GTAP Conference

The economic consequences of air pollution policies in Arctic Council countries

A Sectoral Analysis

OCDE

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Executive summary

1. Air pollution is one of the most serious global environmental challenges, with adverse effects on human health, well-being and the environment. In the Arctic, emissions of some air pollutants that are also short-lived climate forcers also contribute to atmospheric warming. Therefore, due to their proximity to the Arctic region, Arctic Council countries can play a key role in reducing air pollutants, which contribute to climate change, and improving the health of people in the region. .

2. To substantially reduce air pollution and its negative health and environmental impacts, emission reductions are necessary in all emitting sectors: agriculture, road transport, energy, industry, waste treatment, residential and commercial and international shipping. With each sector contributing towards emissions of different air pollutants, having different technological options and emission reduction costs, the macroeconomic consequences of sectoral policy action can be expected to vary substantially across sectors.

3. With a focus on sectoral differences, this report quantifies the environmental, health and economic consequences of policy action on air pollution in Arctic Council countries. The case of Arctic Council countries is particularly interesting due to the large differences in emission sources, emission levels and policy stringency.

4. The report takes a modelling approach and compares a baseline scenario that reflects current policies, with a policy scenario in which the best available techniques (BATs) to reduce emissions are deployed in all emitting sectors. In each scenario, firms and households invest in the BATs to reduce emissions of air pollutants. These sector-specific investments result in costs to the economy, which are compared to the economic benefits from the reduced air pollution impacts. Indeed, air quality improvements result in economic benefits from decreased health expenditures, as well as higher labour and agricultural productivity.

5. The analysis relies on the OECD's computable general equilibrium (CGE) model ENV-Linkages, exploiting its detailed sectoral and regional structure. The advantage of using a large-scale CGE model is that these indirect effects in the economy are brought together to identify the total net market effects. The economic analysis with the ENV-Linkages model is supported by emission and air pollution control cost projections from the GAINS model of the International Institute for Applied Systems Analysis (IIASA) and calculations of the biophysical impacts of air pollution with the TM5-FASST model of the European Commission's Joint Research Centre (EC-JRC).

6. The results from the scenario analysis show that, in the coming decades, current policies will already lead to emission reductions. However, the wide deployment of BATs could lead to much stronger emission reductions in all sectors in Arctic Council countries, with a decrease by around 60% for most pollutants by the middle of the century. Aggregate emission reductions result from different sectoral contributions to overall abatement, which vary by pollutant. While not all sectors reduce their emissions with current policies, emissions of all gases are projected to decrease substantially with the wide deployment of BATs.

7. Emission reductions in the different sectors and pollutants contribute unevenly to the overall decrease in concentrations of $PM_{2.5}$ and ground-level ozone. For instance, in the United States the agricultural sector accounts for half of the total reduction in fine particle concentrations, while in Russia, the largest contribution comes from emission reductions in the industrial sectors, and in Norway, a large share comes from energy-related emissions. The differences depend on two main factors. First, the changes in sectoral emissions in each country, which in turn depend on the potential for technological

improvements in each specific sector. For instance, in Russia, the largest share of reductions of particulate matters concentration comes from improvements in industrial sectors. Second, the differences depend from the relative contribution of each sector to concentrations in the current legislation scenario as well as the different structures of the economy of the countries. For instance, in the United States, the agricultural sector is one of the sectors that contribute the most to concentrations of fine particles.

8. These air quality improvements result in better health. The strongest reductions in air pollution related mortality come from emission reductions in the agricultural sector, followed by industrial sectors, which constitutes a large share of air pollution related deaths in Russia. In Nordic countries, the shipping sector has a significant impact, especially compared with other Arctic Council countries. Besides improvements in human health, lower concentrations of ground-level ozone lead to an increase in crop productivity. The strongest improvements result from policy action in the energy sector, which correspond specifically to the reductions in nitrogen dioxide, which is in turn one of the gases that drive concentrations of ground-level ozone.

9. The macroeconomic effect of policy action in Arctic Council countries as a whole can be considered as GDP neutral, with costs and benefits offsetting each other. However, this aggregate result hides large differences across sectors. Deploying BATs in the agricultural sector results in higher macroeconomic benefits, compared to other sectors. This effect corresponds to the large contribution of this sector to air quality improvements and to the relatively lower cost of the BATs in this sector. On the other hand, the investments in BATs in the residential and transport sectors appear to be more costly and lead to lower benefits. This result does not however imply that, generally, emission reductions in the transport sector do not pay off. It is rather a result of the specific characteristics of the countries considered. Indeed, in most Arctic Council countries there is already a high level of emission reductions in the transport sector in the current legislation scenario.

10. Overall, the results presented in this report suggest that substantial benefits from air quality improvements can be obtained when considering emission reductions throughout the economy, and not just in the sectors that are targeted more often, such as industry and transport. This is especially the case for OECD countries that already have a high level of stringency in air pollution policies but could achieve substantial benefits by further reducing their emissions.

1 Introduction

11. Air pollution is one of the most serious global environmental challenges, with adverse effects on human health, well-being and the environment. It has significant impacts on ecosystems and contributes to climate change, as some air pollutants – most notably black carbon (BC) – are also short-lived climate pollutants that contribute to atmospheric warming. Such impacts are especially detrimental for fragile environments, such as the Arctic.

12. A recent report by the OECD (2021[1]) shows that policy action on air pollution in Arctic Council countries[1] would result in better air quality, and thus in health and economic improvements. This analysis shows that 80 000 air pollution related deaths could be avoided yearly. Curbing air pollution would also reduce other illnesses such as asthma, bronchitis as well as cardiovascular illnesses. Finally, improved air quality leads to economic benefits through higher labour productivity, higher crop productivity and lower health expenditures.

13. Different economic sectors contribute unevenly to the issue of air pollution. Each economic activity leads to emissions of a specific set of air pollutants and the emission intensity of production varies across sectors. Furthermore, the emission reduction potentials and the technologies available to reduce air pollution also vary by sector. Finally, the difference in technological options imply that the investments in Best Available Techniques (BATs) needed to reduce air pollution are also sector-specific.

14. While there is extensive literature that focuses on the differences in emission reductions by sector (Caiazzo et al., 2013[2]; Lanzi, Dellink and Chateau, 2018[3]) and on the uneven economic implications of sectoral policies (Gu et al., 2018[4]) in the context of climate change, less efforts have been made to understand the macroeconomic consequences of sectoral air pollution policies. Only recently, Vandyck et al. (2020[5]) analysed the sectoral and regional differences in the abatement costs of both greenhouse gases (GHG) and fine particulate matter ($PM_{2.5}$).

15. To fill this gap in the understanding of sectoral cost benefit analysis of air pollution policies, this report quantifies the macroeconomic consequences of sectoral policy action on air pollution, focusing specifically on Arctic Council countries. The case of Arctic Council countries is of particular interest given the differences in economic structure, air pollution levels, and current technology options. The report focuses on the technological improvements targeted at reducing emission sources in various sectors: agriculture, road transport, energy, industry, waste treatment, residential and commercial and international shipping. The analysis aims at improving the understanding of the potential contribution of each sector to air quality improvement, balancing the benefits of emission reductions and the costs. Furthermore, it includes the differences across the eight Arctic Council countries.

16. To analyse sectoral contributions to reducing air pollution, the report relies on the OECD's computable general equilibrium (CGE) model ENV-Linkages (Chateau, Dellink and Lanzi, 2014[6]), exploiting its detailed sectoral and regional structure. While ENV-Linkages is the main modelling tool used in the report, additional models are needed to quantify the health and economic consequences of air pollution. In particular, the report links economic projections obtained with the ENV-Linkages model, with emission and air pollution control cost projections from the GAINS model (Amann et al., 2011[7]) of the

[1] The Arctic Council is comprised of the following countries: Canada, Denmark, Finland, Iceland, Norway, the Russian Federation (hereafter Russia), Sweden and the United States.

