Bioenergy and waste incineration in the Renewables Obligation: A Summary of Impacts

Please note: We have included basic facts about the impacts of waste incineration, including waste pyrolysis and gasification in this briefing, given that biomass and waste are treated relatively similarly under the Renewables Obligation. However, since waste incineration is not an issue Biofuelwatch normally works on, we would recommend that readers look at the following websites for more information: www.no-burn.org/ (Global Alliance for Incinerator Alternatives), www.ukwin.org.uk/ (UK Without Incineration Network), www.gainscotland.org.uk (Green Alternatives to Incineration in Scotland). Please also note that the information in this briefing about biomass relates to biomass gasification and pyrolysis as well as conventional combustion, all of which are eligible for ROCs, although pyrolysis and gasification have not so far been commercialised on any meaningful scale in the UK.

Climate change

Biofuels

Virtually all current biofuels have been shown to be worse for the climate than the fossil fuels they replace if all direct and indirect impacts are considered. Palm oil is by far the cheapest type of biofuel that can be burned for heat and power which is widely available. According to a 2007 report by the UN Environment Programme, palm oil is the main cause of permanent forest loss in Indonesia and Malaysia (tinyurl.com/3uexbdk). It is also increasingly a driver of deforestation in many other countries, including the Philippines, Papua New Guinea, Cameroon, Uganda, Benin and Mexico. Emissions associated with palm oil biofuels can be even higher than those from tropical deforestation in general: Particularly in Indonesia and Malaysia, a high proportion of new oil palm plantation is on peatlands. One study found that CO2 emissions from peat fires in 2006 in Indonesia alone were 900 million tonnes (tinyurl.com/y8ko6jk) – far more than the UK's annual greenhouse gas emissions.

Even burning European rapeseed oil has been shown to be worse for the climate than burning mineral oil, due to GHG emissions linked to fertiliser use and taking account of indirect land use change (tinyurl.com/42l7a5a). Used cooking oil and some types of residues, such as tall oil, are often considered to be the most 'climate friendly' biofuels, however both are in very short supply and are already in high demand, for example for transport biofuels in the case of used cooking oil and by the chemical industry in the case of tall oil. Burning them in power stations will simply cause more palm oil or fossil fuels to be used elsewhere.

Biomass

Unsustainable demand for wood and wood-products – together for demand for land for monocultures - is already a key driver behind the destruction of forests worldwide (tinyurl.com/3mwbt5l). In this context, the creation of another vast market for wood, this time for bioenergy, can only accelerate deforestation and forest degradation. The global wood bioenergy market is still in the very early stages, though growing rapidly as a result of subsidies across Europe and North America. The impacts of this demand are likely to be very similar to those which result from the unsustainable demand for paper, particularly since both bioenergy and pulp and paper companies can use fast-growing, 'low quality' wood, grown in monoculture plantations. Trees for bioenergy can be grown on even shorter rotations than for paper. Millions of hectares of forests, in Sumatra, Tasmania, Brazil and many other countries, have been 'pulped' and turned into plantations for paper. A recent article published in the scientific journal *Nature* confirms that tree plantations are one of the reasons for the destruction of tropical forests "with potentially dire consequences for tropical biodiversity"(tinyurl.com/3n2lxll). The impacts of a large new demand for wood as a bioenergy fuel will almost certainly be just as destructive and will compound the existing problems. It is not only tropical forests, but also boreal and temperate forests are being targeted for ever more intense and destructive logging and for conversion to plantations. It is

estimated that deforestation is responsible for 25-30% of greenhouse gas emissions worldwide (tinyurl.com/3vbuqou).

Studies have shown that even if forests are not totally destroyed for bioenergy and if, instead, every tree felled were replaced by a new one – a highly unrealistic assumption – burning wood in power stations nonetheless leads to a 'carbon debt' of decades or centuries (e.g. tinyurl.com/3x25bcg and tinyurl.com/35lb35e), making global warming worse exactly during at a time when CO2 emissions must be brought down as fast as possible. Biomass power stations are particularly inefficient and CO2 smokestack emissions tend to be around 50% higher per unit of electricity produced than those from coal burning (tinyurl.com/3xsvxb2).

