The Economic Benefits of Air Quality Improvements in Arctic Council Countries

POLICY HIGHLIGHTS

OECD
BETTER POLICIES FOR BETTER LIVES

Air pollution in Arctic Council countries

The Arctic is a vital region, helping preserve the balance of the global climate. The Arctic environment is very sensitive to short-lived climate pollutants,[1] due to their strong warming effect. In particular, black carbon, which is the most light-absorbing component of fine particulate matter ($PM_{2.5}$), not only contributes to the negative impacts of air pollution on human health, but is also a major contributor to Arctic warming. At their 2017 meeting, Arctic Council countries (the eight countries closest to the Arctic region; Figure 1) adopted an Expert Group report that recommended a collective, aspirational goal to further reduce black carbon emissions by 25-33% relative to 2013 levels by 2025. All Arctic Council countries support the collective goal.

If Arctic Council countries were to implement more ambitious policy action to improve air quality by reducing a wide range of air pollutants, they would obtain a positive effect on health and the environment throughout their territory, while also helping to slow down climate change by reducing emissions of black carbon. Policy action to improve air quality could also result in economic benefits since the health and the environmental impacts of air pollution generate considerable economic costs to society.

The report *"The Economic Benefits of Air Quality Improvements in Arctic Council Countries"* explores the impacts of this key policy action. It presents projections of the economic consequences of ambitious policies to reduce outdoor air pollution in Arctic Council countries, looking at both the costs and the benefits of policy implementation. The report also analyses the economic consequences of air quality improvements resulting from policy engagement beyond Arctic Council countries (such as by Arctic Council Observer countries, as well as globally) and the implementation of integrated climate and energy transition policies.

Figure 1. **ARCTIC COUNCIL AND OBSERVER COUNTRIES**

ARCTIC COUNCIL

Members

Canada
Denmark
Finland
Iceland
Norway
Russian Federation
Sweden
United States

Observers

France
Germany
India
Italy
Japan
Korea
Netherlands
People's Republic of China
Poland
Singapore
Spain
Switzerland
United Kingdom

1. Black carbon, methane, ground-level ozone, and hydrofluorocarbons.

Main messages

- Arctic Council countries' emissions of air pollutants (sulphur dioxide, nitrogen oxides, black carbon, organic carbon, carbon monoxide, ammonia and non-methane volatile organic compounds) are projected to decline in the coming decades thanks to legislation already in place. Arctic Council countries would come close to their aspirational 2025 target of lowering black carbon emissions by 25-33% of 2013 levels.

- Arctic Council countries could achieve more substantial emission reductions if they adopted ambitious policies to stimulate investment in the best available techniques to achieve the maximum technically feasible reduction in emissions. This would enable these countries to exceed their black carbon reduction target, reducing emissions by 65% by 2025, as well as seeing a 60% decrease in sulphur dioxide and nitrogen oxide emissions by 2050.

- These ambitious emission reductions would reduce population exposure to high air pollution levels in Arctic Council countries. For example, the number of people living in areas with $PM_{2.5}$ concentrations that exceed the World Health Organisation air quality guidelines (10 µg/m^3) is projected to decrease from 18 million to 1 million by 2050.

- The air quality improvements brought by these ambitious policies could see 4 out 10 air pollution-related deaths in Arctic Council countries avoided by 2050, alongside thousands of cases of debilitating illnesses, such as chronic bronchitis and childhood asthma.

- Substantial economic benefits would also result from these ambitious air pollution policies, through improvements in labour and agricultural productivity, and lower health expenditures. These economic benefits offset the costs of investing in improved technologies.

- The net macroeconomic effects vary by country: they are marginally positive and close to zero in the United States, Canada and Nordic countries, though by 2050 Nordic countries incur a small GDP loss. In the Russian Federation (hereafter "Russia"), where there is most scope for technological improvements, the net GDP effects are slightly negative, but still less than 0.2% of GDP.

- Ambitious policies to reduce air pollution would also lead to welfare improvements from lower mortality and illness. These welfare benefits are projected to reach USD 290 billion by 2050 for Arctic Council countries.

- There would be additional health and environmental benefits in Arctic Council countries if other regions in the world scaled up their air pollution policy action. Emission reductions in Arctic Council Observer countries, which include other European countries as well as the People's Republic of China (hereafter "China") and India, could be especially beneficial for Nordic countries and Russia. Black carbon particles reaching the Arctic are also likely to decrease, helping to mitigate local climate change.

- Integrated climate and air pollution policy action would have far-reaching health and climate benefits, as emissions of greenhouse gases and air pollutants would decrease. Lower emissions of greenhouse gases and short-lived climate pollutants could strongly contribute to slowing down and reducing the effects of climate change in the Arctic and at the global level.

- There are many other benefits from air pollution policies, not quantified in this study. These include reducing negative impacts on fertility, cognitive abilities and birth weight, as well as on buildings and cultural heritage. Reducing short-lived climate pollutants in the Arctic could limit changes to the local climate, with benefits for indigenous communities, as well as mitigating climate change beyond the Arctic.

How to model the economic benefits of air quality improvements

The economic benefits of air quality improvements are quantified using the OECD ENV-Linkages model, with inputs from the GAINS (**G**reenhouse gas – **A**ir pollution **IN**teractions and **S**ynergies) model developed by the International Institute for Applied Systems Analysis (IIASA) and the TM5-FASST model of the European Commission's Joint Research Centre (EC-JRC).

This suite of models is used following a step-wise procedure (Figure 2), which starts by linking economic activities to emissions of a wide range of air pollutants: sulphur dioxide (SO_2), organic carbon (OC), nitrogen oxides (NO_x), non-methane volatile organic compounds (NMVOCs), black carbon (BC), carbon monoxide (CO) and ammonia (NH_3). Emission of these gases lead to higher atmospheric concentrations of fine particulate matter ($PM_{2.5}$) and ground-level ozone (O_3), which are the drivers of the impacts of air pollution on human health and agriculture. These impacts have economic consequences (Figure 3).

