This briefing looks at the main public health concerns related to biomass power electricity, including both dedicated biomass power stations and burning significant quantities of wood in coal power stations. This briefing focuses on 'conventional' power stations using direct combustion rather than gasification or pyrolysis and on burning wood, which is the most common type of biomass burned for electricity.

Which types of air pollutants are emitted from burning wood in power stations?

Burning wood emits similar levels and a similar range of pollutants as burning coal, albeit smaller quantities of certain pollutants (mainly sulphur dioxide and mercury) and greater quantity of others (such as Volatile Organic Compounds and, generally, small particulates, i.e. PM2.5).

The largest volume of air pollutants are oxides of nitrogen (NOx), carbon monoxide (CO), small particulates (PM10, including PM2.5) and sulphur dioxide (SO_2) (as well as carbon dioxide, which affects the climate rather than public health when emitted at rates typical for power plants). Burning virgin wood also results in a wide range of other pollutants. These include Antimony, Arsenic, Cadmium, Chromium, Copper, Dioxins and Furans, Lead, Manganese, Mercury, Nickel, Polycyclic Aromatic Hydrocarbons (PAHs), Selenium, Vanadium and Zinc.

Burning chemically treated waste wood emits the same range of pollutants as burning virgin wood, as well as additional ones. It also results in greater emissions of certain pollutants – especially heavy metals and dioxins and furans – compared to burning untreated wood. Wood may be treated with Copper Chromium, Arsenic, Copper Organics, Creosote, Light Organic Solvent, Preservatives, Microemulsion, paint, stain or varnish, fungicides and insecticides. The range and concentrations of toxins will depend on the chemicals used to treat the wood. Hexavalent Chromium (Chromium VI) is of particular concern if treated waste wood is burned.

What levels of air pollution do wood-burning power stations emit?

This depends on various factors: The size of the power station, the efficiency of the plant (with less efficient plants burning more wood and thus emitting more pollutants per unit of energy), the combustion technology, the temperature at which the wood is burned and the type of mitigation systems installed.

Power stations must be equipped to mitigate NOx and small particulate emissions in particular. Some mitigation technology is more effective (and therefore often more expensive) than other systems but none can eliminate NOx, particulates or any other pollutants. Below are three examples that illustrate the scale of NOx and PM10 emissions from biomass power stations.

Power station operator claims about 'average' rates of emissions are usually based on emissions while the plant is smoothly operating. However, every power station will be shut down and restarted several times a year even when there are no technical problems which would otherwise cause shutdowns. When a new power station starts operating – or when a modified and converted coal power station first starts to operate as a biomass plant – shutdowns and startups initially will be

more frequent. During these periods, emissions, of Dioxins and Furans, or Polycyclic Aromatic Hydrocarbons (PAHs) and of other pollutants, including NOx, have been found to spike, often significantly so. For example, a Japanese study found that for an incinerator that had low dioxin emissions during steady state operation, four startups accounted for 41% of all such emissions in a year[1]. A Taiwanese study[2] showed that a single startup operation could emit 60% of the dioxins and furans that would be emitted during a whole year of continuous operation otherwise.

Examples of existing power stations, based on inventories published by regulating authorities

1) Steven's Croft biomass power station, E.On, Scotland:

This is a 50.4 MW biomass power station permitted to burn virgin as well as waste wood. On average, it has been operating at 61% of its load, which means that the emissions would be equivalent to that of a 34 MW power station operating at 90% of its load (the maximum assumed for biomass plants). It uses 'Best Available Technique[3]' for mitigating NOx and small particulate emissions.

In 2012, the plant emitted 359.05 tonnes of NOx 2.307 tonnes of small particulates (PM10)1.154 tonnes of very fine particulates (PM2.5 – which are included in the above PM10 figure)

This is equivalent to:NOx emissions from adding 853,702 diesel cars to the road[4];PM10 emissions from adding 2,000 diesel cars to the road.

