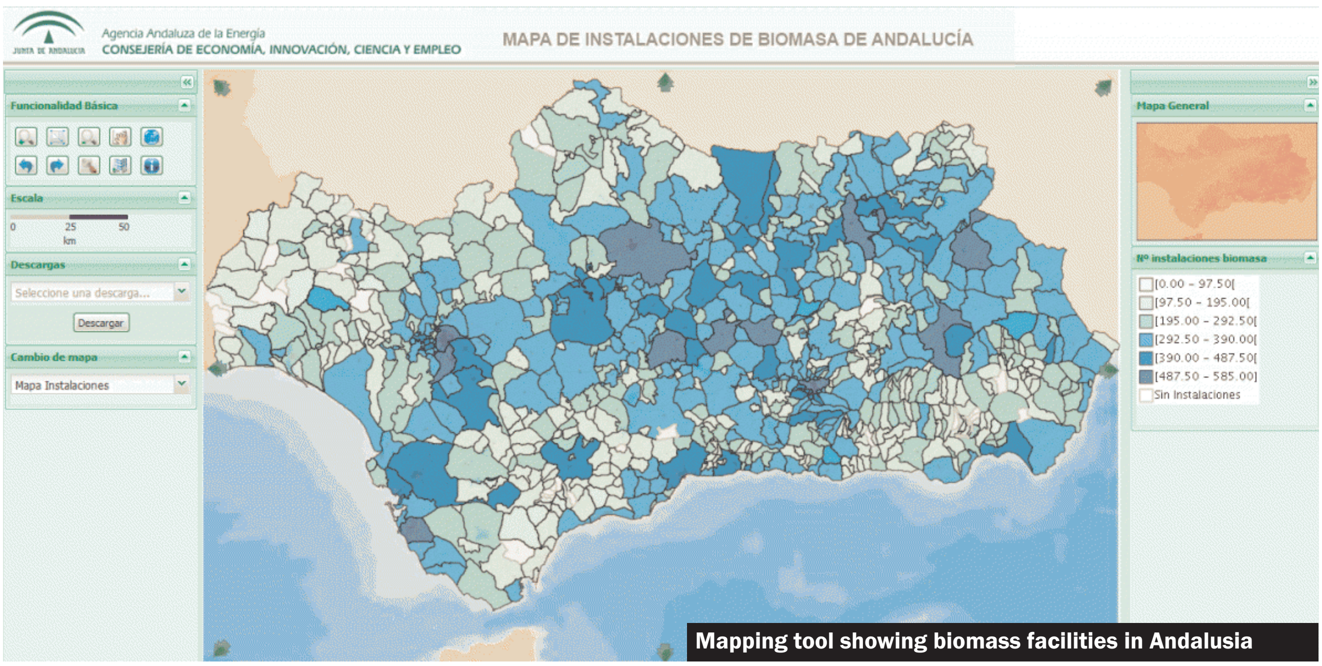
The objective was to provide an informative tool for organisations within the sector, so that by having knowledge of the type and amount of biomass in a given area, plus information relating to the typical technologies (boilers, stoves, furnaces, dryers etc) that make use of it, those companies would have a powerful tool to help them to undertake realistic biomass projects. The reliability of sources of information is very important here.

Map of Potential: To quantify the amount of biomass available, a methodology was established, specified according to the classification of the biomass. So, for agricultural and forest biomass information was derived from the cartography of the “Junta de Andalucía” in order to determine the existing surface area for each crop and species group and a ratio of biomass production per hectare was established based on experience from several trials and test of machines in the field of the Andalusian Agency, and other agencies. In the case of industrial biomass, technical capacity is determined based partly on surveys of the sector. The tool includes a document outlining the methodology for reference.

Map of existing technology installations for the production of heat: The two main sources of information are the database of the Andalusian Energy Agency, which contains accurate information of more than 21,000 facilities, as well as the register of agro-alimentary industries of the Ministry of Agriculture, which contains a list of all of the facilities of the olive industry that consume biomass. This map is updated every 3 months.

Successes

In 2014 the Andalusian Energy Agency website has received more than 349,659 users, which equates to traffic of over 3.17 million accesses to the various contents, including the biomass map.



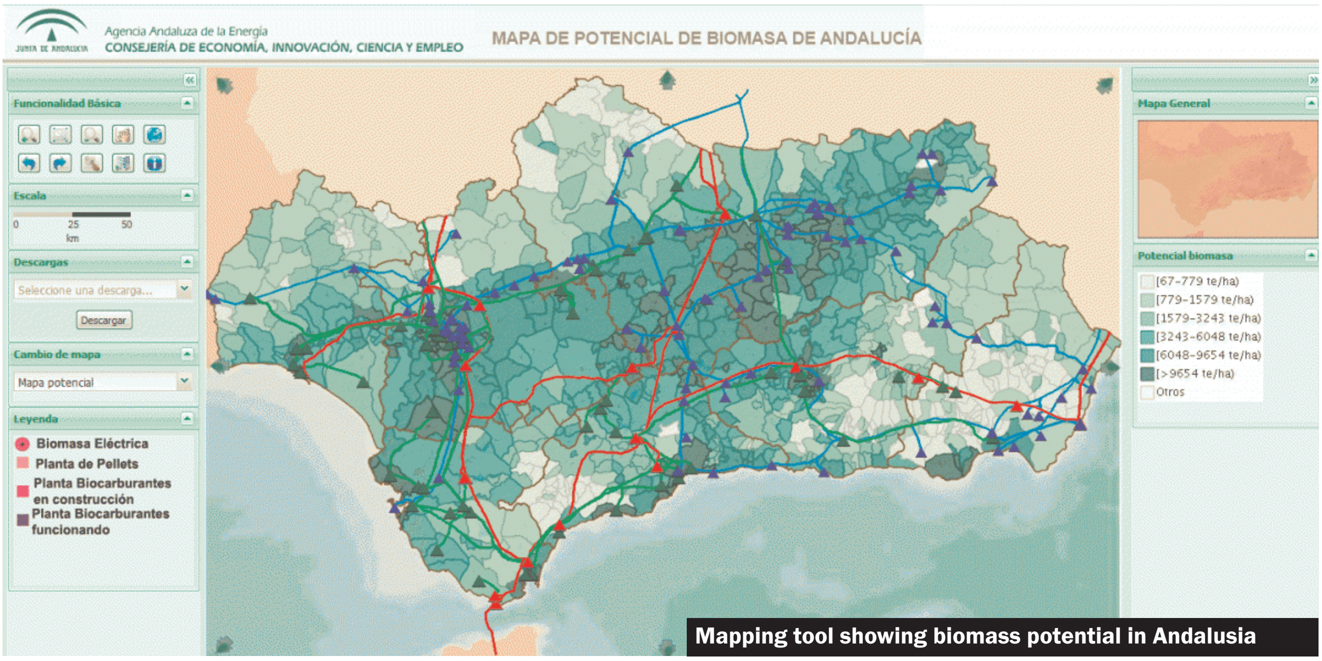
Mapping tool showing biomass facilities in Andalusia

Costs and benefits

Since the field tests for the determination of the ratios of biomass production have been charged to previous projects and other sources of information have been public, the cost of maps has been limited to the necessary staff costs to produce the website and process the information. It is estimated that this work has required approximately 1,000 hours of work.

Lessons learnt and recommendations for future projects

This application must be regularly updated to maintain its validity and usefulness. There are still facilities of biomass where the exact power rating is not known and has instead been estimated, so we will continue making requests for this information within the industry in order to complete the database. Similarly, this map could be supplemented by the incorporation of company information in the sector (including, for example, installers, utilities, agricultural and forestry, distributors of biomass, etc).



Mapping tool showing biomass potential in Andalusia

Contact details and/or further information

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General information on the programme: bit.ly/1H5IM7V

Fuelling dialogue between biomass research, industry, policy & business
www.rokwood.eu

This project is supported by the European Commission under call FP7-REGIONS-2012-2013-1 "Regions of Knowledge" of the 7th Framework Programme for Research and Technological Development.

SEVENTH FRAMEWORK PROGRAMME

CASE STUDY

Topic Promotional activities

"Granada Es Verde" campaign & biomass facility contract promotion

Location

Andalusia, Southern Spain

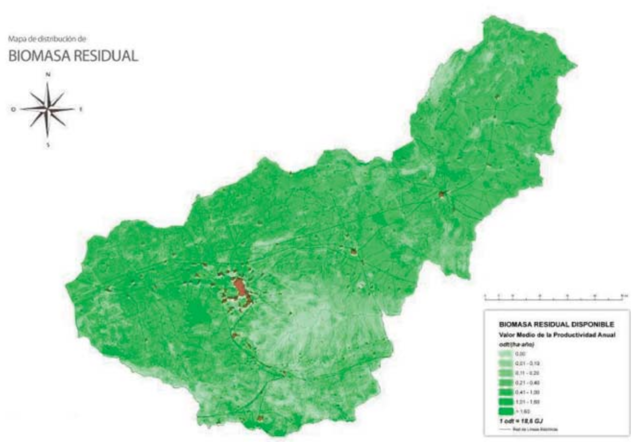
Description of project or activity

The "Granada Es Verde" project wants to use all the information and data collected since the formation of the Granada Energy Agency in 2001, and send a clear message to every kind of stakeholder related to Energy:

Granada province IS Green, it has a vast "green" potential based mainly in its existing solar, wind, and biomass resources, but as well in other renewable sources such as hydro

The project wants to implement directly some of the actions envisaged in the already developed Municipal Energy Audits, the Covenant of Mayors, and Energy Potential Studies. It also aims to promote the potential that the province has to create employment by means of green energies through awareness campaigns and through collaboration with other institutions. Thus, the project stands basically in 2 types of funding, one directly related to its own sources of public administrations to develop example facilities, and another one to promote ESCO contracts among our municipalities. One of the main local energy sources that is available in this region is biomass, and the growth rate of biomass heating facilities has been rising in recent years. 1.968 kW of biomass power has already been produced in municipal building boilers.

Biomass potential in Granada from waste



Background/objectives

The "Granada Es Verde" project includes different actions to promote our vast resources in renewable energy as well as to achieve a better use of energy.

Specifically, the province of Granada has enormous potential in relation to the use of local biomass energy resources. As a province with low winter temperatures it is also ideal for making use of biomass heating systems. These two factors highlight the great potential of developing the sector of biomass and its thermal uses in our region.

The campaign GRANADA IS GREEN was launched to support the development of an industry which has great potential in our municipalities. The project had the following main objectives:

- To study the potential of biomass in the province, mostly related to biomass derived from forest residues and energy crops.
- To promote the importance of the type and quality of biomass and the biomass boilers.
- To make Municipal agreements under the 1389D1 Program to install biomass boilers in our municipalities through ESE schemes.
- To be part of the ROKWOOD European project.

This campaign aims to support the development of the biomass sector by spreading information about the possible paths of actions through social networks, conferences related to the campaign and advice to those involved in the sector (individuals, companies and municipalities).

Successes

The main areas of activity were related to raising awareness within municipalities and with citizens. A recent achievement is that politicians are focusing on promoting energy efficiency and increasing the demand for biomass heat. These are two proven ways of allowing a province to become less energy dependent.

Nowadays, not only does the province have a huge potential in terms of biomass resources, but there is also a local company that produces biomass boilers, a pellet factory, a new biomass distribution company and other specialised companies related to installation and financial schemes. The biomass market is constantly growing, and Granada Province is one of the regions where most biomass boilers have been installed.

Moreover, the project has attracted funding from the EU to promote the establishment of biomass boilers in Municipal Buildings. 1.968 kW of biomass power is now being supplied by municipal building boilers.

Challenges

Much more activity related to ESCO Biomass companies was expected. Recently, the main financial scheme "BIOMCASA" became more complicated and fewer companies now use it as a commercial tool.

Additionally, ESCO contracts and debt management in municipalities has proven much more difficult than was initially expected.

Thus, the main obstacle to tackle in the next phase of the project is to better assess our municipalities in these kinds of contracts. It may also be useful to try to attract some new funding to promote this kind of scheme in order to maximize the impact of the programme.

Costs and benefits

The biomass potential study has cost €5,000, and has mainly gathered information already worked out by other administrations. One of the objectives of the project was to work without many resources and thus taking advantage and creating synergies with other administrations was vital.

The assessment works and part of the awareness campaigns are part of the regular costs of the Energy Agency, and/or come from European projects such as ROKWOOD (for promotion of Poplar plantation in our region, and analysis of the needs of the market).

The investment to achieve nearly 2MW of biomass boilers in municipal dependencies has been €450,000. This funding has come from the budget from ERDF, the provincial council, and the specific municipalities participating in the project.

The main benefits achieved by this project are the production of renewable energy, CO_2 savings, and providing example to the general public through these facilities.

Lessons learnt and recommendations for future projects

The main lessons to learn are outlined in the "challenges" section of this document, as this has been the main issue in which we have had problems. In the new ERDF 2014-2020 there is going to be plenty of opportunities to get funding for projects like this one, so is just a matter of starting to do it!