International Institute for Applied Systems Analysis (IIASA) as well as calculations of the biophysical impacts of air pollution with the TM5-FASST model (Van Dingenen et al., 2018[8]) of the European Commission's Joint Research Centre (EC-JRC). The analysis uses concentrations of $PM_{2.5}$ and ground-level ozone (O_3) as the two main indicators of air quality, due to the negative health impacts associated with the pollutants. As well as in (OECD, 2016[9]) ideally this report would cover many other impacts and costs of outdoor air pollution. Owing to the data available, the report assesses the costs of air pollution of a selected number of impacts associated with $PM_{2.5}$ and ground-level ozone (O_3).

17. Building on the framework of (OECD, 2021[1]), the report compares the costs and benefits of achieving the maximum feasible reduction in emissions in each sector in Arctic Council countries. It further considers how each sector contributes towards overall emission reductions. In each scenario, firms and households invest in the BATs to reduce emissions of air pollutants. These sector-specific investments result in costs to the economy, which are compared to the economic benefits from the reduced air pollution impacts. Indeed, air quality improvements result in economic benefits from decreased health expenditures, as well as higher labour and agricultural productivity. Specific sectors and countries may also benefit from the changes in competitive positions induced by the policy. The advantage of using a large-scale CGE model is that these indirect effects in the economy are brought together to identify the total net market effects.

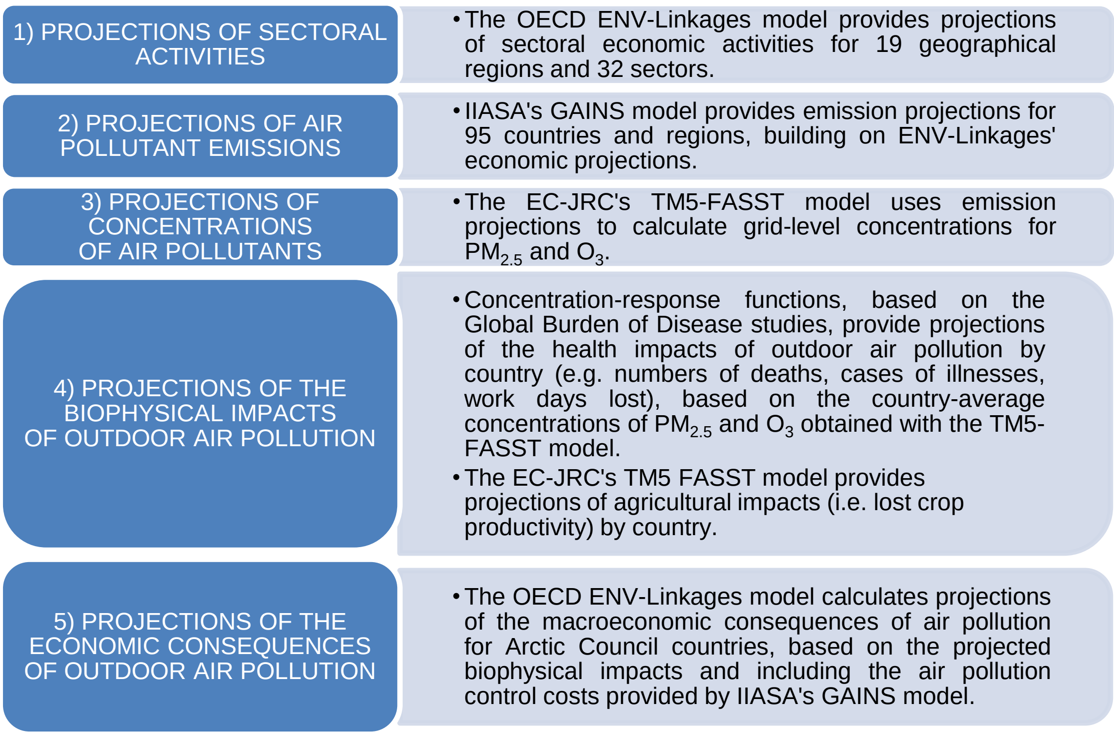
18. The remainder of the report is structured as follows. Section 2 summarises the methodology and describes the policy scenarios. Section 3 provides an overview of recent trends in air quality and the sectoral contributors to air pollution in Arctic Council countries. Section 4 projected concentrations of $PM_{2.5}$ and O_3 in the different scenarios, as well as the associated consequences for human health and crop yields, the sectoral macroeconomic economic consequences of air pollution policies and the discussion of the results.

2 Methodology and scenarios

2.1. Modelling framework

19. This report relies on a quantitative approach to assess the economic consequences of air pollution up until 2050, as used in previous OECD work (OECD, 2021[1]; OECD, 2016[9]). The modelling framework is based on a step-wise approach, which uses different modelling tools to link projections of (1) sectoral economic activities to (2) emissions of air pollutants, (3) concentrations of fine particulate matter and ground-level ozone, and finally to (4) the biophysical and (5) economic impacts of outdoor air pollution (Figure 2.1). These steps are repeted for each sectoral policy scenario and the economic benefit of policy action in each sector is calculated by comparing them with the results in the current legislation scenario.

Figure 2.1. Methodological steps



Source: Methodology based on OECD (2016[9]).

20. This methodology relies on a suite of modelling tools. The main model – used for the economic quantifications in steps (1) and (5) – is the OECD computable general equilibrium model ENV-Linkages,

described in Annex A (Chateau, Dellink and Lanzi, 2014[6]). As described in step (2), ENV-Linkages provides projections of the economic activities to the GAINS model (Amann et al., 2011[7]; Höglund-Isaksson et al., 2020[10]; Klimont et al., 2017[11]; Gómez-Sanabria et al., 2018[12]). The pollutants projected in this report are obtained from the GAINS model and include black carbon (BC), organic carbon (OC), sulphur dioxide (SO_2), nitrogen oxides (NO_x), non-methane volatile organic compounds (NMVOC), carbon monoxide (CO), methane (CH_4), and ammonia (NH_3).[2]

21. Projected emissions are then used to calculate atmospheric concentrations of $PM_{2.5}$ and ground-level ozone. This constitutes step (3) and relies on the Fast Scenario Screening Tool TM5-FASST, a global air quality source-receptor model developed by the European Commission's Joint Research Centre (EC-JRC) (Van Dingenen et al., 2018[8]). The concentrations of pollutants are used to calculate the biophysical impacts of air pollution on human health and agriculture, which constitutes step (4). These biophysical impacts are described by a range of indicators, including mortality, hospital admissions and crop productivity losses. Health impacts at the country level are obtained using concentration-response functions based on the results of the Global Burden of Disease project $PM_{2.5}$ (Forouzanfar et al., 2015[14]) and as described in OECD (2021[1]). Finally, the agricultural impacts are calculated using the TM5-FASST model, which estimates the crop yield changes associated with ground-level ozone concentrations (Van Dingenen et al., 2018[13]; Van Dingenen et al., 2009[15]).

22. Finally, the macroeconomic consequences of air pollution policies are calculated in step (5), based on (i) the macroeconomic benefits from increase air quality; and (ii) the macroeconomic costs from implementing such policies. The macroeconomic benefits from increased air quality comes from decreased health expenditures, and higher labour and agricultural productivity. The macroeconomic costs from implementing more stringent air quality policies instead are related to the investments needed to deploy BATs. Both benefits and costs are included in ENV-Linkages model to calculate the net macroeconomic effects.

