

Smog from major Copenhagen street heads straight into living rooms

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Credit: Pixabay/CC0 Public Domain

A large amount of the heavy automobile pollution from Copenhagen's Bispeengbuen thoroughfare goes straight into people's homes, according to a study by researchers at the University of Copenhagen. A sensor

developed by one of the researchers can help fill in the blanks of our understanding about local air pollution.

Air pollution cuts the lives of more than four thousand Danes short every year. Locally, we have a very limited understanding how many harmful substances waft in the air we breath. Indeed, air pollution is only monitored at fourteen locations across Denmark.

This prompted University of Copenhagen chemists to set up their own measuring devices along one of the Danish capital's busiest thoroughfares, a place where [air quality](#) is not otherwise measured: Bispeengbuen—an elevated roadway that bisects densely populated residential areas and leads into and out of the heart of the Copenhagen.

The team has found that pollution from the 50,000–70,000 cars that drive over the six-lane raised road every day goes directly into nearby homes. The results are presented in a study led by University of Copenhagen chemistry student Frederik Hildebrand, which has just been published in the journal [Dansk Kemi](#).

The scientists placed a range of low-cost pollution sensors along Bispeengbuen, outside an inhabited apartment thirty-five meters from the roadway and inside one of the apartment's rooms. The devices, which were developed by researchers at the Department of Chemistry, measured [air pollution levels](#) for over four weeks.

"The sensor in the apartment was placed in a storage room where there were no people and where the doors and windows were closed for the entire period. Here, we found a close correlation between indoor and outdoor air pollution. This means that the air pollution originated outdoors and came into the room, despite it having been completely shut off. It was surprising," says Frederik Hildebrand.

Result: 48% of the pollution came from the roadway

The scientists' measurements demonstrate that 48% of the apartment's indoor air pollution comes directly from Bispeengbuen-generated car pollution.

"This could in part be due to it being an old building, which is not as well insulated as the newer ones. But for the most part, most of Copenhagen's buildings are old. If one assumes that the same is true in other types of buildings that are similar, indoor pollution could be significant. Some of the homes are just five meters from the roadway," says Matthew S. Johnson, the Department of Chemistry professor who supervised the project and helped develop the sensor that was used.

The most alarming types of pollution the researchers measured were [nitrogen dioxide](#) (NO₂) and [fine particulate matter](#) (PM_{2.5}). NO₂ is notorious for wreaking havoc on the lungs, causing cancer, dementia and cardiovascular diseases. Because they are so small, fine particles (PM_{2.5}) can enter the lungs and find their way into the bloodstream and body. Among other things, the particles can lead to pulmonary diseases, diabetes, blood clots and cancer.

Exceeds WHO guidelines

While the average concentration of [fine particles](#) measured outdoors along the Bispeengbuen remained within the [WHO guidelines for healthy air quality](#), the average level of NO₂ exceeded the WHO's 24-hour limit values during the measurement period.

When PM_{2.5} concentrations were at their highest—which particularly occurred during the morning rush hour—they were more than ten times as high as the 24-hour limit values. For NO₂, the values were six times as

high.

"Our measurements at Bispeengbuen are as high as levels at the most polluted stretch of road in Denmark—H.C. Andersens Boulevard in downtown Copenhagen. The difference is that here we are up on the second floor, so the pollution is spread even more into the local area and most likely into people's homes," says Professor Johnson.

Within the apartment, concentrations remained below WHO limit values throughout the measurement period, during late spring of 2022.

"But that doesn't mean that it doesn't require attention. After all, the concentrations depend on the amount of traffic. In winter, we suspect that car traffic increases and alongside that, the amount of air pollution—as studies from elsewhere show. So, it is not impossible that the limits are exceeded," says Frederik Hildebrand.

"It is definitely worrying that there is such a close link between outdoor and indoor pollution. It finds its way in and is very likely to harm people's health. Part of the problem can be alleviated through building renovations. Still, it is very unfortunate planning for the roadway to be so close to the building," says Johnson.

After years of political discussion, it has been decided to demolish one of Bispeengbue's two elevated roadways, which will be reduced from six lanes to three. What do the researchers think about this solution?

"Car traffic is still constant, so you really just move pollution from one place to another. If, on the other hand, you move traffic underground, you will not spread the pollution to the nearby areas, and you would be able to control it through filters and other things that can clean the air in the tunnel," says Hildebrand.

For the time being, measurements only gathered at three places in Copenhagen

Today, official air quality monitoring in Denmark is conducted with instruments that provide very precise measurements, but are large, expensive and energy intensive. Therefore, the number of measuring stations is severely limited, with only 14 stations spread across Denmark. Three of them are in Copenhagen.

"So, you need a more accurate picture of the rest of Copenhagen and of local effects in general. This is what the sensors we've deployed here can provide—faster, better and cheaper. For example, we have set up 225 of these measuring devices around the Borough of Camden in London. They serve as a good complement to official measurement networks. Working side-by-side these networks can provide us with much better knowledge than we have today about how polluted the air we breathe really is," concludes Johnson.

Air pollution fatalities

- Danish calculations show that air pollution in Denmark in 2020 resulted in 4,030 [premature deaths](#). 3,170 of the deaths are due to sources of air pollution abroad, while 860 cases are due to Danish sources. Danish sources also contribute approximately 1,930 premature deaths annually in Europe.
- According to a 2019 estimate, 11.65% of all deaths worldwide are due to air pollution. This makes air pollution the third leading cause of death after smoking and [high blood pressure](#).
- In 2019, outdoor air pollution was estimated to cause 4.2 million premature deaths worldwide.

The measuring devices used by the researchers in the study are [low-cost](#)

[sensors](#) developed by the Danish company DevLabs. The low-cost sensors are compact, have low energy consumption and cost 100 to 1,000 times less than traditional [air pollution](#) monitoring devices. This makes it possible to create affordable networks of devices for studying local pollution at a previously unheard of level. However, the sensors must be calibrated against a more accurate and more expensive measuring instrument.

More information: Frederik B. Hildebrand et al, [Smog i stuen med hovedvej på 2. sal](#), *Dansk Kemi* (2023).

Provided by University of Copenhagen

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