

POLICY BRIEF

Potential for reducing the health burden of air pollution from residential wood combustion in the Nordic countries



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<https://pub.norden.org/nord2025-017>

Introduction

Air pollution is the largest environmental health risk in the Nordic countries despite relatively low concentrations.

The project NordSmoke aimed to evaluate scenarios for mitigation measures to reduce air pollution and the health burden from residential wood combustion towards 2030 in the Nordic countries: Denmark, Finland, Sweden and Norway. Based on updated baseline emissions and by setting up both realistic and more ambitious emission scenarios for the four countries, the project examined the evolution of air pollution and its consequences for public health. The project also evaluated the associated health costs to society to provide advice for policy makers.



Photo Clay Banks / Unsplash.

Key findings

Air pollution from residential wood combustion is a major contributor to premature deaths and morbidity.

The number of premature deaths associated with residential wood combustion in the four Nordic countries is predicted to decrease from approx. 1,600 to 1,200 from 2019 to 2030 in the baseline projection. The health costs to society decrease from EUR 3.2 to 2.5 billion. This is the result of a combination of the development in decreasing number of appliances, replacement of older appliances with less polluting ones and also e.g. decrease of average wood use per household due to better energy efficiency in new houses.

In addition to the baseline projection, two alternative scenarios for 2030 have been evaluated. A technology scenario examines realistic ways at the national level to replace older combustion appliances with newer technology at a faster pace than in the baseline projection. A zone-based scenario reduces emissions by either reduction of or bans of residential wood combustion in selected densely populated areas to achieve high health benefits. These unique scenarios are developed by national emission and air quality experts and reflects national differences in feasibility and ambition in mitigation debates.

The technology scenario reduces the number of premature deaths in 2030 by approx. 190 across the four Nordic countries, while the zone-based scenario reduces the number of premature deaths by 240. The reduction in health costs to society is EUR 390 millions and 510 millions, respectively. The technology scenario reflects the differences in the level of feasibility and ambition in the debate on realistic mitigation measures in the different Nordic countries. The zone-based scenario has a high impact in gaining health benefits with relatively lower emission reductions since they are implemented in targeted areas with relatively high population density and generally favour ban over replacement.

Scenarios for reduction of air pollution from residential wood combustion

Updated emissions for all sectors including residential wood combustion were developed for the year 2019 and for 2030 including both a baseline and the two scenarios. This was done on a high-resolution map of 1 km x 1 km. This enables the quantification of the health impacts of the different emission reduction scenarios. In the case of residential wood combustion, it includes air pollution associated with heat appliances like woodstoves, fireplaces, masonry stoves, saunas, boilers and pellet stoves, capturing the technological differences across Nordic countries.

Potential mitigation measures are grouped in a technology scenario and a zero-emission zone-based scenario. In the technology scenario, older combustion appliances are replaced with newer technology to reduce emissions. The zone-based scenario either reduces or bans residential wood combustion in selected areas. The technology scenario generally has a national scope or includes a large part of the country, whereas the zone-based scenario targets selected populated urban areas or areas with district heating.

The scenarios are different in the different Nordic countries to reflect the differences in the level of feasibility and ambition in the debate on mitigation measures in the countries. These tailor-made scenarios are designed and developed by national emission and air quality experts.

Despite many similarities between the Nordic countries, there are also differences in the character of the residential wood combustion sector. In Denmark, wood is combusted predominately in relatively light iron stoves and it is mainly focused on creating cosiness. In Norway, iron stoves are also the most common appliance type, but they are also used as an important heating source in rural cabins and even in some apartment buildings in cities. In Sweden, large appliances and wood boilers are commonly used as a primary heat source. In Finland, heavy-built masonry heaters are the most common combustion appliances, and sauna stoves are important with relatively high emissions. These national characters and their differences are important to take into account when assessing emission mitigation opportunities in the Nordic countries. The access to stoves as a backup heating source is regarded as important from an energy security point of view, especially in rural areas in Finland, Norway and Sweden, where power cuts are quite common.