23. The net macroeconomic effects quantified reflect the impact of air pollution policies on the economic system as a whole, including impacts on expenditures, factor productivity, production, consumption and trade. The indicator used for the macroeconomic effect is the gross domestic product (GDP), as in previous OECD work on the costs of environmental inaction (OECD, 2015[16]; OECD, 2016[9]). The modelling framework takes into account both direct and indirect effects. For instance, changes in households' health expenditures (direct costs) lead to changes in their consumption choices (indirect costs). Furthermore, in ENV-Linkages, higher government spending encourages firms to increase investment, therefore leading to a positive effect on economic growth that partly offsets the initial costs.

2.2. Policy scenarios

24. This report analyses the economic consequences of policies targeting air pollution, based on a scenario analysis performed with the OECD Computable General Equilibrium (CGE) model ENV-Linkages (Chateau, Dellink and Lanzi, 2014[6]). The report compares several policy scenarios that reflect the implementation of air pollution policies in different sectors to a reference baseline scenario, all with a 2050 time horizon. Table 2.1 provides an overview of the scenarios.

25. The baseline scenario assumes the effective implementation of current legislation (CLE) globally in all the sectors of the economy, including the eight Arctic Council countries. This scenario assumes no changes to current policies in place, i.e., no increase in ambition of air quality standards and therefore no further measures are introduced. It considers national and regional laws and regulations on emission limit

[2] Due to lack of data, the report does not cover other pollutants that affect the Arctic region, such as mercury (AMAP/UN Environment, 2019[25]) and persistent organic pollutants (POPs) (AMAP, 2016[26]).

values, energy efficiency and relating to climate change in place in 2017. The legislation covers emissions from a number of activities, including combustion plants, industrial processes, transport, agriculture, use of solvents and the residential sector.[3] In this baseline scenario, growth is projected to be steady for OECD countries while non-OECD countries are projected to enjoy high level of growth (OECD, 2019[17]).[4] Current policies do not imply that emission levels are constant over time, as growth varies by country and sector. Furthermore, efficiency improvements (e.g., energy use and total factor productivity growth) imply a weak relative decoupling of emissions from output growth (i.e., emissions grow more slowly than production volumes and GDP).

Table 2.1. Scenario name and description

Sectoral coverage	Geographical coverage of the policy action	
	Arctic Council countries	Global
No additional policy action	CLE	
Agriculture	AGR-AC	AGR-Global
Transport	TRA-AC	TRA-Global
Energy	ENE-AC	ENE-Global
Industry	IND-AC	IND-Global
Waste treatment	WST-AC	WST-Global
Residential and commercial	RES-AC	RES-Global
Shipping	SHP-AC	SHP-Global
All sectors	MTFR-AC	MTFR-Global

26. All policy scenarios reflect the achievement of the maximum technically feasible reductions (MTFR) of emissions in the eight Arctic Council countries, referred to as the MTFR-AC scenario. For this scenario, the GAINS model provides data on the investments needed to reduce air pollution, corresponding to the technologies deployed in each sector to reduce emissions. These investments are included in ENV-Linkages for the various sectors in order to study the economic consequences of the sectoral policies. This scenario is central since it serves as a basis for the sectoral analysis.

27. The MTFR scenario explores the extent to which emissions could be further reduced through the policy-induced application of all existing best available techniques (BATs) to reduce emissions, in addition to the implementation of current regulations. The reduction of air pollutant comes from the introduction of more stringent limits for large scale stationary processes and combustion, road and non-road vehicles, medium and small-scale residential boilers. Additional incentives and regulations are assumed to assure steady improvement of energy and nutrient efficiency as well as more efficient application of organic and mineral nitrogen fertilizers resulting in reduction of ammonia and soil NOx emissions. Evaporative NMVOC losses from storage and distribution of liquid fuels can be reduced installing capture and recovery systems, while policies to reduce emissions from solvents use could include incentives to increase application of low solvent and water based paints and products. For methane, key additional policies address venting emissions from fossil fuel (coal, oil, gas) production and distribution, development of efficient waste management system for industrial and municipal water and solid waste, reduction of emissions from rice production, and incentives to increase farm-based biogas production capacity. Introduction of these policies assures that the maximum technical mitigation potential is achieved in all sectors.

[3] A detailed description of the emissions control policies considered is provided Amann et al. (2018[31]) . For a detailed description of the climate, energy use and energy efficiency policies, please refer to the New Policies Scenario of the World Energy Outlook 2018 (IEA, 2018[30]).

[4] OECD (2019[17]) details the key assumptions and exogenous trends underpin this scenario.

28. To illustrate the macroeconomic impact of sectoral technological improvements, this report focuses on seven sectoral emission sources: agriculture (AGR), road transport (TRA), energy (ENE), industry (IND), waste treatment (WST), residential and commercial (RES), and international shipping (SHP). Sectoral scenarios are implemented individually. For instance, the scenario AGR-AC corresponds to a scenario where the agricultural sector is implementing the maximum technically feasible reductions to abate pollutant emissions in Arctic Council countries while the rest of the sector and countries maintains current legislations.

29. Finally, additional scenarios aims to study competiveness effects. This is done by taking into consideration an additional scenario (MTFR-Global) that reflects the global deployment of the MTFR technologies. Similar global scenarios are also analysed for each sector (e.g. AGR-Global for a global implementation of the MTFR scenario in the agricultural sector).

3 Sectoral emissions and potential for emission reductions

3.1. Sectoral sources of air pollution in Arctic Council countries

30. To improve air quality in Arctic Council countries, emissions need to be reduced in all the main emitting sectors, and targeting the range of pollutants that drive the concentrations of fine particulate matter, which is the main driver of the health impacts of air pollution. Specifically, it is necessary to reduce emissions of primary $PM_{2.5}$ – including black carbon (BC) and organic carbon (OC) - and of other pollutants that contribute to the formation of secondary $PM_{2.5}$, which include sulphur dioxide (SO_2), nitrogen oxides (NO_X), ammonia (NH_3), and non-methane volatile organic compounds (NMVOCs).

31. According to estimates from IIASA's GAINS model, transport, including shipping, is an important source of air pollution in Arctic Council countries. It contributes significantly to the formation of $PM_{2.5}$ and ground-level ozone. Transport accounts for half of NO_X and BC emissions and for one-quarter of organic carbon and NMVOCs emissions in the region (Figure 3.1).

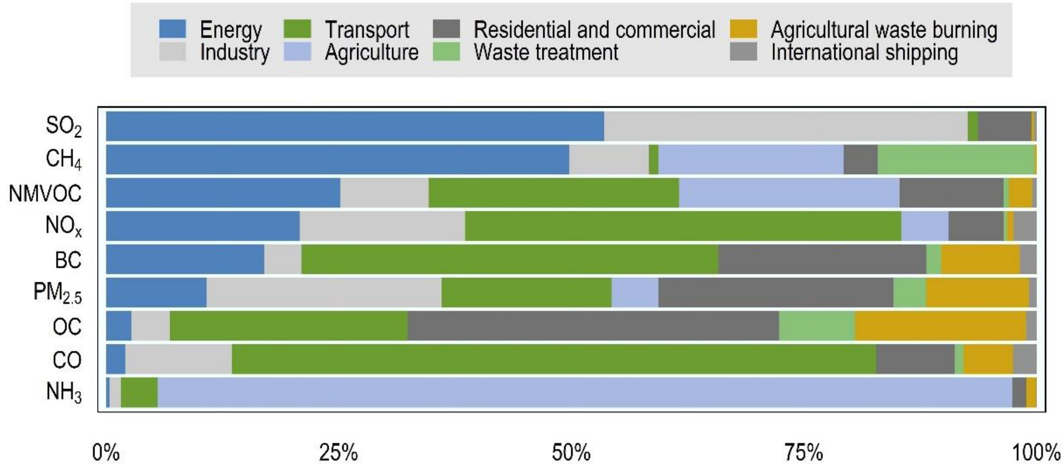
32. Energy and industry sectors are other key sources of pollution in Arctic Council countries. Together, energy production and consumption, and the industrial sector are responsible for nearly all SO_2 emissions (57% energy and 39% industry) and one-third of NMVOCs and NO_X emissions in the region. The energy sector is also responsible for a significant share of BC (15%) emissions, where flaring has a predominant impact, with 90% of all the BC emissions in this sector.

