(This document was a submission to comment on the UK government's regulation of co-firing biomass within coal-fired power stations. It is now available on the Prima Bio website to help raise awareness of the complex issues involved in developing roles for large-scale production and use of energy crops.)

Response to the Statutory Consultation on the Renewables Obligation (Amendment) Order 2003

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Summary

This response concludes that the proposed changes to the Renewables Obligation may encourage some co-firing of biomass with coal until March 2009. After that date, it is implausible that any co-firing will take place. Thus the changes will neither help government to meet its target for 10% of renewable electricity by 2010, nor will it stimulate planting of energy crops.

The immediate reason for this conclusion is that there will be inadequate time to secure the land and the planning consents required for the supply of energy crops from 2009. A further range of reasons indicate that, even if this immediate constraint was overcome, a co-firing enterprise based on the energy crops would be of very high risk, and would be unlikely to attract support from investors, including farmers.

A simpler and more helpful amendment to the Renewables Obligation would be to allow co-firing until March 2011, but without any requirement to use energy crops. This would immediately stimulate co-firing and assist the government to meet its 2010 target. The present cap of the proportion of electricity that can come from co-firing plants may need to be modified, so as

not to discourage investment in other forms of renewable electricity production. The terms under which co-firing should be allowed after March 2011 should be considered as part of the planned review of the Renewables Obligation in 2005/6.

1. Introduction, premises and assumptions

My comments refer exclusively to the proposed changes that affect co-firing.

The Consultation and the proposed Amendment explicitly are a response to the recognition that there has been minimal planting of energy crops in response to the Renewables Obligation (paras 1.3 and 2.4 of the consultation), particularly with respect to co-firing. In my view, the changes proposed will not materially change this situation, because the proposals do not take account of either the practical and economic realities of the production and utilisation of energy crops, or of co-firing.

The major reasons for my views are set out in sections 2 and 3. However, I believe it is important first to state three fundamental points:

a) Within the Renewables Obligation (and also the Bio-energy Capital Grants Scheme for dedicated biomass power plants), the requirement to use a proportion of energy crops as biomass feedstock is not intrinsically necessary, however laudable the political intentions behind any such requirement.

b) I assume that the purpose of the Renewables Obligation is to provide a mechanism that will help permit the government to achieve its target of having 10% of electricity supply in UK by 2010. The point seems obvious, but the original Obligation, the proposed Amendment, and other initiatives such as the Bio-Energy Capital Grants Scheme, seem designed to discourage investment in biomass power generation generally, and co-firing in particular, to the extent that the government's 2010 target will not be met.

   A sceptic might reasonably ask if this is deliberate. My responses are based on my belief that the 2010 target is challenging[2] but worthwhile, and that the Renewables Obligation and other schemes should be designed to assist achieving it and the associated 2020 aspiration.

c) Co-firing of biomass with coal in power stations originally designed to use only coal is generally acknowledged not to be a wholly satisfactory solution to providing 'green' energy. However, because the UK lacks significant low-cost biomass resources (because it does not have a substantial domestic wood processing industry that would produce large quantities of bark and clean waste wood at specific locations), it

[2] The target equates to approx 5700MWe!

does not have experience in supplying, handling and using biomass energy feedstocks on a large scale. The co-firing approach offers an opportunity to examine the viability of providing such resources at acceptable cost and moderate risk. In my view, doing this is a big challenge in itself. Achieving it on a worthwhile scale within five years will deserve congratulations as well as financial reward, not a movement of goal-posts towards use of energy crops. It would be better to gain experience, and then decide what the role of co-firing could be after 2010.

It is also worth noting that I am a proponent of energy crops. My underlying concern is that government policies and initiatives seem to consistently ignore the need to ensure that energy crops require customers who genuinely want the biomass they can provide, because the products meet (or will meet) their operational needs at acceptable cost. I am very sceptical of current efforts to use legislation as a substitute for developing genuine demand for energy crops. I believe that both the government's renewable energy targets, and the future development of energy crops in the UK, would be better served by abolishing the requirements to plant energy crops until such time as a recognisable biomass power industry exists in the UK.