ENV-Linkages can provide projections of the macroeconomic benefits of air pollution policies, resulting from higher labour and agricultural productivity and lower health expenditures. In the model, these benefits are weighted against the macroeconomic costs that follow investments in the best available techniques (BATs) to reduce air pollution. Additionally, the welfare costs related with mortality and morbidity are calculated using results of valuation studies, specifically the OECD's values of a statistical life.[2]

Figure 2. **STEPS TO STUDY THE ECONOMIC CONSEQUENCES OF AIR POLLUTION**

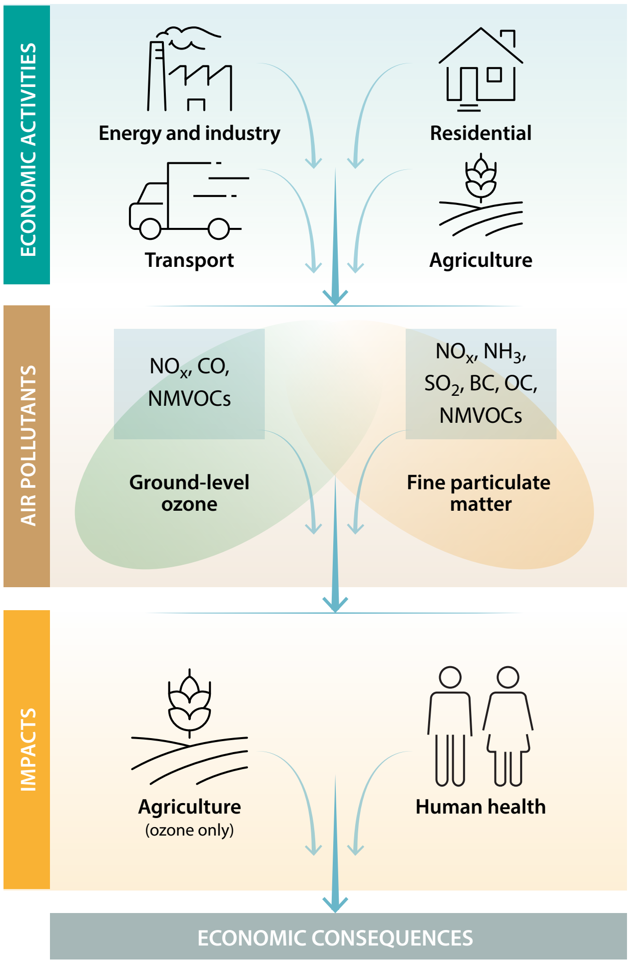
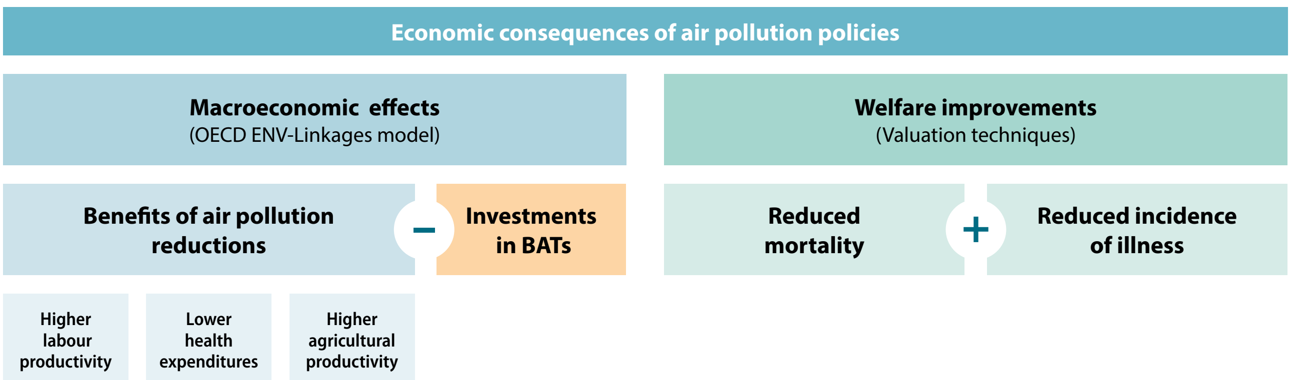


Figure 3. **COST CATEGORIES CONSIDERED IN THE ANALYSIS**



2. https://www.oecd.org/env/tools-evaluation/env-value-statistical-life.htm

Policy scenarios

The economic and health consequences of air pollution policies are projected to 2050 for five scenarios which vary in policy ambition and geographical scope (Table 1). The *Current legislation* scenario projects the impacts of current policies by 2050. The *Ambitious policies* scenario models the impact of Arctic Council countries adopting the best available techniques (BATs) to achieve the maximum technically feasible reduction (MTFR) in emissions in these countries. Two additional scenarios consider the implementation of these ambitious policies in Observer countries (shown in Figure 1) and globally. The fifth scenario looks at the impacts of *Integrated policies* that simultaneously address air pollution and climate change.[3]

These ambitious policy scenarios target a range of pollutants that contribute to fine particulate matter and ground-level ozone pollution: SO_2, OC, NOx, NMVOCs, BC, CO, and NH_3.

Table 1. **OVERVIEW OF THE FIVE SCENARIOS**

Scenarios	Arctic Council countries	Observer countries	Rest of the world
Current legislation *at the global level*	Current legislation	Current legislation	Current legislation
Ambitious policies – Arctic Council MTFR *in Arctic Council countries*	Ambitious policies	Current legislation	Current legislation
Ambitious policies – Arctic Council and Observer countries MTFR *in Arctic Council and Observer countries*	Ambitious policies	Ambitious policies	Current legislation
Ambitious policies – Global MTFR *at the global level*	Ambitious policies	Ambitious policies	Ambitious policies
Integrated policies MTFR and climate mitigation scenario *at the global level*	Integrated air pollution and climate policies	Integrated air pollution and climate policies	Integrated air pollution and climate policies

3. This scenario entails the implementation of ambitious policies to reduce air pollution together with the Sustainable Development Scenario of the International Energy Agency's 2018 World Energy Outlook.