33. The residential sector is a key contributor to the emissions of primary and formation of secondary $PM_{2.5}$. In particular, the combustion of solid and liquid fuels for domestic heating is a major source of organic carbon (40%) and black carbon (over 20%), while also contributing to NMVOCs (10%), NO_X (5%) and SO_2 (3%) emissions in the region.

34. Finally, the agricultural sector is a major contributor of NH_3 (92%) emissions, and also has an important role in the emission of NMVOCs (25%). Furthermore, agricultural waste burning is responsible for nearly 20% of OC emissions, 12% of $PM_{2.5}$ and 8% of BC emissions in Arctic Council countries.

Figure 3.1. Emissions of air pollutants in Arctic Council countries

Sectoral shares in 2019



Note: "Residential" emissions are due to wood and other fuels combustion. $PM_{2.5}$ refers to primary emissions only.
Source: IIASA's GAINS model.

35. Although ground-level ozone is not directly emitted to the atmosphere, human activities contribute to the emission of its precursor gases, which include methane (CH_4), NMVOCs, NO_X, and carbon monoxide (CO). In Arctic Council countries, the transport and power generation sectors emit large shares of these pollutants (Figure 3.1). Most notably, emissions of methane and CO, which are particularly relevant to ground-level ozone formation, are largely driven by energy-related emissions (50% of methane emissions), and by transport emissions (62% of CO emissions from land transport and 4% from shipping).

36. Despite some similarities of sectoral composition of certain pollutants (e.g. NH_3), sectoral emissions vary across countries (Figure 3.2). For instance, a high share of emissions is caused by the residential sector in Canada and in most Nordic countries,[5] while energy and industry represent a high share of emissions in Russia. In the United States, the transport sector represents a significant share of overall emissions, especially for CO and BC.

[5] Nordic countries include Denmark, Finland, Iceland, Norway and Sweden.

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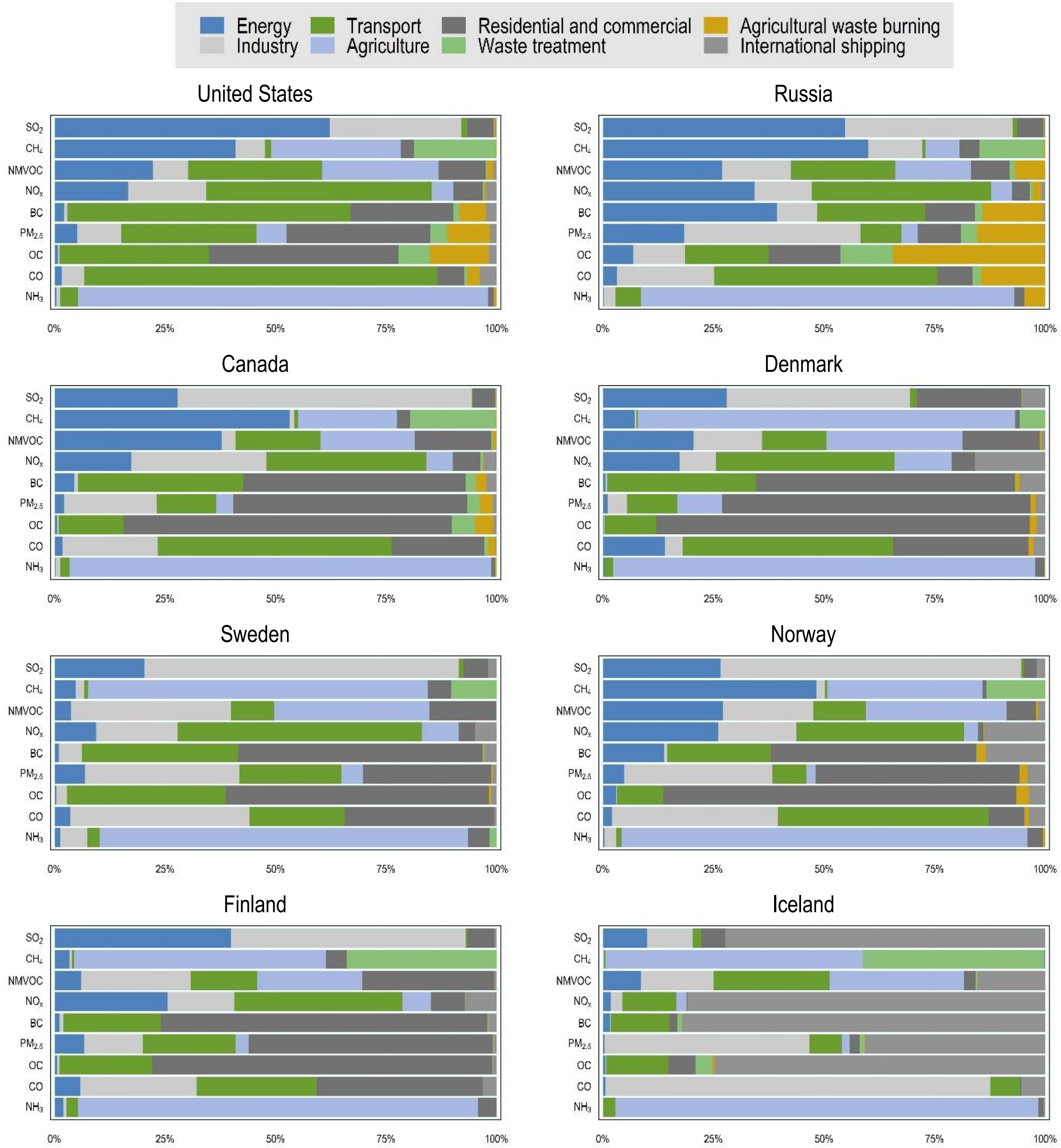
Figure 3.2. Emissions of air pollutants by country

Sectoral shares 2019



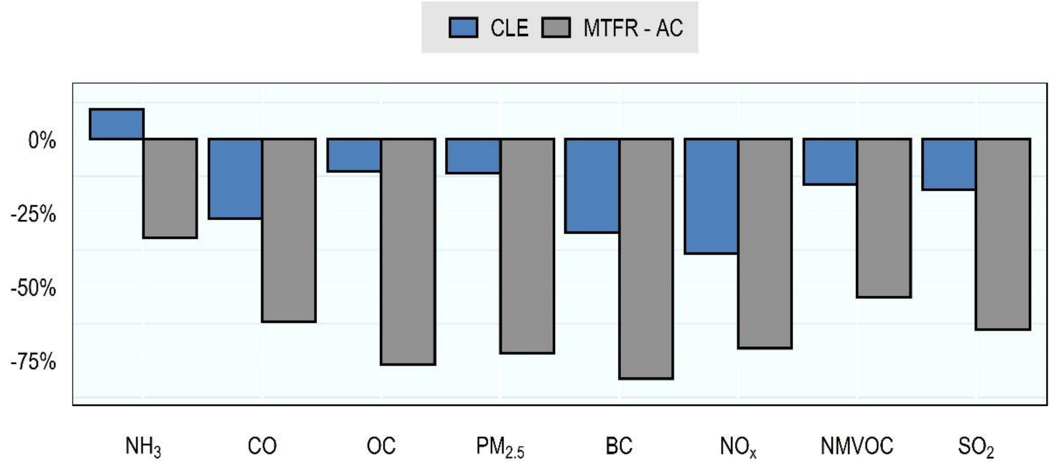
Note: "Residential" emissions are due to combustion of wood and other fuels. $PM_{2.5}$ refers to primary emissions only.
Source: IIASA's GAINS model.

