

Environmental briefing II (March 2022)

Pollution inside houses with wood stoves

It is well recognised that wood smoke is a significant source of outdoor air pollution. Wood smoke contains same health hazardous and carcinogenic compounds as tobacco smoke. According to the Danish authorities, wood smoke in the ambient air contributes significantly to morbidity and premature mortality.

However, focus on indoor air pollution from wood stoves is very limited despite that wood stoves are placed inside houses, e.g. in the living room, and thereby can emit pollution directly to the indoor air where it can spread to the entire house (e.g. bedrooms and children's room). Furthermore, wood stoves are mainly used in seasons where ventilation is limited and while families are at home; people could thereby be exposed to high levels of air pollution for many hours inside their houses 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 hot surfaces of the wood stove.

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 who performed measurements in 20 houses in 2017-18. In the fall 2021, students at the Technical University of Denmark confirmed again that even new eco-labelled wood stoves can cause high indoor pollution levels.

Despite these investigations, there are still no requirements on indoor pollution levels from wood stoves; not even for new eco-labelled wood stoves. Green Transition Denmark has now made new measurements to clarify if residents themselves can smell the pollution in their houses and use this indicator (smell of wood smoke) as a sign of exposure to health hazardous compounds and urgent need of ventilation.

Pollution screening

Green Transition Denmark has performed a screening of particle pollution in five houses with wood stoves installed. The results are summarized on the following pages. The purpose was to clarify if the residents can smell smoke in houses with high levels of indoor air pollution from wood stoves. The measurements were financed by European Climate Foundation and Birdlife Europe.

Conclusion

The screening confirms that significant indoor air pollution with ultrafine particles can occur even in houses where the wood stoves are eco-labelled. Pollution levels can be sky high and exceed the levels measured at the most polluted streets during rush hour. More important, the residents cannot detect smell of smoke and are therefore not aware of the health hazardous air pollution they inhale.

Recommendations

- 1) Authorities should inform about the risk of toxic indoor air pollution from wood stoves.
- 2) The eco-label should require that eco-labelled wood stoves cannot cause indoor air pollution.
- 3) For coziness, people should change to electric fireplaces to avoid health hazardous air pollution.

Results

The table shows the results of the measurements. Background measurements were performed outside the house and indoor in the living room before using the wood stove. Pollution measurements were performed during use of the wood stove (average level of particle pollution and highest 30 minute pollution levels). For comparison is shown pollution along the most polluted street in Copenhagen during rush hour.

	Background outside (particles/cm ³)	Smell of smoke	Inside the living room (2-5m from the stove)		Rush hour along the most polluted street	
			Background inside (particles/cm ³)	Stove in use (particles/cm ³)		Max. 30 min (particles/cm ³)
				Average	Max. 30 min.	
House 1	1,750	No	1,850	7,350	20-25,000	
House 2	2,100	No	2,150	35,700		
House 3	2,650	No	700 ¹⁾	58,450		
House 4	2,300	No	6,700 ²⁾	12,100		
House 5	2,250	No	4,150	115,500		

1) It was not possible to explain the low background concentration. Typical level of clean indoor air is 2,000-4,000 particles/cm³.

2) The relative high pollution level in the living room before using the stove may be due to use of the wood stove the day before.

The table shows a significant increase in indoor air pollution in all five houses while using the wood stoves. In two of the five houses (house 1 and 4), pollution levels do not reach the levels of the most polluted street during rush hour. However, particle pollution levels in the other three houses significantly exceed the levels on the street during the rush hour; in house 5, the levels exceed the levels along the most polluted street by a factor 10 (max. 30 min.), and in average by a factor 5. This pollution level is directly health hazardous. The graphs for the five measurements are shown on the following pages.

According to the residents, none of them can smell smoke when the stove is in use, only when lighting the fire. However, as the graphs show, the peaks of air pollution occurs an hour or more after lighting up the fire, which implies that the residents cannot smell smoke when the pollution is highest. There can be several reasons for this. Firstly, the particles are odourless contrary to the volatile organic compounds, which are dominant while lighting up the fire. Secondly, perhaps the residents get used to the smell of smoke in the house (as one gets used to other odours inside a house). Hence, the smell of smoke cannot be used as an indicator for high levels of air pollution with toxic particles from wood stoves inside houses.

The graphs also show that there is not always coherence between an increase in pollution levels and putting a log on the fire. This indicates that the pollution enters through leakages in the chimney pipe or the wood stove, and/or because dust is burned on hot surfaces of the wood stoves.