2) McNeil Generating Station, BED, Vermont (US):

This is a 50 MW biomass power station that burns virgin wood only. Its systems for mitigating NOx and small particulate emissions would be classed as 'Best Available Technique' within the EU. It is currently the single largest source of air pollutants in Vermont.

In 2011, the plant emitted240.31[5] tonnes of NOx 1.91 tonnes of small particulates (PM10) 1.64 tonnes of very fine particulates (PM2.5 – which are included in the above PM10 figure)

This is equivalent to:NOx emissions from adding 571,378 diesel cars to the road;PM10 emissions from adding 1,656 diesel cars to the road.

What are the health impacts of biomass power station emissions?

Health risks depend on various factors: The amount of pollutants emitted by a particular plant, the height of the stack (with higher stacks dispersing pollution more widely so that more people are affected but pollutants from the plant are less concentrated nearby), the local topography (which determines how quickly and widely pollutants disperse), weather conditions, and the level of pollution to which people are already exposed without the power station. Health risks will always increase with the level of pollution. The health impacts of a new power station will therefore be particularly severe in areas that already have high existing pollution levels, and in areas where the pollution cannot disperse easily (for example if it is located near hills which block air movement).

---

1 Characteristics of dioxin emissions at startup and shutdown of MSW incinerators, Hajime Tejima et al, Chemosphere 66 (2007) 1123–1130

2 Influence of start-up on PCDD/F emission of incinerators, Lin-Chi Wang et al, Chemosphere 67 (2007) 1346-1353

3 Best Available Technique is a legal term that covers a range of different technologies, some more effective than others. In practice, it often means second or third best technology.

4 For emission figures for diesel cars, see http://www.air-quality.org.uk/26.php. The calculation is based on the assumption that each car will travel 13,567 km per year, the UK average for 2010: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/8932/nts2010-01.pdf

5 All figures converted from the EPA's short ton figures to metric tonnes.

Furthermore, vulnerable groups of people are at greater risk. Babies, children, elderly people and people with underlying health problems such as asthma or heart disease are particularly vulnerable.

Biofuelwatch's research[6] indicates that in England, proposed and existing biomass power stations are predominantly sited in areas with a high level of deprivation. This could mean that existing poor community health in socially deprived areas is compounded by increased air pollution from these power stations.

Detailed evidence of the health effects of different air pollutants has been published by the World Health Organisation[7]. Here is a very brief summary:

- 80% of deaths linked to air pollution are due to heart disease and strokes, 14% to lung and bronchial disease and 6% to cancer;
- Long-term exposure to nitrogen dioxide (***NO_2***) is linked to reduced lung functions and increased symptoms of bronchitis in children with asthma;
- Short-term exposure to very high levels of NO_2 causes inflammation of airways;
- NO_2 is an important source of ultrafine particulates (PM2.5);
- NO_2 is a major source of ground-level ozone, which is linked to breathing problems, asthma attacks, reduced lung function, lung and heart disease;
- Long-term exposure to small particulates (***PM10***) is linked to respiratory and heart disease and to lung cancer. Most serious are the impacts of the smallest of those particulates (***PM2.5***), for which there are no safe levels of exposure;
- High levels of SO_2 affect the respiratory system and lung function and are a particular risk to people with asthma;
- Polycyclic Aromatic Hydrocarbons (***PAHs***) are carcinogenic and directly damage cells;
- Dioxins and Furans are highly toxic and persist long-term in the environment. They can cause reproductive and developmental problems, damage the immune system, cause cancer and interfere with hormones. Air emissions of dioxins can be inhaled, but they can also end up in the food chain;
- Other pollutants emitted by biomass burning in power stations pose a range of health risks, including cancer, inflammation of airways, hormone disruption and birth defects.

Recent studies suggest that air pollution may be responsible for a wider range of health effects, including learning and memory difficulties, depression[8], the risk of dementia[9], autism and schizophrenia[10].

Wood dust exposure

Wood dust is a known carcinogen, according to the World Health Organisation's International Agency for Research on Cancer[11]. Exposure to wood dust is associated with a range of other health risks, including skin disease, allergic and non-allergic respiratory problems such as increased incidents of asthma attacks and chronic bronchitis, as well as nasal problems[12].