3.2. Emission projections

37. Based on current legislation, emissions in Arctic Council countries are projected to decrease in the coming decades. Altogether, under the baseline scenario, by the middle of the century Arctic Council countries are projected to see emissions of most pollutants fall by 20% to 40%, depending on the pollutant (Figure 3.3). Emissions only increase for ammonia (NH_3). For this pollutant, emissions are projected to increase in the next three decades by 5% compared to 2019 levels, mostly due to the agricultural sector.

Figure 3.3. Projected emissions of key air pollutants in Arctic Council countries

% change in 2050 w.r.t 2019 levels



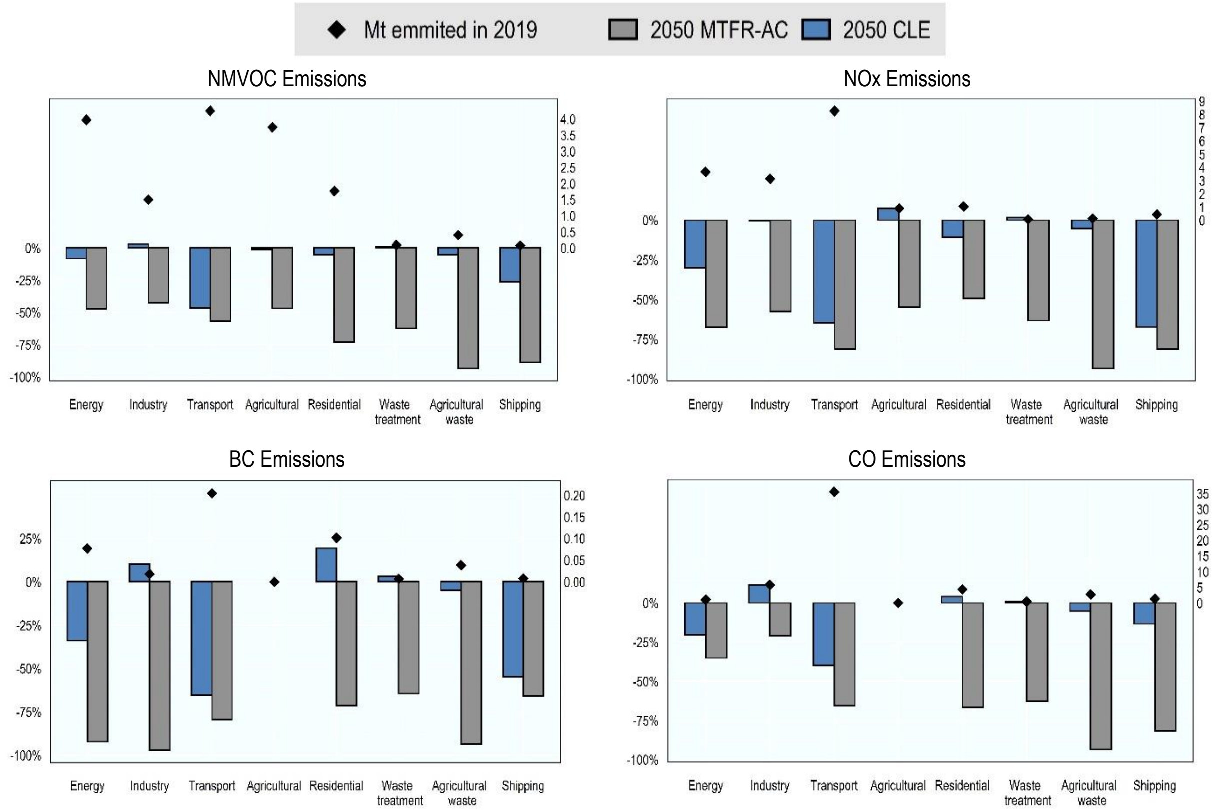
Source: IIASA's GAINS model.

38. The implementation of policies to deploy the best available techniques could achieve much greater emission reductions. Indeed, in the scenario reflecting the Maximum Technically Feasible Reduction in emissions in Arctic Council countries (MTFR-AC), NO_X, SO_2, and CO emissions are projected to decrease by 60% by the middle of the century.

39. Aggregate emission reductions result from different sectoral contributions to overall abatement, which vary by pollutant (Figure 3.4Figure). In the baseline scenario, the largest emission reductions are projected to take place in the transport sector, especially for CO, BC and NO_x while energy and industry are responsible for emission reductions of SO_2 in the baseline. However, not all sectors reduce their emissions in the baseline scenario. For instance, BC and CO emissions are projected to increase in the residential sector, and CO emissions increase also in the energy and industry sectors. In the MTFR-AC scenario, there will be further sectoral emission reductions, including a reduction in emission sources that were projected to increase in the baseline scenario.

Figure 3.4. Projected sectoral emissions by pollutant in Arctic Council countries

Mt/year (right axis); % change wrt 2019 (left axis)



Note: Right axis Mt/year: (Million tonnes per year), in the left axis percentage emission reduction with respect to 2019 levels. The graphs use different scales.
Source: IIASA's GAINS model.

40. These emission reductions are the consequence of investments in BATs in each sector in Arctic countries (Figure 3.5). Investments are higher in sectors for which less policies on air pollution are currently in place, such as the agricultural sector. Sectors such as transport already have several regulation in place; therefore, lower investment is needed to achieve the maximum feasible reduction in emissions.

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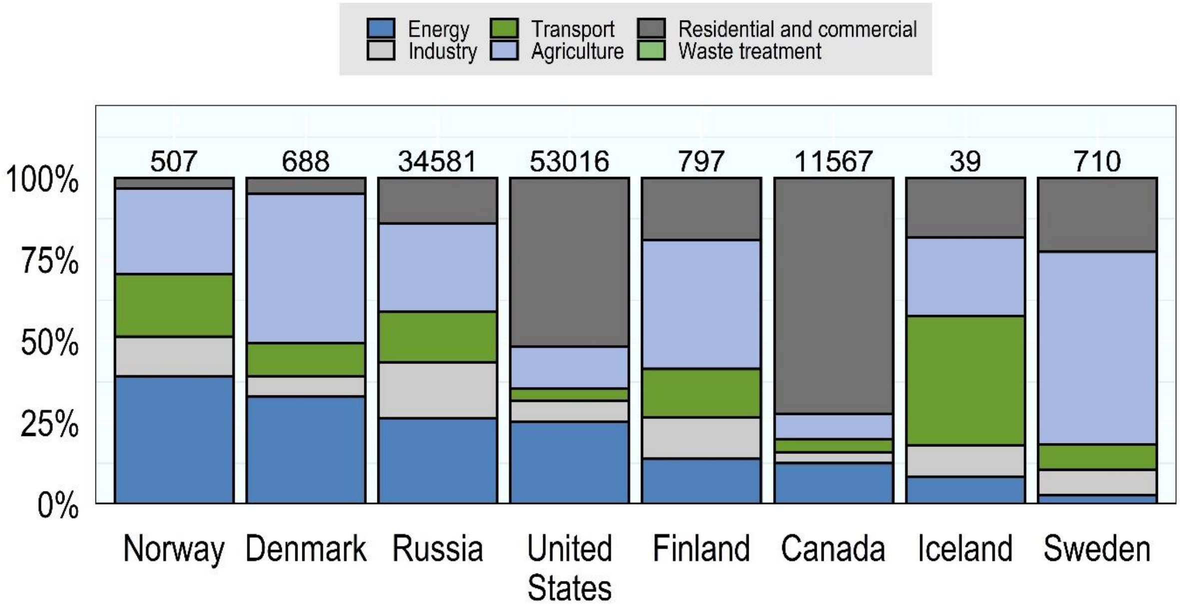
Figure 3.5. Arctic Council country investment in BATs

