Enhancing the reduction of black carbon emissions to protect the Arctic

Mapping the policy landscape of national, regional, and international action – Technical Report 5

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Contents

Introduction

Emissions of black carbon are significant in terms of both air pollution and climate change. As fine particulate matter, black carbon in the atmosphere poses a risk to human health, and due to its light-absorbing properties it also accelerates global warming and the melting of snow and ice by absorbing heat and reducing albedo. Technological development has already substantially reduced emissions from specific sectors such as transport, and solutions are available to cut emissions further. Cooperation between bodies and activities of international organisations is key to effective action.

The sources of black carbon emissions are diverse, and range from diesel engines, the use of wood and coal for residential heating and cooking, flaring in oil and gas production to open burning of agricultural waste and wildfires. Globally residential combustion and road transport have been estimated to cause approximately 75% of total anthropogenic emissions of black carbon, corresponding to nearly 60% of the total global flux of black carbon to the atmosphere. Other significant sectors include industrial processes, agriculture, non-road transport, oil and gas extraction and production (Klimont et al. 2017, Figure 1). Forest and savannah fires, part of which are caused by human activities, correspond to nearly 25% of the total global black carbon flux to the atmosphere.

The importance of different sources of emissions varies across regions. This variation needs to be considered when developing and focusing action strategies. Furthermore, actions should be considered holistically in order to identify synergies – progress in one area can support emission reductions in another. For example, regulations that cut emissions from cars stimulate the development of cleaner off-road vehicles and diesel generators for electricity, both commonly used in remote areas of the Arctic region.

A range of actions are needed to address the diverse sources of black carbon emissions. Cross-sectoral actions, such as the development of reliable monitoring, modelling and the accumulation of data on emissions, all contribute to the knowledge base that guides the transformation to a low emission society. Further, cross-sectoral actions prepare the ground for more ambitious and specific actions in all areas contributing to emissions of black carbon. A combination of technological progress, changes in practice and new incentives and regulations can lower emissions significantly, implying a need for multifaceted policy development. Policies should be designed to regulate activities causing emissions, encourage the spread of cleaner technologies and support changes of practices that currently cause emissions.

Reducing black carbon emissions is in line with many of the objectives of several international strategies for the next decades such as the Paris Agreement of the United Nations Framework Convention on Climate Change (UNFCCC), the UN Sustainable Development Goals (SDGs), the UNECE Convention on Long-Range Transboundary Air Pollution (Air Convention), the EU European Green Deal,[1] and those of the Arctic Council.

1 Commission Communication: The European Green Deal, Brussels, 11 December 2019, COM (2019) 640 final

Black carbon and the Arctic region

The Arctic is one of the regions in which the goals to reduce emissions of black carbon have been given prominence.[2] Global emissions of black carbon contribute to the heating of the Arctic as black carbon particles reach the Arctic through long range transport. When deposited, black carbon darkens snow and ice, reducing reflection (albedo) and speeding up melting, especially in the spring and summer months with intensive sunshine. The exact contribution of black carbon to the warming of the Arctic is, however, still uncertain.[3]

The negative health effects of black carbon and fine particulate matter have been extensively documented. For example, in communities using diesel engines for electricity generation or in towns and cities with outdated heating or old fleets of cars and buses, black carbon contributes to health problems arising from local air pollution. Furthermore, exposure to particulate matter emited from open burning of biomass is considered a serious global health issue.

The members of the Arctic Council have recognised the importance of reducing emissions of black carbon in the Arctic, but also globally since a part of the globally emitted black carbon reaches the Arctic through long-range transport. Scenarios have been developed showing that global anthropogenic black carbon emissions could be reduced from the 2010 level by 70% by 2030, if currently available technologies are fully implemented.[4] If full action were to be implemented by just the Arctic Council member countries, the corresponding reduction would be approximately 15%.