Air quality improvements

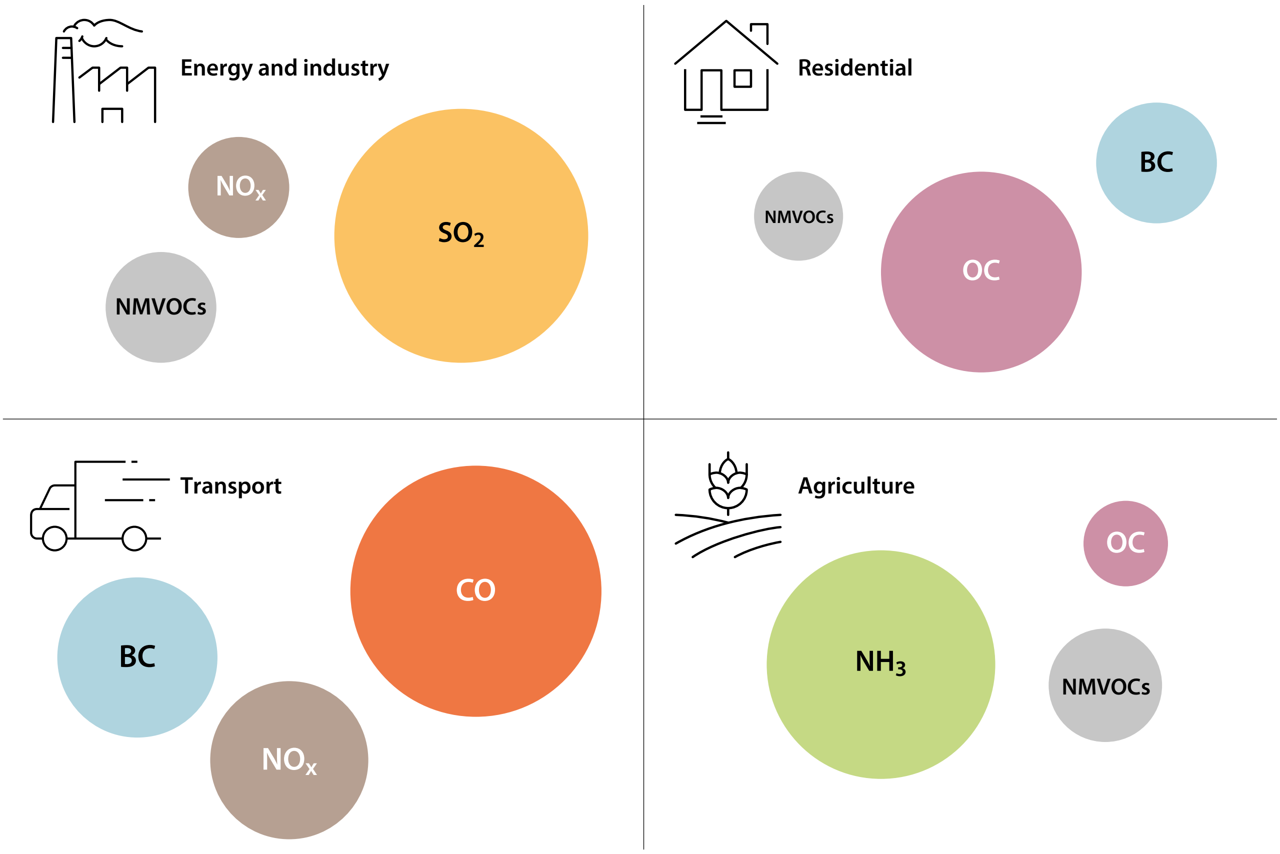
Each economic sector emits different shares of air pollutants. For example, in Arctic Council countries the transport sector is responsible for the majority of carbon monoxide emissions, while the energy and industry sectors emit a large share of sulphur dioxide. The implementation of best available techniques across all sectors would improve air quality by reducing the emission of a wide range of pollutants (Figure 4).

Overall, under the *Current legislation* scenario, by 2050 Arctic Council countries are projected to reduce their emissions of all pollutants on average by 30% compared with 2013 levels, with the exception of emissions of ammonia which increase slightly. However, with *Ambitious policies* in place in these countries, the reductions of air pollutant emissions would be more substantial, reaching on average 60% by 2050 compared with 2013 levels.

Under *Current legislation*, **black carbon** emissions in Arctic Council countries are projected to decrease by 21% by 2025 compared with 2013 levels, coming close to the aspirational black carbon reduction target. However, under the *Ambitious policies* scenario they would fall by 65%, allowing Arctic Council countries to reduce emissions well beyond their collective aspirational black carbon target.

Although concentrations of **fine particulate matter** ($PM_{2.5}$) are projected to decrease in the coming decades with *Current legislation*, the implementation of *Ambitious policies* would result in substantial air quality improvements. For example, the number of people in Arctic Council countries living in areas with average $PM_{2.5}$ concentrations that exceed the World Health Organisation (WHO) air quality guidelines of 10 µg/m^3 would fall from 18 million to 1 million by 2050 (Figure 5).