2. Characteristics of biomass demand for co-firing

The following comments relate primarily to co-firing in coal-fired power stations. However, most of the points are also relevant to co-firing in gas-fired power stations.

a. Location

Existing coal-fired power stations are mostly located either close to coalfields, or to ports. Coal is transported to them by combinations of ship, rail and fixed conveyors. In some cases, for example in former coalfields, long-distance (150+ km) rail transport is used. Road transport of coal is of minor significance.

b. Size

Stating the obvious, existing coal-fired power stations are large. Fuel demand is correspondingly large. Taking a 2 GWe station as an example, co-firing with biomass to produce 5% of the output (i.e. 100 MWe) from the biomass would require approx 500K oven-dry tonnes (odt) of biomass per year. Note that this output is just 1.75% of the national 2010 target for electricity from renewable resources!! However, there are precedents for using biomass on this scale and greater: many pulp mills use at least 1000K – 2000K tonnes/y of wood as feedstock. It is notable and relevant that such large pulp mills:

- Are frequently located at ports, to facilitate wood imports and product exports.
- Are frequently surrounded by dedicated plantations, which supply a significant proportion of feedstock using vehicles. In many cases they do not use public roads, or they use public roads in sparsely inhabited areas that have little other traffic.
- Tend to store only a few weeks supply of feedstock in their woodyards. Despite this, the woodyards are immense by UK standards!

c. Biomass characteristics for energy conversion

Biomass is less energy-dense than coal. The energy density [GJ (oven-dry basis) per unit bulk volume] varies considerably with biomass type and degree of processing, but the energy density of bulk wood chips is typically one-sixth that of coal. The impact of this difference on costs of any volume-constrained operation, including transport and storage, is obvious!!

Green (freshly- harvested) biomass tends to contain a lot of water. Most of this water has to be removed, because:

- Wet biomass tends to rot, which means that its energy density will decline. Fungal spores associated with the rots can present health hazards.
- Biomass may need to be stored before use.
- There is a cost involved in transporting water
- It is usually desirable that biomass fuel is relatively dry when it is burnt or gasified.

While these points are obvious, and there are some exceptions (e.g. miscanthus is relatively dry when harvested) the costs and practicalities of managing the consequent issues with energy crops in a cost-effective way, on an operational co-firing scale, are not trivial and are not yet well understood. Some of the issues are discussed further in section 3.

d. The future life of existing coal-fired power stations

Existing coal-fired power stations in UK face an uncertain lifetime before they are closed. All are relatively old, and new capital investments on them will be increasingly difficult to justify. Some are expected to close as emissions regulations become more stringent, because the alternative of further investment to comply with new regulations is unattractive. However, actual decisions on any further investments in them could be driven by a range of factors, including future plans for nuclear energy and forecasts for electricity demand and prices. In such a situation, decisions on investments in co-firing for individual stations will be difficult enough on a five-year horizon (to 2009). Additional investments by power companies in 2004 and onwards, in planting and/or purchase agreements for energy crops that can only give financial

benefit from 2009 and which will have an implied requirement to continue operations until 2016, will inevitably be viewed as increasing risk further and hence unattractive.

3. Characteristics of biomass/energy crop supply on the scale required for co-firing.

a. Location with respect to demand

The volumes and tonnages of biomass required for co-firing are such that large-scale bulk transport will be preferred from an economic and planning standpoint[3]. In principle, this would fit well with coastal power stations that have docking facilities, to allow delivery by ship. Other scenarios, including combinations of transport modes operating in parallel, are possible. However, coastal power stations will probably be the most favourably placed to obtain biomass fuel at acceptable cost, if only because they could rely on a large proportion of imported feedstocks. Inland power stations that use a proportion of imported coal will presumably have the transport infrastructure to handle biomass also, although the economics will of course be less favourable compared with coal.

Storage of biomass fuels at power stations, particularly if the biomass is delivered by ship, may be an issue because of their low energy density compared to coal's.

Energy crops can in principle be grown close to power stations. However, the vehicle movements required for such fuel delivery will certainly be a major constraint from a planning standpoint at some existing stations.

b. Seasonal availability of biomass and energy crops

Many types of biomass, including wood and certain crop residues, are available year-round, and can be purchased and delivered in bulk at modest moisture contents consistent with stability. Such biomass types will clearly be ones favoured for large scale use; the issues for the customers will be delivered prices and quality.

[3] 100MWe from woody biomass would require **200 two-way vehicle journeys per day** if the biomass was supplied entirely by road! (source: DTI leaflet ERE-WF2 'Wood fuel for Electricity and Heat', March 2000)

Energy crops currently supported and promoted in UK are harvested seasonally, essentially in winter. This means that they will have to be stored if they are to supply a significant proportion of the feedstock for power plants operating year round. The consequences of this are formidable, particularly for short rotation coppice (SRC), because:

- At least partial drying will be required for satisfactory on-farm storage of SRC. In practice this will be problematic – see sect 3.3.

