

POLICY BRIEF

Air Quality, Health Effects and External Costs

in Selected Cities in Nordic Countries

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This publication is also available online in a web-accessible version at:
<https://pub.norden.org/nord2023-049>



Introduction

The purpose of the project is to gain a better understanding of the implications of the new WHO air quality guidelines (AQG) from 2021 in a Nordic setting. Among other things, to estimate how far Nordic countries currently are from complying with the new guidelines, and to provide a foundation for assessment of measures in the Nordic countries to achieve the new recommended WHO levels. This understanding will also serve to provide a Nordic perspective on the new proposed EU's air quality directive from 2022.



Key findings

- All five Nordic countries exceed the 2021 WHO AQG for key health-related pollutants at measurement stations in 2021
- Air quality in the Nordic countries and the selected cities will improve towards 2030 due to emission reductions
- It is likely that Copenhagen, Stockholm, Helsinki and Reykjavík will comply with WHO AQG for nitrogen dioxide in 2030 at the urban background stations. For fine particles, Copenhagen may slightly exceed whereas the other cities covered by the study are likely to comply. For peak ozone all capital cities will exceed the guidelines, and ozone concentrations show a slight increase towards 2030 in the cities
- Premature deaths and related socio-economic costs due to air pollution are predicted to decrease from 2019 to 2030 for Copenhagen, Stockholm and Helsinki whereas Reykjavík will stay at the same level due to a high population increase off-setting the decrease in emissions
- The key contributing sectors to the air pollution emissions are road transport, residential wood combustion and the combined sector of energy, industrial combustion and industrial processes, except for Reykjavik where the contribution from residential wood combustion is insignificant and the off-road emissions play a larger role due to the fishing fleet.



Background

The Nordic Working Group for Climate and Air under Nordic Council of Ministers has initiated this project and Aarhus University has conducted the project.

The project focuses on three areas (1) Evaluation of air quality monitoring in Nordic countries based on measurements from 2021 with comparison to WHO guidelines and EU limit values for the Nordic countries as well as for the selected cities, and general implications of the new proposed EU's air quality directive for the Nordic countries, (2) Projection of air quality for 2030 for Nordic countries and selected cities, (3) Sector specific contribution to air quality in 2030 and health effects and related external costs. The selected cities are for Sweden: Stockholm, Gothenburg and Malmö; Denmark: Copenhagen, Aarhus and Odense; Finland: Helsinki, Tampere and Oulu; Norway: Oslo, Bergen and Trondheim; Iceland: Greater Reykjavík. Some of the analysis focuses on the Nordic capitals.

Evaluation of air quality monitoring in 2021

The new WHO AQG from 2021 further documents that health effects of air pollution are significant also at relatively low concentrations as in the Nordic countries. The health impacts of air pollution are by far the largest for long-term exposure to PM_{2.5} (particles less than 2.5 micrometre) then followed by NO₂ (nitrogen dioxide) and then exposure to elevated levels of O₃ (ozone).

WHO has tightened their air quality guidelines from 2005 to 2021 for the three pollutants that pose the largest health burden (PM_{2.5}, NO₂ and O₃). WHO AQG are much lower than the present EU Air Quality Directive (AQD), and also lower than the proposed revised EU AQD from October 2022. However, the proposed EU AQD will eventually align with WHO guidelines for annual PM_{2.5} and annual NO₂ based on a continuous requirement for reduction in concentrations until the target is met.

All five Nordic countries exceed the 2021 WHO AQG for annual means of PM_{2.5} and NO₂, and also ozone (8h peak season) based on the *highest* measured values in 2021 at any measurement station (except Iceland where peak ozone data is not available).

Estimates of urban background concentrations in 2030 versus WHO AQG

Urban background concentrations in 2030 were modelled in selected cities. Modelled data for 2030 for Oslo are not available due to incorrect geographic distribution of the emissions from oil and gas production for 2030 allocated to land areas and not to the sea areas where the emissions take place.

Concentrations of NO₂ and PM_{2.5} are decreasing from 2019 to 2030 whereas concentrations of O₃ are slightly increasing. The decrease in concentrations is due to the projected decrease in emissions. The increase in O₃ is expected due to chemistry in the atmosphere, where NO_x (nitrogen oxides) emissions lead to lower ozone concentrations. As NO_x emissions decrease ozone concentrations will increase in urban background.

Based on the present observed levels of NO₂ in 2021 at urban background measurement stations in Denmark, Sweden, Finland and Iceland and the modelled decline in concentrations, it is likely that the concentrations at the urban background stations in Copenhagen, Stockholm, Helsinki and Reykjavik will be below the WHO AQG for NO₂ of 10 µg/m³ in 2030. For PM_{2.5} Copenhagen may be slightly exceeding the WHO AQG of 5 µg/m³ in 2030 whereas other cities are likely to have concentration levels below the guideline.

