

Brief, March 2026

Particle pollution inside homes using wood stoves

It is well recognised that wood smoke is a significant source of outdoor air pollution. Wood smoke contains many of the same health hazardous particles and carcinogenic PAHs as tobacco smoke. Thereby increasing the risk of cancer, cardiovascular diseases, lung diseases etc i.e., contributing significantly to morbidity and premature mortality. According to Aarhus University, wood smoke from residential heating is the most harmful pollution source to outdoor air pollution in Denmark even though residential heating with wood only covers 2-3 % of the Danish energy consumption and could be replaced by cleaner heat sources without challenges.

However, focus on indoor air pollution from wood stoves is very limited despite that wood stoves are placed inside homes, e.g. in the living room, and thereby can emit pollution directly to the indoor air where it can disperse to the entire house (bedrooms, children's rooms etc.). Furthermore, wood stoves are mainly used during seasons where venting is limited and while families are at home inside the house; people are therefore potentially exposed to high levels of air pollution for many hours in their homes if their wood stoves leak pollution.

The pollution can leak from the wood stove when logs are put in (open stove door), because the chimney pipe and/or the wood stove are leaking, or because dust is burned on the hot surfaces of the wood stove. Turning on a cooker hood or opening a window or door while using a wood stove can cause draught down through the chimney and out in the living room increasing indoor pollution.

Previous investigations from 2012 made by the Danish Building Research Institute showed that even new eco-labelled wood stoves can cause high levels of indoor pollution. These investigations were confirmed by Green Transition Denmark performing measurements in 20 houses in 2017-18. In the fall 2021, students at the Technical University of Denmark confirmed once more that even new eco-labelled wood stoves can cause high indoor air pollution. Despite these investigations, there are still no requirements to limit indoor pollution levels from wood stoves; not even for new eco-labelled stoves. Investigations from Healthy Indoor Environment in 2023 documented that residents cannot smell the wood smoke inside their homes and use the smell as an urgent warning signal.

To attain focus on harmful wood smoke inside homes and thereby motivate people not to use wood stoves by switching to cleaner heating, Green Global Future has performed this pollution screening for woodsmoke funded by the *Clean Air Fund*: www.cleanairfund.org

Methods

Particles from a wood stove were measured synchronically:

- Ultrafine particles by a P-Trak (Model 8525) from TSI.
- Fine particles by a DustTraks (Model 8530) from TSI.
- Black carbon (soot) by a BC-meter from www.bcmeter.org

The measurements were conducted on February the 25th, 2026, in a typical residential home in Gentofte close to Copenhagen in Denmark. During the measurements, the owner of the house was asked to use and manage the stove as he usually does. Dry beech firewood was used. However, during our measurements venting was needed several times which is not usually done by the house owner when using the stove. This has reduced the recorded pollution significantly.