Contact details and/or further information

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This project is supported by the European Commission under call FP7-REGIONS-2012-2013-1 "Regions of Knowledge" of the 7th Framework Programme for Research and Technological Development.

CASE STUDY

Topic Promotional activities; Policy support

Spanish BIOMCASA ESCO promotion scheme for biomass facilities

Location

Spain

Description of project or activity

This programme aims to establish a funding system for those who use biomass to supply hot water and air conditioning to their buildings. It finances projects submitted by approved companies and which meet programme requirements on ESCO schemes. The National Energy Agency (IDAE) provided a specific budget amounting to €5 million. Recently, a second phase programme with the same budget has been approved. The programme's goal is to continue to facilitate the promotion and financing of biomass thermal projects in buildings and thus further such projects.

Background/objectives

Since the beginning of the economic crisis there has been a lack of finance available from banks. The National Energy Agency in Spain (IDAE) thus saw a need for a new financing scheme for renewable heat. This was funded by ESCOs, there are three programmes:

- SOLCASA: Solar thermal energy facilities financed by ESCO companies
- BIOMCASA: Biomass thermal energy facilities financed by ESCO companies
- GEOTCASA: Geothermal thermal energy facilities financed by ESCO companies

IDAE and private companies that want to work as ESCO companies in these kinds of facilities have agreed to the terms of the programme. The programme will be open until the fund is spent or until a specific objective on power generation for each technology is achieved. The BIOMCASA programme has been so successful that there has been a second round with improved criteria and more money.

Successes

The BIOMCASA ESCO programme was the most successful of the three ESCO promotion programmes of IDAE. It is thought that this is because biomass can replace oil in homes easily and with financial benefit. In fact, this is the only programme that has covered the first objective on power installation and finance.

The success of the project can be attributed to the fact that thermal energy is the largest energy demand in homes, and that in Spain the price of oil compared to biomass is quite high. Thus, this kind of scheme is perfect for financing by ESCO companies, especially in an economic climate with little available finance.

Another strength of the programme is that the financing conditions are better than those that can be found in the private sector, have greater flexibility (financing up to 10 years) and companies must be certified to join the programme. IDAE can therefore control the quality of the companies and final customers can be more confident.

Another contribution to the success of the programme has been its strong promotional campaign that informs both companies and final users about the programme.

Challenges

There were some problems in the first offering, mainly relating to the quality of some of the companies, and maintenance contracts. In the second round, however, IDAE has improved the criteria to certify companies in order to better control how companies do their job.

Costs and benefits

Due to their other work promoting renewable energy in Spain, IDAE already had the technical and administrative resources needed to manage the initiative. Thus, the only need was related to financial resources for the project.

A national institution already exists in Spain to finance strategic projects (ICO). Thus, the €5 million of finance were met by means of an agreement with the ICO institution for the promotion of biomass.

There are no estimates of the numbers of local jobs produced.

There is an estimation of installed capacity, and thus CO_2 emission reductions achieved. The main objectives achieved in the first round:

- 48 registered companies
- 11.9 MW of biomass heating power installed
- €4.4 million distributed
- 7,023 tonnes of CO_2 abated per year
- 22.7 M kWh generated by means of biomass

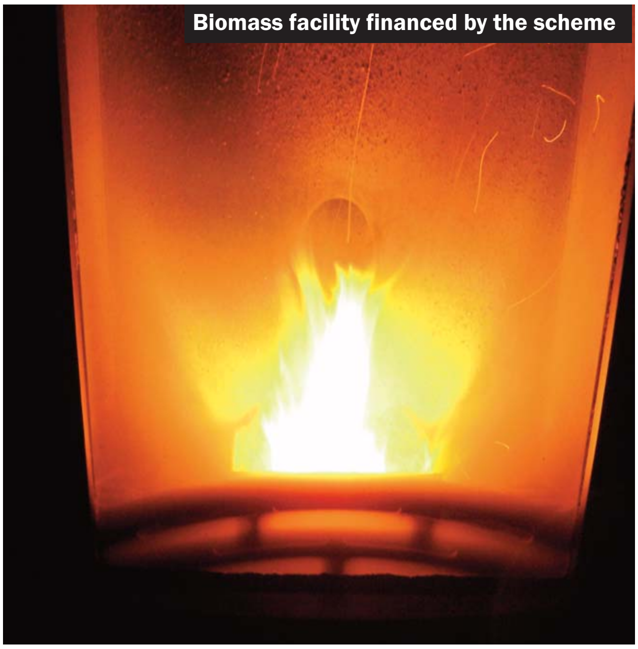
The facilities save those clients that worked with the programme up to €600,000 per year.

Lessons learnt and recommendations for future projects

The criteria which define which companies can work with public money in this kind of project are crucial. If there are too many criteria, then no companies will work with the programme; if there are too few criteria, then inappropriate companies may be involved, leading to unsuccessful projects and unhappy clients.

It is essential to encourage companies and clients to create confidence in the programme and to develop an awareness campaign to promote the programme.

It is also important for financing schemes to be flexible to allow the programme to adapt to different types of companies and clients.


Biomass facility financed by the scheme

Contact details and/or further information

IDAE | Tel: +34 913146673 | Website: www.bit.ly/1sTGfqd

General Information on the programme: www.bit.ly/1vjzQpa

This project is supported by the European Commission under call FP7-REGIONS-2012-2013-1 “Regions of Knowledge” of the 7th Framework Programme for Research and Technological Development.

CASE STUDY

Topic Business models; Additional areas of application of SRPs

Using willow to produce fuel and treat wastewater at Nynäs Farm

Location

Enköping, Sweden

Description of project or activity

Nynäs farm is located in Enköping and is partnered with the ENA Energy district heating plant and the nearby treatment plant. The farm has 76 hectares of willow plantation. The Salix plantations are watered with sludge water and outgoing treated water from the treatment plant. This gives the farms about 200,000 m^3 of water per year, of which 20,000 m^3 is nutrient-rich sludge water. When watering is not possible, the sludge water is stored in storage ponds on the farm.

The collaboration is governed by a 15 year contract and the farm gets payment for receiving water from the treatment plant. In addition, the farm sells willow chips at market price to the nearby power plant. On Nynäs farm, cooperation between growers, cogeneration plants and sewage treatment plants has contributed to a profitable business for all parties

Background/objectives

Nynäs farm initially tested willow cultivation on a small scale in the 1990s. When the potential for cooperation with the municipality and the district heating plant appeared in the late 1990s, they decided to plant more willow. At this time the power plant was in need of more fuel and the municipality was looking for a partner to clean the water from the treatment plant.

Willow was planted between 1998 and 2000, and now amounts to 76 hectares. Other land is used for grain cultivation, forage crops and pasture for the farm's horses. The cultivations are fertilized with sludge water from the treatment plant and with outgoing water from the treatment plant. The water is continuously supplied during growing season through irrigation hoses.

The Salix grows fast in the nutrient water and is harvested every three years using a direct chip harvester. The chips are transported about 2km to the CHP plant, ENA Energy. The boiler produces 55 MW of thermal power and a 24 MW electrical output.

Willow grown as short rotation coppice grows exceptionally well when irrigated wih wastewater

Successes

On Nynäs farm, cooperation between growers, cogeneration plants and sewage treatment plants has contributed to a profitable business for all parties. One reason for the profitability of the willow production is the reimbursement of 150,000 SEK per year that the farm receives in return for taking sludge water from the municipal wastewater treatment plant. The compensation is equal to 1,974 SEK per hectare per year. It is also guaranteed that the farm can sell their chips to the CHP at market prices.

New clones are currently being grown in the plantations. The situation is very stable with the willow cultivation not currently in need of replanting and contracts for the sludge and wood chips running for another few years. If the contracts are renewed then the farm plan to replant the willow, but they have no plans to expand the willow acreage.

Costs and benefits

The fertilization with sludge and waste water means that the willow plantations give good returns, in the latest cutting cycle 9 metric tonnes per hectare per year was achieved. The heating plant will pay about 900 SEK / metric tonne for the chips. The compensation for the sludge is 1974 SEK per hectare per year. The production costs for the last cutting cycle were 479 SEK / metric tonne. In addition to applying fertilizers and controls to the willow, there are further costs in the form of hardware costs, the cost of time, work and space invested in the willow cultivation and enterprise wide costs. This gives a net allowance of 5728 SEK per hectare per year (excluding farm payment).

When planting, the planting support was 5000 SEK per hectare, which gives a production cost of 588 SEK per hectare per year for the calculation of all cutting cycles.

The project was financed by the Swedish Board of Agriculture through the Rural Development Programme.

Lessons learnt and recommendations for future projects

Commitment is important in all aspects, from maintenance to the user's interest in having a working fuel chain with good profitability. Creating good relationships with local actors helps in the formation of favorable fuel contracts.

The choice of land, careful weed control, regular fertilizing and good access to water and nutrients are all important in achieving a high willow yield. The size of the fields and care of headlands affects production and helps keep harvesting costs down.

Locating the willow growing near to a local user is essential in order to keep down transport costs and total production costs. Being able to fertilize willow cultivations with residues from wastewater treatment has a positive effect on both the growth and profitability of cultivation, especially if payment is also received for spreading the sewage.

Contact details and/or further information

Profitable willow cultivation (Swedish) | download from www.jti.se or www.bioenergiportalen.se

Developed by JTI - Swedish Institute for Agricultural and Environmental Engineering (Carina Gunnarsson), SP Technical Research Institute (Susanne Paulrud) and by Håkan Rosenqvist, agricultural economist and independent consultant.

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CASE STUDY

Topic Weed control

Investigating the impact and control of weeds in biomass willow clones

Location

Lund, Sweden

Description of project or activity

In order to investigate if willow short rotation coppice (SRC) varieties differ in their ability to compete with weeds, the Swedish University of Agricultural sciences (SLU), has established three field trials (one hectare each) where ten commercial cultivars were tested for their weed competitiveness. The study also investigated if the competitive ability of weeds was affected by the common practice of cutting back first year shoots.

The recommended practice when establishing a willow plantation is to use a combination of herbicides and mechanical weeding. However, to further improve the good environmental profile of willow SRC, it is desirable to omit the use of herbicides during establishment. Another study at SLU therefore compared the weeding efficiency of the recommended practice, treatment (one application of herbicide two days after planting + one run with a row crop cultivator in the first season and two runs in the second season), with four non-chemical treatment strategies.

Background/objectives

Willow SRC is known to be sensitive to weed competition during the establishment phase and the present Swedish recommendation when establishing a willow plantation is to use herbicides in combination with mechanical weed control measures. The primary objective in the Swedish studies was to determine the possibility to further improve the environmental profile of willow SRC by omitting the use of herbicides during establishment. Through plant breeding, many new varieties have been developed, with higher yields and better resistance to pests and diseases such as leaf rust and certain insects. However, no study has investigated if there is a difference among willow cultivars in their ability to compete with weeds. If genetic variation in the competitive ability of willow SRC in relation to weeds could be found, this would be an

Salix plantation trial site

incentive for breeding even more weed competitive cultivars.

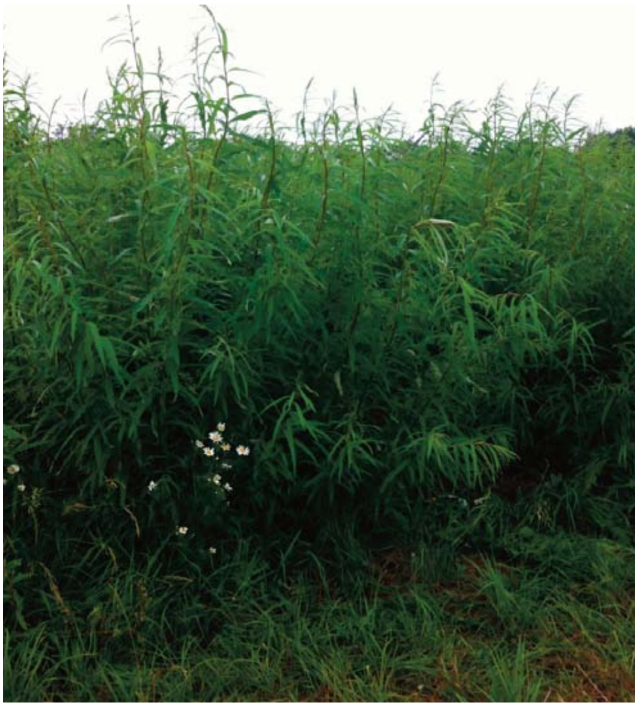
The importance of finding alternative methods or combinations of methods to control weeds has increased, as that the number of herbicides permitted for use in the European Union is decreasing.