Anaerobic digestion

Most people in the UK associate biogas with energy from food waste and perhaps other types of waste, even sewage. When organic waste rots in landfill it emits methane, which is more than 20 times as powerful a greenhouse gas as carbon dioxide when calculated over a century. Turning such waste into biogas rather than putting it into landfill is clearly beneficial for the climate, provided that biogas does not compete with composting and thus lead to more synthetic fertilisers being used.

What the experience with biogas in Germany has shown, however, is that generous subsidies for biogas that do not discriminate between biogas from waste and biogas from whole crops, especially maize, result in large-scale land conversion and create the same food versus fuel conflict as biofuels. In Germany, even carbon-rich moorlands and nature reserves are being ploughed up and turned into maize monocultures and then cultivated with fertilisers which result in high emissions of nitrous oxide, a greenhouse gas some 300 times as powerful as CO2 – all of that to supply the country's 6,000 biogas digesters. The direct and indirect climate impacts of maize biogas are thus likely to be very negative (tinyurl.com/3g2o482).

Waste incineration

The energy generated by incinerating waste is a small proportion of that which would be saved by recycling and reducing the same materials (tinyurl.com/275hqmm). For example, recycling paper saves over 9 times as much energy than incinerating it, recycling plastics saves 3 times more and reducing computer waste saves 1,700 times as much. There is no evidence that gasification and pyrolysis are any more efficient than conventional mass burn waste incineration. On the contrary, a report by the UK's Fichtner Consultant Engineers says that both are even less efficient than mass burn incineration (tinyurl.com/6d9zso5). And a study commissioned by the German government shows that small-scale gasification for electricity has been developed for over 30 years, but that virtually all projects have faced serious technical problems as well as having very low efficiency (tinyurl.com/36ywgl7).

Black carbon (soot) from biomass, bioliquid and waste incineration

Black Carbon (or soot) is emitted to the atmosphere by combustion processes like biomass and bioliquid power generation or waste incineration. It is considered by some scientists to be the second largest contributor to global warming after CO_2, James Hansen's report in 2003, 'Soot climate forcing via snow and ice albedos' (tinyurl.com/6zm3pzb) concluded: *"The soot effect on snow albedo may be responsible for a quarter of observed global warming. Restoration of snow albedos to something approaching pristine preanthropogenic values would have the double benefit of reducing global warming and raising the global temperature threshold at which dangerous anthropogenic interference with climate occurs."*

The UNECE's Executive Body for the Convention on long-range transboundary air pollution has set up a dedicated expert group to tackle Black Carbon (tinyurl.com/6dllwaw) saying, *"In 2009, the Executive Body of the Convention recognized that black carbon poses significant risks to human health and the environment. It has a significant climate forcing impact, leading to increased warming, particularly in areas covered by snow and ice, such as the Arctic."*

Official greenhouse gas balances used for bio-energy and 'energy from waste' take no account of the warming effect of black carbon and are therefore underestimating the climate damage resulting from biomass and bioliquid combustion and waste incineration.

Biodiversity

Biofuels

The large-scale destruction of tropical and sub-tropical forests for palm oil is well documented and widely known. It takes five years before palm oil can be harvested from new plantations. Clearing forests and selling off the hardwood allows companies to make substantial profits in the meantime. In the Malaysian state of Borneo, the government has decided to grant concessions for 1 million more hectares of Native Customary Forest for oil palms (tinyurl.com/3ey3b7k). In Cameroon, US company Herakles Farms, is reported to have started bulldozing forest for a 60,000 hectare oil palm plantation, despite local and international protests. The plantation would be adjacent to Korup National Park, home to over 600 species of trees, some 200 species reptiles and amphibians, 1,000 butterfly and 400 bird species and 160 mammal species and it would disrupt vital wildlife routes and isolate populations (tinyurl.com/3w2zn3a). There are similar examples of oil palm plantations across the tropics and subtropics.

Rapeseed oil is the most common vegetable oil produced in Europe that is used for biofuels, although experience in Germany has shown that, even with generous subsidies, companies tend to find it uneconomic to burn any biofuels other than palm oil in power plants. Yet oilseed rape expansion, too, has serious consequences for biodiversity. In 2008, following strong lobbying by the biofuel industry, the European Commission abolished all set-asides. Previously, farmers had to leave 10% of their land fallow. Within one year, farmland populations in England had fallen by 5%, to their lowest level for 40 years, with lapwings declining by 12% and grey partridges by 23% (tinyurl.com/4ym5vuu). And while the precise reasons are difficult to prove, those declines are in line with what conservation organisations had predicted when set-asides were abolished.

