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Co-firing of most biomass feedstocks is favourable for the environment

Dutch power generators have agreed with the national government to substitute some of the coal burned in their power stations by biomass. The main aim is to reduce greenhouse emissions. One of the companies who made such a pledge is Electrabel.

On the international market there are a wide range of biomass feedstocks suitable for burning as an auxiliary fuel in (coal-fired) power stations. To make a responsible choice from among them, Electrabel commissioned CE Delft to review the environmental performance of eight options, taking Electrabel's 'Gelderland 13' power station as a reference. For each of these feedstocks CE examined whether utilisation in other sectors of the economy would not be a better option environmentally and assessed the risk of undesirable knock-on effects occurring. Electrabel will be using the results of the study, along with economic and social considerations, to arrive at a balanced decision on the issue.

The following biomass feedstocks were reviewed: wood waste, chip fat, fatty acids from the palm-oil industry, tall oil pitch and rice-residue, corn-cob, eucalyptus and palm-kernel pellets. For a number of these materials an environmental license had already been applied for and in some cases granted.

To compare the environmental impact of co-firing the respective biomass feedstocks with that of alternative applications we used a method based on standard LCA methodology, as per ISO 14040, that respected the terms and constraints agreed on beforehand with the Working Group on Sustainability of the Biomass Transition. The following five environmental themes were considered: greenhouse effect, acidification, eutrophication, human toxicity and ecotoxicity.

The study also looked at the market shifts potentially arising as a result of new, government-subsidised demand for these feedstocks. In the case of biomass from developing nations, loss of biodiversity is also a key issue, specifically in the case of natural forest and other undeveloped areas being converted to biomass plantations. Although the study did not examine this latter issue in detail, where relevant it has been recommended that further study be undertaken.

For the respective biomass feedstocks the conclusions were as follows:

Wood waste
It is environmentally sounder to co-fire wood waste in the 'Gelderland 13' power station than to use it for chipboard production. In building applications, chipboard competes with plasterboard, manufacture of which today requires less energy and causes less emissions than chipboard production. Substituting chipboard by plasterboard therefore benefits the environment. In earlier CE studies the opposite conclusion was drawn.

Chip fat
Co-firing chip fat in ‘Gelderland 13’ is the best option environmentally, as this means direct substitution of coal, yielding greater environmental gains than substitution of oil in the alternative options.

Palm-oil fatty acids
In the case of palm-oil fatty acids the pivotal issue is whether use as a power station fuel leads to new biomass plantations being created in producer countries at the expense of natural (rain)forest. In that case there will be various undesirable impacts, including loss of biodiversity and additional greenhouse emissions. In practice, though, it is unclear whether new plantations will indeed be created. If there are guarantees that such will not be the case, then co-firing palm-oil fatty acids will, on balance, score better on all five environmental themes considered than using them in animal feed. Without such a guarantee, though, the impact on greenhouse gas emissions and biodiversity will probably be negative. CE advises Electrabel to engage with NGOs on the issue and undertake further research.

Tall oil pitch
Co-firing tall oil pitch, a by-product of paper and card production, in power stations is environmentally beneficial. Social considerations, however, indicate that it would be better to extract the sterols contained in the feedstock for use in ’health foods’. This would lead to little loss of combustion efficiency.

Rice-residue and corn-cob pellets
Even with pelletisation and ocean transportation, co-firing rice and corn-cob residues in the Netherlands is clearly superior to local use of these materials as a fertiliser or as raw fibre in animal feed. On balance, co-firing leads to substantially lower greenhouse gas emissions. In our analysis it was assumed that farmers in the producer country (Thailand) compensate the loss of natural fertiliser with artificial fertiliser.

Eucalyptus pellets
In environmental terms, eucalyptus wood that is currently burned in the open air as waste at logging sites can far better be transported to the Netherlands for co-firing in ‘Gelderland 13’. Although it would obviously be preferable to use this biomass in domestic, South African coal-fired power plants, this does not happen because coal is cheaper in South Africa and bio-energy is not subsidised.

Palm-kernel pellets
The environmental performance of co-firing palm-kernel pellets depends very much on the current application with which it is compared. If that is animal feed, then co-firing is probably the inferior option. In a comparison with use as a fertiliser or with incineration as waste, though, co-firing emerges as the better option. If there are guarantees that the palm-kernel pellets for ‘Gelderland 13’ would otherwise have been used as a fertiliser, then, the net environmental impact is positive.

Co-firing palm-kernel pellets leads to greater NO_x emissions and therefore possibly to some decline in local air quality around the power station. In practice, though, this effect will probably be only minor, as technical considerations severely limit the fraction of pellets that can be co-fired. By using fuels with a lower nitrogen content and through suitable technical measures, moreover, the impact of co-firing palm-kernel pellets on NO_x emissions can be fully offset.

The above analysis leads to the following general conclusions:

- For most of the biomass feedstocks studied there are environmental gains to be achieved by co-firing in the 'Gelderland 13' power station, the two exceptions being palm-oil fatty acids and palm crop residues. In these cases the net environmental impact is only positive if there are guarantees that use as a fuel does not lead to the creation of new plantations in currently forested areas.
- Co-firing materials currently used in animal feed is generally positive if they are used merely as a bulking agent (raw cellulose) and negative if they are ingredients with nutritional value.
- Co-firing the alternative fuels considered improves local air quality near the 'Gelderland 13' power station, except in the case of palm-kernel pellets, which, being relatively rich in nitrogen, may cause higher NO_X emissions.
- In the case of biomass feedstocks with an alternative application as a transport fuel like biodiesel, co-firing is the environmentally superior option, as this means substitution of coal rather than oil.
- It is difficult to predict the full consequences of additional market demand for a given biomass feedstock on alternative uses for that feedstock. Great caution should therefore be exercised when drawing any conclusions, particularly in the case of feedstocks for which additional market demand may lead to creation of new plantations at the expense of natural (rain)forest or other such habitats.

In the meantime, Electrabel has entered into discussion with Dutch NGOs on utilisation of the various biomass feedstocks in the 'Gederland 13' power station. It is recommended that if such feedstocks are imported from developing countries where there is a risk of deforestation, a sustainability certification scheme be established similar to the FSC scheme for timber.