Most of the studies that have looked at the health effects of wood dust exposure have focussed on the impacts of workers, for example in sawmills. However, local residents in various places exposed to dust from wood chipping operations have reported similar health problems. A US study confirms a higher incidence of reported health problems associated with wood dust exposure amongst residents who live close to a wood treatment plant.[13]

---

6 http://www.biofuelwatch.org.uk/2013/chain-of-destruction/
7 http://www.who.int/topics/air_pollution/en/
8 http://www.sciencedaily.com/releases/2011/07/110705071735.htm
9 http://www.alzinfo.org/07/articles/prevention-and-wellness/air-pollution-raise-dementia-risk
10 http://www.urmc.rochester.edu/news/story/?id=4100
11 http://monographs.iarc.fr/ENG/Classification/ClassificationsAlphaOrder.pdf
12 https://www.osha.gov/SLTC/etools/sawmills/dust.html

Wood dust can affect local people who live close to wood-burning power stations, especially if woodchipping is carried out on the same site. However, many power station operators rely on wood that has been chipped elsewhere, and/or on wood pellets. In these cases, the impacts of wood dust are most likely to be felt by residents who live close to the wood chipping (often, misleadingly called 'wood recycling') and woodchip storage sites, and the pellet mills that supply power stations.

Other health risks associated with wood-burning power stations

Persistent noise nuisance has been reported as a serious problem by residents living close to some biomass power stations[14]. Noise pollution, particularly at night, is associated with a wide range of health impacts[15]. In addition to the air emissions from the power station, there will be increased traffic-related air pollution, particularly if the wood is transported by lorry.

Noise, dust and traffic have been reported as serious problems by people living close to pellet plants which supply power stations[16].

Safety risks

Self-ignition of woodchips or pellets, and fires and explosions caused by wood dust, are major safety risks wherever large quantities of woodchips and pellets are handled. These safety risks are greater than the risks involved in handling large quantities coal[17]. Between 2008 and 2012, at least 76 accidents involving fires or wood dust explosions linked to wood pellets – some of them fatal - were reported worldwide by the media.[18]

The conversion of coal power stations to biomass poses particular risks because of the large quantities of wood pellets burned by such plants. This is because many of them rely on burning pulverised wood pellets and because there is relatively little experience with such conversions. In the UK for example, out of three coal power stations partly or fully converted to biomass, two have subsequently experienced major fires[19].

Read more:

Biomass: The Chain of Destruction - http://www.biofuelwatch.org.uk/2013/chain-of-destruction/
Partnership for Policy Integrity - http://www.pfpi.net/air-pollution-2
Energy Justice Network - http://www.energyjustice.net/biomass/health

---

13 Health effects on nearby residents of a wood treatment plant, J. Dahlgren et al, Environ.Res, June 2003, www.ncbi.nlm.nih.gov/pubmed/12854688
14 http://www.wuft.org/news/2013/10/09/locals-frustrated-by-gainesville-biomass-plant-noise/, http://www.fifetoday.co.uk/news/local-headlines/markinch-residents-still-not-happy-with-biomass-noise-1-3462390
15 http://www.medscape.com/viewarticle/554566_3 , http://www.cbc.ca/daybreaknorth/interviews/2014/05/15/prince-rupert-residents-upset-about-smell-noise-coming-from-pellet-plant/
16 http://www.cbc.ca/daybreaknorth/interviews/2014/05/15/prince-rupert-residents-upset-about-smell-noise-coming-from-pellet-plant/ and http://www.dogwoodalliance.org/2014/03/monster-enviva-wood-pellet-plants-invade-northeast-nc-communities/
17 This refers to storage and handling of coal in power stations, not mining.
18 http://www.biofuelwatch.org.uk/?s=fires
19 http://www.bbc.co.uk/news/uk-england-essex-17177035 and http://www.expressandstar.com/news/2014/02/04/fire-breaks-out-at-ironbridge-power-station/