Biomass

The biodiversity impacts of timber plantations for energy from biomass are much the same as those of oil palm plantations for biofuels – although that the trade in palm oil for biofuels is much more established and advanced than that in woodchips and pellets for bioenergy. The effects of tree plantations for pulp and paper, on the other hand, are well known. And while oil palm plantations tend to target forests, timber plantations are commonly established at the expense of biodiverse grasslands as well as forests.

In West Papua, the Indonesian government has already granted a concession for rainforest conversion for woodchips and pellets for export for bioenergy (tinyurl.com/3d4aasn). In Ghana, Liberia and Guyana, energy companies are investing in plantations for the export of wood for European power stations, however no independent information has been published about those projects. In Tanzania, diverse grasslands are being converted to tree plantations by a Norwegian company which cites bioenergy as one purpose. And in Brazil, plantation company Suzano Papel e Celulose is investing in new eucalyptus plantations in an area with Cerrado savannah, the world's most biodiverse savannah, as well as remnants of the Atlantic rainforest (tinyurl.com/3gsuqg4). One of Suzano's key aims is to grow wood for bioenergy, to supply MGT's two new large power stations in north east England (tinyurl.com/3ztbqr9).

Anaerobic digestion

In Germany, the demand for biogas from maize and, to a lesser extent, grass silage, is widely regarded as a key driver of biodiversity destruction. 90% of German biogas is made from maize and 800,000 hectares of land have been converted as a result, expanding maize monocultures to 1.85 million hectares. In some regions, as much as 60% of arable land is now under maize. Furthermore, richly biodiverse meadows, which used to be cut once or twice a year are now cut as often as six times annually, decimating their fauna and flora – in order to produce high yields of grass silage to supply biogas digesters. Often, meadows are displaced directly with a few species of fast-growing grasses, optimised for biogas production but disastrous for biodiversity (tinyurl.com/3ugp3nn). Other meadows are converted to maize. Birds including Montagu's harrier, barn owls, sky larks and storks are under serious threat.

Waste incineration

Waste incineration in the UK and elsewhere in the world discourages reusing, recycling and, where appropriate, composting materials, whether fossil-fuel based plastics, or organic waste, including paper (tinyurl.com/6d9zso5). It thus encourages more overconsumption of natural resources, such as wood and fossil fuels and thus contributes to ecosystem degradation and destruction.

Air pollution and public health

Biofuels

Biofuel power stations emit significant amounts of nitrogen oxides, as well as emitting small particulates, Polycyclic Aromatic Hydrocarbons and a range of Volatile Organic Compounds, some of which are linked to cancer and birth defects. Their emissions are very similar to those from burning mineral diesel. Nitrogen oxides and small particulates are associated with respiratory and heat disease (tinyurl.com/6kfqo75). In a planning appeal regarding a biofuel power station application in West London, the developer was refused planning permission because impacts on air quality (nitrogen dioxide in particular) would have been very significant, despite the company planning to use the most effective abatement technology (tinyurl.com/665ndku).

Biomass

According to figures by the US Environmental Protection Agency (tinyurl.com/6ew4omu), burning 'clean', i.e. not chemically treated wood emits 79 different pollutants. Those include nitrogen oxides, sulphur dioxide and small particulates, dioxins and furans, formaldehyde, benzene, cadmium, arsenic and chromium and lead. Some of those are linked to respiratory and heart disease, others to cancer and birth defects or other health problems. Burning chemically treated wood emits even more different pollutants, as well as higher rates of dioxins and furans, heavy metals and some other toxins. Former UK Energy Minister Jim Fitzpatrick cited Government commissioned research which showed that 'ambitious' scaling up of biomass in the UK will lead to between 340,000 and 1.75 million life years being lost in 2020 (tinyurl.com/6dl7b67).

Waste incineration

Waste incineration (including gasification and pyrolysis) emits hundreds of different chemicals, many of them toxic and many of unknown composition (tinyurl.com/6x2vyvx). Those include, amongst others, small particulates, dioxins and other halogenated organic compounds, mercury, heavy metals and nitrogen oxides. Some of them, such as dioxins and mercury, remain in the environment for a long time, accumulate over time and are toxic even in very low doses. Health impacts of dioxins include cancer, birth defects, immune system damage, behavioural disorders, IQ deficits and disruption of normal hormone production. Mercury is a powerful neurotoxins, which means it attacks the central nervous system, as well as heart, kidney and lungs. Like many other toxins, it is particularly harmful to young children and to unborn babies.

