

The RELU Debates 2006

Energy crops running out of steam?

Crops grown specifically to produce energy could make an important contribution to the UK's commitment to reducing CO₂ emissions, but is there a market for them and what would be the impact on the countryside? The government concentrates its quest for alternative sources of energy on electricity production, but the potential of energy crops may be better realised as a local source of heat or fuel. Planning decisions based on climate, soil and water must be balanced against impacts on the landscape, biodiversity and rural economy.

The search for clean, reliable sources of energy is beset with difficulties. Fossil fuels produce unacceptable greenhouse gases and acid rain pollution. In any case we are running out of them, and our present sources are fraught with political uncertainties. The public distrusts nuclear power, the long-term waste disposal and security problems seem intractable and in any case, in March 2006 the Government's advisers deemed it unnecessary. Renewables? Wave-power generators have been smashed by the very forces they seek to harness, tidal power chokes on silt and wind-farms are seen as a threat to the appearance of the countryside worse than pylons.

One solution, partial though it may be, scores on several counts: grow energy on the farm!

Biomass energy production is close to carbon neutral, the technology is proven and the benefits demonstrated. It is already well established in several countries around the world, but uptake in the UK has so far been extremely limited.

However, a Royal Commission on Environmental Pollution, May 2004 concluded: "Sufficient biomass is already available to initiate the development of the sector, in the form of forestry products and by-products, straw and municipal arisings. Systematic use of this material will have the additional benefits of producing additional income streams for farmers and foresters, improving forest management, and diverting materials from landfill. In the longer term, the use of biomass for energy will depend at least partially on the production of energy crops." This development, the report went on, would require a significant change in the use of agricultural land.

Meanwhile, the Commission continued, biomass conversion technologies were particularly adaptable; the scale, type of fuel, and heat/power ratio could be varied according to local supply and demand. Further, and this threw the ball squarely into the RELU court, *distributed generation offered opportunities to engage local communities and to develop a sense of ownership of, and responsibility for, localised energy production.*

The door to biomass energy is swinging open but it still needs a hefty push.

The first RELU Debate of the ESRC Science Week brought together Dr. Angela Karp, Deputy Head of the Plant and Invertebrate Ecology Division, Rothamsted Research; Professor Peter Lillford, Chair, National Non-Food Crops Centre; and Sir Ben Gill, until Feb 2004 the Chairman of the National Farmers Union and now Chair, Biomass Task Force.

Dr. Karp is Principal Investigator in an RELU research project looking at the social, economic and environmental implications of increasing the use of rural land for crops grown specifically to provide energy. Given the level of policy support that now exists, a much greater area of land may well be covered by these crops in the future. Decisions on how and where to convert the land will be based on climate, type of soil and the availability of water, but the RELU maintains that these practical considerations should be balanced against possible impacts on the environment, social acceptance and the rural economy.. The results of the research are intended to benefit not only farmers, but also energy producers, land planners, regional development agencies and the public.

By March 2006, levels of CO₂ in the atmosphere had risen to record levels which the planet had not seen for over a million years. Not only that, but despite the Kyoto agreement, the rate of increase was growing. “We cannot keep depleting fossil fuels and emitting greenhouse gases,” Karp says, “but we can grow our own energy.” As to carbon emissions, the CO₂ given off when biomass crops are burned to produce heat and electricity are taken up by the next generation of crops as they are grown, so biomass energy is carbon neutral.

In 2003 the UK had some 2,000 ha of land producing energy crops: principally miscanthus grass, and short rotation coppice willow and poplar. Dr Karp quotes a target of 6% of UK electricity by 2020, which would need 350,000 hectares although up to 680,000 hectares has been envisaged. This represents 1.9 – 3.7% of the total agricultural land in the UK although in some localities this could rise to 10 – 20%.

Biomass crops are perennial, in the ground for 7 – 25 years and are harvested in winter and spring over a cycle of 1 – 4 years. They comprise dense plantings of tall crops which require little or no nitrate fertilisers, insecticides or fungicides, although herbicides are used to keep weeds down during establishment and after cut-back. Harvesting would need only slightly modified conventional machinery and the crop would be burned in combustion plants which do not necessarily have to be large scale. A school, hospital or even farm could have its own bio-power station with the national grid used as back-up!