Value in million USD, 2017 PPP exchange rates, MTFR-AC scenario, 2050



Note: In the graph, the left axis represents the share of investment in each sector. The figure at the top of each bar represents the total investment in BATs in million USD, 2017 PPP exchange rates. Waste volumes don't show as the amounts are minimal in comparison to the other sectors.
Source: IIASA's GAINS model.

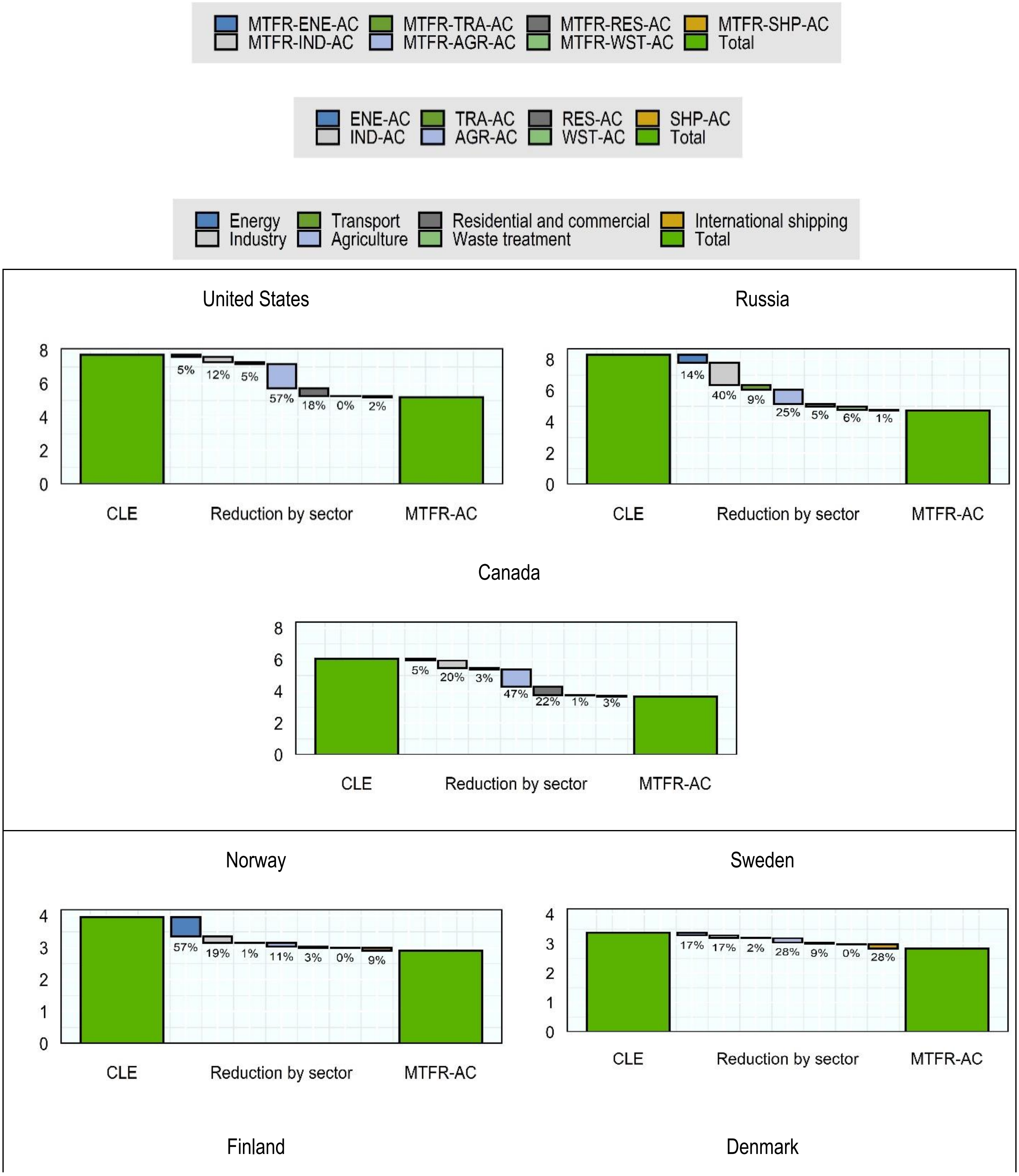
4 Air quality, health and agricultural benefits of air pollution policies

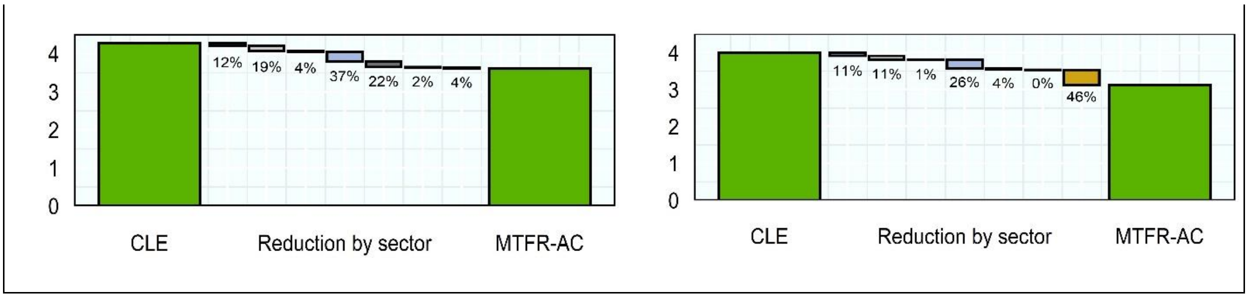
4.1. Concentrations of $PM_{2.5}$ and ground-level ozone

41. Emission reductions in the different sectors contribute unevenly to the overall decrease in concentrations in the MTFR-AC scenario (Figure 4.1). In the United States the agricultural sector accounts for half of the total reduction in $PM_{2.5}$ concentrations, while in Russia, the largest contribution comes from emission reductions in the industrial sectors, and in Norway, a large share comes from energy-related emissions. These differences depend on two main factors. First, the changes in sectoral emissions in each country, which in turn depend on the potential for technological improvements in each specific sector. For instance, in Russia, the largest share of reductions in $PM_{2.5}$ emissions comes from improvements in industrial sectors. Second, the differences depend on the relative contribution of each sector to concentrations in the baseline. For instance, in the United States, the agricultural sector is one of the sectors that contributes the most to concentrations of fine particles.

Figure 4.1. Country specific changes in population weighted $PM_{2.5}$ concentrations

2050, sectoral policy action in Arctic Council countries only





Note: In green absolute concentration level in microgram per cubic meter in the CLE (LHS) and MTFR-AC (RHS) scenarios. The graphs use different scales.
Source: TM5-FASST model.

