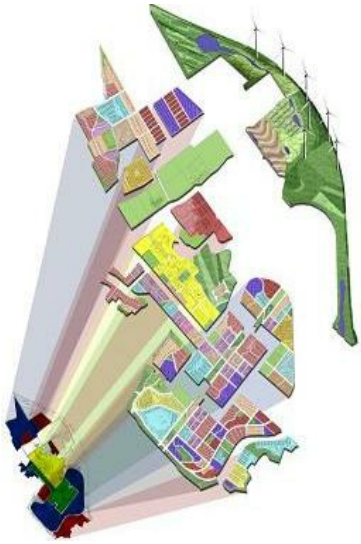

Health Briefing Sheets

The ReVISIONS research aims to provide the knowledge and evidence base for public agencies and private companies to plan regional development together with infrastructure for transport, water, waste and energy, in a more coordinated and integrated way so as to maximise economic competitiveness, reduce impacts on the environment and resources and allow households to live more sustainably, with a socially inclusive and enhanced quality of life.

EPSRC

Biomass Use & Health

This fact sheet, based on a review of the literature, aims to provide a brief introduction to biomass use and bring information to a non-specialist audience on the potential health impacts of its widespread implementation. For those who want further information an extensive and fully referenced report on Energy and Health is available at:

http://www.regionalvisions.ac.uk

Background

"*Biomass is the collective term used to describe plant matter and also derivatives such as residues from forests and crops, animal wastes and the organic content of municipal and domestic waste*"[1]. Biomass sources can, therefore, be very diverse. In addition (as with fossil fuels) biomass can provide energy for a wide range of applications, including domestic and industrial heat, transport fuels and electricity[2].

Compared to fossil fuels, biomass is often limited by the energy density of the stored fuel (i.e. it has a large volume to energy content ratio). In its raw, unprocessed, state it is often geographically widely dispersed. It is, therefore, important to strike a balance between the costs and energy used in collecting and concentrating the fuel and the returns expected from its use[1]. Ideally then, it should be produced and consumed locally.

Small-scale domestic use and district heating

Traditional home wood heating systems (especially open fires), which use unprocessed firewood, are both inefficient and emit pollutants. In a study in Sweden, it was reported that old firewood boilers emit about 80% more particulate matter (PM_{10}) and benzene, than modern, environmentally approved ones[3]. This potential for pollution has led to speculation that extensive use of biomass fuels in residential areas could lead to poor indoor (and outdoor) air quality if obsolete boilers or systems are used or heating units are inappropriately used or poorly maintained[4]. Jonsson and Hillring[3] investigated the impact that conversion from electrical heating to modern (wood pellet) firewood boilers and small-scale district heating systems would have on the local air quality of residential areas in Sweden. They concluded that conversion to biomass heating would not significantly negatively impact on outdoor air quality (i.e. local environmental quality standards would not be breached as a result). Small-scale district heating systems, however, offered a number of advantages over home-based systems, including lower emissions and convenience (with no maintenance required by individual residents). A different approach to the question of emissions was taken by Meyer[5]. He prepared an inventory of annual and monthly emissions from small-scale residential wood combustion appliances in Switzerland, including open fireplaces, closed fireplaces, wood stoves and wood pellet stoves. He used emission factors that accounted for both normal and poor combustion conditions and also different types of wood (hard and softwood). Emissions were, perhaps not surprisingly, found to be dominated by those from open fireplaces and Meyer notes that selective targeting and upgrading of open fireplaces could have a large positive impact on Swiss emissions.

Electricity generation

Biomass is the only fuel available for renewable, combustion-based electricity generation[6]. There are three main

technology types for the combustion-based conversion of biomass into electricity, namely pyrolysis, gasification and direct combustion. Direct combustion is the oldest and simplest, but most inefficient, technology. Gasification and pyrolysis have higher efficiencies, but require significantly more process control and investment.

In the UK, 2007 figures showed that there were 19 dedicated biomass plants with an installed generating capacity of 50kW or more[7]. Some of these plants have been designed to utilise specific animal or plant by-products and generate income from the production of by-products such as fertiliser or from the disposal of agricultural waste[7]. More common than dedicated biomass plants is the co-firing of biomass in coal-fired power stations, with the level of co-firing being dependent on the type of biomass and the co-firing techniques used. Tests have demonstrated that up to 20% biomass (by thermal input) can be successfully co-fired[7]. The highly variable nature of biomass feedstocks can cause complications; while a product such as coal can be carefully monitored and maintained at steady calorific and ash levels, allowing for steady process control and minimising fouling, the same is not true of biomass[6]. Even when using the same crops significant variations can be seen.