A large-scale change of use of land to biomass crops will have wide ranging implications for the countryside, Karp says. The visual appearance and character of the landscape will change, but farm income could well increase. Income from tourism needs to be monitored as does water use and biodiversity. Meanwhile the RELU-Biomass project will provide a scientific framework for locating energy crops in areas where the benefits are greatest and inform policy decisions, for example on environmental assessments.

Photographs of existing plantings of energy crops in Woburn, in Somerset and the Duchy of Cornwall show a countryside that certainly looks different, but arguably no

more so than with the introduction of hectares of rape. Thickets of miscanthus or willow also provide much-needed cover and habitat for wildlife. So, in a situation where we badly need extra sources of energy, Karp asks, what would you rather have? More nuclear power stations? More wind farms? Or more fields of crops?

Sir Ben Gill sees as his point of departure the global oil situation. The total oil consumption since 1850 is 1,000 billion barrels. The total reserve remaining worldwide is a further 1,000 billion barrels, but at current consumption levels this means we only have enough oil for the next 33 years! If the whole world used oil at the same rate as the USA this would reduce to 15 years. “Those of us who are 50 and over may feel that’s all right, but anyone younger should start to be a little bit concerned!” says Gill.

Meanwhile, oil production is at its peak, while demand and price is soaring. “The Government has no magic switch to bring prices down,” Gill says, and when we look at our gas supply “we are at the far end of a very long pipeline with Germany and the rest taking their share first.” The recent dispute between Russia and the Ukraine over gas supplies should make anyone nervous.

Add to this the concerns over climate change, population explosion, world trade liberalisation, Common Agricultural Policy reform and food chain issues and, Gill says, we are living in a time of enormous pressure for change. Meanwhile we wallow in waste.

“In an age of energy efficiency, we waste enough heat in the way we generate electricity to heat the whole country for free,” Gill says. “There is a ripe fruit there, just waiting to be picked!” Of the 5 to 6 million tonnes of reclaimed timber we re-use only 1.4 million, the rest going to expensive landfill. This equates to about 400,000 hectares of short-rotation coppice. We have seen over the years a lot of attention paid to renewable sources of electricity, and concessions on duty for transport obligations, but we need now to consider options for renewable high-grade heat. Options, plural? There is only one widely available and that is biomass.

Taking examples from mainland Europe, Austria, according to an FT report (3 Feb 2006) is producing an astonishing 70% of its electricity from renewable sources of which biomass accounts for 11.2% of the total energy supply and 21% of heat production. Bear in mind that Austria is heavily forested and subsidises biomass by covering as much as 50% of the investment cost. Nevertheless the result is a thriving industry that promises to strengthen the Austrian economy and stimulate further, more cost-effective innovation.

Sweden aims to be the first country in the world to stop using oil for energy purposes by 2020, with energy production from waste and biomass playing a key role. Already there are 29 “waste to energy” plants operational in Sweden incinerating more than 3.1 million tons of waste per year and generating over 9 terawatt hours of energy. Of this 8.6 is thermal energy, the rest power production. District heating is forecast to produce 33 TWhrs by 2010. To meet the 2010 heat and power targets the country is on course to spend the equivalent of £3 billion in new investments.

Box 1: UK Land Use average 2001/04, Ben Gill

Total Cropped area	4.558 mha
Total set aside	0.665 mha
Grass<5 years old	1.224 mha
Total arable land	6.447 mha
Grass > 5 years old	5.602 mha
Total arable + grass	12.049 mha
Woodland	0.536 mha
Common rough grass	1.235 mha
Total agric. Area	18.491mha
Total cereals	3.113 mha

In comparison with many European countries, however, the UK has at its disposal a limited amount of land, about 18.5 million hectares with competing demands for its use for food production, energy production, environmental and recreational use. We are further constrained by the availability of water. People glibly talk about going up to 10 or 20% land use for biomass but we need to consider whether this would affect not only the price of foodstuffs, but also their use. World sugar prices have rocketed in the past ten months as Brazil has turned from sugar as a food to sugar as a source of ethanol fuel, which is far more profitable. Even in the UK it is now cheaper to burn feed wheat to produce heat (provided you have invested in the appropriate boiler) than to burn oil.

“Looking at biomass as a heat source the underpinning economics are revenue positive already,” Gill says, “but there is no recognition of the carbon savings compared with electricity and transport.” All we need is a capital grant scheme for boilers etc. to get things going. With the energy situation as it is, we simply cannot afford to ignore biomass. We have to back all sources, then mix and match to raise the UK’s energy efficiency from the present 25% to 85 or 90%.