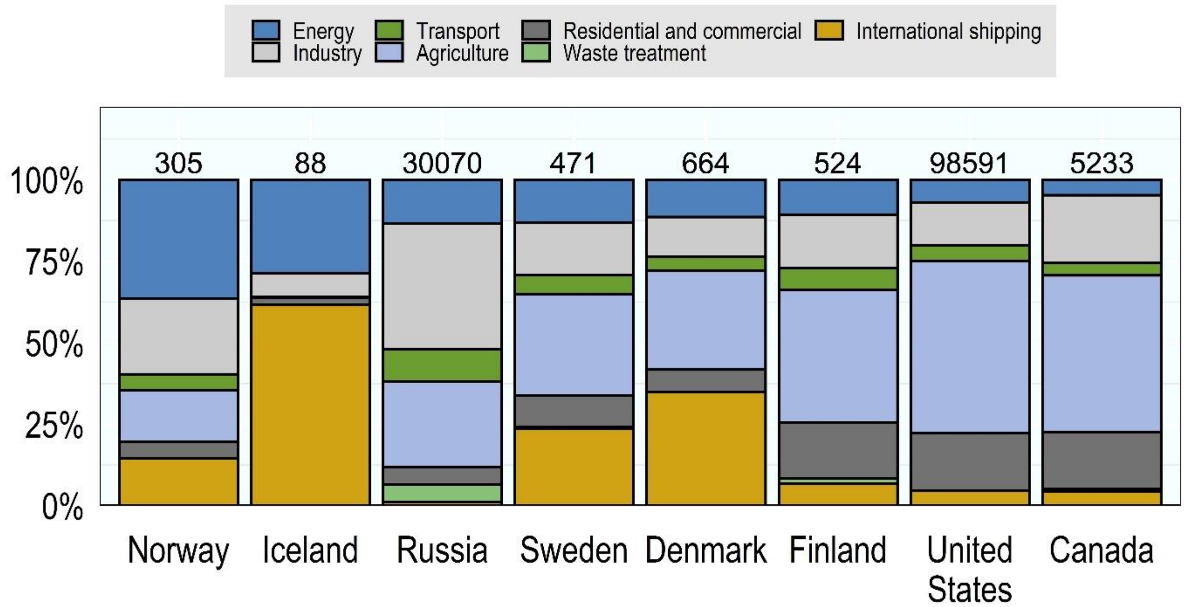
4.2. Biophysical impacts

42. In Arctic Council countries, fine particulate matter and ground-level ozone are responsible for more than 200 000 deaths every year (OECD, 2021[1]). One third of these air pollution related mortality could be avoided thanks to the wide deployment of BATs, with around 80 thousand less air pollution related deaths yearly by 2050.

43. In most countries, a large share of the reduction in air pollution related mortality comes from policy action in the agricultural sector, which would reduce air pollution related deaths by more than 20 thousand, mostly taking place in the US and Canada. The industry sector also contributes to a large share of reduced deaths: 15 thousand, mostly taking place in Russia (Figure 4.2). In Nordic countries, the shipping sector has a significant impact, especially compared with other Arctic Council countries. These sectoral shares reflect the relative contributions of each sector to air quality improvements, i.e. reductions in concentrations of fine particles and ground-level ozone.

Figure 4.2. Avoided air pollution related deaths by sector

2050



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Note: In the top legend, the absolute value of avoided air pollution related mortality, in the left axis the share by sector. Agricultural sector includes agricultural waste burning.
Source: ENV-Linkages' model projections, based on Global Burden of Disease (GBD, 2018[18]).

44. Besides improvements in human health, ground-level ozone pollution also reduces plants' physiological functions, resulting in reduced productivity and yield. Increasing air quality in Arctic Council countries is therefore projected to increase crop productivity and agricultural yields (Table 4.1). The strongest improvements come from policy action in the energy sector, which correspond specifically to the reductions in NOx, one of the gases that contribute to the formation of ground-level ozone.

45. Russia and Nordic countries have a lower levels of crop production compared to Canada and the United States, e.g. the United States only produces 6 times more wheat that Russia and the Nordic countries together. Despite the small volumes, policy action would increase the crop productivity in both Nordic countries and Russia.

Table 4.1. Projected increase in crop yields in the policy action scenarios

Percentage change w.r.t. Current Legislation scenario, 2050

	Maize	Soybean	Wheat	Rice
Agriculture	2%	2.5%	2.6%	5%
Residential and commercial	2.3%	2.4%	2.3%	2.8%
Industry	4.2%	4.3%	4%	5%
Energy	6.1%	6.3%	5.9%	7.5%
Transport	2.2%	4.7%	2.5%	3.5%
International shipping	4.6%	4.7%	5%	4.8%

Source: EC-JRC's TM5 FASST Model

4.3. Economic consequences of sectoral air pollution policies

46. Health and environmental benefits, in the form of higher crop productivity, also have positive consequences on economic output and growth. Following the methodology of OECD (2021[1]), macroeconomic benefits are associated with increased labour productivity, reduced of health expenditure and increased agricultural productivity. However, these benefits come with the costs associated with the investments in BATs.

47. The macroeconomic effect of policy action in Arctic Council countries as a whole can be considered as GDP neutral, when BATs are deployed in all sectors (Figure 4.3). In the sectoral scenarios considered, both macroeconomic benefit and cost are small, since the sectoral changes in emissions and concentrations only bring about one part of the overall health and environmental benefits and correspond to only part of the BAT investments.

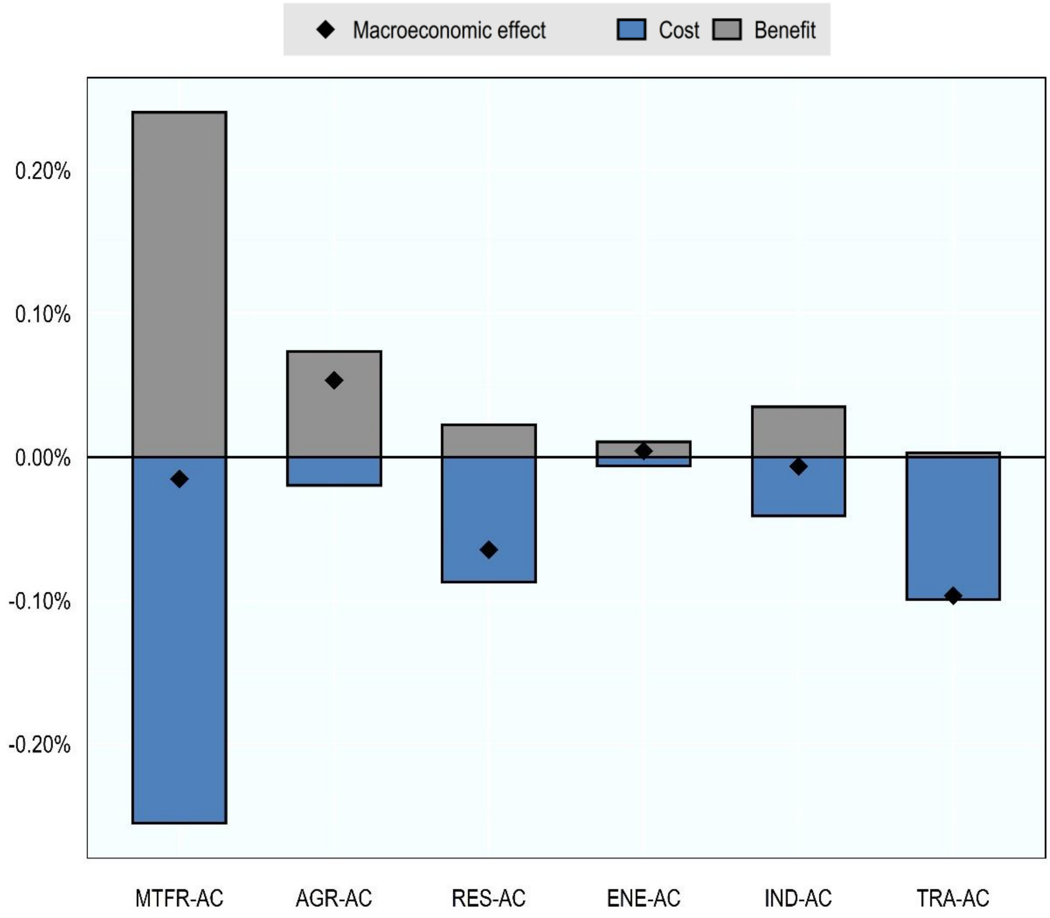
48. While overall costs and benefits offset each other, this aggregate effect hides large disparities across sectors. Deploying BATs in the agricultural sector results in higher macroeconomic benefits, compared to other sectors. This effect corresponds to the large contribution of this sector to air quality improvements, as outlined in Section 3. On the other hand, the investments in BATs in the residential and transport sectors appear to be more costly and lead to lower benefits. This result does not however imply that generally emission reductions in the transport sector do not pay off. It is rather a result of the specific characteristics of the countries considered. Indeed, in most Arctic Council countries there is already a high level of emission reductions in the transport sector in the baseline scenario. Therefore, the MTFR-TRA-AC scenario mostly reflects the deployment of more expensive technological options.