Successes

The studies showed that there are only small differences between willow clones in terms of their ability to compete with weeds when willow growth reduction and plant mortality is measured after the first harvest. All willow clones were in fact severely hampered by weeds and, depending on site, the mean growth reduction ranged between 68.3% and 94.3% and the mean cumulative plant mortality in the unweeded treatment between 9.8% and 57.3%. The plant mortality in the weeded treatment was approximately 1% regardless of site. Consequently, choice of clone, at least from among the currently available commercial stock, will probably have limited effect on weed control in willow SRC. Furthermore, the results indicate that breeding for competitive ability is probably not a feasible way to improve the environmental profile of willow SRC, since there were only slight differences in weed competitiveness between clones. The results confirmed previous findings that weed control measures should be applied during the first growing season to ensure proper establishment of a willow plantation.

The biomass production of willow plants under severe weed pressure was either negatively affected or not affected by cutting back the first-year shoots. The magnitude of the differences between the two treatments was only affected by clone to a small extent. In addition, at one of the three sites this practice increased plant mortality. Hence, the results indicate that cutting back the first year shoots does not increase the ability of willow plants to compete with weeds and may in fact decrease it.

The results from the study about effects of different weed control measures on growth and economic viability of two willow cultivars indicate that a row crop cultivator combined with torsion weeders (treatment:- three runs with a row crop cultivator with torsion weeder in the first season and three in the second season) might be a good option if herbicides are to be omitted during the establishment phase of a willow SRC plantation.



Contact details and/or further information

Swedish University of Agricultrual sciences, Faculty of Landscape Architecture, Horticulture and Crop Production Science, Department of Plant Breeding Alnarp

Johannes Albertsson | E-mail: johannes.albertsson@slu.se

Film from a visit to the trial sites: www.crops4energy.co.uk/why-weed-control-is-so-important-during-energy-crop-establishment

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CASE STUDY

Topic Fuel processing and quality

Researching the effects of different storage and drying methods for Salix

Location

Sweden

Description of project or activity

If Salix is to become a more common fuel in smaller and medium sized heating plants, the entire chain, from the storage of fuel to combustion, needs to function in an efficient, environmentally sound and economically viable way. An important requirement is that producers and users know the properties of Salix fuel and understand how these are affected by handling and storage.

During 2013-2014, the SP Technical Research Institute identified combustion experiences, performed combustion field tests and collected a large amount of fuel analysis from differently stored and harvested Salix (chips, whole stems, bales). The affect of fuel quality on slagging and fouling during combustion was also analyzed. The results were used for training on Salix as fuel for users and potential users during 2014.

Background/objectives

It is generally believed among many users of biomass that Salix cannot be used as a single fuel (i.e. not in a mix with other biomass fuels) in small heating plants. Several projects have therefore been conducted around the willow's fuel properties during 2012-2014. One project aimed to develop knowledge of Salix fuel properties. More precisely, the goal was to study the effects that different methods of storage and drying of Salix chips and storage of whole rods/bales has on slagging and fouling during combustion. In addition, the goal was to develop a set of requirements and conduct a discussion of operational strategies and boiler technology for the use of Salix fuel in the size range 0.1 to 5 MW.

Another goal of the project was to identify methods for drying and storage of Salix chips in order to investigate the possibilities of using Salix in various small-scale heating plants and to calculate the economy of small-scale heating with Salix chips. The storage and drying methods that have been tested are; outdoors storage of a large chip pile (400m^3) stored on concrete pad, storage of a small chip pile (40m^3) on a concrete slab

Indoor storage of a Salix chip pile

and stirred about five times, and indoors storage of a small chip pile (80m³) dried with cold air.

The experiments were performed at Tågra farm outside Sjöbo. Salix were harvested in April 2013 and then stored directly in the above described chip piles. The project has also included testing and verifying that Salix can be used as single fuel in three different heating systems in the size 0.1 - 2 MW. The three boilers / burners that have been tested in the project are; ETA Hack, Veto burner and Reka boiler and the experiments have been performed at three different farms.

The results of the projects have been used at various workshops and courses in 2014 that have been conducted on the subject of using willow as fuel.

Successes

Salix works very well as fuel for smaller boilers when the fuel meets the requirements of a boiler on moisture content and size fraction. Salix has low slagging tendency, but during combustion, fine particles are produced that increase the demand for more frequent cleaning of the pipes to avoid foulings. Salix should be carefully handled during loading and storage to reduce the risk of soil and sand particles being added to the fuel, since these increase slagging tendency. It is an advantage to choose a boiler with a moving grate that can handle a little higher ash content and slag if contaminated Salix chips are entering the boiler. Although biofuel prices are low and the prices of traditional crops have been relatively high over the past two years in Sweden, the results from studied farms show that the use of own grown Salix has an equivalent fuel cost to current fuel alternatives.

Challenges

The biggest challenge with willow as fuel for use in smaller boilers is the moisture content, as smaller boilers require drier fuel. If a system of direct chip harvesting is applied, the fuel must be dried in the form of chips.

The results show that it is possible to store willow in the stack outdoors over the summer and that the moisture content can decrease down to 30% without artificial drying. However, there is some uncertainty as to how large the substance losses are and more studies need to be conducted in order to determine how willow chips can be dried in a cost effective manner without substance losses.

Costs and benefits

In the past two years biofuel prices have been relatively low while prices of traditional food crops have been relatively high, making it difficult to motivate farmers to cultivate and use willow, especially for those farms that have fertile land and where the option value of the land is high. Despite these conditions, the cost analysis shows that the use of own-grown willow provides an equivalent fuel cost against other options for both of the farms. For many farms, there is also some value in being self-sufficient in fuel for heating.

Lessons learnt and recommendations for future projects

To succeed with willow as fuel in boilers with the size 0.1-5 MW, the following is recommended:

1. When using the own-grow willow, handle the fuel with care and avoid reloading. Increased handling increases the risk that the fuel will be contaminated with soil or sand particles and that the fuel will fall apart and produce a lot of fines. Leave the last layer of chips on the ground.
2. Do a fuel analysis before combustion to control moisture content, ash content and calorific heat value. The ash content can provide a lot of useful information, such as how well the fuel has been handled. The ash content should be below 2.5%.
3. Choose a boiler with a moving grate that can handle a little higher ash content and slag in case contaminated salix chips enter the boiler.
4. Try to choose automatic cleaning of tubes since more frequent cleaning is required when using willow chips in comparison with wood chips.
5. Salix chips have a lower energy content per unit weight than wood chips, so the boiler must therefore be large enough to meet the heating requirements. The volume and weight also affects the setting of the augers.
6. Design the augers and feeding system so that they meet a certain proportion of pins and needles that can go with the processing of bales and whole stems. Needles are not a problem when using direct chip harvest willow.

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This project is supported by the European Commission under call FP7-REGIONS-2012-2013-1 “Regions of Knowledge” of the 7th Framework Programme for Research and Technological Development.

CASE STUDY

Topic Business models

Locally produced Salix - a model for increased co-operation

Location

Ystad, Sweden

Description of project or activity

The project was carried out by Salixenergi Europa AB in cooperation with the district heating company, Ystad Energi AB, belonging to Ystad municipality during 2012 to 2014. Someone with an extensive agricultural background, local roots, a contacts network and with experience of managing projects that require municipal cooperation was engaged to implement the project in the field . The project started with a series of meetings with various local government bodies to get the backing of the municipal organization. Land suitable for salix was identified and farmers were contacted to determine their interest; some of these were already salix growers but there was potential to encourage them to increase their cultivated area. The individual contacts would be the base for joint briefings for farmers in the next step. Early contacts were made with local environmental and energy consultants conducting projects in the municipality, and it was then possible to take advantage of their networks and knowledge.

Business models for cooperation between growers and the municipality were discussed with new and existing growers, especially at the individual meetings but also at open information meetings. It was difficult to arrange open seminars since there was low interest from farmers for these, so we focused instead on individual meetings.

As farmers weren't initially that interested in planting, the focus was instead placed on planting on municipal land. Unfortunately for the project, the identified land was sold during the project period to farmers who were not interested in growing salix. The result of the project was 54 new hectares of salix cultivation and a secured market for salix fuel produced locally. The goal of forming long term contracts between growers and heating plants was not achieved and the newly planted area was only a third of the planned size.

Background/objectives

Ystad Energi AB, a company fully owned by Ystad Municipality, has the objective of increasing the proportion of locally produced salix wood chips in the fuel mix from 10 to 20%. For this to be achieved, a much larger salix acreage is required along with better collaboration between growers and the heat plant.

Interest in salix cultivation near the Ystad heat plant has been weak during the last 10 to 15 years due to the high level yield of traditional crops and the fact that farmers do not believe there is a long-term demand for the chips. Some years the salix wood chips are transported long distances, and the growers have to pay for this, meaning the practice has received a bad reputation. If locally grown salix could be delivered to a reasonably secure market then this should increase the attractiveness to both producers and users. Suitable land has been identified within a few miles of the range where we judged that salix could be an economically competitive crop to complement traditional farming.

The objective of the project was initially to plant 150 hectares of salix, form a producer association and develop a business model. During the project the objective was changed to trying to reach 50 hectares of salix planted on agricultural producers' land and 100 hectares on municipally owned land and to involve various municipal departments in the process.

Successes

The 54ha of Salix which have been planted as part of this project constitute more than half of the total acreage of salix planted in Sweden during the project period, and so the project must still be considered a success.

Project leader Ulf Andersson checking the biofuel quality

The actors in the local salix business developed good contacts with Ystad Municipality and built up knowledge of long-term cooperation with municipal heating plants and with the local environmental experts. Very importantly, the salix produced in the neighborhood of Ystad has been delivered to Ystad heat plant on one-year contracts during the project period.

Farmers now have better contacts with the salix industry and some larger landowners who previously had not wanted to hear about salix can now take up the subject in other contexts. Many farmers in the area have begun to speak of salix, although not yet deciding to plant it on their own land. When conditions change, however, such as the rules of the CAP or the market for traditional crops they have the knowledge to allow them to take up salix production.

Challenges

The Ystad Heat plant has not decided to increase the proportion of salix or to make long-term contracts with local salix growers as a result of the project. The original idea was too dependent on the interest and commitment of the individual officials in the municipal organization. During the project, the internal conditions have changed, and thus so has the basis for the project within the municipality.

Different models for a producers association have been discussed as part of the project and are described in the report. However, there was no interest from the salix producers in forming a producer association to organize the sale of salix chips. The producers argued that the current set up where the harvesting contractor takes care of planning and marketing works well. The producers were therefore not motivated to put the time and commitment into running the organization themselves.

The project was run during the final two years of EU agricultural policy programmes of 2007-2013. No one knew what the CAP regulations would be after 2013 and interest from farmers to invest in long-term salix cultivation was weak. In addition, yields of wheat and rape seed were unusually high in the area in 2012 and 2013 and prices were also very good which made salix appear a bad economic choice even on poorer land.

Lessons learnt and recommendations for future projects

Farmers have little interest in involving themselves in a sales organization which is positive in the sense that they consider the current system, in which the harvest contractor also sells the salix fuel, to be efficient. The salix growers do value advice, harvesting and selling services but they are already receiving these from local contractors.

For long term contracts to be formed with the municipality they must be anchored at the political level. If they are only formed at the operational level then they will easily be dislodged by staff and management changes. Involvement from strong agricultural profiles can have a strong influence at the poltical level.

The project was run during the transition between two agricultural programs (CAP) and no one knew what the conditions would be for salix in the new programme. This was a bad time to be trying to make decisions about long-term changes in the crop production. In addition, the price for traditional crops was unusually high in the project area during the project and chip prices were falling which together made the salix look like a poor economic option, even on poorer land. The uncertainty about CAP and the relatively good economic outlook for traditional crops were the main reasons why the goal of 150 hectares of new salix plantations was not achieved.

Loading the furnace at Ystad with biofuel

This project is supported by the European Commission under call FP7-REGIONS-2012-2013-1 “Regions of Knowledge” of the 7th Framework Programme for Research and Technological Development.

CASE STUDY

Topic Harvesting

Developing a new model of billet harvester for SRPs

Location

Sweden

Description of project or activity

Henriksson Salix AB (HSAB) is currently constructing a new model of the billet harvester for the production of dry SRC fuel for the European market. Billets of two types, 10 or 30cm length, are produced directly at harvesting and combine the advantages of bulk handling with storability. Billets will dry over the summer without artificial drying from 50% to 30% moisture content with maintained quality.

The work started in 1991 but stalled due to a lack of market interest and HSAB changed to the construction of an improved head for Self Propelled Forage Harvesters (SPFH). The 10cm billets can be used without further processing in some heat plants. The 30cm billet can be used in whole-bale incinerators at farm scale or in traditional chip-fed heat plants or CHP plants after on-site chipping. The 30cm billets can also be used as cuttings for planting with the HSAB billet planting method.

The construction work includes the cutting, feeding and chopping mechanisms, and incorporates experience from the construction of the HSAB Salix head for John Deere, Krone and Claas SPFH. Field tests, demonstrations, storage trials and test deliveries to heat plants have also been conducted in the region of Skåne. The project is being carried out in collaboration with an Australian company who specialize in cane harvesting and the development of harvesters.