All selected cities have concentration levels that are exceeding the WHO guideline in both 2019 (observations) and 2030 for peak ozone (modelled). Modelled peak ozone concentrations show a very slight decrease towards 2030 and mean ozone concentrations slightly increase.

Emission sector contributions to air quality in the Nordic capital cities in 2030

This analysis included Copenhagen, Stockholm, Helsinki and Reykjavik. The contribution to urban background concentrations of PM_{2.5} in 2030 for the four capital cities ranges from 10% to 26% from city emissions, 16% to 23% from country emissions and 51% to 76% from emissions originating abroad. The similar numbers for NO₂ are 18% to 35%, 18% to 42% and 23% to 55%, respectively.

The three largest sectors contributing to urban background concentrations of PM_{2.5} in 2030 from city emissions are road transport, residential wood combustion and the combined sector of energy, industrial combustion and industrial processes, except for Reykjavik where the contribution from residential wood combustion is

insignificant and off-road plays a larger role due to the fishing fleet. For NO₂ the three largest sectors are road transport, the combined sector of energy, industrial combustion and industrial processes, and off-road but all other sectors with emissions from combustion also contribute.

The largest sectors contributing to urban background concentrations of PM_{2.5} in 2030 from country emissions are residential wood combustion, road transport, the combined sector of energy, industrial combustion and industrial processes, and off-road, but also agriculture. For NO₂ the largest sectors are off-road, road transport, and the combined sector of energy, industrial combustion and industrial processes.

Contributions to health effects and external costs in Nordic capital cities in 2030

Key factors in determination the number of premature deaths are concentration levels of PM_{2.5}, NO₂ and O₃ and the number of inhabitants. This is evident from Table 1. It is also seen that although populations are expected to grow from 2019 to 2030, premature deaths are predicted to decrease as air quality improves except for Reykjavík that will stay at the same level due to a high population increase offsetting the decrease in concentrations.

Table 1. Number of premature deaths in capital cities in 2019 and 2030.

	Area (km ²)	Inhabitants in 2019	Inhabitants in 2030	2019	2030	Differ- ence
Copenhagen	95	594,679	610,810	410	310	-22%
Stockholm	207	1,064,033	1,154,401	620	510	-19%
Helsinki	195	687,693	687,865	390	330	-15%
Reykjavík	173	226,661	264,756	39	39	1%
Oslo	262	664,000	697,526	450	n.a.	n.a.

The distribution of premature deaths caused by emissions from the city, from the country and from abroad for the Nordic capital cities is shown in Table 2.

The contribution from the city range from 15% to 43%, from the country from 18% to 27% and from abroad from 30% to 63%. Reykjavík has the highest contribution from the city and lowest from abroad. The opposite picture is seen for Copenhagen

with the lowest contribution from the city and highest from abroad due the close proximity to central Europe.

Table 2. Percentage of premature deaths in Nordic capital cities in 2030 distributed on contributions from city to city, from country and from abroad

	From city	From country	From abroad	Total
Copenhagen	15%	23%	63%	100%
Stockholm	35%	18%	47%	100%
Helsinki	25%	21%	53%	100%
Reykjavík	43%	27%	30%	100%
Oslo	n.a.	n.a.	n.a.	n.a.

The external costs follow the number of premature deaths as the costs of morbidity play a minor role, and hence the distribution on emission sectors and on the contribution from city, country and abroad also follow the distribution of premature death given earlier. In 2030, the external costs in billion EUR are estimated to 1.3 for Stockholm, 0.9 for Copenhagen, 0.9 for Helsinki and 0.14 for Reykjavík.



Key policy messages

Regulation of air pollution can provide large socio-economic benefits from reduction in premature deaths and morbidity.

Transboundary air pollution is a large contributor to health effects for most Nordic countries and selected cities and calls for more international regulation.

Nordic cities can obtain the largest effect in reduction of health effects of air pollution of the part originating from city emissions by reducing emissions from road transport, wood stoves, energy/industry and off-road.

The proposed new EU air quality directive poses additional requirements for measurements, modelling and information to the public.

The earlier targets formulated in the WHO Air Quality Guidelines are met in the future the sooner the health effects of air pollution are minimized.

Report

The report is available at pub.norden.org/temanord2023-548

About this publication

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Steen Solvang Jensen, Jesper H. Christensen, Zhuyun Ye, Lise M. Frohn, Camilla Geels, Mikael Skou Andersen, Ole-Kenneth Nielsen, Claus Nordstrøm
Aarhus University, Department of Environmental Science, Denmark

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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

www.norden.org

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