Type	Denmark	Finland	Norway	Sweden
Technology scenario	Ban on all wood stoves before 2008 – 50% replaced by new ones	Replacement of 14–20% of masonry heaters/ sauna stoves by new ones	Ban of open fireplaces and stoves produced before 1998	Old boilers before 1998 replaced in urban areas
Zero emission zone-based scenario	Ban on wood stoves in areas with district heating	Ban in seven most populated urban areas	Ban in 10 most populated urban areas	Increase of district heating use, with decreased use of wood as primary heating source in urban areas

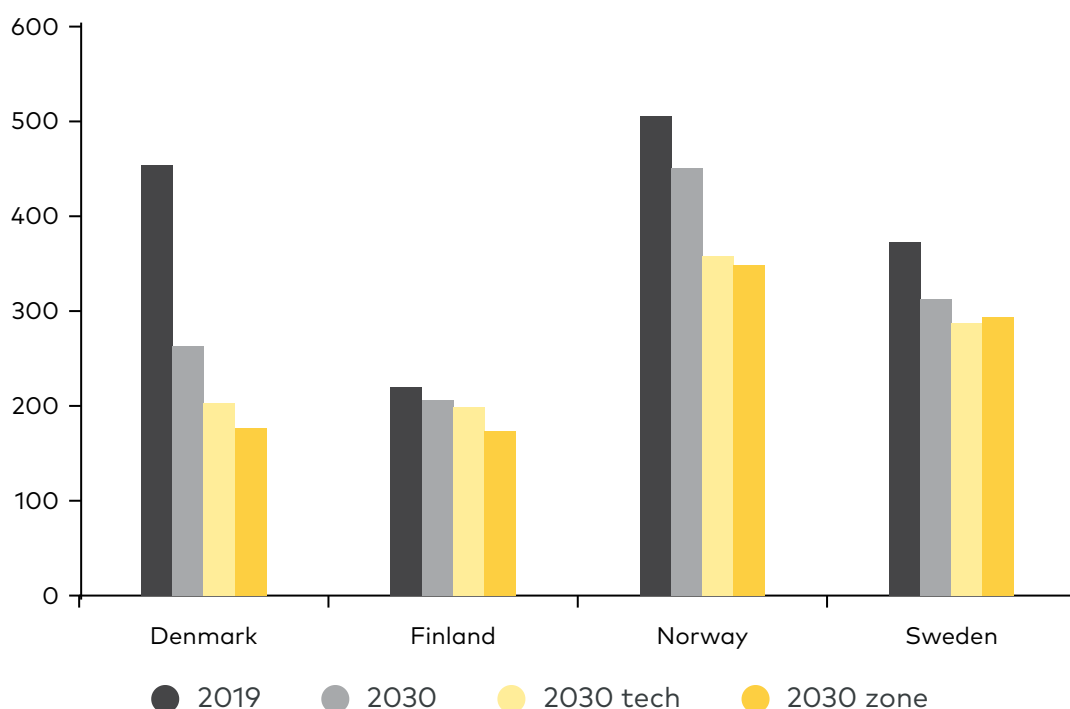
Health impact assessment of scenarios

The number of premature deaths has been calculated with the EVA-system (Economic Valuation of Air Pollution). One premature death is equivalent to approx. 11 lost life-years.

From 2019 to 2030 the number of premature deaths associated with residential wood combustion in the four Nordic countries is predicted to decrease from approx. 1,600 to 1,200. This is based on the baseline projection for 2030 that assumes a combined development in the number of appliances, replacements of older stoves and wood use. In Denmark, Finland and Sweden this sector accounts for about 9-14% of the total estimated number of premature deaths related to air pollution in 2019 and 2030. In Norway the share is about 25%.

The selected technology scenarios will further reduce the number of premature deaths by 190 in the four Nordic countries and the selected zone-based scenarios by 240. Due to the comprehensive modelling, it is possible to make a detailed analysis of the reduction in emissions and the following reduction in negative health impacts. Overall, the zone-based scenario has a higher impact compared to the technology scenarios since it is implemented in targeted areas with relatively high population density. In the technology case, there is approximately a 1:1 ratio between reductions in emissions and health impacts. In the zone scenario, the ratio can reach up to approx. 1:3 (e.g. a 6% reduction in the emissions in Finland and Norway leads to an approx. 20% reduction in health impacts). These results underline that the introduction of a ban in urban areas will be more efficient in terms of health benefits than a general replacement of older stoves.