Background/objectives

Short rotation coppice for sale on the biomass market is mainly harvested by direct chipping, a method which has been developed over a period of 20 years, to a large extent in Sweden where Salix fuel was first used commercially. Directly chipped Salix fuel has a moisture content of approximately 50% and fits the Swedish market for Salix, where boilers over 5 MW are usually equipped with a condensation technique which enables energy efficient use of wet fuel.

In countries that have more recently started to develop a market for biomass, often for cogeneration with coal, the end users usually require dry fuel and cannot utilize wet fuel efficiently. In this large and developing market, the access to dry fuel is a market advantage and in some cases is absolutely essential, and this is a challenge for the whole biomass industry, not just for SRC. For SRC the solution has so far been to use different types of whole stem harvesting for storing and drying and re-chipping, which is labour-intensive and expensive. The challenge is finding a method which combines the efficient bulk handling of direct chipping with the storability of whole stems.

Successes

The development of the CRL SRC Harvester has been an ongoing process. Over time the design has shifted from being front mounted on a tractor to being mounted onto the side of a harvester. Also the size of the device has increased with the newest models able to achieve a daily yield 24 times greater than the original model.

The harvester is used across the CRL holdings and has been purchased by others harvesting SRC willow. There have been models sold to the US market as well.

Challenges

The main difficulty was that the Swedish market, where HSAB is based, was not ready for a billet fuel at the time when HSAB started developing this method in 1991. Because SRP was a new business developed in Sweden there was a tendency only to look for Swedish solutions. HSAB looked internationally and chose to work with the then leading manufacturer of cane harvesters, the Australian company Austoft Industries. However, it was difficult to get acceptance for this way of working and to apply existing technology from the tropics in a Nordic environment.

The billet harvester introduced by HSAB, the Austoft 7700, was the first which could actually harvest Salix in field conditions, running up and down the rows, harvesting stems of 100mm without breakdowns and stoppages. But the fuel type produced, billets of 10-15cm, did not fit into the Swedish Salix market where the majority of the heat or CHP plants were built for wet fuel in the form of chips from forest residues. The small scale heat plants which required a more homogenous and drier fuel were using chipped whole trunks of forest trees with which Salix could not compete. Eventually the forage harvester project for Salix copied the cutting and feeding mechanism of the billet harvester and improved their operational efficiency to the extent that they took the whole of the domestic harvesting market.

New model of billet harvester. Tågra Gård, 2014
Image: Christer Hansson

The work on developing a billet harvester for the Swedish market was consequently abandoned, but two billet harvesters for the production of 30cm billets were produced for the UK market and one is still in use by Strawsons Energy in the UK. HSAB based the Salix adaptation of the early model of the billet harvester on the Austoft technology for cane from the 1980s. Compared to the modern SPFH, the early billet harvester has a lower capacity and can produce only the 30cm type of billets.

Costs and benefits

The machine construction work has been done in the Henriksson Salix AB family business over a period of many years. The constructor is Mr Gunnar Henriksson and the project administrator is Ms Annika Henriksson. The mechanics have been developed in cooperation with Mr Mal Baker, Austoft Industries and his successors in Mobile Equipment in Queensland, Australia; and the hydraulics in cooperation with Mr Håkan Sollerhed at the Swedish company AMAB Hydraul, Malmö. The total project cost over the years has been approximately €800,000, of which the Swedish Energy Agency has provided approximately 30%.

The construction project has resulted in three earlier versions of billet harvesters. These have been commercially operating in Sweden and in the UK during the 1990s and up until today, plus one prototype of new more efficient model. As a spin off, the billet planting technology has been developed, a project in its own which will lower the establishment cost for Salix considerably.

Henriksson Salix AB has created an international network and promotes billet harvesting in all SRC growing countries, mainly via personal contacts and the website of Salixenergi Europa AB, of which company HSAB is share owner. There is significant international interest in billet harvesting and billet planting.

The Swedish Energy Agency and its predecessors have financially supported the different stages of development of the billet harvester. The work could not have been done without the support from the skilled and committed project coordinators in this agency and without the commitment of the Swedish government to develop this sector.

Lessons learnt and recommendations for future projects

National or European funding for machinery development for SRP is extremely important since machine projects for this small sector are not profitable in the short term. It is equally important that funds are available directly to small companies in this sector because the small market does not attract interest from the large machine companies.

The skills and technology needed to develop machines for SRP can be found among the existing commercial actors in agriculture and forest machinery, it does not rely on new research. Where more sophisticated techniques are required, an existing solution from another machine sector can probably be applied.

This does not mean that machinery development is simple. Developing machines that are good enough for serial production, along with international marketing and providing both technical support and a spare parts service is very expensive and requires long term work by technically skilled people.

After 25 years in the SRC field we know that the best ideas usually come from contractors working in the field with practical experience of SRC crops and general agriculture. However, these companies often have very limited resources and are usually not orientated towards serial production. Some can, with the right support, develop competitive machines and develop into specialized SRC machine manufacturers. The problem for the funding body is to find the right small scale actors and to facilitate connections. This requires technical competence and market knowledge from the agricultural and forest machine sector as well as from the end users and the funding institutions.

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CASE STUDY

Topic Harvesting

Developing a fully hydraulic head for SRC harvesting

Location

Sweden

Description of project or activity

Henriksson Salix AB (HSAB) started work in the early 2000s to construct an improved head for the Claas Jaguar forage harvester for more robust direct chipping, based on the HSAB experience from the construction of the billet harvester. The changes were related mainly to the design and drive mechanism of the saw discs, the design of the feed channel, the design and drive mechanism of the horizontal and vertical feed rollers, and simplifications and conversion to hydraulic drive, and the work predominantly consisted of rebuilding existing heads.

In a construction project during 2010 to 2013, HSAB applied their 10 years experience of rebuilding new fully hydraulic prototypes heads for Claas, Krone and John Deere forage harvesters. The goal was to set up serial production in Sweden and then to export to all SRC growing countries in Europe along with a system for the supply of spare parts and technical support. The HSAB head was approved by all three machine manufacturers for use on the respective base machine. John Deere Zweibrücken (the company's European manufacturing base) was involved in creating technical solutions, training sessions were carried out for the John Deere forage harvester team, and contacts were established with the Krone and Claas European sales organisations.

Background/objectives

Direct chipping of SRC is a very efficient method for large scale production and fits well with the Swedish market for fresh fuel. Commercial SRC production was first developed in Sweden in the mid 1980s to early 1990s and the leading commercial actor developed a salix head for the Claas self-propelled forage harvester (SPFH). At the same time, Henriksson Salix AB (HSAB) constructed the billet harvester 'Austoft 7700' in cooperation with the Australian company Austoft Industries Ltd. Both were developed in line with the concept of direct chipping, but the HSAB system was based on sugar cane technology instead of on maize or grass technology and the end product was not as finely chipped. The Austoft billet harvester was fully hydraulic and had a robust cutting and feeding system which secured continuous flow of material and high reliability, however the billets did not fit the Swedish market.

In the early 2000s HSAB constructed an improved head for a Claas SPFH. The result was a more reliable forage harvester which could handle thicker stems, more crocked stems, wider stools and weeds and other tree species which will invade the plantations after a few harvest cycles.

Successes

After 10 years of self-financing, in the year 2010 HSAB got in contact with the main funding body, the Swedish Energy Agency, and got financial support to develop professional prototypes of the HSAB fully hydraulic head for SPFH. Thanks to this financial support the HSAB head for Claas, Krone and John Deere self-propelled forage harvesters could in a few years be developed for serial production and for an international market.

The SRC sector is small and HSAB has been part of this international network since the early work on the billet harvester in 1991. The European network was enlarged when the company Salixenergi Europa AB, partly owned by HSAB, built a network of about 30 salix cutting producers and distributors across 16 countries.

As a result of the growing interest for SRC in the EU, the agricultural contractors in forage harvesting started approaching the big manufacturers of self-propelled forage harvesters in connection with SRC applications. At this stage the HSAB head was the latest development in direct chipping and it was approved by the three companies Claas, Krone and John Deere. HSAB reached international recognition in the SRC sector.

HSAB is market leader in harvesting SRC by direct chipping - including the billet harvester - which has been the goal from the start of the business in the early 1990s.

Challenges

SRC production is a very small industry at present but it was even smaller when HSAB started working in the sector in 1991, confined to Sweden and dominated by a few large actors. It was very difficult at this time for an outsider to get market access.

It was clear from the beginning that although HSAB had innovative technical solutions which could be easily copied, patenting was not an option since it is quite difficult for a small enterprise to protect a patent. The only way for the company to maintain its advantage was to be constantly at the forefront of innovation. It was

HSAB fully hydraulic head for John Deere self-propelled forage harvester. Image: Nick Parfitt

also clear that even if Sweden was leading the development of SRC, the Swedish market was not going to sustain specialized SRC machinery development. It was necessary to acquire international recognition and produce for the European market.

The construction of the HSAB head was privately financed for the first 10 years, which was particularly difficult during the years of the financial crisis in the early 1990s when the interest rates for machinery financing exceeded 20% for a period.

Costs and benefits

The initial construction work of the head, during the period from 2000 to 2010 was privately financed. During this period three heads were built and sold, which meant that most of the work input was unpaid. During 2010 to 2013 the HSAB project budget to develop prototypes for Claas, Krone and John Deere was approximately €530 000, out of which approximately 50% was support from the Swedish Government via The Swedish Energy Agency.

The project resulted in a total of 8 new heads sold in Sweden, Denmark, Poland and Germany during the period 2010-2014. At present, with the decline of the Swedish market, the international demand in Latvia, Lithuania, the Ukraine, the Czech Republic and the UK can largely be met by export of used HSAB heads from Sweden. But even at present there is one head under construction all the time in the workshop in Sweden which equates to approximately 1 person working full time throughout the year with manufacturing, sales and technical support.

The main benefit however is that there is a technically reliable solution for direct chipping which can applied to all the makes of self-propelled forage harvesters on the European market. The SRC market benefits from this general step forward in the HSAB cutting and feeding technology.

Lessons learnt and recommendations for future projects

Constructing machines for export and developing a reliable and convincing sales and support organization for a market as small as SRC with such limited resources, requires enormous commitment over many years by people who are active in the sector. National or European funding for machinery development for SRC must be available for small and medium size enterprises, for example SRC contractors, since this is the type of actor who will move forward the technical development until the SRC sector has grown significantly.

Since a self-propelled forage harvester is a very sophisticated and valuable machine to which a head specifically constructed for SRC harvesting must be fitted, this requires the acceptance and the approval of the manufacturer of the base machine. This is important primarily for the seller's guarantee for the base machine to be valid, and secondly and in the best case, for the manufacturer of the base machine to recommend this particular application to those of their customers who are interested in going into SRC contracting.

It is a long and difficult process for a small enterprise to convince a world-renowned machine manufacturer that not only will the SME-developed machine do a good job but that the small enterprise will actually be able to provide the technical support and the spare parts service required on an international scale. The SME manufacturer must also convince the big manufacturer of its ability to provide training for their sales and service personnel around Europe.

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CASE STUDY

Topic District heating; Business models

Successful use of SRP as a fuel by long lasting three-party collaboration

Location

Sweden

Description of project or activity

A long term three-party relationship over more than 20 years has been established between the local willow harvest contractor Salixenergi Europa AB, the willow growers and different operators of small-medium scale (5-10 MW) district heating plants in Skåne.

The contractor holds contracts with the heat plants to plan and perform the harvest as well as transport and sell the Salix biomass. The payment to the growers is individual and based on net energy delivered in MWh, price per MWh, transport and harvest cost and a sales margin. There are no contracts between the growers and the contractor as the business relies on mutual benefits.

Around 100 hectares is harvested and sold per year, this has been stable for about 20 years.

Background/objectives

When Salix was established as a commercial crop in south Sweden in the early 1990s one company dominated the market across the whole country and took care of all aspects of the production from planting to the sale of the biomass. The Salix was marketed and sold mainly to large energy plants, which was considered to be an efficient strategy for a centralized organization. However, in Skåne there are not many large heat plants and when the only customer was shut down there was suddenly no market for the Salix biomass. This gap in the sales organization could have been filled by a grower' s organization if there had been more active growers who were prepared to take on the work. Instead, one of the growers, a family enterprise called Henriksson Salix which was also the local Salix contractor, developed an alternative sales organization focusing on the smaller heat plants, 5-10 MW. This organization was based on personal contacts with growers and other actors in the Salix business and gradually took over the market. In 2010 Henriksson Salix joined two other small Salix enterprises in the region and started the company Salixenergi Europa AB and acquired the Salix business from Lantmännen.

Successes

The contractor knows the requirements of the end users and plans the harvest time and fuel quality to fit the needs of the different customers. The contractor also knows the location and quality of the fields/willow crops and can plan the harvest to minimize the transport distance.