Human rights, landgrabbing, the right to food

Biofuels

According to a 2011 report by the High Level Panel of Experts on Food Security and Nutrition, published by the UN's Food and Agriculture Organisation (tinyurl.com/3kjjbpz), "food price volatility over the last four years has hurt millions of people, undermining nutritional status and food security". Food prices spiked in 2007/08 and are now climbing again, following a drop in 2009/10. The Panel found: "The biofuel boom had a major impact on the evolution of world food demand for cereals and vegetable oils." Between 2000 and 2010, vegetable oil use for biofuels climbed by 23% whereas demand for vegetable oil for food rose by only 3.3%, less than the previous decade. The Food and Agriculture Organisation estimated that between 2007 and 2009, food price rises forced an additional 173 million people to go hungry, with the

number of hungry people rising again in 2011, after a temporary slight drop (tinyurl.com/648wh9r).

However, food price rises are not the only way in which biofuels cause people to go hungry:

Between 2006 and 2011, at least 50 million hectares of good agricultural land worldwide, most of it in the global South, has been leased or sold to private companies and thus lost to farmers (tinyurl.com/6gvh5m6). According to ActionAid, in just five Africa countries, 1.1 million hectares of land have been given over to industrial biofuels and European companies have requested at least another 5 million hectares of farmland for biofuels across the global South (tinyurl.com/yd8p9cv). ActionAid Tanzania also point out that industrial scale biofuel plantations divert labour away from food growing, leaving some land idle and meaning local communities have to rely on distant and expensive markets for their food.

Growing numbers of small farmers are seeing their land, often communal land, handed over to private investors, very often without their consent and for pitiful 'compensation', if any. In many cases, communities have found themselves evicted by force, which can involve violence, including by paramilitaries hired by companies, even torture and murder. For example, in the Bajo Aguan Valley in Honduras, at least 45 peasants were murdered between June 2009 and June 2011, with deaths linked to private security forces employed by oil palm plantation companies (tinyurl.com/66blrxw). Nobody has been prosecuted for any of the murders.

Biomass

Similar land-grabs as described for biofuels are also happening for industrial tree plantations across Southern countries. So far, most such plantations are for pulp and paper but the new demand for biomass is leading to new investments in plantation expansion, from West Africa to West Papua to Brazil, this time to supply European power stations. Some of the plantations are being established to grow eucalyptus or other trees for biomass burning in Europe – others to fill the gap in wood supplies for the paper industry and others created by more and more North American and European wood being burned. A recent report by the International Institute for Environment and Development warns: "Already there is evidence of foreign investors acquiring land in Africa, South America and Southeast Asia to establish tree plantations for biomass energy. If left unchecked, these trends could increase pressures on land access and food security in some of the world's poorest countries and communities."(tinyurl.com/6dw5czh) This confirms warnings in a previous report by the Global Forest Coalition (tinyurl.com/5wfu5vh). An example is a proposed $1.3 billion investment in new eucalyptus plantations by the Brazilian paper and plantation company Suzano Papel e Celulose in the Northeast of Brazil, which coincides with a Memorandum of understanding between Suzano and UK energy company MGT Power. MGT have obtained planning permission for a 299 MW biomass power station and are awaiting permission for another one the same size, which together will burn 5-6 million tonnes of biomass a year, most of it to be supplied by Suzano. At least 150,000 hectares of eucalyptus plantations will be needed to supply MGT's power stations in England. Suzano has been denounced by Brazilian social movements, including the MST, over land-grabbing and expanding eucalyptus at the expense of food crops, undermining agrarian reform (tinyurl.com/3x259s2).

Anaerobic digestion

Biogas feedstock is not globally traded but tends to be far more local than that for biofuels and biomass. Nonetheless, large-scale biogas production from whole crops such as maize will cause the same food- versus-fuel competition and is likely to further push up food prices in the same way as is the case for European and US biofuel production from corn and wheat.

Water demands

Biofuels and biomass

Currently nearly one billion people lack access to safe water and 2.5 billion live without improved sanitation. Much of Africa, and parts of South America and Asia are officially in 'Water scarcity' Water demands will increase due to population growth, economic development

and as climate change causes more erratic and severe weather patterns. The impacts of these trends will particularly be felt in the Global South which contains important regions for biofuel production where they directly affect human health and economic livelihood.