Figure 4. **THE PROPORTION OF EMITTED POLLUTANTS IN ARCTIC COUNCIL COUNTRIES VARIES ACROSS SECTORS**

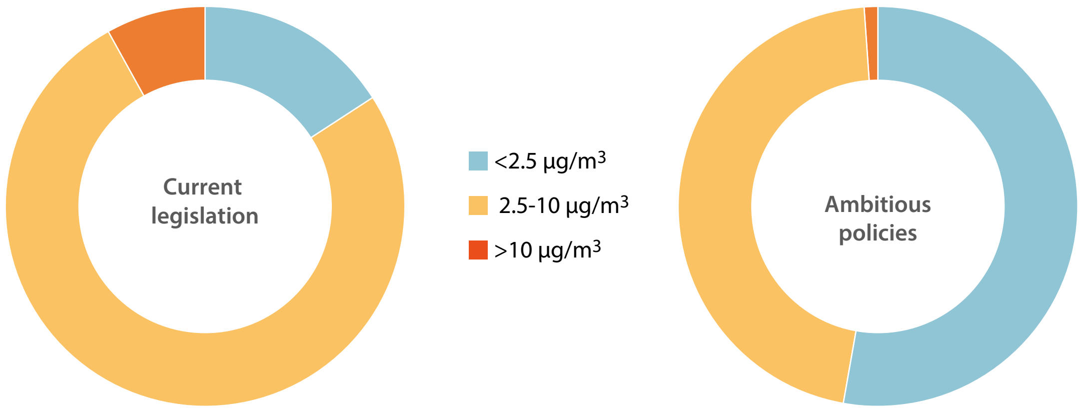


Note: The size of the circles shows the relative share of each sector in the emission of each pollutant in 2015. Only the three most emitted pollutants are shown for each sector.

Source: IIASA's GAINS model.

Figure 5. **AMBITIOUS POLICIES WOULD SUBSTANTIALLY REDUCE EXPOSURE TO UNSAFE $PM_{2.5}$ LEVELS**

Exposure to fine particulate matter concentrations in Arctic Council countries in 2050



In 2050, **18 million people** in Arctic Council countries are projected to live in areas with $PM_{2.5}$ concentrations that exceed the WHO air quality guidelines (10 µg/m³).

In 2050, **1 million people** in Arctic Council countries are projected to live in areas with $PM_{2.5}$ concentrations that exceed the WHO air quality guidelines (10 µg/m³).

Note: The highest threshold (10 µg/m³) refers to the WHO air quality guidelines, while the lowest (2.5 µg/m³) to the threshold under which the Global Burden of Disease functions consider that $PM_{2.5}$ pollution does not have significant health impacts. .

Source: EC-JRC's TM5-FASST model.

Ground-level ozone concentrations in Arctic Council countries are projected to remain high under both the *Current legislation* and *Ambitious policies* scenarios for these countries. Ground-level ozone remains in the atmosphere longer than fine particulate matter, so concentrations are linked to ozone formation in other countries, including Observer countries. This implies that greater effort is needed across a broader geographic area to reduce ground-level ozone concentrations significantly.

In Arctic Council countries the transport sector is responsible for the majority of carbon monoxide emissions and for a large share of black carbon and nitrogen oxide emissions.

Health benefits of air pollution policies

Exposure to fine particulate matter and ground-level ozone causes hundreds of thousands of deaths every year in Arctic Council countries, as well as an increase in the risk of cardiovascular diseases and respiratory diseases.

Despite the projected improvement in air quality in Arctic Council countries, in the absence of additional policy action an increasing number of people is set to be exposed to air pollution in the region. The additional air quality improvements from *Ambitious policies* are projected to lead to significant health benefits in Arctic Council countries (Figure 6), avoiding 4 out of 10 air pollution-related deaths by 2050. This represents an overall reduction of 84 000 air pollution-related deaths every year in Arctic Council countries alone.

Figure 6. **AMBITIOUS POLICIES CAN SIGNIFICANTLY REDUCE MORTALITY RELATED TO AIR POLLUTION**

Additional number of lives saved with ***Ambitious policies*** compared with ***Current legislation*** scenario, 2050

Country	Number of lives saved out of 10 air pollution-related deaths	Number of lives saved yearly by 2050
Canada	6	7 930
Norway	5	370
Russia	5	30 690
Finland	3	290
Sweden	3	240
United States	3	44 790
Denmark	2	220

Note: Iceland is not included here as air pollution-induced mortality is already minimal in the **Current legislation** scenario.

Source: OECD ENV-Linkages model projections, based on Global Burden of Disease (GBD, 2018).

The additional air quality improvements resulting from ambitious policies are projected to lead to significant health benefits in Arctic Council countries.

Better air quality can also significantly reduce the incidence of diseases that affect quality of life, such as chronic bronchitis in adults, as well as asthma in children (Figure 7). These illnesses affect welfare and labour productivity, and increase costs, as they restrict people's activity and increase hospital admissions.

Figure 7. **AMBITIOUS POLICIES CAN SIGNIFICANTLY REDUCE AIR POLLUTION-RELATED ILLNESSES IN ARCTIC COUNCIL COUNTRIES**

Avoided health impacts with ***Ambitious policies*** compared with ***Current legislation*** scenario, 2050

330 thousand
cases of bronchitis in children (aged 6-12)
avoided by 2050

3 million
days of asthma symptoms in children (aged 5-19)
avoided by 2050

100 thousand
hospital admissions
avoided by 2050

139 million
restricted activity days
avoided by 2050

Source: OECD ENV-Linkages model projections, based on Global Burden of Disease (GBD, 2018) and Holland (2014).