The sale and delivery of Salix is negotiated and agreed each fuel season but is subject to changing conditions during the season. The sale depends more on the goodwill on both sides than on formal contracts.

Since Salix normally makes up less than 10% of the fuel mix in the heating plants, delivery and quality problems can be solved through mutual agreement. This flexibility lowers the risk and allows the fuel broker to keep a higher price for the SRC growers. The contractor is the stable and reliable link between the salix growers and the heat market.

The growers have confidence that their product will be harvested and sold at the best possible time and price and the end users know that the contractor can deliver according to the agreed delivery plan and will deliver fuel of the agreed quality.

Over the years this model has been proven to be successful and is the reason why in the Skåne region there is up to now no initiative to organize growers organizations and very few growers are selling their willow fuel themselves. The mutual trust allows the contractor to test new products, for example the recently developed short billets (10cm). The end user is prepared to try a truck load of a new product because they know that the contractor/fuel broker has a good knowledge around what is technically possible and will not deliver a product that is likely to cause major problems in the boiler.

Intermediate storage of salix chips on concrete slate. Image: Rune Källén

Challenges

One of the most critical factors in this business is that the heat plant operator is prepared to do the extra work to adjust the boiler to fit in the relatively small quantity of salix. In addition, Salix has a higher content of potassium than forest tree biomass resulting in more fly ash and a need for more frequent sweeping of the boiler. This is a disadvantage with Salix and has to be tackled seriously otherwise the fuel will get a bad reputation.

The challenge for the seller of Salix biomass is to maintain such high performance towards that it compensates for its disadvantages compared to other fuels (e.g. to traditional forest biomass which is the bulk fuel in Sweden).

It is a big challenge to balance the harvesting with the market requirement between years and during the fuel season. This requires harvesting experience and knowledge of local conditions.

Salix delivered directly from the field to the heat plant. Photo: Rune Källén

Costs and benefits

The harvesting and sale of Salix biomass in Skåne has a total turnover of about €200,000 to €300,000 per year and employs three people part time for organization and harvesting work, not including the transporting which is done by the regular biomass transporters.

Lessons learnt and recommendations for future projects

The small biomass trader must be aware that in situations where there is a surplus of biomass the buyer can stop deliveries in spite of contracts because a small biomass trader relies on maintaining good relationships for the coming seasons. The biomass trader must plan the harvesting so as not to produce surplus biomass, in order to minimize the risk of not being able to sell everything that has been harvested. Ending up with surplus biomass at the end of the fuel season is the worst case scenario as the biomass will deteriorate over the summer and the value of the fuel will be lost. This can hit a small company very badly and the Salix business as a whole is then at risk of achieving a bad reputation.

Good working relationships with the heat plant and flexibility on both sides are the most important factors for small scale biomass trading. Personal contact with the person who is in charge of the fuel intake and fuel mix at the heat plant is equally as important as contacts with the purchase office. It helps to develop a positive attitude to the new fuel and the fuel trader can learn about the requirements of the plant and can adjust the relevant processes accordingly.

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CASE STUDY

Topic Planting and establishment; Business models

Establishment of large scale willow plantations in Lithuania and Latvia

Location

Lithuania and Latvia

Description of project or activity

Salixenergi Europa AB offers establishment of SRC willow plantations as a service in both Lithuania and Latvia. The offer includes advice on soil preparation, supply of cuttings and planting contractors, on-site organization of planting, as well as advice on weed control, fertilization, harvesting technique and logistics. Training in fuel handling and how willow chips fit into the biomass fuel mix is also offered to the project owners, in cooperation with Swedish experts on incineration and district heating.

Background/objectives

Much of the agriculture production and the associated infrastructure in the Baltic States collapsed after the fall of the Soviet Union. This occurred particularly in Latvia, where hundreds of thousands of hectares of land is currently unused and has been gradually invaded by bushes. There is a strong political drive to get the agricultural land back into production and maintain soil fertility, and to stop the ongoing afforestation. There is also a strong political aim to replace gas for local energy supply and large land owners have started to look at SRC willow as suitable land use on marginal land, especially in Lithuania where a planting grant is also available.

Salix started in Latvia and Lithuania at research-scale in 2008. Currently about 2000 - 3000ha has been established in total within the two countries, largely by specialized Salix growers. Interest has grown since harvesters have become available from Sweden and to a smaller extent through investments locally.

Successes

Salixenergi Europa AB has the experience and machinery to establish large growing areas and the network to put together planting teams from several

Large scale planting project in Lithuania, 2013. Image: Ulf Andersson

Long rods in the field. Image: Ulf Andersson

countries that are so far using a conventional planting technique. In one project about 1000ha was established between 2013 and 2014, and the project is ongoing.

Challenges

The challenge lies mainly in convincing the company that owns the plantations about the necessity of good soil preparation, largely because the SEP companies do not have farming experience and do not have their own agricultural staff and equipment, but instead rely on local contractors. The companies focus very much on saving money on planting materials and planting but do not always realize that inadequate soil preparation means that the whole investment is wasted and valuable time is lost. The rush to plant the land as soon as possible in order to shorten the pay-back time means that the planning process becomes too short and important field preparation is excluded.

Costs and benefits

A planting team consisting of two expert project leaders, local tractor drivers to deliver cuttings to the fields, and five planting teams using conventional planting methods (long rods planted with Step or Egedal machines) can plant about 500ha in three weeks if the weather is stable. The cost is about €1300 per ha including consultancy services for evaluating the fields, soil preparation, organizing the planting, recommended spraying on site and final evaluation after emergence.

Lessons learnt and recommendations for future projects

There is the potential to produce Salix at a larger scale on presently unused agricultural land of medium quality near the existing and new heat or CHP plants. Salix is a profitable land management solution.

Lack of knowledge on agriculture is a big problem in the establishment phase. There is also a lack of knowledge about harvesting logistics, fuel quality, end user requirements and the specific traits of SRP fuel. With billet planting, the cost of large plantations can be significantly reduced.

New billet planting technicque that significantly reduces the cost of establisment in large fields. Planting at Jordberga, Sweden, 2012. Image: Gunnar Henriksson

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SEVENTH FRAMEWORK PROGRAMME

CASE STUDY

Topic Additional areas of application of SRPs

Using Salix to encourage biodiversity in Sweden

Location

Enköping and Vingåker, Sweden

Description of project or activity

If well situated, a salix plantation can offer a new element in a landscape and help contribute to biodiversity by providing shelter for wildlife and birds. On Tillinge-Lundby manor, Enköping there are about 90 hectares of willow cultivation in a landscape consisting of alternating field and forest. The cultivations are connected mostly to the adjacent cropland but there are also some smaller forest parcels allowing the willow cultivation to insert well into the landscape and contribute to biodiversity, leading to richer flora and fauna.

In Vingåker on Kjellsäters farm, there is a willow cultivation that blends well into the landscape. The cultivation of 12 hectares was planted in 2007 using the clones Tora and Gudrun. It is located on a large field and it is located beside a road and parallel to a railroad, with the railway embankment shielding the cultivation from the road's view. In other parts, the cultivation connects to a wildlife field and a forest plot. The field's shape and long continuous lines make for easier management and harvesting. Grain was formerly cultivated in the field, but because of the low yield, willow was planted, partly with the aim of improving hunting opportunities.

Background/objectives

At Tillinge and Kjellsäter farms, willow has been planted for energy production and with the hope of improving conditions for wildlife.

Short rotation plantations often contribute to increased biological diversity if they are small and established on homogeneous agricultural land where cereal crops previously grew. Essentially, the energy forests act as protection for the wildlife. If the SRP is cultivated near or adjacent to woodland, animals and plants can easily spread into the SRP cultivation and thereby contribute

Salix plantation connected to a forest plot

Salix plantation alongside a railway

to increased biodiversity. Willow can grow to 7-9m high and poplars and hybrid aspen trees to 20-25m high before they are harvested. This means that cultivations of SRP have a greater impact on landscape than traditional crops and therefore require more careful planning.

Challenges

The challenge is to find a balance between sensible, profitable cultivation and increased biological diversity and variety in the landscape

Costs and benefits

As with conventional crops, the production of SRP must be profitable. It is therefore important that the cultivation returns a high yield, and that it is planted on good soil, weed controlled and fertilized as needed. Conflicts may exist. In some respects there may be a conflict between trying to make a profit and trying to promote biodiversity. For example, harvesting less frequently can help to stimulate biological diversity and variety in the landscape, but it also generally means increased cost of harvesting.

It is therefore up to individual growers to do their own valuation and to find a balance between net income and the other positive characteristics of the cultivation. The value of increased wildlife and better hunting is likely to vary between growers.

Lessons learnt and recommendations for future projects

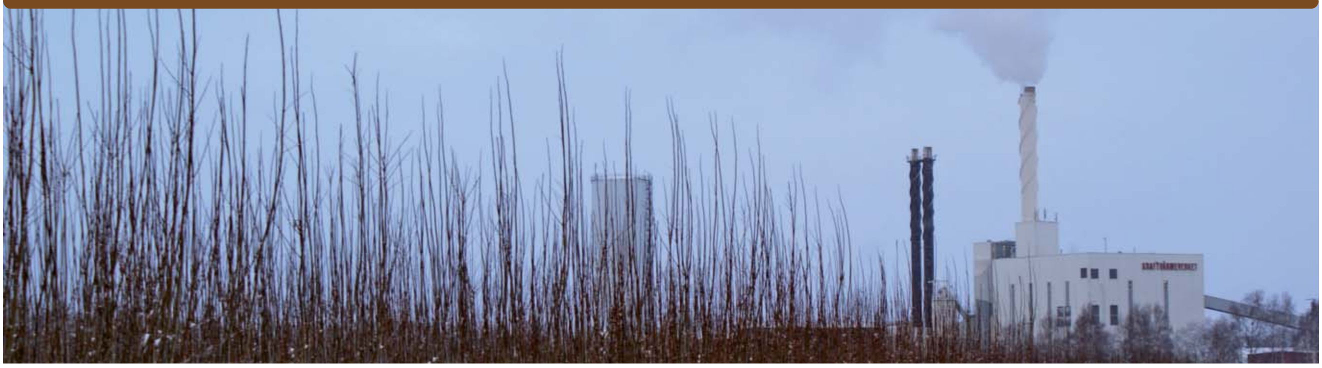
An energy plantation should be planned based on the landscape characteristics.

Energy forests can be a positive connecting link in the landscape. In the right places, SRPs become a new element in the landscape that contribute to biodiversity by providing shelter for wildlife and birds.

Contact details and/or further information

SRP-Location, consultation and investment (Swedish) | download from www.jti.se or www.bioenergiportalen.se

Developed by Swedish University of Agricultural sciences (Nils-Erik Nordh), JTI - Swedish Institute for Agricultural and Environmental Engineering (Carina Gunnarsson), SP Technical Research Institute (Susanne Paulrud)



Fuelling dialogue between biomass research, industry, policy & business
www.rokwood.eu

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CASE STUDY

Topic Additional areas of application of SRPs

Using willow for wastewater treatment at Fernhill Farm

Location

Compton Martin, Somerset, UK

Description of project or activity

Fernhill Farm uses a Wetland Ecosystem Treatment (WET) system to treat its wastewater. This system uses soil banks and the wetland ecosystem to purify water with little energy consumption. Willow suitable for short rotation coppicing forms a key part of this system.

The willow and micro-organisms have a symbiotic relationship which is used to purify the water. The microbes convert the organic matter in the wastewater to nutrients that can be used by the willow for growth. The plants in turn provide oxygen, sugars and a habitat for the microbes.

The regular coppicing of the willow increases the systems effectiveness. This is because the growth rate of the willow is greater as a result of the coppicing. Thus, more wastewater can be purified and more biomass produced. As the system matures, its capacity increases as the growing plants create more soil and the root zone expands.

Background/objectives

The farm aims to become self sufficient and is based on permaculture philosophy. The WET system helps in this regard as it means that water treatment is handled on-site whilst also producing a useful fuel which is used for heating.

The general aims of all WET systems are:
- To purify wastewater with minimal energy cost
- The creation of a diverse wetland ecosystem and habitat
- The generation of a biomass resource


Wetland ecosystem used to purify wastewater

Successes

The WET system has exceeded the expectations of the farm's owners. The system cleans the water and gives off no unpleasant odours. The system has now matured into a bio-diverse environmental zone which provides a habitat for a wide variety of wildlife. Another easily overlooked benefit is the WET system becoming a valued recreational space.

Challenges

The location of the farm in the Mendip area of natural beauty AONB and in a sensitive aquifer area feeding Bristol's reservoirs posed a challenge. By working with the Environment Agency, plans were drawn up for a self contained system. This necessitated the use of a Geosynthetic Clay Liner and a leak detection system.

Willow crop grown as a biomass resource

Costs and benefits

The total cost of the works was in the region of £70,000. The main costs were the pumps necessary to transport dirty water into the system, the civil works creating the necessary trenches and banks, and planting the area.