The main obstacle to the uptake of bio-energy is ignorance, says Gill. He quotes the case of a scheme to put a bio-energy plant in a new city academy that came to a shuddering halt when the quote for the special boiler was £170,000 more than for a standard unit. It turned out that neither the contractor, the sub-contractor nor his adviser had dealt with this kind of installation before so each added 100% safety factor in price estimates. When the sums were done properly the new unit was still more expensive, but only by £15,000.

Professor Lillford says in a situation where we waste from 50 – 75% in generating our energy, then throw away 50% more by wasting it in our homes, it is paradoxical to

find that environmental issues are finally becoming major drivers. We badly need alternatives to fossil fuels but in any scheme performance characteristics must be met and, with energy crops, the agricultural scale must meet demand. We have to have an industrial process and a supply chain. “Put in an order for logs and you may get them tomorrow, but where are you going to put them, and how are you going to burn them, and where will you put the ash? This, writ large, is the distribution problem,” Lillford says, and on the large scale we do not have a solution for distributing biomass. Moreover, present regulations do not understand the problem and can actually stop us moving in the direction in which we want to go. Meanwhile people need to know what they are going to get out of any changes they may be called upon to make. Then who is going to buy the product, and how will it be applied? But it *is* going to happen, and there *is* money to be made.

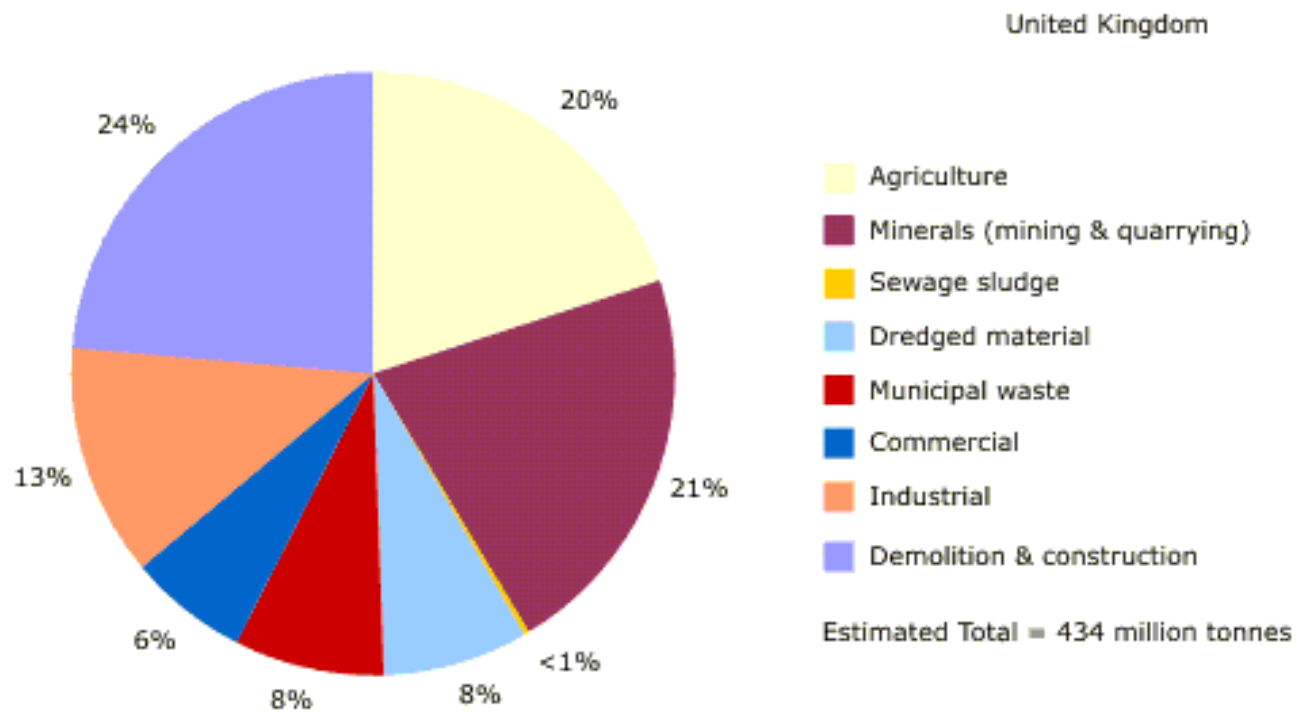
A comparison with oil shows that crops can trade blow for blow in the arena of applications. Fuel and energy yes, but also lubricants, monomers, plastics, pharmaceuticals, adhesives, paints, packaging, construction and one extra : food.