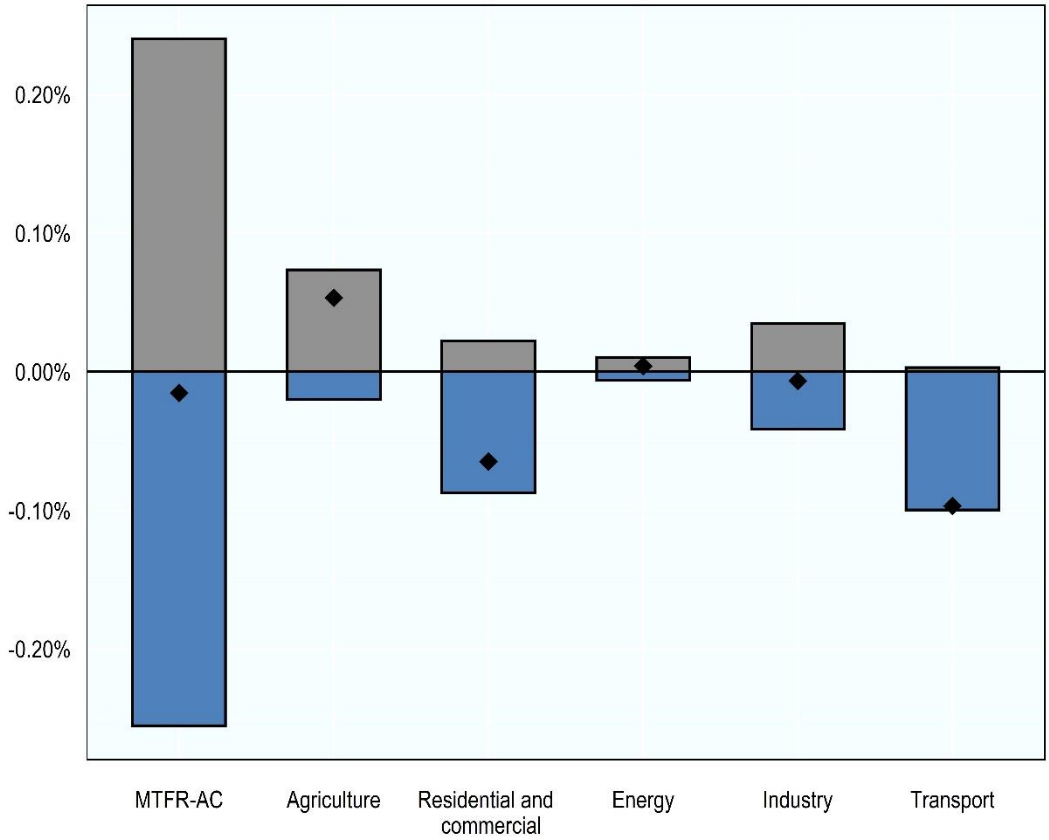
|

49. Overall, these results suggest that substantial benefits from air quality improvements can be obtained when considering emission reductions throughout the economy, and not just in the sectors that are targeted more often, such as transport. This is especially the case for OECD countries that already have a high level of stringency in air pollution policies.

Figure 4.3. Macroeconomic consequence of BAT investment in Arctic Council countries

Percentage change in GDP w.r.t. CLE, 2050





Source: OECD ENV-Linkages model.

50. Most macroeconomic benefits are due to the health improvements that follow the emission reductions. Therefore, the sectoral results reflect the relative changes in emissions and concentrations, with GDP benefits being higher when BATs are deployed in the agricultural sector (+0.07% GDP in 2050, compared to the baseline), followed by the industrial sectors (+0.04%) and residential (+0.03%).

51. Concerning the macroeconomic costs, reducing residential and transport emissions results in higher costs, compared to other sectors. Investment in BATs in these sectors would reduce the aggregate GDP of Arctic Council countries by 0.09% in the MTFR-TRA-AC scenario and 0.08% in the MTFR-RES-AC scenario, compared to the baseline. Macroeconomic costs from reducing emissions in the agricultural sector are the lowest, due to the fact that some emission reductions could also be obtained from better practices with low costs.

4.4. Discussion

52. These results of the modelling analysis presented in this report are subject to uncertainties concerning the emission projections, including the link between concentrations and exposure to air pollution, the quantification of the biophysical impact, and the economic projections. In addition, that are some limitations in combining different modelling tools.[6] For instance, health concentration-response functions from the Global Burden of Disease (Forouzanfar et al., 2015[14]) are rounded to only one decimal

[6] See Figure 2.1

point, meaning that some concentration reductions in Arctic Council countries are not taken into account in the biophysical impacts and therefore in the macroeconomic analysis.

53. It is also important to keep in mind that the framework used of this report does not focus on the optimization of the investment to increase air quality. An optimisation exercise over costs would need to consider the relative contribution to costs and benefits of each pollutant and would not be possible with the current available tools. Nevertheless, the report provides information on the heterogeneity of macroeconomic effects of sectoral investments.

54. While the analysis focuses specifically on benefits from health[7] and crop yield improvements, there are additional benefits from air pollution that would not be quantified, such as those on biodiversity and ecosystems and the interactions with climate change, which are particularly relevant for preserving the Arctic environment. An overview of additional benefits is presented in OECD (2021[1]).

55. Despite uncertainties about the exact figures presented in this report, there are clear environmental, health and welfare benefits to scaling up commitments to reduce air pollution in Arctic Council countries. The sectoral analysis highlights the need for each country to focus on the largest emission sources and to exploit technological options, especially in sectors that can lead to higher benefits.

1. [7] Besides the ones considered in the report, air pollution can also have other impacts on health, affecting fertility (Nieuwenhuijsen et al., 2014[32]), cognitive abilities in children (Allen et al., 2017[33]; Basner et al., 2014[34]) and low weight at birth (Wang et al., 1997[35]).There are other pollutants like SO_2 and NO_X that have direct impact on human health (WHO, 2013[38]; Walton et al., 2015[39]), as well as increased mortality (RCP, 2016[37]). Finally, exposure to air pollution can also exacerbate the consequences of diseases that affect the respiratory system, such as COVID-19 (Wu et al., 2020[36]).

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