Globally, biofuels currently take about 1 percent of all water used by crops but this will increase in line with bio-energy expansion. It takes on average roughly 2500 litres of water to produce one litre of biofuel. (tinyurl.com/6a4s6d4).This is about the same amount of water used on average to provide the daily food for one person.

Plantation trees that are starting to be grown for bioenergy like eucalyptus, pine and acacia have extremely high water demands. The experience from plantations grown to supply the paper and pulp industry is that they will rapidly out-compete indigenous plants, deplete ground water resources and adversely affect agriculture in nearby areas.

Food plants grown for biofuel such as palms, sugar cane and soy, need fertile soil and water to give high yields. Non-food plants, notably Jatropha, are promoted as suitable for arid areas, but yields are very low without adequate water. Research by the University of Twente, published in 2009, (tinyurl.com/6zkkbza) gave estimates for the water footprint of different biofuels. Jatropha is highlighted as the worst plant - needing up to 20,000 litres of water to produce 1 litre of biodiesel. An unpublished research project at Imperial College London reported in Sept 2011 that Jatropha's footprint could in some cases be as much as 200,000 litres of water per litre of fuel.

The University of Twente report concludes, "*The ethical discussion on whether food crops can be used for energy should be extended to a discussion on whether we should use our limited water resource base for food or for energy*." While it is very valid to raise overall concerns in this way, it is important to recognise that global averages hide the localised effects of extreme demands for water to grow biofuel or biomass crops in plantations. It is these local impacts that can move indigenous people from adequacy into subsistence and then into extreme water shortage.

As well as depleting water supplies, increased use of pesticides, nitrogen fertilisers and other agro-chemicals contributes to the pollution of freshwater as well as marine ecosystems.

Anaerobic digestion

In Germany, the rapid expansion of maize for biogas poses threats to groundwater and other freshwater, because maize monocultures require large quantities of nitrogen fertilisers. Water suppliers have warned that increased maize production for biogas is causing nitrate levels in ground water to rise and thus threatening the safety of drinking water (tinyurl.com/63by26a).

ROCs for Bioenergy and Impacts of Genetic Engineering

Biofuels and Biomass

Biotech companies developing Genetically Engineered trees, crops, algae and microbes play a strong role within the biofuel and biomass industry, both directly and through strategic partnerships with corporations including BP, Shell, ADM and with pulp and paper/timber companies (tinyurl.com/5wqqalf). For example, many of the companies investing or proposing to invest in biofuel power stations state that they want to use jatropha and/or algal oil. However, there are no commercial supplies of either. In the case of jatropha, large areas of land continue being grabbed and converted to plantations but crop failure has been widespread and jatropha oil harvests have been very poor at best. In the case of algae, after more than 30 years of research, nobody has yet found a way of producing energy from algal biofuels. Growing, harvesting and refining algae without expending much more energy on the process than is gained from burning the biofuels has so far proved impossible. Jatropha and algae are two of many biofuel and biomass feedstocks which companies are trying to genetically engineer in the hope of raising yields.

The growing demand for wood for bioenergy is being used to justify the development of GE trees, including faster-growing varieties or cold-resistant GE eucalyptus by companies such as Arborgen or Suzano (see information above about Suzano in relation to land-grabbing).

Unintended and unpredicted effects of genetic engineering of crops have been widely found and documented (tinyurl.com/6z8ky3f). They relate on the one hand to genetic mutations and very poorly understood links between crop genes and crop traits/properties, and on the other hand to wider environmental impacts. For example, 'herbicide resistant' GM crops are associated with a steep increase in herbicide-resistant 'super weeds', causing ever more different and toxic agro-chemicals being applied. Even less is known about the impacts which GE trees, GE algae and GE microbes would have on ecosystems, however trees can cross-pollinate and spread over much larger areas than crops, while algae and microbes can multiply much faster, thus making controls and containment even less possible. What is certain, however is that any technical 'breakthrough' in those developments would lead to even more lands being converted to fast-growing tree plantations (e.g. if eucalyptus plantations became viable in temperate or boreal zones), threatening yet more natural forests, and to a new commercial exploitation of freshwater and marine habitats in the case of GE algae. Economic impacts of genetic engineering include greater economic power and control by companies holding the patents.