Wood burning pollutes the urban air in Norway

Around 45 per cent of the wood consumed in Oslo is burned in apartments. Thus, wood burning for residential heating, and the resulted particle emission, may have a much larger impact on air quality in Norwegian urban areas than previously thought.

While electricity produced from hydropower is the primary means of residential heating in Norway, wood burning stoves are the second most important source of heating. The consequences are significant emissions of particulate matter (PM) and other compounds with negative effects on human health.

Capturing the city details

The use of wood for residential heating is increasing in Norway, as it is in the rest of Europe. But what most of us do not realize is that residential heating with fuelwood increases emissions of harmful pollutants and consequently the undesirable environmental effects, especially in urban areas characterized by high population density. Wood burning, along with traffic, is a main contributor to particulate matter in many European cities, and together they often cause high pollution episodes during winter.

"If we want to know how much of the pollution derives from wood burning, we need to regularly update our knowledge. This is mainly because the emissions are largely dependent on climatic conditions – if we have a long and cold winter, it will result in higher fuelwood consumption than shorter and milder winters," says senior scientist Susana Lopez-Aparicio from NILU – Norwegian Institute for Air Research.

"More detailed information will also help to design efficient strategies towards emission reductions and clean air in cities."

In Norway, national emissions from wood burning for residential heating are estimated based on the product of the amount of fuelwood consumed per type of technology (i.e. open fireplace, closed stove produced before 1998 and closed stove produced after 1998) and the corresponding emission factors. These emissions are available at regional level, and its use for urban areas is quite uncertain as the emissions needs to be defined at high spatial resolution in order to capture the differences within the urban environment.

Crowdsourcing to improve emissions

To gain understanding of wood burning emissions in cities, scientists from NILU, Aalto University in Finland and the Finnish company Mapita Ltd. joined forces in the Research Council of Norway-funded project iResponse.

Together, they designed and carried out a crowdsourcing study about emissions from wood burning for residential heating in Oslo and Akershus. When crowdsourcing, you obtain information from a large number of people via online platforms. The scientists used a geographic information system (GIS) based tool, which participants used to report their localized insights about three main issues:
1. Place of residence and characteristics of the living space
2. Wood burning for residential heating; use of fuelwood for heating, type of wood stove and amount of 
   fuelwood consumed in the winter season from November 2015 to February 2016 
3. Environmental perception associated with air pollution and specifically with wood burning.

The survey was designed using the cloud service Maptionnaire, and open for residents in Oslo and Akershus. 
The participants could choose to answer via computers, smart phones or tablets, and the scientists received 
ca. 500 individual responses and around 1500 geo-located responses. The majority of the participants (90%) 
are over 30 years old, with a gender distribution of about 50/50.

Combining perception and data

Information about what kind of homes people live in and the type of heating source they have is essential to 
understand emissions from residential heating. For example, in Finland wood burning is a common heating 
source mainly in detached houses, whereas in France, Italy or Spain it is mostly restricted to rural areas. In 
Norway, many apartments are equipped with wood burning stoves, and thus wood burning can be considered 
a common heating source in both urban and rural areas.

"As far as we know, our study is the only one that includes multifamily dwellings in urban areas," says 
Lopez-Aparicio.

"We know too little about wood consumption for residential heating in our cities, knowledge that we need to 
develop proper air pollution mitigation plans to reduce citizen exposure to harmful levels."

By asking participants to point out those areas they perceive as polluted, and from what, the scientists also 
gain knowledge from citizens' localized insights of which parts of the city require particular attention. The 
information gained was combined with existing environmental data, showing certain correlation.

Economic incentives not working?

Around 23% of the households using wood burning reported to have an old stove (produced before 1998), 
52-54% a new stove (produced after 1998), 14-18% of participants a closed fireplace and 5-10% have open 
fireplaces.

The share of old stoves reported differs from available official information. In Oslo municipality, the Fire 
and Rescue Agency have registered ca. 119 482 stoves in total, 57% of these registered as old fuelwood 
stoves. The discrepancy may be because the Fire and Rescue Agency registry could be relatively outdated, 
and thus has not yet caught up with the shift from old stoves to more efficient ones in the latest years.

More surprising is the fact that according to the participants, the share of new stoves (52-54%) is very 
similar in Oslo and Akershus. As there have been economic incentives for shifting from older to newer 
appliances in Oslo since 1998, one would expect the proportion of newer wood stoves to be higher there.

The challenge of characterizing human activity

When it comes to the amount of wood burned, the total amount reported in the study is around 193 515 kg of 
wood for the winter season between November 2015 and February 2016. Oslo residents report around 39%, 
Akershus residents 56%, and people residing in areas outside the study report the last 5%.

These values result in an average amount of fuelwood per household of around 400 and 1 040 kg for Oslo 
and Akershus, which amounts to an estimated total of 130 and 344 kilotons, respectively. This result is about
four times higher than the official 2013 numbers, which were 34 ktons in Oslo and 86 ktons in Akershus.

A number of the participants reported that they burn wood found in the closest forest, at their cabins or as garden waste, and this may be missing in official statistics. The GIS-survey could also have a certain bias towards citizens that use fuelwood, so that they are overrepresented among the participants.

"We asked the National Institute for Consumer Research in Norway," says Lopez-Aparicio. "And they shared the results from a 2016 survey on urban environmental issues. Their data from five urban areas in Norway show that fuelwood is used by around 45-50% of the households in most of the cities, except in Oslo, where the share of fuelwood consumers is of around 30%. If we scale our GIS results for Oslo and Akershus based on 30% and 50% of the population using fuelwood, our derived PM2.5 emissions is around 665 and 836 tons, respectively. For Oslo, this value is similar to emissions based on official statistics."

Norwegian urbanites burn wood

"When looking at the amount of wood used per type of dwelling, we found that 46% of the wood burned in Oslo is consumed in apartments," explains Lopez-Aparicio.

"This shows the importance of wood burning as a heating source in cities like Oslo, and that wood burning is not as restricted to rural areas in Norway as it is in other countries. Thus, it is also a significant source of air pollutants."

Around 86% of the participants think that Oslo and Akershus have a problem regarding air quality. They identified around 700 points as air pollution hotspots, associating them with traffic, wood combustion and shipping as main pollution sources.

"How we perceive our environment influences on how we judge our individual quality of life," says Lopez-Aparicio."

This should be of interest for the municipality and other authorities. The results from our study show how mitigation measures to reduce urban air pollution will have a positive impact on the citizens' environmental perception, and on their quality of life. In addition, it can help reduce the negative consequences of air pollution on human health."

Lopez-Aparicio also thinks that how people perceive their environment is important for whether or not they will accept implementation of certain policy measures, such as car-free areas, banning of diesel vehicles in specific areas, or forced replacement of old wood burning stoves. As she sees it, the results from their study supports co-benefit measures that involves the citizens and are designed towards a sustainable urban environment.

Norwegians enjoy firing up the stove, also in small, city based apartments. But that might not be very environmentally friendly? (Photo: Frank May / NTB scanpix) [5]

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