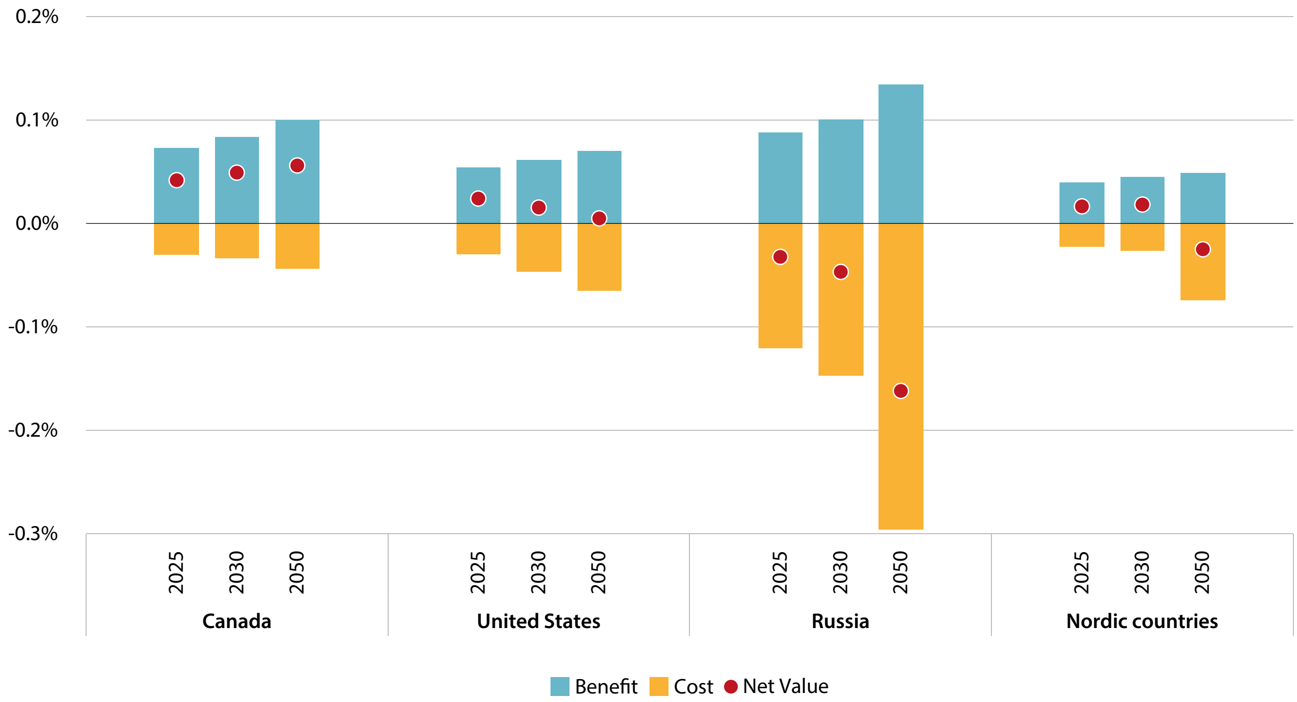
Economic consequences of air pollution policies

Air pollution can be costly for the economy through its negative impacts on labour and agricultural productivity, and through higher health expenditures. Improved air quality can therefore result in economic benefits. At the same time, reducing emissions necessitates additional investment in new technologies from firms and households, which can be costly to the economy.

By 2050, the positive gains from implementing *Ambitious policies* in Arctic Council countries are projected to equal 0.2% of their aggregate GDP, while the costs of technology deployment would equal 0.1% of aggregate GDP (Figure 8). As a consequence, adopting *Ambitious policies* to improve air quality is projected to have no overall effect on GDP in Arctic Council countries.

Figure 8. **AMBITIOUS POLICIES IN ARCTIC COUNCIL COUNTRIES CAN BE IMPLEMENTED WITHOUT AFFECTING ECONOMIC GROWTH**

Percentage change in GDP with ***Ambitious policies*** compared with ***Current legislation***



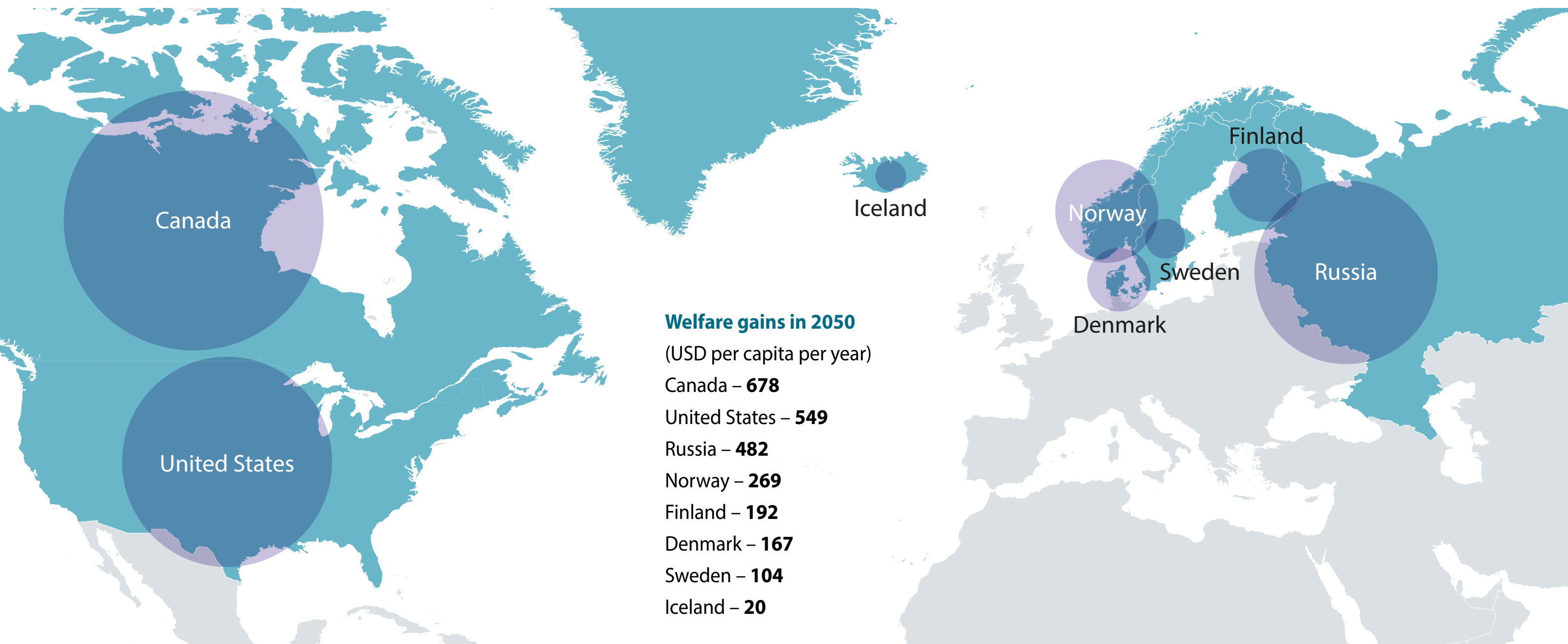
Source: OECD ENV-Linkages model.