Before the system was installed the monthly cost of having waste water removed by a contractor was around £1,000 a month. Using these figures the project has a payback time of less than six years.

The expected lifetime of the WET system is at least 40 years and so should have a lifetime return on investment of more than 700%.

Lessons learnt and recommendations for future projects

Overall the installation of the WET system was a great success and is viewed as having been a good investment by the farm's owners. However, if the project was to be repeated the following changes would be made:

- The trenches would be dug to a deeper level, this would have had the duel benefit of providing more water storage but also would have yielded stone during the excavation process which could have been put to use in other projects.
- More possible uses for the water would have been investigated this would include looking into the possibility of adding filters to make the water potable.

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CASE STUDY

Topic Technology development specific to the growth and harvesting of SRC

Strawson's Energy and Koolfuel

Location

East Drayton, Nottinghamshire, UK

Description of project or activity

Koolfuel is a range of woodfuel specifications produced from SRC willow harvested as 20cm billets. These are reprocessed using a facility permanently housed on the back of a large lorry which can be moved around at will. The products range from a high quality chip through to a granule. The smallest form of granule is used in co-firing with coal whilst larger forms are suitable for woodfuel boilers. The processing vehicle can convert 22 oven dry tonnes of billets into Koolfuel per day and costs around £40 per tonne. A Koolfuel processor could be purchased for around £275,000-£300,000.

A Koolfuel processor : yours for around £275,000-£300,000

Background/objectives

Mr Strawson was one of the first UK farmers to begin growing SRC as a commercial crop in 1999-2000. At this time wheat prices were low (around 65£/t) and SRC provided a more profitable crop option for his land. The intention was to supply the ARBRE project (a 10 MW biomass gasification power plant) in Selby. Unfortunately, the power plant went to liquidation in 2002.

He co-formed the Renewable Energy Growers (REGRO) producer group (see case study 35) to try and develop markets for the SRC produced by 40 local growers.

He was tasked with investigating the various options they had for harvesting their crops and embarked on a Nuffield farming scholarship in 2003 to learn lessons from Sweden and other European countries where the biomass industry was more highly developed. Based on this REGRO members imported an Austoft sugar cane harvester from Australia that produces longer pieces of stem called billets. Billets retain the bark on the stem pieces and therefore are much easier to store outside. Within three months a billet is below 30% moisture.

Successes

Mr Strawson is the UKs largest grower of SRC willow with 400 hectares. This is 15% of his total holding and the land used is good quality arable as the aim is to produce high yields and good quality willow biomass.

By adhering to best practice the farm has been able to achieve very satisfactory yields of around 10-12 oven dry tonnes per hectare per year.

Since 2010 Strawsons Energy has sold the majority of its SRC to DRAX power station. There is no need to process or transport the fuel anymore since these steps are performed by DRAX. The Koolfuel processor is only used to produce premium quality fuel for local boilers.

Koolfuel wood chip has a lower moisture content than standard wood chip with an calorific value of 4,000 kWh/tonne as opposed to standard woodchip which is approx. 3,000 kWh/tonne at 35% MC. Koolfuel wood chip reaches the stringent European standard EN14961-4. As the chips are produced using a granulator rather than a standard chipper, no long pieces that may block up a boiler are produced.

Challenges

Following the demise of ARBRE the only potential large scale market was co-firing in local coal fired power stations. Mr Strawson approached EDF Energy who own Cottam power station situated just 4 miles away from the farm. The latter require biomass to be a uniform, flowable product less than 10mm in diameter. To convince them of the potential to blend SRC with coal he had to do "in-house" processing of the fuel.

There is not a chipping machine on the market that could produce this requirement from a billet and indeed during an eight month period he trialled machinery from all over the world with the same results - a useless feathery product. He explored other options and eventually linked up with a British manufacturing company to develop a hammer mill that could do the job.

The results have been exceptional with the processing machine capable of producing six grades of uniform woodfuel without stringy bits. Strawson has christened the product KOOLFUEL™.

The smallest form of granule called Koolfuel 6 is used in co-firing operations at coal power plants whilst larger forms Koolfuel 10, Koolfuel 15 and Koolfuel 25 are suitable for woodfuel boilers.

The harvesting step is also core in their process. There are very few harvesting actors on the market so they have had to develop their own harvesting technique.

Costs and benefits

Since 2010 Mr Srawson has been selling SRC direct to Drax power station (95%) and into local markets (5%).

15% of farm income is derived from SRC. The profit from the crop is £17/odt (net of transport). DRAX pay approximately £70 oven dry tonne (ex farm price, net of transport).

Local heat users include the farm's offices and conference centre (called the Centre of Renewable Energy or CORE) as well as a local school.

The main competitive advantage of Koolfuel 30 is the quality compared with woodchip from other suppliers. It is a very dry fuel that "never clinkers", according to Mr Strawson.

There are two employees who are entirely dedicated to SRC out of a workforce of over 30 people.

Lessons learnt and recommendations for future projects

Initially the company planted SRC on a 16 year horizon, with 5 harvests. At the current time Mr Strawson is considering removing SRC to go back to wheat.

Major reasons:

- Regulation risk under which SRC could be considered as permanent
- The longer SRC is grown the harder it gets to go back to wheat, because roots get bigger
- Too much uncertainty as to whether it pays more than wheat
- The Energy Crops Scheme (2) has killed any incentive for new farmers to grow SRC

Mr Strawson is also not convinced by the fact that selling to heat users is the solution for uptake for the following reasons:

- Small market
- The prices calculated (around 180£/ha) are based on vertical integration
- Selling is made within a competitive environment against international wood chip.

Regulation risk:

- That the EU that will proceed the crops as permanent in the new 2015 policy scheme, whereas before they could be considered as arable land.
- Nitrate Variable Zone (NVZ) regulation has decreased allowances for use of fertilizers, which drives the yields down

Market risk: Before DRAX received 2 ROCs/MWh produced from local bioenergy crops, but under new regulation, it has changed to 1ROC/MWh. So this has decreased the price that DRAX pays to local bioenergy crops since these ones have less interest in relation to other international wood fuel.

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CASE STUDY

Topic Business models; Policy support

Regro: representing the interests of farmers growing energy crops

Location

Eagle Farm, Yokefleet, Goole, Yorkshire, UK

Description of project or activity

Renewable Energy Growers Ltd is a not-for-profit organisation representing farmers growing energy crops. They represent the majority of farmers growing Short Rotation Coppice (SRC) in the UK and are the country's largest and most experienced producer of SRC wood fuel. They offer a comprehensive service to growers, looking after the whole growing process from planting to harvesting.

Background/objectives

ReGro covers growers in Yorkshire and the East Midlands and was initially formed by a group of 36 farmers to supply the Arbre bioenergy plant.

Funds from the Rural Development Fund were used to set up a group and buy planting, harvesting and processing equipment.

Gareth Gaunt with his Talbott boiler

Successes

ReGro is the UK’s largest SRC producer group with 40 members and a combined area of 650 hectares. The annual production of biomass by ReGro’s growers is between 7,000-10,000 ODT (oven dry tonnes). They are now an established provider of bio fuel to three different power stations; Drax, Cottam and Wilton 10.

Pile of graded woodchip (main image) with detail (inset left) and mulch (inset right)

Regro's portable woodchip grading facility

Challenges

There has been some difficultly in attracting and retaining members due to an increase in wheat prices. Wheat competes with willow for growing area and better prices make it a more attractive alternative.

A limited budget means that their harvester, which was destroyed by a recent fire, has not been replaced and that ReGro no longer has any permanent staff. This has led to complications with providing biomass to the specifications set by Drax.

Costs and benefits

Initial start-up costs were minimal and there was little risk to growers due to the provision of an establishment grant. In addition to this Arbre paid every year, even in the years without a harvest. Drax pays £60 per ODT, but their contacts are flexible to avoid risk to the growers.

Lessons learnt and recommendations for future projects

There could be benefit in providing a complete service of boiler, supply and maintenance. This would ensure that boiler specification meets the wood chip that is available. This could help ReGro break into the more lucrative smaller markets that they cannot currently access.

Contact details and/or further information

www.energycrop.co.uk

rok wood

Fuelling dialogue between biomass research, industry, policy & business
www.rokwood.eu

This project is supported by the European Commission under call FP7-REGIONS-2012-2013-1 “Regions of Knowledge” of the 7th Framework Programme for Research and Technological Development.

SEVENTH FRAMEWORK PROGRAMME

CASE STUDY

Topic New cultivars

UK bred SRC willow varieties

Location

Markington, Harrogate, North Yorkshire, UK

Description of project or activity

Murray Carter is a farming entrepreneur based in North Yorkshire in England with over 30 years' experience of growing SRC and breeding, testing and marketing improved willow varieties. Mr Carter was the driving force behind and one of the three sponsors of the European Willow Breeding Partnership (EWBP) based at the former Long Ashton Research Station (LARS). He currently owns the rights to multiply and sell all of the elite willow varieties produced from this venture.

Background/objectives

The EWBP ran from 1996 – 2003 and was formed from a partnership between Mr Carter, LARS and the Swedish company Svalöf-Weibull AB. The crossing programme element of the project ceased with the closure of LARS in 2003. During the 7 years of the programme 923 crosses were completed, 45,000 seedlings screened and 3,383 genotypes evaluated in observation trials. The breeder at Long Ashton was Kevin Lindegaard (who now runs Crops for Energy Ltd – an SME partner in the Rokwood consortium).

The breeding programme benefited from the germplasm resource held at the National Willow Collection at LARS. As a result it was possible to make very wide crosses utilising diverse genetic material. During the breeding programme 24 different species were used.

Willow breeding trials at Ingerthorpe

The breeding programme was designed to select new varieties on the basis of:

- High yield
- Good form (straightness and reduced side branching)
- Resistance to disease and pests

Successes

So far 11 varieties have been registered with the Community Plant Variety Office (CPVO). Currently 8 varieties are available to buy.

Year of release:

2001
Beagle: S. viminalis Astrid x S. viminalis

2002
Resolution: (S.viminalis x (S. schwerinii x viminalis)) x (S. schwerinii x S. viminalis) x (S. schwerinii x S. viminalis))
Quest

2005
Endeavour: S. schwerinii Hilliers x S. viminalis Jorr
Terra Nova: (S. viminalis x triandra) x S. miyabeana
Shrubby willow

2014
Advance: Salix viminalis Pavainen x (S. schwerinii x viminalis) Bjorn
Meteor: S. viminalis Bowles Hybrid x S. viminalis

2015
Endurance: S. redheriana x S. dasyclados

2016
Paramore: S. redheriana x S. dasyclados

Several of the varieties produced have shown excellent results. The yield of the variety Endurance has been measured on 20 occasions in UK and Irish trials. It has led the rankings 8 times and was second twice. It has the highest mean yield for performance in the second rotation with 14.3 oven dry tonnes per hectare per year. Along with Endeavour, it exhibits excellent woodfuel characteristics (low moisture content at harvest, higher bulk density and higher calorific value) compared to other varieties. Terra Nova produces modest yields but has shown encouraging results on exposed sites and is more tolerant of soil contaminated with heavy metals. Importantly it adds to crop diversity and reducing disease risk. It is also tolerant of shading when planted next to taller varieties. Resolution has also performed well in yield trials, topping the rankings on nine occasions from 26 data sets. Both Resolution and Endurance have also performed well in drier soils in eastern England.

Many of the SRC willow varieties produced from other breeding programmes are from a similar genetic background based on crosses involving the elite Swedish bred varieties Tora and Bjorn. In the UK and Ireland SRC is grown in mixed plantations of 5 to 8 varieties in order to combat pests and diseases. The EWBP recognized the genetic similarity of the available varieties as a big risk and from 1998 these parents and related breeding lines were largely excluded from the crossing programme. From this point onwards, the attention was based on a wide range of very diverse species originating from Asia and North America and crossing these together and with species from Europe. The programme included many crosses involving the following species: S. redheriana, S. glaucophylloides, S. caprea, S. miyabeana, S. discolor, S. koriyanagi, S. hookeriana, S. aegyptiaca, S. eriocephala, S. triandra and S. rossica.

Challenges

The closure of LARS in 2003 led to the break-up of the partnership. Since then Mr Carter has continued testing and multiplication. Unfortunately, the market for SRC planting in UK and Ireland has not increased significantly in recent years and this has hindered the commercialisation of new varieties from the breeding programme. So far, the varieties that have been released were produced from the first 3 years of the breeding programme (1996-98). There were many crosses made after this time but without definite market progression it is harder to justify the substantial costs involved in multiplication, testing and registration of new varieties with the CPVO. As a result there are 1,800 breeding lines in a collection at Mr Carter's farm in Yorkshire undergoing further evaluation and in some cases multiplication for future commercialisation.

