IEA Bioenergy

Aerosols from Biomass Combustion

Summary Series

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SUMMARY

The use of biomass for heat and power production is supported in many countries since biomass as a renewable fuel can effectively substitute fossil fuels and consequently reduce fossil CO_2. During biomass combustion, inhalable particulate matter smaller than 10 micrometres (PM10) can be generated which can cause adverse health impacts. CO_2 mitigation strategy involving biomass therefore needs to consider potential health impacts and ensure low PM emissions. This report summarises the current knowledge on the health relevance of combustion generated PM, describes the mechanisms which can cause PM in biomass combustion, describes different particle types, and provides information on measures to reduce PM from biomass combustion. In summary, biomass can play an important role in future energy supply in an environmentally friendly manner through implementation of state-of-the-art combustion devices and their appropriate operation.

The full report is available at: http://task32.ieabioenergy.com/wp-content/uploads/2017/07/Nussbaumer_IEA_T32_Aerosol-Report_2017_07_14.pdf

RECOMMENDATIONS

Due to the significance of particulate matter on ambient air quality, IEA Bioenergy Task 32 has long acknowledged the need to evaluate the role of biomass combustion on PM and to identify priorities for improvements to reduce PM emissions. Based on the collected findings, IEA Bioenergy Task 32 concludes that the following topics need to be supported to avoid an adverse impact of biomass combustion on ambient air quality and to promote the implementation of bioenergy in an environmentally friendly way:

1. Particularly high exposure levels to biomass combustion particles in indoor air are caused by **open fires and poor combustion conditions** in appliances used for cooking and heating in developing countries. Consequently, it is a high priority to implement measures to substitute such combustion principles with improved concepts such as gasifier stoves or to replace such applications with cleaner technologies and fuels in order to reduce the global mortality caused by biomass smoke.

2. Operation of combustion devices has a direct and strong influence on emissions of air pollutants. This is true for all devices, but is however, most relevant for *manually operated*

stoves, furnaces and boilers. One important issue is the use of **appropriate fuel** with respect to its moisture, size, and ash content for meeting the design and operational requirements of the combustion device. Another important aspect is establishing an **appropriate start-up regime**. In addition, the amount of wood for each batch **loading** needs to match the size of the combustion chamber. Finally, **sufficient combustion air**, although not exceeding a reasonable amount, needs to be supplied, while air throttling during the combustion phase needs to be strictly avoided. Secondary measures such as catalytic converters and electrostatic precipitators are available for wood stoves and boilers and may assist reducing pollutants in certain cases. Nevertheless, these measures should only be considered as an add-on to near-complete combustion as they can be limited in their effectiveness.

3. **Standardisation** of biomass fuels, combustion devices, test types, and measurement methods and devices can assist target-oriented development furthering the quality of biomass combustion and ensure low impact on air quality. New standards should not only consider ideal situations of steady state conditions but also mimic real-life operations.

4. *Automated* biomass combustion plants for heat and/or power production incorporate advanced design and sophisticated controls conditions to achieve near-complete combustion. Hence **very low emissions of carbonaceous pollutants can be achieved with the appropriate operation** of the systems. Flue gas cleaning such as precipitation can be effectively applied to reduce inorganic particle emissions to an acceptable level. For automated plants, **quality management** of plant planning including design guidelines, appropriate sizing of combustion systems, heat storage to avoid frequent start-ups and load changes, and fuel quality management plans are pre-requisites for ideal operation. Furthermore, **plant monitoring** can assist the plant operation.

5. IEA Bioenergy Task 32 **supports the implementation of modern automated boilers** which are equipped with combustion control and efficient particle precipitation, used for heat and combined heat and power production in medium and large scale. Residential applications can also be justified if specific quality criteria for fuel and equipment are met. These include operating modern pellet boilers with high quality wood pellets and without overly frequent start-ups, or appropriately designing and operating log wood boilers, using seasoned dry wood logs, equipped with an electronic control and a heat storage tank. Applications causing high emissions such as **open fireplaces and old log wood appliances without combustion control should be discouraged especially in urban areas**.

6. Different types of primary aerosols, with significantly different properties and health impacts are formed during biomass combustion. In particular, there is evidence that organic pollutants from incomplete combustion, as emitted from inappropriately operated manual devices, exhibit strong cytotoxicity, while inorganic particles as emitted from properly operated automated biomass combustion reveal a far lower or even undetectable effect on the cell viability. In addition to primary particles, secondary aerosols can be formed in the atmosphere from volatile organic precursors, which are also present in flue gases from incomplete combustion. Consequently, future regulations should **consider the health relevance of different aerosol components** and take into account the potential impact of secondary aerosols.

7. An **international exchange** among all the stakeholders from research, industry, energy economics, and regulatory authorities can assist in furthering the advancements in a continuous manner. Establishing regulations on energy standards and air quality plays an important role and needs to be enforced on a national basis.