However, the total results hide significant country differences. The net change in GDP is either marginally positive and close to zero in the United States, Canada and Nordic countries, though by 2050 Nordic countries incur a small GDP loss. In Russia, where the scope for technological improvement is higher and therefore costlier, the net GDP effects of implementing ambitious air pollution policies are slightly negative, but still under 0.2% of Russia's GDP.

While *Ambitious policies* are projected to have a very small effect on GDP, the reductions in air pollution-related illness and mortality would have significant welfare benefits. The welfare effects of premature mortality are calculated using the value of a statistical life (VSL), while the effects of illness are based on the willingness to pay to reduce the risks of falling ill. Overall, these welfare benefits are projected to be substantial in all Arctic Council countries (Figure 9), reaching USD 290 billion a year in 2050 in aggregate terms.

Figure 9. **AMBITIOUS AIR POLLUTION POLICIES IN ARCTIC COUNCIL COUNTRIES RESULT IN SIGNIFICANT WELFARE GAINS**

Welfare gains per capita (2017 PPP USD) with ***Ambitious policies*** compared with ***Current legislation*** scenario, 2050



Source: OECD ENV-Linkages model projections, based on OECD VSL values (OECD, 2020) and Holland (2014).

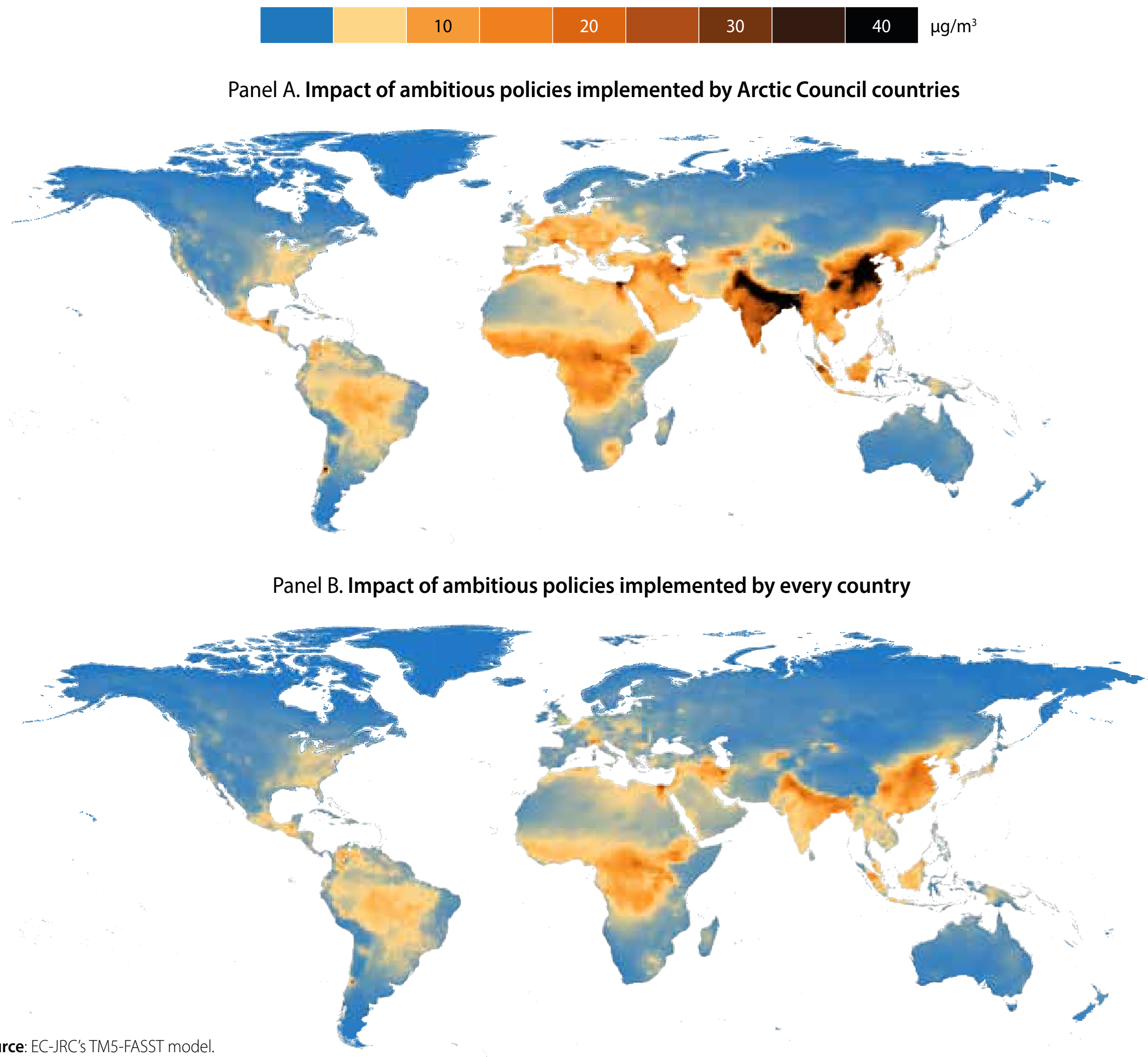
The benefits of wider geographical action

Policy action in regions outside the Arctic Council could bring additional air quality improvements in Arctic Council countries. In particular, $PM_{2.5}$ concentrations in Nordic countries and Russia are affected by emissions in nearby European countries, as well as China and India. Therefore, implementing ***Ambitious policies*** in Observer countries can lead to increased benefits in Arctic Council countries, as well as having far-reaching health and economic benefits in Observer countries themselves. Likewise, the implementation of ***Ambitious policies*** at the global level would produce significant additional air quality benefits (Figure 10). For instance, the United States would enjoy better air quality thanks to policy action in nearby non-Observer countries like Mexico.