Occupational health

It is claimed that there are more occupational injuries and illnesses associated with biomass in agriculture and forestry than with underground coal mining, oil or gas extraction[6]. There may also be health issues related to the storage of biomass. Depending upon how and where it is stored there may be a risk of spores and fungus formation[8], which may have implications for respiratory health. The Electricity Industry Occupational Health Advisory Group has outlined a number of health aspects associated with burning biomass in power generation[9]. The principal hazards are from exposure to dusts and to spores and bacteria with the potential to cause respiratory problems, including occupational asthma, organic dust toxic syndrome (a potentially severe flu-like syndrome) and extrinsic allergic alveolitis (inflammation within the lung and airways). Information available to the end of 2010 suggest that, to date, there have been no cases of organic dust toxic syndrome and extrinsic allergic alveolitis associated with biomass use in the electricity industry[9].

Sustainability issues

The use of biomass is often claimed to be carbon neutral[10,11], but this may well not be the case and depends on a number of factors including the type of biomass and whether land is cleared in order to grow the crop[6,12].

In order for biomass to play a significant role in the world's energy future, dedicated energy crops are essential[6]. It is, however, vital that these crops do not displace food crops. Short rotation energy crops, such as poplar, willow, eucalyptus and non-woody perennial grasses (e.g. *miscanthus*) are popular, but it is vital that depletion of soil nutrients, organic matter and moisture-holding capacity are considered in relation to the use of these crops. There is disagreement over the viability of dedicated energy crops[6]. Some authors claim that the production of energy crops on abandoned agricultural land and land 'at rest' may allow large amounts of biomass to be produced economically[13,14], while others feel that there is insufficient surplus agricultural land available[15], although this may vary on a country-by-country basis.

In a nutshell

The health impacts of using biomass as an energy source are likely to depend on how its use is implemented, i.e. at individual properties, for district scale heating or in centralised production of electricity. The source of biomass is also likely to be important (waste material versus specifically grown material). With proper management and maintenance of biomass systems air pollution should not be a problem. There are, however, a number of occupational-related health hazards associated with biomass.

References

1. IET (2007) Fuels from biomass. The Institution of Engineering and Technology.
2. Gross R, Leach M, Bauen A (2003) Progress in renewable energy. *Environment International* 29, 105-122.
3. Jonsson A, Hillring B (2006) Planning for increased bioenergy use – evaluating the impact on local air quality. *Biomass and Bioenergy* 30, 543-554.
4. Verma VK, Bram S, De Ruyck J (2009) Small scale biomass heating systems: standards, quality labelling and market driving forces – an EU outlook. *Biomass and Bioenergy* 33, 1393-1402.
5. Meyer NK (2012) Particulate, black carbon and organic emissions from small-scale residential wood combustion appliances in Switzerland. *Biomass and Bioenergy* 36, 31-42.
6. Evans A, Strezov V, Evans TJ (2010) Sustainability considerations for electricity generation from biomass. *Renewable and Sustainable Energy Reviews* 14, 1419-1427.
7. Perry M, Rosillo-Calle F (2008) Recent trends and future opportunities in UK bioenergy: maximising biomass penetration in a centralised energy system. *Biomass and Bioenergy* 32, 688-701.
8. Rentizelas A, Tolis AJ, Tatsiopoulos IP (2009) Logistics issues of biomass: the storage problem and the multi-biomass supply chain. *Renewable and Sustainable Energy Reviews* 13, 887-894.
9. OHAG (2011) Health aspects of burning biomass in power generation. Guidance Note 4.3. Electricity Industry Occupational Health Advisory Group.
10. Turkenberg WC (2000) Renewable Energy Technologies. In: *Energy and the Challenge of Sustainability*. UNDP, New York, USA. pp. 220-272.
11. Johnson E (2009) Goodbye to carbon neutral: getting biomass footprints right. *Environmental Impact Assessment* 29, 165-168.
12. Van Belle J-F (2006) A model to estimate fossil CO_2 emissions during the harvesting of forest residues for energy – with an application on the case of chipping. *Biomass and Bioenergy* 30, 1067-1075.
13. Strezov V, Evans T, Hayman C (2008) Thermal conversion of elephant grass (*Pennisetum Purpureum Schum*) to biogas, bio-oil and charcoal. *Bioresource Technology* 99, 8394-8399.
14. Hoogwijk M, Faaij A, de Vries B, Turkenburg W (2009) Exploration of regional and global cost-supply curves of biomass energy from short-rotation crops at abandoned cropland and rest land under four IPCC SRES land-use scenarios. *Biomass and Bioenergy* 33, 26-43.
15. Koh MP, Hoi WK (2003) Sustainable biomass production for energy in Malaysia. *Biomass and Bioenergy* 25, 517-529.

Dr Lorna Fewtrell

Centre for Research into Environment and Health (CREH)
Aberystwyth University