



The Institute of Grassland and Environmental Research

Biomass: the Sleeping Giant of Renewables

Background

The Institute of Grassland and Environmental Research (IGER) is one of eight research institutes funded by the Biotechnology and Biological Sciences Research Council, and the only one in Wales. Its mission is to

'To determine viable options for grassland-dominated landscapes and land use systems that lead to a sustainable rural economy, a multi-functional healthy environment, and a safe and high quality food chain.

A multi-functional agriculture includes the use of biomass for energy.

The strength of IGER lies in the fact that we undertake work from basic research through more strategic target driven research and the transfer of research outputs into the marketplace via collaborations with the private sector. We have a strong commitment to communicate our research effectively to beneficiaries and policy makers.

Scope of paper

This paper largely covers biomass for heat and electricity generation. Biofuels for transport deriving from oilseed rape or recovered waste oil (biodiesel) and from the fermentation of cereal starch (bioethanol) are less energy efficient and dependent on tax rebates.

Biomass – defined as any biological matter derived from plant or animal matter – includes material from forests, crop and food chain residues, energy crops, municipal solid waste (MSW) and imports. We see little reason to use the term 'woodfuel' as used in TAN 8.

The current situation and potential of Biomass in Europe, UK and Europe

Biomass has recently been described as the 'sleeping giant' of renewables (Renewable Energy World, January-February 2006). The sustainability of different forms of biomass is important.

The EU currently derives 4% of its energy from biomass. **The EU Biomass action plan, published in December 2005, states that if it made full use of the potential, it would more than double biomass use by 2010 (from 69 mtoe in 2003 to about 185 mtoe in 2010 without significantly affecting domestic food production. The potential in 2020 is 3 -3½ times the contribution today and the potential for 2030 is 3 ½ to 4 ½ times that of today. Bulgaria and Romania's accession will improve availability – these countries have 0.7 ha of land per capita compared to 0.4 in the EU-25. Imports offer more potential still. The EU action plan proposes, for biofuels**

such as bioethanol and biodiesel, a balanced approach be taken encouraging both domestic production and imports be taken. Imports would need to be sustainable e.g. if we were to import part of the 7m t from sugar cane in Brazil, we would need to be certain that this would not cause deforestation .

In the UK, biomass contributes about 1.5% of electricity and about 1% of heat (Biomass Task Force to Government October 2005). The Renewable Obligation (RO) has been the main mechanism of support.

The Biomass Task Force (to which IGER contributed) suggests that 20 m tonnes of material are available in the UK. 2.5 m t of MSW (9% of 29m t total) are currently being used in England for energy generation and 10m t (36%) is anticipated for 2010. This needs to be burnt in Waste Incineration Directive plants, and real and perceived issues relating to public health, the environment, and whether it would be better seek greater recyclability or sustainability need to be addressed.

The report also suggests that forestry, wood waste and crop residues such as straw could contribute 5m tonnes.

The current use of energy crops in the UK is estimated at 2,500 ha, capable of yielding 25,000 t of biomass per annum). The BTF's vision is for 1m ha producing 8 m t of energy crop. There have been two significant papers on how much of UK electricity could be generated by biomass crops (one from John Clifton-Brown) and others. These demonstrate that energy crops biomass can produce significant contributions to electricity generation (3 – 7% of UK electricity). However all scenario playing involves some subjective value judgement on how much land we could devote to reducing greenhouse gases.

Energy crops will be required to fill a gap between imminent demand of 500,000-700,000 t of biomass in Wales and that which can be provided by forestry or waste wood. Forestry Commission Wales has set aside 100,000 t of small roundwood. It should be noted that using green waste is not sustainable from nutrient recycling or quality viewpoints. Although we have found it difficult to quantify the amounts of waste wood available, it is unlikely to be available in sufficient quantity. There are examples of wood businesses that use their own wood waste to heat their own premises. There is about 1.6m t of MSW available in Wales. Use of 20% of this would provide a resource with a third of the energy content of coal (woody biomass is about half) and is also variable. A project for submission to WERC currently under development, led by Cardiff University, proposes to examine this (and other materials) for bioenergy use. The comments made above apply. Crop residues such as cereal straw are unfortunately not available in large quantities – the growing of more cereals in Wales for feeding to livestock and use in bioenergy would bring considerable biodiversity benefits.

We have attempted to calculate the amount of electricity that could be generated from energy crops. There is no question of semi-natural grassland, SSSIs and so on being used for energy crops. Environmental Impact Assessments are needed for permanent pastures other than those which are

regularly cultivated and fertilised, regularly disc or chain harrowed or received regular applications of farmyard manure, slurry or fertilisers, or has been regularly grazed or cut for silage. 2005 Welsh Agricultural Statistics report on total tillage (arable in usual sense) (66,588 ha), all grasses [grasslands] under five years old (183,978) and permanent grasses [grasslands] (1,002,246) in 2003. The CEH map (information kindly provided by David Howard) indicates 103,000 ha of arable and 777,000 ha of 'improved grassland'.