On occasions, some genotypes have gone all the way through the breeding programme only to fail during the final testing stage. At this point genotypes are grown in large scale monoclonal plots at close spacings to intensify pest and disease pressure. Genotypes that fail at this stage add substantial expense to the programme.

Costs and benefits

Breeding these new SRC willow varieties has been a long and expensive process. By the time it is commercialised a variety will have been involved in a minimum of 8 trial plots in different locations. It is estimated that the cost of breeding, selection, multiplication and registration of a well-tested variety is in the region of around £150,000. Just to pay back this investment, 500 hectares (7.5 million cuttings) of each variety would need to be sold.

Lessons learnt and recommendations for future projects

The project has achieved excellent results with several new varieties with high yield, disease resistance and good woodfuel qualities. However, the lack of recent initiatives and grants to encourage planting has significantly affected sales in the UK and Ireland. As yet, there has been very little planting of these varieties in other European countries. It is likely that there is much greater scope for developing businesses opportunities elsewhere – particularly in Eastern Europe.

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You can find out more about these and other willow varieties in the Willow Variety Guide produced by Teagasc (the Agricultural & Food Development Authority of Ireland) | Website: bit.ly/16h9pu3

You can find out details of all varieties that have been registered for plant breeders' rights with the CPVO by doing a search for Botanical Taxon: Salix L. on the CPVO extranet | Website: bit.ly/1GbqzZu

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CASE STUDY

Topic Additional areas of application of SRPs

Small scale municipal wastewater treatment using SRC

Location

Drumkee, Co Tyrone, Northern Ireland

Description of project or activity

The treatment of wastewater in modern wastewater treatment works (WWTWs) is highly effective and produces an effluent which is non-damaging when discharged into waterways. However, WWTWs are very expensive both to build and run, and involve extremely energy intensive processes. These are sometimes not cost effective for dealing with the low volumes of wastewater produced by small rural communities. As there are hundreds of small rural settlements across Northern Ireland and Ireland it is essential to develop economical, environmentally friendly and sustainable alternatives.

The ANSWER (Agricultural Need for Sustainable Willow Effluent Recycling) Project ran from 2010 to 2014. The primary objective was to further evaluate and demonstrate the use of Short Rotation Coppice (SRC) willow for the bioremediation of a range of effluents including municipal wastewater, landfill leachates and industrial effluents.

ANSWER was part-financed by the European Union's European Regional Development Fund through the INTERREG IVA Cross-border Programme managed by the Special EU Programmes Body.

There were seven partners: Agri-Food & Biosciences Institute (AFBI) (lead partner), South West College, Northern Ireland Water, ITSligo, Teagasc, Monaghan County Council and Donegal County Council.

Pipework laid out within the double rows of willow

Background/objectives

Northern Ireland Water (NIW) are the sole provider of water and sewerage services in Northern Ireland, with over 780,000 domestic, agricultural, commercial and business customers. NIW is dedicated to providing the community it serves with water and wastewater services which meet regulatory requirements at the lowest sustainable cost.

From 2015 onwards, new water quality legislation will be introduced through the EU's Water Frameworks Directive. This will directly impact on NIW and as a result they are looking to adopt innovative techniques to deliver compliance, whilst reducing costs and environmental impact. The Drumkee project started in August 2013 and involves a twenty year contract with a local company to use SRC willow to clean wastewater from a small rural treatment works.

Raw wastewater from the local settlement (22 person equivalents) is initially screened and settled in a retention chamber/septic tank. It is then filtered through a gravel filter, after which it enters a pump sump. The effluent is then pumped through filters, along two mainline feed pipes to a one hectare SRC willow plantation. The effluent is distributed evenly across the plantation using a series of irrigation pipes. A rain gauge measures rainfall events and automatically prevents irrigation taking place should soil moisture levels get too high. When such conditions persist, effluent is discharged to the river. This has been agreed by the Northern Ireland Environment Agency (NIEA) under a 'Variable Discharge Agreement'. Soil temperature probes are used to ensure that irrigation does not take place when the soil is frozen or snow has fallen. Automatic data recording of the volume of effluent irrigated per day, soil temperature and rain fall is also active. This data is supplied to the NIEA and NIW on a monthly basis by uploading to an online web-based application via GPRS link. There is also ongoing analysis of boreholes and the stream for ground and surface water quality.

Successes

The turnkey planting and installation of the pipework was done by Resourceful Organics Ltd, who have twenty years' experience in all aspects of SRC production and use. The crop establishment was good and the pipework was laid out properly within the double rows (see image). It is simpler to lay pipes between the double rows but this leaves them vulnerable to damage from machinery tyres and the harvest head. As a result of the care and attention taken by the contractor, there was no need of remedial work after the harvest.

The hydraulic and nutrient loading on the system at present is estimated to be between 1,900 to 4,000m^3 of effluent per hectare per year. This supplies between 87 and 180kg nitrogen/ha/year and between 6kg and 14kg phosphorous/ha/year – both of which are well within the sustainable level of nutrient uptake of the SRC willow.

The project established a landmark change to NIW's regulations. This is termed 'variable consenting' and allows the discharge from a treatment system to be synchronised with the current environmental conditions. Discharges to waterways are far more diluted during times of heavier flow (principally rainfall), when application to land is least environmentally preferable. When stream flow is low due to low rainfall, application to SRC willow is far more environmentally sound than discharge into a low-flow/low-volume receiving water body. The Drumkee Project has proven this concept. If the carbon sequestration by the crop and its ultimate substitution of fossil fuel is taken into consideration, this is a very strong carbon negative solution for waste water treatment. This solution is now being replicated on another 15ha site by NIW and has application potential in many situations across the island of Ireland and beyond.

Challenges

This technology is also well developed in Sweden but to give reassurance the data and experiences are being gathered from this site and others to further refine, develop and commercialise the technology.

Stagnant effluent

SRC field after harvest - irrigation points are visible

As such the monitoring and regulation can be quite onerous. Hopefully this will change as the technology becomes increasingly accepted.

Costs and benefits

The benefits to NIW are the massive reduction (90%) in the yearly outfall of pollution from the treatment works and the reuse of the nutrient as a fertiliser for an agriculture crop (willow). A willow plantation has an estimated life of approximately 25 years and this scheme has a very beneficial improvement over the upgrading of the treatment works in terms of reduced carbon footprint, introduction of environmental sustainability, cost efficiency of treating the effluent and reduction in capital expenditure. The turnkey costs for the establishment of the SRC plantation and the installation of all the pipework was £20,000. The major component of this was the civil engineering involved. Over 15 years, this project is estimated to save NIW 50% in cost and 1500% in CO_2 emissions. These economics can be improved greatly with increased scale.

Community, waste water treatment and irrigation setup

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You can find out more information about the ANSWER project and further case studies in these reports:
www.afbini.gov.uk/answer_current_knowledge-_web.pdf
www.afbini.gov.uk/answer_project_report-web.pdf

rokwood

Fuelling dialogue between biomass research, industry, policy & business
www.rokwood.eu

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SEVENTH FRAMEWORK PROGRAMME

CASE STUDY

Topic District heating; self-supply; fuel processing and quality

Self supply of SRC woodfuel at Berkshire College of Agriculture

Location

Maidenhead, West Berkshire, UK

Description of project or activity

Berkshire College of Agriculture (BCA) was founded in 1949 and has an estate of around 160 hectares of farmland. The remit of the college has expanded enormously in recent years with courses on child care, construction, floristry and sports science. There are currently around 1500 full-time and part-time students.

The campus consists of numerous buildings including teaching facilities, residential accommodation, a sports centre and restaurants. These buildings are heated by two biomass boilers via a district heating scheme. The majority of the fuel used is produced from 18 hectares of short rotation coppice (SRC) grown on the estate.

Background/objectives

The BCA biomass project began in October 2009 with the installation of a Froling Turbomat 220 kilowatt (kW) boiler. A second Froling Turbomat 320 kW was installed in January 2014. Both installations were carried out by Econergy Ltd, a very experienced installer with a 15 year track record. These installations now provide heating and hot water to all the buildings at the southern end of the campus. Both systems are backed up with oil boilers in case of breakdowns.

BCA planted two fields with SRC. A 13 hectare plot on former arable land in 2009 and a five hectare plot on former grassland in 2010. This was supported with a 50% planting Energy Crops Scheme grant distributed by Natural England. Both plots were planted by Coppice Resources.

Successes

Each of the plantations has now had two harvests and the college is 80% self-sufficient in their fuel needs. The system is working well, although getting the SRC fuel in a state that was suitable for the boiler initially posed a steep learning curve (see below).

Now that the college is familiar with the fuel they prefer it to conventional woodchip. The Facilities Manager Tom Woods states that the college has had more issues with auger blockages from bought in chip than their own SRC. He said that “We have been promised that the fuel

Berkshire College of Agriculture. Image: Econergy

is good and to the right specification, but you might end up with what the supplier has that day. With the SRC, there is always a BCA staff member on hand to supervise the harvest. After each trailer is unloaded we look at the fuel and if there are any long stringy bits we ask the contractor to stop and sharpen the blades.”

Challenges

The college at first had some issues with the fuel. Because the crop is planted on wet ground, harvesting may be delayed until the spring. The first crop was cut very late and was in full leaf. The college had been informed that the harvested SRC chip would dry down well when stored in tall windrows in the field. However, this was not their experience. The stack composted and quickly turned to mulch. Rokwood SME partner, Crops for Energy Ltd, arranged for a lorry load to be dispatched to leading woodchip supplier Forest Fuels for testing. Although, they were happy with the particle size, the load was significantly contaminated with mud and stones. This resulted from the transfer of chip from the field into the trailer. The laboratory analysis showed that the ash content was quite high (1.6%), the net calorific value was low (11.4 MJ/kg), but the moisture

Froling Turbomat 320 kW boiler. Image: Econergy

Willow coppice. Image: Econergy

content was acceptable (32.2%). However, Forest Fuels deemed the fuel in this form unacceptable for use in small-medium scale wood chip boilers.

As a result the first harvest was abandoned as a fuel, and instead used as mulch on the college's extensive flower beds.

In order to improve the storage of the crops, the college constructed a barn with a concrete floor and agricultural frame. This cost £40,000.

With both boilers there were teething problems, but these were resolved as the installer and the BCA team became more familiar with the system. One of the things that did come as a bit of a surprise was the operations and maintenance involved. A typical week requires around 5-6 man hours of work. There are two very large hoppers and keeping these topped up takes four hours per week. Then there is around two hours a week on cleaning and general maintenance. The ash pans are emptied each week and recycled on to the land. This time requirement is now absorbed into the daily tasks of the maintenance team.

Costs and benefits

The total turnkey costs for the project (two boilers, heat network, SRC establishment, storage barn) were around £600,000. The college anticipates that they are saving £93,000 per year from fuel savings. The boilers are not eligible for payments from the Government's Renewable Heat Incentive as the first installation was grant aided.

Lessons learnt and recommendations for future projects

Tom Woods said that if they were doing this again they would definitely go and see a working installation in practice and ask lots of questions about logistics and storage. They would also have included a storage barn in the original business case and have it ready in time for the first harvest.

The first SRC plantation was quite gappy with lots of missing plants. Unfortunately, these spaces were not gapped up. The college learned from this experience with the second plantation, and at the end of the first year, a team of 2nd year horticultural students was used to gap up the crop. Mr Woods wasn't sure how successful this was though, as he said the students considered it as a punishment duty and were less than enthusiastic in their approach.

Willow planting. Image: Econergy

Contact details and/or further information

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Econergy – A British Gas Company | Website: www.bghn.co.uk

Coppice Resources | Website: www.coppiceresources.co.uk

Forest Fuels | Website: www.forestfuels.co.uk

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CASE STUDY

Topic District heating; Self-supply; Fuel processing and quality

Self supply of woodfuel at Umberleigh Barton Farm

Location

Umberleigh, North Devon, UK

Description of project or activity

Umberleigh Barton Farm is a working mixed farm situated in North Devon. The owners of the farm business have installed a biomass boiler to supply space and water heating to the various buildings on site. As a result the farm is no longer dependent on the fluctuating costs of heating oil. The Umberleigh Barton Farm complex consists of six residential properties. Two of these are occupied by Mr and Mrs Andrew and Mr Andrew's parents, whilst the other four are occupied by tenants.

A 130 kW Eta boiler was installed in August 2013 by Dunster Biomass Heating. Currently the family are buying in wood chip but the intention is to become entirely self-sufficient by using 14 hectares of existing undermanaged woodland and a new plantation of short rotation coppice (SRC) willow. The annual woodfuel requirement is around 56 tonnes at 30% moisture content.

The boiler and fuel store are located in a barn at the centre of the site. The floor of the barn was levelled in order to make woodfuel deliveries and movements of a front end loader as simple as possible.

A 3.95 hectare plantation will be planted in 2015. The production from SRC should provide an assurance that sufficient woodfuel would be available in the eventuality that the tenants and Mr and Mrs Andrew use more heating than predicted. Also, it should provide enough fuel for additional buildings if the district heating scheme is expanded in the future.