Further information

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Leaflet on wood smoke: https://rgo.dk/wp-content/uploads/GTD_Pollution-from-wood-burning_2022.pdf

Air pollution: <https://rgo.dk/frontpage-english/air-pollution/>

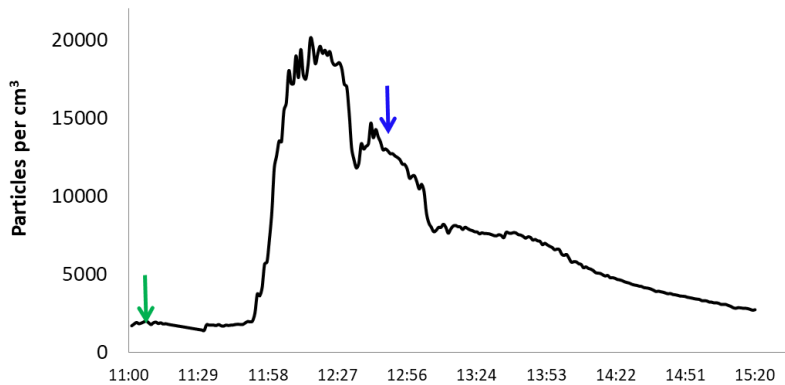
Pollution measurements

Ultrafine particles were measured with three calibrated P-Traks (Model 8525 Ultrafine Particle Counter) from TSI cross-calibrated before and after the measurements.

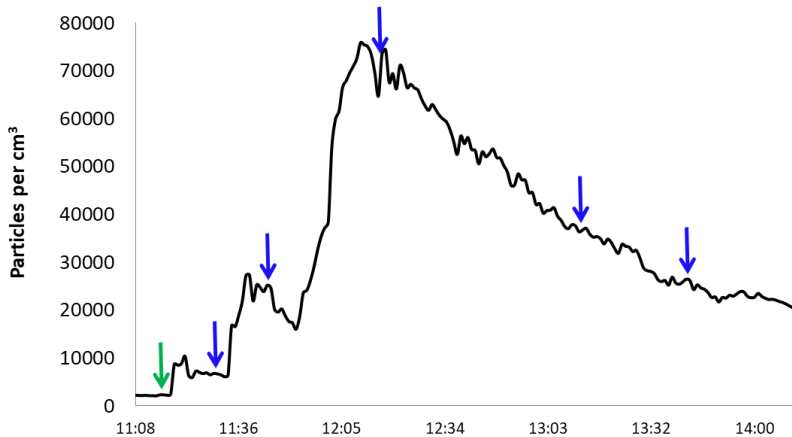
During measurements, the P-Traks were placed at locations where the residents would typically stay when the stove was in use, e.g. on the coffee table or dining table. Measurement period was around three hours in each house i.e. more than 10,000 measurement points (one measurement per second). Minute averages are used in graphs thereby reducing pollution peak values.

8-10 minutes before lighting the fire, background measurements were taken. After that, the residents were asked to light the fire and put logs on as they usually do, taking notes of when they put on a new log. Candlelight, tobacco smoking, cooking, vacuum cleaning or other activities that could generate air pollution inside were avoided during measurements. Hence, measurements only reflect pollution generated by the wood stove. The residents were also asked if they could smell smoke when they usually use their stove. Green arrow indicates kindling and blue arrows indicate when logs are put on the fire.

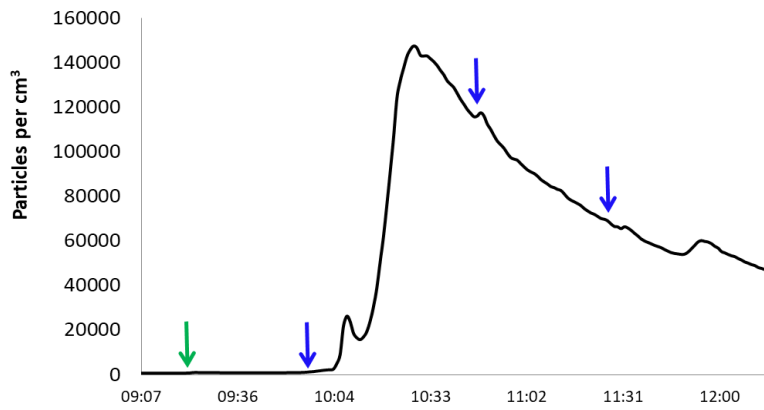
House 1: Indoor air pollution from wood stove



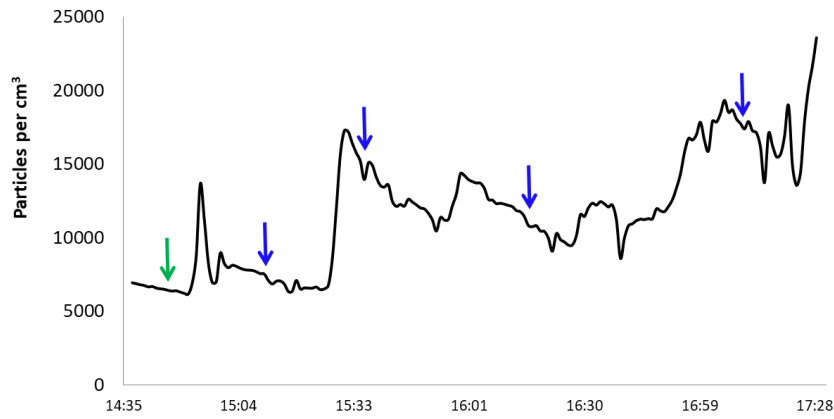
House 2: Indoor air pollution from wood stove



House 3: Indoor air pollution from wood stove



House 4: Indoor air pollution from wood stove



House 5: Indoor air pollution from wood stove