A major difficulty therefore is quantifying the amount of grassland that could be used. (Further GIS work is required). We have taken two scenarios: using 5, 10, or 20% of arable and grassland under five years is used, then assuming annual yields of 10t/ha dry matter, then 0.16 – 0.64 TWh of electricity would be generated. Using 5, 10 or 20% of arable, temporary and permanent grasslands, then 1.4 – 4.1 TWh of electricity, that's 6.5 – 25.9 % of requirements would be generated. The potential is 50% greater if yields of 15t/ha (still well below theoretical potential) can be achieved through genetic improvement, with 6.2 TWh of electricity, that's 16% of requirements would be generated at 20% of available land. Electricity is only at most 35% efficient of course. Much higher efficiencies can be achieved if heat is used as well.

We believe that Wales could set itself a target for 100,000 ha of biomass, using one-tenth of the grassland and arable areas in Wales, from energy crops, producing 1m t of biomass per annum, by 2020. That would be equivalent of 10.9% of current electricity generation.

It is important to realise that it's not just quantities that's important. Co-firing, biodiesel and bioethanol from oil and starch are all first generation technologies. They are inefficient with very little scope for improvement. Their significance lies in that they are the kick-start and countries like Denmark have also demonstrated that they produce a range of profitable ancillary industries. Using the analogy with wind, it's very profitable to make turbines as well as generating wind energy. Combined heat and power is more efficient. Internationally, there is a lot of R and D going on to produce transportation fuels from woody biomass. Beyond that, there is the biorefinery concept, in which one derives added value through the derivation of platform chemicals in addition to bioethanol and material for combustion. IGER is currently seeking funds to develop the biorefinery concept using high sugar grasses and Miscanthus.

A role for energy from biomass has been noted in all the future energy output and demand scenarios produced by the Tyndall Centre for Climate Change Research (Decarbonising the UK - Energy for a Climate Conscious Future 2005).

Why isn't biomass making a greater contribution?

Biomass is in a young state of development, similar to that of wind in the last decade.

The Biomass Task Force identified a number of reasons why biomass was not making a greater contribution:

- Ignorance of potential
- Perceived as complex and high risk
- Lack of policy clarity with fragmented approach within Governments and need for stronger Government 'ownership' of biomass.
- Need for regional delivery of information and services.
- Too heavy emphasis on electricity rather than heat
- Lack of robust supply chains

The BFT made 42 recommendations, which are currently being assessed by Defra.

What about Wales?

The Woodland and Biomass Development Group was set up in 2001 and reported in May 2002. The report was passed in plenary in the Assembly in the same year. A steering group was recommended to monitor and co-ordinate the delivery of the action plan but this did not happen until this year. A number of action points have taken place but a smaller Farm Woodland Development and Biomass Steering Group, with the lead and chair being from Forestry Commission Wales, has now been established with the role of identifying priority areas for Working Groups to take forward and that it would seek specialist advice where necessary.

In view of increased interest in renewable energy technologies resulting from 1) sharply rising prices for oil emphasising the need for alternative sources of energy and 2) increasing awareness of the need to decrease carbon dioxide emissions in order to combat global warming, it is important to realise that

- **the requirements from biomass exceed that which can be provided by forestry and wood waste.**
- **energy crops will be viable and significant players in the market.**

The Industry needs to be given **confidence**. Planting grants for both willow and Miscanthus have been ear-marked in the 2007-13 RDP which is presently out for consultation and it is essential that these are delivered.

This will give commercial industries the confidence to invest e.g. in a local office, producing cuttings in Wales and having the machinery in Wales with benefits of cost-saving and security of supply.

The largest project is the development by RWE npower of 35MW biomass co-firing at Aberthaw. This power station is a major employer in south Wales bringing an estimated £52m into the Welsh economy. RWE npower has obtained environmental consents and has now built the necessary wood-processing plant. Energy crops will be needed to make obtain sufficient biomass. The project will produce enough green electricity to supply more than 50,000 homes. It would cut CO₂ emissions by over 200,000t per annum. The saving in fossil fuel will be achieved by cutting coal from Russia and China rather than Welsh coal.

We estimate that in order to satisfy the needs of Aberthaw Power Station for 25% of biomass to be met by energy crops by 2009, we have calculated that significant areas of SRC needs to be planted in 2006, 2007 and 2008. Assuming that 2006 plantings will be insignificant, we consider that for the development of energy from short-rotation coppice to fall no further than one year behind in meeting these and broader targets, the following steps involving important players in Wales are necessary:

- The Helyg i Gymru - Willow for Wales project demonstrates the technologies of SRC to farmers and others at first hand as outlined in the Technology Transfer paper, presenting a clear route to getting started (end-user contracts, permissions and planting)
- Farmers have confidence that they can plan for spring 2007 planting on the basis of the level of grant indicated in the draft 2007-2013 Rural Regeneration Plan for Wales and demand-led contracts.
- End-users such as Aberthaw enter into arrangements with Industry who are capable of giving advice, and can provide and plant cuttings to the required scale.
- Industry sets up a Welsh office (with assistance from WDA or WAG if this is possible) and signs up sufficient farmers by October 2006.
- A 'One-Stop' advice centre is set up, in conjunction with Industry.