Coppice willow and miscanthus are only a small part of the picture says Lillford. The global biomass from forestry, crops, waste and other sources is 170×10^9 tonnes of which 75% is carbohydrate, cellulose, hemicellulose, starch, and sugars; 20% lignin from the cell walls of plants; and 5% others: fats, oils and proteins. Of this total, 6×10^9 is put to use, of which 3% or 180 million tons are non-food uses. In the UK, waste (434 megatonnes growing at 3 – 4% per annum) is a rich source of biomass. Agricultural waste alone amounts to 80MT of which wheat straw is 10 MT.

So why isn't it all happening? One of the problems is, which do you do first? Plant hectares of willow or build the power station? “Each faction says you go first”, Lillford says. Another obstacle is the mindset of chemical engineers who have to design plant. They are used to oil, or perhaps powders which flow easily. The idea of chunks of biomass gives them nightmares. This again is where wheat might come in. It does not clog up the works because it comes in pellets naturally. And it is economic – at least, as a questioner commented, it is now because the farmer is subsidised for growing it. In five years time it may not be, but in the interim, wheat could be one way of drawing attention to the advantages of biomass through the building of economic heat and power installations. Let us keep quiet about the fact that, because wheat, unlike willow, is reaped only months after it is planted, carbon does not have a chance to get back into the soil and so keep the carbon footprint zero.

Box 2: UK Waste: A rich source of biomass, Peter Lillford

Figure 2: Estimated total annual waste arisings by sector



Source: Department for Environment, Food and Rural Affairs; Environment Agency; Water UK

UK Waste = 434MT

Growth rate = 3-4% pa

UK has very high landfill rates

Although the government's emphasis is on electricity production, biomass does not have to be burned to be useful. Anaerobic digestion, hydrolysis, pyrolysis and gasification produce chemicals, fuels and heat. Where electricity is a requirement, more efficient conversion rates are achieved by combined heat and power schemes.

Any industrialist looking for an investment opportunity in energy might well first look at the modern oil refinery. Evolved over 150 years from producing kerosene lamp oil, these huge complexes are now highly integrated to use the entire crude oil feedstock in numerous thermal and catalytic processes to produce fuels, chemicals, power and materials for large volume markets. In comparison a bio-refinery would also use the whole diverse crop in biochemical as well as chemical processes to produce diverse products including ethanol, hydrogen, chemicals and platform chemicals for a wide range of markets. But on what scale? That of the oil refinery or in local processing?

Our fat-cat industrialist would look at what was already happening in the UK:

- Biomass for burning and combined heat and power. Short rotation willow and wheat.
- Bio diesel already being manufactured and sold. The first bioethanol plant under construction.
- Bioplastics/biocomposites in innovative building materials, insulating and packaging has a long way to go.
- Oleochemicals/lubricants a well established industry, still innovating.
- Pharmaceuticals/nutraceuticals suggesting a return to plants as factories.

North America and continental Europe have already demonstrated that biomass is already a realistic industrial raw material. Technology is not the issue; capital investment is. If we are to benefit from the energy crop opportunity, we need a commercial scale pilot plant to demonstrate the viability of the process, the product performance, and market acceptance, Lillford says. This must be backed by a robust feedstock supply at full commercial scale. But we cannot at the outset rely simply on market forces; the government needs to tilt the level playing field and provide incentives for industry to adopt renewables as mainstream raw materials, and restructure the regulatory framework to increase the benefits and reduce waste.

Meanwhile, we need to change our mindset. “Other countries cannot believe how we plan and construct,” Lillford says, “they think it is hilarious”. When the Swedes start a new building complex, they begin by building a biomass heat and power plant, and only then proceed with as many houses as the power plant will supply. On the other hand, in our quest to curtail our dependence on oil, the UK plan to import ethanol from Brazil. This is certainly economic, but who is monitoring where the Brazilians are getting their biomass from? It isn’t at the expense of the rain forests, is it?

As is typical with many of the issues with which the RELU Project is actively engaged, nothing is simple and straightforward, but the Project is now a powerful force in ensuring that all the relevant factors, disciplines and interests are explored and mapped out in detail. Then there will be no excuse if they are not taken into account when decisions have to be made.

Written by
Laurie JOHN
TVSF Consultants