Furthermore, while black carbon emitted closer to the Arctic is likely to have a stronger warming impact, a large share of black carbon particles polluting the Arctic is emitted in non-Arctic Council countries. For this reason, emission reductions in other regions of the world can also help to slow down climate change in the Arctic and globally.

Figure 10. **AMBITIOUS GLOBAL POLICIES WOULD REDUCE $PM_{2.5}$ CONCENTRATIONS IN ARCTIC COUNCIL COUNTRIES AND BEYOND**

Annual average anthropogenic $PM_{2.5}$ concentrations (µg/m³), 2050



Source: EC-JRC's TM5-FASST model.

Slowing down climate change in the Arctic can prevent global impacts, including a rise in sea levels and loss of fish stocks, and reduce the risk of reaching climate tipping points.

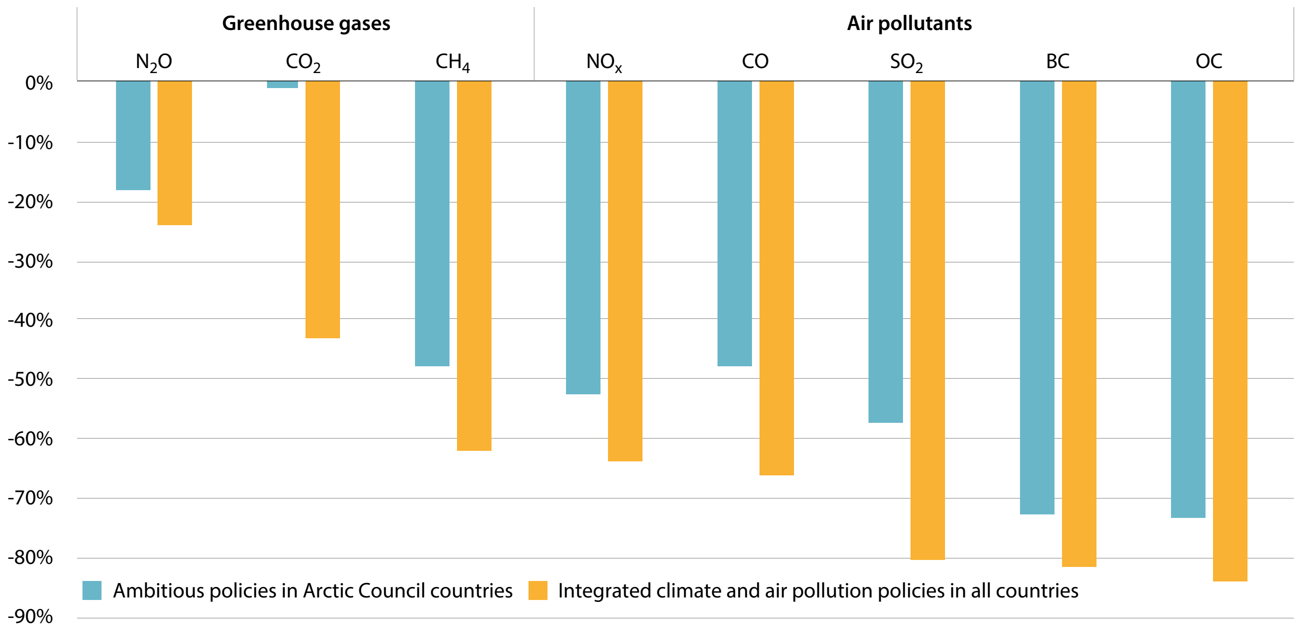
The benefits of integrated air pollution and climate policies

There are many interactions and synergies between air pollution policies and climate policies as many greenhouse gases share the same emission sources as air pollution. Furthermore, a reduction in short-lived climate pollutants, such as black carbon, can benefit air quality while also helping to achieve climate policy goals. ***Integrated policies*** that include both ***Ambitious policies*** on air pollution and climate mitigation policies can therefore have an even greater impact on harmful emissions (Figure 11).

The further reduction of greenhouse gas emissions and short-lived climate pollutants would likely slow down and reduce the effects of climate change in the Arctic and at the global level. Slowing down climate change in the Arctic can prevent global impacts, including a rise in sea levels, changes in weather patterns, severe weather events and loss of fish stocks, and reduce the risk of reaching climate tipping points.