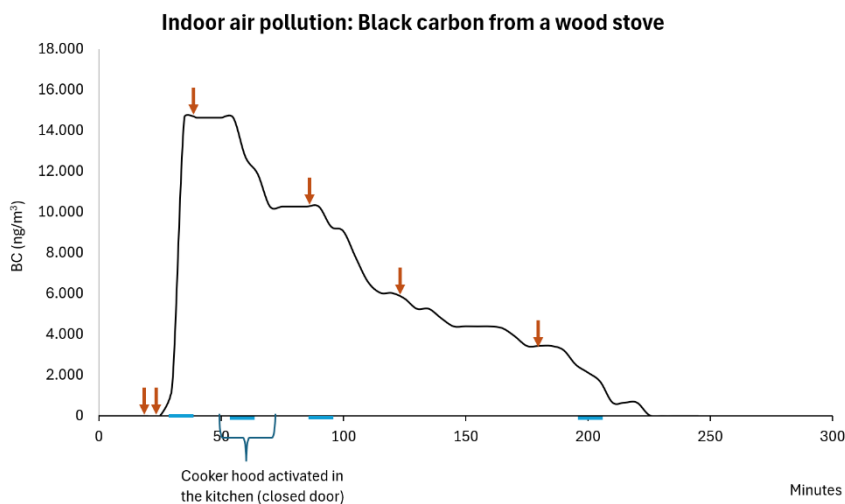
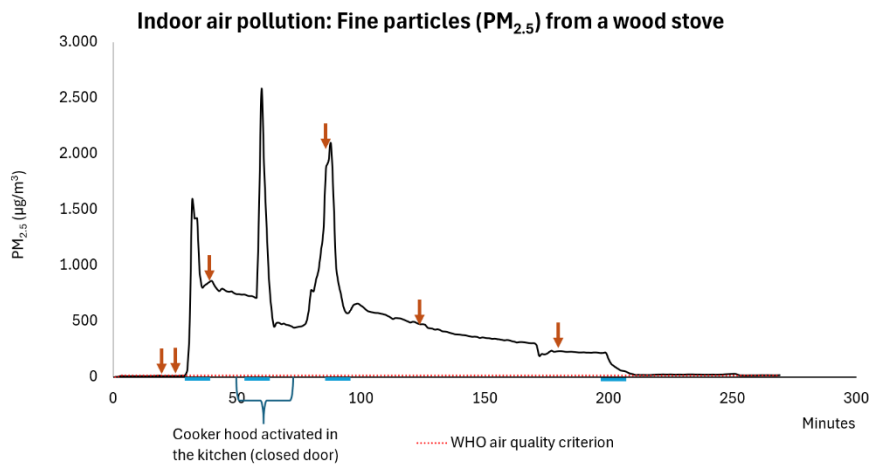
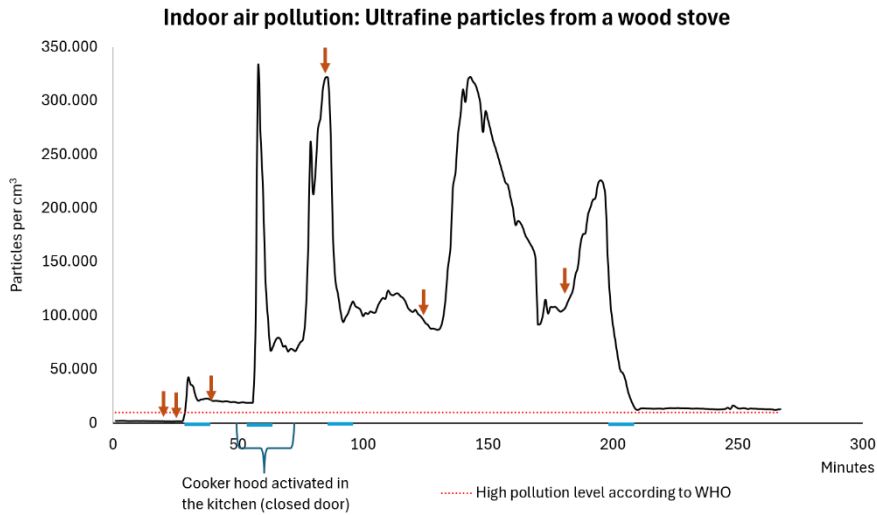
During measurements, the measuring devices were placed in the same distance from the wood stove as the residents would typically stay while using the stove (picture below).

Measurements were started 20 minutes before kindling and stopped around 4 hours after kindling. Candles, tobacco smoking, cooking without closed door to the kitchen during and after cooking, or other air pollution generating activities were avoided during measurements. Hence, measurements reflect pollution generated by the wood stove in the living room.



Results

In figure 1, the results of the air quality screening are shown. Measurements start 20 minutes before kindling. Brown/red arrows indicate that firewood was added. Blue lines indicate venting reducing the pollution in the living room. The cooker hood in the kitchen was turned on for 20 minutes during measurements with closed door between the living room and the kitchen.



From figure 1 it is clear, that the wood stove pollutes the air in the living room to very high levels with ultrafine particles, fine particles and black carbon. Air pollution levels far exceeding the levels of ultrafine particles considered as high by the World Health Organization (WHO) and levels of fine particles far exceeding the WHO air quality criteria for fine particles (daily mean). The pollution level with ultrafine particles in the living room are 10-15 times higher than the air in the rush hours on the most polluted streets in Copenhagen. The pollution level with fine particles in the living room are around 100 times higher than the air in the rush hours at the most polluted streets in Copenhagen.

Pollution peaks do not seem to be systematically related to adding wood to the stove and thereby an open stove door which indicates that the stove is leaking pollution even when the stove door is closed. The same observation was seen for many stoves in previous studies.

Pollution peaks for ultrafine particles, fine particles and black carbon do not systematically occur at the same times during measurements which could be because different pollutants are formed at different times in the incineration cycle depending on temperature, air supply etc.

Venting is efficient to reduce pollution in the living room (not seen as clear for black carbon probably because the BC meter measures averages with a 5-minute interval whereas the P-Trak and DustTrak measure every minute).

Conclusion

The screening confirms that a wood stove can pollute air inside homes to extremely high levels with hazardous ultrafine particles, fine particles and black carbon (soot).

Recommendations

- 1) Stop burning wood and switch to cleaner heat sources (district heating and heat pumps).
- 2) Use electric fireplaces to sustain a cozy atmosphere or just enjoy life without a fireplace.
- 3) Authorities should inform about the risk of high toxic indoor air pollution from wood stoves.
- 4) Wood stoves should have a label: *This stove can cause high toxic pollution inside your home.*
- 5) Wood stoves fulfilling the EU Ecodesign directive should be tested and required not to leak pollution inside homes (and have much stricter emission limits to outdoor air as well).

Further information

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