Background/objectives

Mr Andrew got specialist help looking at the feasibility of a biomass boiler installation and potential for SRC on his land from Kevin Lindegaard of Crops for Energy. The two days of consultancy support was partly funded by the farmer (30%) and the balance was paid by the Resource Efficiency for Farmers (R4F) scheme run by Rural Focus. A feasibility study and business case was completed in November 2012. Four boiler installers were invited to quote and a decision was made in February 2013. The boiler was installed in August 2013.

The economic viability of the project depended on the boiler installation being accredited by the UK Government's non-domestic Renewable Heat Incentive (RHI). This pays a set tariff for all eligible renewable heat consumed in the various properties. The application was made by the installer in August 2013 and accreditation was achieved 11 weeks later. So far the Farm complex has consumed and been paid for 110,000 kWh of heat.

In addition, Mr Andrew wanted to establish the SRC crop with financial support from the Energy Crops Scheme (ECS) offered by Natural England. This pays 50% towards the establishment costs of SRC willow but has a minimum planting area of 3 hectares. The scheme ended in September 2013 but Mr Andrew's application was approved before this date and therefore can be planted in the spring of 2015.

Successes

The project has run very smoothly. Mr Andrew was very impressed with the detailed quote offered by Dunster Biomass Heating and the professional service offered before, during and after the installation.

Challenges

The biggest hurdle facing would-be energy crop growers in the South West of England is the lack of infrastructure to plant and harvest SRC. It is not feasible to hire machinery from North England as the transport costs are prohibitively expensive. As a result Mr Andrew will have to plant the crop by hand. The plantation design will have wider spacings (0.5 metres in the row and 2 metres between rows) to give a stocking density of 10,000 plants per hectare. This will enable thicker growth over a three year rotation and provides the flexibility to harvest manually if a local harvesting machine doesn't become available in the future. It should be possible to harvest a third of the plantation each year with a chainsaw in 5.5 man days. Clearing the harvested rods could be done with a telehandler and should take 2.25 man days per year. The rods will be dried in elevated piles – the air circulation between the rods should be sufficient to allow outside drying. Once the rods have dried down to 30-35% moisture content they should be chipped with a hired-in drum chipper. This should take around 2 man days per year. The quality of willow chip will be poorer than that produced from more mature woodland as it will have longer shards and more bark. Hence, it will be mixed in with the roundwood chip. The ETA boiler has a rotary chopper to cut oversize material so that it doesn't clog the feed mechanism and cause a boiler breakdown.

Mr Andrew had hoped to plant the SRC crop in the spring of 2014. However, a long delay in the Energy Crops Scheme grant approval process meant that this was deferred until 2015. Although this delay was annoying, Mr Andrew preferred the option of taking extra time to ensure the land preparation and pre planting weed control was done to best practice protocols.

The barn in which the boiler and fuel store are housed is a listed building. As a result, prior to the boiler being installed it was necessary for Mr Andrew to apply for listed building consent. This was achieved in 2 months which is a standard period. During the first year of the project Mr Andrew decided it would make sense to get to know the working of the boiler and not spend too much time trying to harvest fuel from the undermanaged woodland. This necessitated buying in wood from a local supplier. The feasibility study had indicated that Mr Andrew would be paying around 2.9-3.2 pence/kWh for bought in fuel. In actual fact the cheapest price he could find was much more expensive at around 3.6 pence/KWh delivered. Unfortunately, the popularity of the RHI scheme and the shortage of available woodfuel and suppliers had pushed up the price quite considerably in the space of a year.

Costs and benefits

The turnkey installation costs for the district heating scheme was £98,000. Based on annual fuel savings of £5,700 per year, operations and maintenance costs of £2,275 per year and an annual RHI rebate of £14,400, the investment should be paid back in 5.5 years. Over the 20 year lifetime of the RHI the farm could be better off by over £250,000 based on current oil prices (as at November 2012). This presents a return on investment of over 13%.

The annual fuel savings (compared to oil) will be maximised by selling heat to the tenants as part of an Energy Services Company arrangement (ESCO). Each property has their own heat meter and pay for each unit of heat that is used. Mr Andrew is charging his tenants a unit heating price of 6 pence/kWh. The properties previously all had old oil boilers (70% efficient) and were costing in the region of 8.5 pence/kWh to run. If the replacement biomass system initially achieves 90% efficiency then they would immediately use less fuel and be paying less for their heating.

The establishment costs of SRC are likely to be quite high at around £4,000/ha, although 50% of this will be paid for by the ECS grant. The high costs are due to the need for hand planting and the use of rabbit fencing. The cost of rabbit fencing alone is around £1,850 per hectare but it is likely to be a worthwhile expense in order to give the crop the best possible start. Over a 22 year period, it should be possible to produce SRC wood chip for around £60/tonne at 30% moisture content or 1.9 pence/kWh if the establishment, management, harvesting, storing and chipping costs are spread across this period. Even with all the work required this is a massive saving compared to oil.

The annual fuel saving of £5,700 per year assumes an average woodfuel production cost of 2.4 pence/kWh over the 20 years of the boiler lifetime (to take into account fuel being bought in years 1-3). The Government are predicting year on year price rises of 8% for fossil fuels so the savings are likely to increase.

Lessons learnt and recommendations for future projects

Mr Andrew has so far achieved an exemplary project by taking a considered, stepped approach to various activities. By employing the services of a specialist advisor Mr Andrew was aware of the hurdles involved in self supply with SRC from the outset. He also chose to use a highly respected boiler installer despite the quote being somewhat higher than the competition. Rather than get to grips with the new boiler and try and self-supply from the outset, he chose to buy in fuel and will gradually progress to using the farms own supply. The decision to delay planting the SRC crop will ensure that the crop has the best chance of success and should achieve high yields.

Contact details and/or further information

www.crops4energy.co.uk

www.dunster.biz

www.bit.ly/1FNTjaB

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CASE STUDY

Topic Disease and pest control

SRC mixture research at the Agri-Food and Biosciences Institute

Location

Loughgall, Co Armagh, Northern Ireland

Description of project or activity

The Agri-Food and Biosciences Institute (AFBI) based in Northern Ireland has been involved in research and development work on energy crops and in particular Short Rotation Coppice (SRC) willow for over twenty five years. AFBI has seven locations throughout Northern Ireland with work on SRC being carried out mainly at the Loughgall and Hillsborough sites. The Institute has carried out invaluable research on diseases and pests and how these can be controlled by the establishment of mixed species plantations.

Background/objectives

Melampsora, a foliar rust disease, is the primary limiting factor to sustainable production of SRC Willow in Ireland, Wales and the west coast of England. This is principally because the disease is favoured by the cool moist maritime type climate.

Rust infections can spread very quickly on susceptible varieties leading to premature defoliation. This has serious implications for yield and also more seriously for the entry of secondary die-back organisms through the unprotected leaf scars. These die-back organisms (Fusarium sambucinum and Glomerella miyabeana) can cause significant levels of damage to and subsequent death of shoots and stools. In the moist relatively mild winters experienced in Ireland, it is also believed that Melampsora spp. can survive over winter in bud scales and leaf litter, resulting in serious disease levels early in the next growing season.

Where significant levels of infection have developed, high levels of yield loss in excess of 50% have been recorded.

In common with most fungal diseases, control can be achieved using fungicides. However, in the case of SRC willow, this is not considered practical (due the height of the crop) or economic and does not fit with the environmental credentials of the crop.

One of the major contributing factors to the development of the disease was the lack of genetic diversity of the single varieties used in early plantations. It was argued that genetic diversity could be increased by planting mixed variety plantations. This has proved to be a successful approach, with mixtures delaying the onset of the disease and reducing its spread, so that at the end of the growing season the disease, although still present, was not at levels where yield was affected. As a result of the research it is recommended that all commercial SRC willow plantations should contain at least six improved varieties, for example, from the breeding programmes in Sweden and the UK, and they should be planted in as intimate and random a mixture as practically possible.

Successes

Over 25 years scientists at AFBI have published six papers on the mixture research in peer reviewed scientific journals, have written a booklet called 'Best Practice Guidelines of growing SRC willow' and have edited a book, 'Rust diseases of willow and poplar' (see reference below).

Evidence clearly indicates that where disease pressure is high, as it is in Ireland, the planting of single variety plantations even where the variety is less susceptible or resistant to rust, is a short term high risk strategy and not to be recommended. There are examples where a previously resistant variety has become susceptible as the natural rust population has evolved, resulting in severe losses in single variety plantations.

In Ireland, mixtures are now the industry norm and growing mixtures has been recommended in the Best Practice Guidelines.

Mixtures have also been found to be effective in limiting damage by Chrysomelid beetles particularly the blue willow beetle (Phratora vulgatissima), and the brown willow beetle (Galerucella lineola). This is a result of a variation in feeding preference between different varieties.

Damage on an SRC willow leaf caused by Chrysomelid willow beetles


Leaf rust (Melampsora epitea)

Challenges

Ideally, mixtures should be planted in a completely random fashion to maximize yield compensation. However, this cannot be achieved with the planting machinery normally used. Using the Step Planter a mixture will be planted as short runs (10 –15 cuttings dictated by the length of the rod used in the planter) of individual varieties followed randomly by short runs of the other mixture constituents as the planting rods are randomly fed into the planter.

Unfortunately, some contractors are resistant to planting in mixtures. They are not prepared to mix bundles of individual varieties as this adds time to the planting process. Even when bundles are mixed there is no simple way of ensuring random planting of rods. In addition, there is a received wisdom that mixed plantations will lead to inconsistent stool size leading to difficulties for harvesting machines. However, this is more likely to result from poor planting practice where gaps have occurred between plants rather than competition between varieties. The experience in Northern Ireland has been that there are no significant problems with harvesting plantations planted with genotype mixtures.

There are a number of varieties that share a similar heritage and a mixture should ideally be as diverse as possible. Unfortunately, often growers have to rely on contractors to make the choice of variety for them. This may be based on price rather than a mixture that has a wide genetic background as well as the potential for high yield and good quality wood chip.

Costs and benefits

SRC crops should be in the ground for 20 years. This practice should help maintain productivity and ensure farmers get a good return from their crop.

Lessons learnt and recommendations for future projects

The following conclusions have been made by scientists working on the project:

- Yield from diverse mixtures is greater than the equivalent yield of the mixtures' components grown in monoculture even in the absence of the disease.
- Where less diverse mixtures have been planted e.g. mixtures of exclusively Salix viminalis varieties, these yield increases have not been recorded and the disease suppression aspects, whilst present, are not as marked. This is an important aspect since many of the commercially available varieties are very similar in origin.
- Increasing diversity in mixtures can result in yield compensation. Where individual components of the mixture become susceptible to the disease over time, it has been shown that in a mixture of ten varieties, the loss of up to 30% of component varieties can be fully compensated for by the remaining varieties.
- Where varieties have been shown to have a high level of rust susceptibility, their inclusion in mixtures does not improve their productivity or sustainability.

Contact details and/or further information

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Short Rotation Coppice Willow Best Practice Guidelines. Published jointly by AFBI and Teagasc (Republic of Ireland) | www.afbini.gov.uk/willowbestpractice.pdf

Rust Diseases of Willow and Poplar. Edited by M Pei and A McCracken . CAB International. 2005. ISBN-10: 0851999999

You can find out more about the varieties available and those that would work together well in a mixture in the Willow Variety Guide produced by Teagasc: bit.ly/16h9pu3

Fuelling dialogue between biomass research, industry, policy & business
www.rokwood.eu

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Rokwood is an ambitious 3-year, 6-country study which aims to make the regionally based production of woody biomass economically attractive, technically feasible and environmentally sustainable.

Funded by the European Commission, Rokwood focusses on researching the development, implementation, monitoring and utilisation of short rotation coppice (SRC), also known as short rotation plantations (SRPs).

The main objectives include:

1) Creation of an overview of the main obstacles and barriers hindering the development of local biomass regions in Europe

2) Generation of at least 10 innovative co-operative project ideas tackling the technical barriers(e.g. harvesting, drying technologies)

3) Identification of financial resources for the development of innovative products and services in this sector

4) Reaching a maximum number of stakeholders by effective dissemination activities

List of Rokwood project partners

Germany:	ttz Bremerhaven, Agraligna, Regional Planning Authority Altmark
Spain:	Institute of Agricultural and Fishery Research and Training, ASAJA Granada, BioAzul, Granada Energy Agency
Ireland:	Bio-tricity, Dublin Institute of Technology/Dublin Energy Lab, Western Development Commission
UK:	Centre for Sustainable Energy, Crops for Energy, Dorset County Council
Poland:	EKSPERT-SITR, Gmina Zaluski, Mazovian Agricultural Advisory Centre
EU:	European Biomass Industry Association (EUBIA)
Sweden:	SalixEnergi Europa, Scania's Association of Local Authorities, SP Technical Research Institute of Sweden

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