- Storage at power plants rather than farms would be logical, particularly because waste heat could in principle be used for drying. Even assuming the logistics for this could be developed, the sheer size of the resulting chip piles would be awesome – a single one could dwarf the Millennium Dome![4]

c. The impact of moisture content on biomass quality

All crops grown and processed on a large scale have recognised limits on moisture content at point of sale. These limits reflect deterioration of product quality at higher moisture levels, and in some cases also the consequent health risks associated with microbiological spoilage. There are also obviously issues of quantity bought when product is supplied on a weight basis. Suppliers who exceed the limits are penalised. This situation will apply to biomass, including energy crops, and I am aware of a few examples of such issues having occurred within the UK biomass energy industry.

For many types of biomass this situation is manageable, because of precedents. However, for SRC grown and supplied on a large scale, the issue seems problematic. SRC has a particularly high moisture content at harvest, and a significant nutrient content. SRC harvested as chips is consequently unstable (as ARBRE discovered!), and needs to be at least partially dried if it is to be stable in storage. This is feasible on farms on a small scale, because drying and storage barns may be available (although the associated costs of this need to be understood better). But on a larger scale, the need to dry large volumes quickly will lead to pressure to sell freshly-harvested material to customers or intermediaries who will take responsibility for drying and storing it.

The use of harvester-bundlers rather than modified forage or cane harvester-chippers for SRC may increase the scope for on-farm storage of harvested

[4] The following illustration is instructive: Assuming 100MWe requires 500K odt/year biomass, and that 75% of this is supplied from SRC. Assume all the SRC is delivered to the power plant for drying in Q1 of any year, and that 75% of this is stored dry for use in Q2 – Q4. Assume that the loose bulk density of SRC chips is 120 kg (odt)/m3 (figure from 'Wood for Energy Production', Danish Centre for Biomass Technology, 1999). The resulting chips would occupy **2.3 million cubic metres** at the start of each Q2. **In a conical pile covering 20 acres (80K m2), this would be 86metres high!!** For comparison, the Millennium Dome covers 20 acres and is 50 metres high.

SRC somewhat, but deterioration in storage will still be highly probable without some forced drying.

d. Production costs and delivered prices

The Proposals are based on rather simple estimates of the cost of energy crops in future (e.g. £45/odt excluding haulage costs)[5]. Reality will be more complex. It will obviously be very dependant on yield/hectare, which in turn will be affected by:

- site quality (soil type, altitude)
- average climate (yields in Scotland will be lower than in southern England)
- Unusual seasons (e.g. growing seasons with low rainfall)
- Quality of crop establishment
- Pests and diseases (a real issue with rust diseases of willow and poplar, given that the crops are perennial)

It will also be very dependant on harvesting costs, which will be influenced by:

- The scale of harvesting in a given locality, because of the scope for economies of scale
- Field size and topography
- The impact of unusually wet winters

Clearly, not all these factors can be controlled. But many of them can be, and under the current Proposals there is no point in developing plans for co-firing at an otherwise suitable power station if there is not a clear prospect of being able to produce energy crops locally at a reasonably competitive price. The obvious conclusion is that it would be sensible to look at the land catchment around existing coal-fired power stations, to assess the potential to grow sufficient energy crop at acceptable and competitive delivered average cost. I would guess that there will not be much co-incidence of existing power stations, ports, sufficient land suitable for energy crops to be produced at lowest cost at roadside, and acceptable road infrastructure to deliver the energy crop.

[5] Annex B, para 15

The price quoted above is at the high end of the range quoted for cordwood/firewood at roadside in SE England[6]. There is a LOT of such wood without a market in SE England, and much of this has the potential to compete on both price and quality (including storage properties) with energy crops. The effect of an increased demand for such wood on its price is an issue. But it does indicate that energy crops would need to be sited particularly close to customers in order to be competitive with existing quality biomass resources. The situation in other parts of the UK is likely to be broadly similar.

e. Impact of the Energy Crops Scheme and associated promotion

The Proposals acknowledge the very limited planting of energy crops to date, and indicate that part of the reason for this is the overly-restrictive rules on co-firing in the present Obligation. I think a more honest and accurate assessment would be:

- The rules concerning energy crops and co-firing within the current Obligation were going to be impossible to meet from the outset!
- The ARBRE debacle has made farmers very wary of committing to contracts to plant and supply energy crops, because of the risk that the contracts will not be honoured, and because the prospect of finding alternative customers within a reasonable time appears slight.
- The two energy crops currently supported and promoted by DEFRA appear to have been developed with a focus on production and harvesting, and little attention to the product requirements of potential customers. The issues surrounding the storage and drying of SRC are a good example, but there are other aspects also. I think it significant that small-scale biomass heating initiatives within the former ARBRE catchment seem not to be paying much attention to the existing SRC resource there, but are focussing on other cheaper and more suitable biomass fuel resources.
- So far, SRC has not yielded as advertised, in any operational planting. Informed farmers are well aware of this, and the consequent implications for their income! I am sure there is potential to improve yields as experience is gained, but this does not help farmers who take the plunge early. I believe that the effect of site type on yield potential of SRC has not been given adequate recognition or publicity within promotional material, and that too many analyses have been built based on assumed yields of 10 odt/ha/year. Such yields have proved optimistic in practice.

f. Timing and scale

[6] £10 – 30/tonne at roadside, quoted in Woodlots No 48, July/August 2003. The range depends on species, access, quantities etc. Assuming the wood is winter-felled mixed hardwoods, the average moisture content will be around 40% (wet basis); the price range thus equates to £17 - £50/odt

Under the current proposals, a single co-firing plant aiming to produce 100MWe from ca. 500K odt of biomass and wishing to operate between April 2009 and March 2010, will need to source 25% of its fuel from energy crops. If this is to be from SRC, a significant proportion of this fuel will have had to be harvested by Q1 2009. The crop to produce this will need to have been planted in Q2 2005. Farmers normally make annual cropping plans in advance of the autumn sowing season for winter cereals and the other principal arable crops. Thus they will be deciding whether to plant some SRC no later than July/August 2004. Assuming the proposed Amendment is incorporated within the RO by 1st April 2004, then the power plant owners will have just 3 months to persuade farmers to plant the first energy crop. If they aim to plant sufficient SRC in 2005 for 12.5% of the total biomass fuel requirement in 2009, this will require 62.5K odt of energy crop. Assuming an average annual yield of 7 odt/ha/year over three years, this will require an initial commitment of 3000 hectares. **This alone is double the area that ARBRE succeeded in having planted in the 5 years from 1996 to 2001!** Things have hardly got easier since then, and it would make no sense at all to stop there. The total area that would need to be planted by 2007 is 15,000 hectares. **This is equivalent to 75% of the planted area of Thetford Forest, England's largest lowland plantation!** I believe that scale of the private sector commitment required to make this all happen within the necessary timescale, and the scale and nature of the host of planning issues that would need to be resolved in order to secure local agreement to the developments, make this scenario implausible. Even a scaled down version of the scenario looks implausible within the proposed timescale, even at just one location.

It is also worth noting that the current Energy Crops Scheme finishes in 2006, and is due for a review in 2004. This inevitably will create further uncertainty on the levels of future planting grants, and consequently deter farmers from committing to future plantings.

4. Conclusions and recommendations

It is evident from the foregoing that trying to maintain a link between co-firing and energy crops within the Renewables Obligation is probably futile and counter-productive. This assumes that the government wishes to encourage and not inhibit the development of co-firing, because encouraging co-firing has the potential to:

i) Stimulate development of biomass supply and handling mechanisms on a large scale and with modest risk.
ii) Help the government achieve its target of 10% electricity from renewable resources by 2010.

I suggest that the changes necessary to achieve this within the framework of the Renewables Obligation would involve:

a) Allow co-firing of biomass with fossil fuels until 31st March 2011, with no requirement to use energy crops in the feedstock.

b) Retain a cap on the total proportion of renewable energy that can be supplied annually by co-firing until 31st March 2011. The cap should be designed so as not to inhibit investment in other forms of renewable energy, including electricity from dedicated biomass power plants. I cannot comment on whether the current cap would be appropriate.

c) Indicate that co-firing will be permitted beyond 2011, but that the terms for such permission will be announced following the RO review planned for 2005/6, at the earliest. The general terms for companies that wish to co-fire biomass with coal after 31st March 2011 might include:

- Each company should have also installed a specified capacity of dedicated biomass power or CHP plant by 2011.
- Each new dedicated biomass power plant should have been designed to utilise a specified proportion of at least one specified energy crop of the company's choosing, and that such utilisation should have been successfully demonstrated in trials.
- There is evidence of sufficient investment in large-scale infrastructure for handling, drying and storing biomass at a co-firing site, to justify building a dedicated biomass power plant at the site before the existing co-fired plant is closed.