Figure 11. **INTEGRATED GLOBAL CLIMATE AND AIR POLLUTION POLICIES CAN FURTHER REDUCE EMISSIONS IN ARCTIC COUNCIL COUNTRIES**

Percentage change in emissions with ***Ambitious policies*** and ***Integrated policies*** compared with the ***Current legislation*** scenario

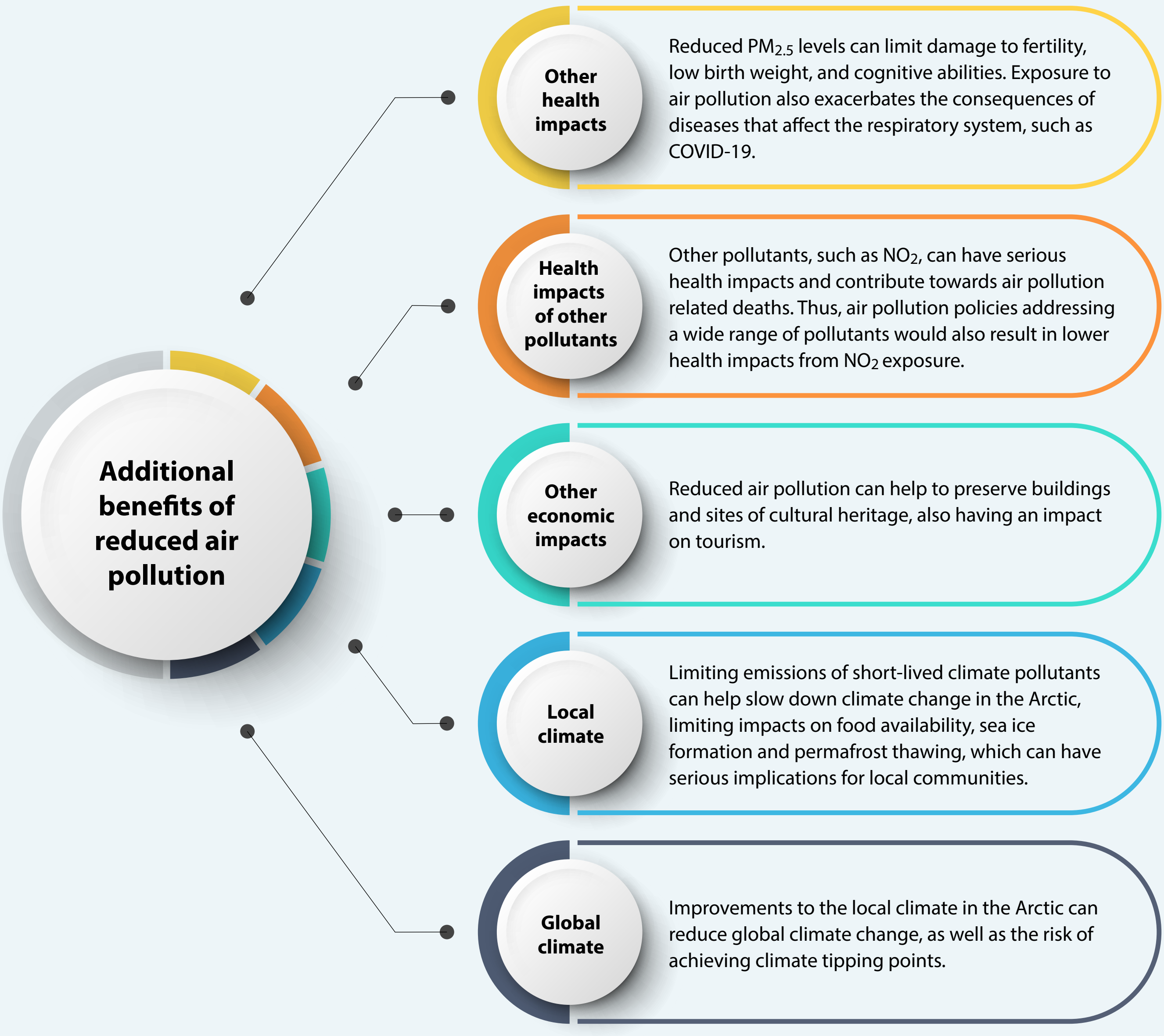


Source: IIASA's GAINS model.

Additional benefits

While this modelling analysis report covers only a selection of benefits from improved air quality, there are many other advantages of reducing air pollution (Figure 12).

Figure 12. **ADDITIONAL BENEFITS OF REDUCED AIR POLLUTION NOT ACCOUNTED FOR IN THIS STUDY**



FOR FURTHER INFORMATION

OECD (2021), ***The economic benefits of air quality improvements in Arctic Council countries***, OECD Publishing, Paris. https://doi.org/10.1787/9c46037d-en

OECD (2016), ***The economic consequences of outdoor air pollution***, OECD Publishing, Paris. https://doi org/10.1787/9789264257474-en

OECD (2015), ***The economic consequences of climate change***, OECD Publishing, Paris. https://doi.org/10.1787/9789264235410-en

www.oecd.org/environment/circle.htm
www.oecd.org/environment/modelling
www.oecd.org/environment/air-pollution

REFERENCES

ENV-Linkages model
https://oe.cd/env-modelling

GAINS model
http://gains.iiasa.ac.at/models/index.html

TM5-FASST model
https://tm5-fasst.jrc.ec.europa.eu/

This Policy Highlights summary is based on the OECD publication ***The Economic Benefits of Air Quality Improvements in Arctic Council Countries***. The findings in the report call for ambitious policy action to reduce air pollution in Arctic Council countries, highlighting the environmental, health, and economic benefits from policy action.

The Arctic environment is very sensitive to short-lived climate pollutants, including black carbon, due to their strong warming effect. In this context, Arctic Council countries have established a policy target to reduce their black carbon emissions.

If Arctic Council countries were to implement more ambitious policy action to improve air quality by reducing a wide range of air pollutants, they would obtain a positive effect on health and the environment throughout their territory, while also helping to slow down climate change by reducing emissions of black carbon and other short-lived climate pollutants.

To access the full report, visit: **oe.cd/env-arctic**

Contact:

Shardul Agrawala, Head of the Environment and Economy Integration Division, OECD Environment Directorate, *shardul.agrawala@oecd.org*

Elisa Lanzi, Senior Economist, OECD Environment Directorate, *elisa.lanzi@oecd.org*

OECD
BETTER POLICIES FOR BETTER LIVES

For more information:

oe.cd/env-arctic

www.oecd.org/environment/circle.htm
www.oecd.org/environment/modelling
www.oecd.org/environment/air-pollution

@OECD_ENV

Environment Directorate