Modelled premature mortality linked to residential wood combustion



Fact box on method for health impact assessment

EVA (Economic Valuation of Air Pollution) is a model system to calculate health effects and related costs to society of air pollution. It is based on the impact pathway approach that models the linkages from emission sources to health effects. The model system includes emissions from all sources and calculates the geographic variation of air quality with high geographic resolution (1 km x 1 km) based on the local-scale air quality model UBM (Urban Background Model) that is coupled to a chemical transport model DEHM (Danish Eulerian Hemispheric Model) to provide background concentrations. The simulated concentrations are evaluated in detail by comparison to observations from all the four Nordic countries. The concentration map is combined with population data to estimate population exposure and based on exposure-response relations the health effects can be calculated. Coupled with economic valuation of each health outcome the health costs of air pollution to society can be calculated. The EVA-system is developed by Aarhus University, Denmark.

Key policy messages

The European Ecodesign Regulation sets emission standards for new small-scale combustion units in the market and thus reduces emissions over time as the appliances are renewed. The Nordic countries can mitigate air pollution from residential wood combustion beyond this regulation.

Mitigation of air pollution from residential wood combustion offers substantial socio-economic benefits through reduced premature deaths and morbidity in the Nordic countries.

Based on the technology scenario of this study, the potential to further reduce the emissions and mitigate negative health impacts by accelerating the renewal of appliance stock at the national level are relatively limited. However, there are differences between the Nordic countries in the selected realistic policy options to execute the reductions, which reflects the differences in the level of feasibility and ambition in the debate on mitigation measures in the countries.

The zone-based scenario demonstrated that implementing emission mitigation in targeted areas with relatively high population density would bring considerably higher benefits of improved health for the emission reduction, compared to national-level measures.



Photo Annie Spratt / Unsplash.

About this project

The project was conducted in cooperation between Aarhus University, Denmark (Camilla Geels, Marlene Schmidt Plejdrup, Ole-Kenneth Nielsen, Lise Marie Frohn, Zhuyun Ye, Christopher Andersen, Jesper H. Christensen, Jørgen Brandt, Steen Solvang Jensen), NILU, Norway (Henrik Grythe, Susana Lopez-Aparicio), Finnish Environment Institute, Finland (Niko Karvosenoja, Ville-Veikko Paunu) and Swedish Meteorological and Hydrological Institute, Sweden (Christian Asker). Camilla Geels was the principal investigator.

The Nordic working group for Climate and Air (NKL) under the Nordic Council of Ministers has funded the project.

The project period was between June 2022 and November 2024.

The final project results were presented at a stakeholder webinar in November 2024 and a scientific journal article is in preparation for an internationally recognised journal.

About this publication

Policy Brief: Potential for reducing the health burden of air pollution from residential wood combustion in the Nordic countries

Aarhus University: *Camilla Geels, Marlene Schmidt Plejdrup, Ole-Kenneth Nielsen, Lise Marie Frohn, Zhuyun Ye, Christopher Andersen, Jesper H. Christensen, Jørgen Brandt, Steen Solvang Jensen.*

NILU: *Henrik Grythe, Susana Lopez-Aparicio*

Finnish Environment Institute: *Niko Karvosenoja, Ville-Veikko Paunu*

Swedish Meteorological and Hydrological Institute: *Christian Asker*

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Nordic co-operation

Nordic co-operation is one of the world's most extensive forms of regional collaboration, involving Denmark, Finland, Iceland, Norway, Sweden, and the Faroe Islands, Greenland and Åland.

Nordic co-operation has firm traditions in politics, economics and culture and plays an important role in European and international forums. The Nordic community strives for a strong Nordic Region in a strong Europe.

Nordic co-operation promotes regional interests and values in a global world. The values shared by the Nordic countries help make the region one of the most innovative and competitive in the world.

The Nordic Council of Ministers

Nordens Hus

Ved Stranden 18

DK-1061 Copenhagen

pub@norden.org

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