One-stop advice

There is a great need for easier to obtain comprehensive advice. In the biomass supply chain, a lot of information is spread over a wide range of expertise.

This could be provided

- a) commercially. For instance, RFL has considerable experience of the logistics of planting, harvesting, advice and varieties.
- b) through existing projects such as Willow for Wales, the Wales Biomass Centre or CALU. In reality, these projects would not be able to cope with the necessary activity.
- c) **a real or virtual centre for research, development and advice, possibly as a branch of the Welsh Energy Research Centre, similar to that of Organic Centre Wales. A well managed demonstration / technology transfer group working with industry and the rest of the supply chain could really work on providing information. The Centre could also include expertise in conversion technologies, supply chain economics etc.**

Organic Centre Wales (OCW) was established in 2000 as a focal point for the dissemination of information on organic food and farming to producers and other interested parties in Wales. In 2003, it was agreed that it should extend its focus to public education, public procurement, policy and strategy development, thus providing support to the whole of the organic community in Wales. It is based at the University of Wales, Aberystwyth.

OCW is run by a partnership of five organizations actively involved in organic farming research and knowledge transfer in Wales: ADAS, Elm Farm Research Centre (EFRC), the Institute of Grassland and Environmental Research (IGER), the Institute of Rural Sciences at the University of Wales, Aberystwyth (IRS) and the Soil Association. OCW core staff are responsible for the co-ordination of the different areas of activity, with the partners responsible for much of the delivery of services to producers and others. The funding for OCW comes from the Welsh Assembly Government (WAG) and Farming Connect (with additional support from the European Union EAGGF Objective 1 funds) to carry out the co-ordination functions, with additional funding for delivery through a separate WAG Organic Conversion Information Service contract and the Farming Connect Organic Development Programme.

We believe that a similar organisation to OCW would also provide a Welsh voice for biomass that is able to give a clear view of

- **what is necessary in Wales**
- **what research is needed in Wales throughout the supply chain**
- **and is able to advise Welsh Assembly Government departments in the same way that they consult with the Forestry Commission.**

Research and Development – Brief Overview

Biomass energy is dependent on the conversion of solar energy to sugar by the process of photosynthesis. The source of carbon is carbon dioxide from air. Photosynthesis takes place in specialized membrane structures in leaves where the light reaction chemicals are embedded. Bioenergy can be converted to power and heat by combustion or some other process.

Research is needed to increase primary productivity and adaptation to Welsh conditions; to quantify other benefits of biomass e.g. carbon credits, environmental benefits, application for bio remediation; to improve conversion technologies and to model supply chain issues in different currencies.

Current IGER projects include

- the Helyg i Gymru - Willow for Wales project, funded by EU structural funds through the Wales European Office, the Welsh Assembly Government, WDA and Industry including RWE npower who operate the Aberthaw Power Station and smaller ESCOs (Energy Service Companies) who are interested in small and medium scale generation. This is a demonstration project that links to supply chain and end-user industries. It has demonstrated how difficult the biomass supply chain is. Currently there are so many barriers, administrative and practical, that it would be difficult for individual farmers to do on their own. Other parts of the project are aimed at identifying the best varieties of SRC willow for Wales and quantify biodiversity impacts.
- the Defra- funded UK breeding programme of Miscanthus. There is currently only one commercially available genotype. The programme is aimed at reducing this genetic vulnerability and increasing primary production in order to make the supply chain more economic.
- SUPERGEN: Sustainable Power Generation. Biomass & Biofuels Consortium (EPSRC) – IGER's role in this is to understand the genetic variation in combustion quality
- ECAS: Energy Crops in the Atlantic Space (EU-Interreg)

In addition, Central Science Grant research at IGER includes elements which relate to biomass, renewables and biotransformation in terms of genetic and environmental limitations on yield of biomass; carbon sequestration, metabolism and partitioning; cell wall properties and fermentability; and microbial transformation of biomass and waste.

Review of IGER's recent interactions with Government

Strong interest in energy from biomass in the Welsh Assembly Government, which has included a visit to IGER in 2005 by Andrew Davies, the Economic Development Minister, presentations to Dr Ron Loveland and others, and contributions from IGER to various consultations. Information supplied by us has been used in WAG's Draft 2007-2013 Rural Development Plan. We have also contributed to the deliberations of the Biomass Task Force and to the

Defra consultation on the costs of planting SRC in order to determine the magnitude of the new Defra Planting Grant. On March 14th, IGER appeared before the Welsh Affairs Select Committee to contribute oral evidence to the Enquiry into Energy in Wales. IGER is a founder member of the Welsh Energy Research Centre, and gave a presentation in the Inaugural Conference of WERC.

John Valentine and John Clifton-Brown, IGER. March 2006