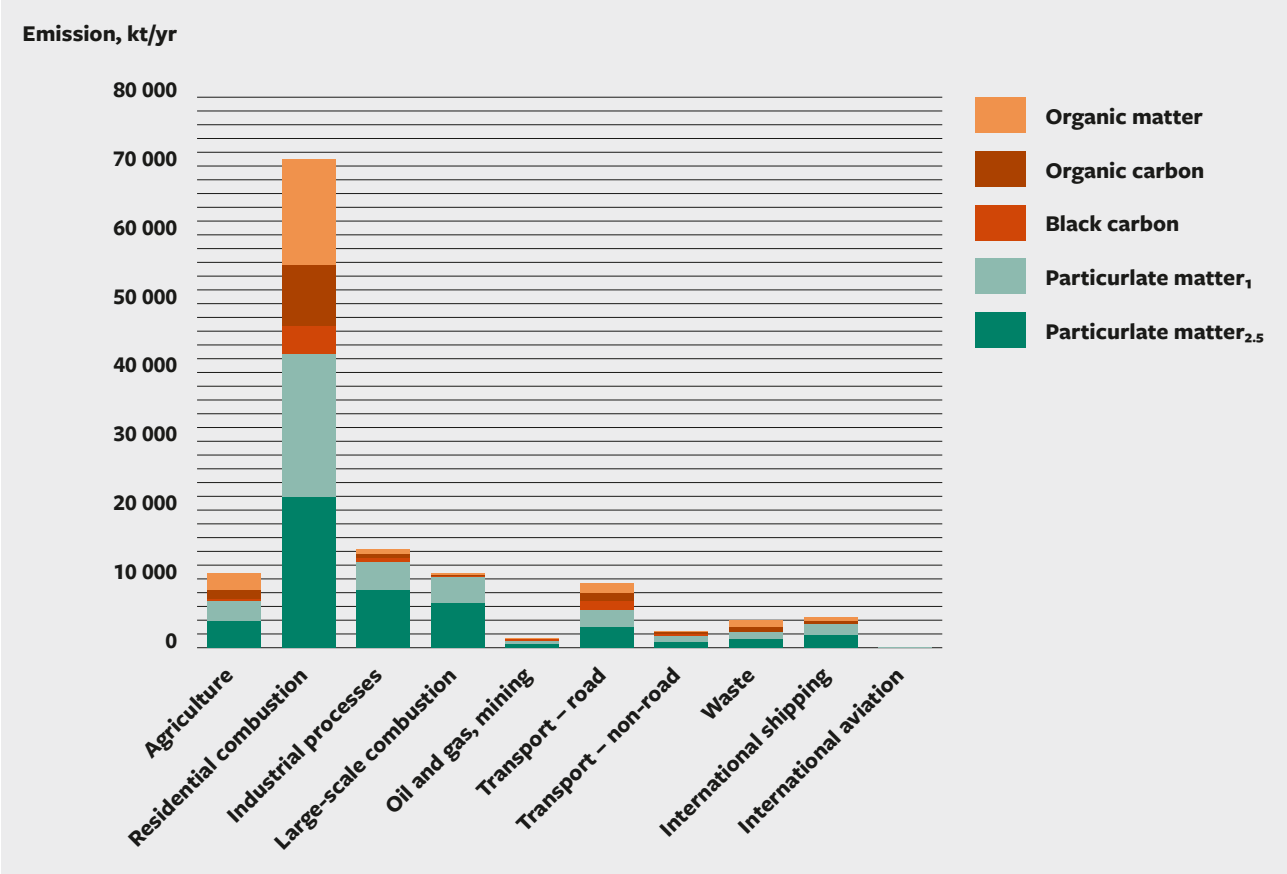

Figure 1: The figure shows sectoral emissions of particulate matter in 2010 (kton per year) and is adapted from Klimont et al. (2017).[5] Data originates from ECLIPSE V5a

2 IQALUIT 2015 SAO Report to Ministers: Enhanced Black Carbon and Methane Emissions Reductions – An Arctic Council Framework for Action

3 Kühn et al. 2020. Effects of black carbon mitigation on Arctic climate. Atmos. Chem. Phys., 20, 5527–5546, https://doi.org/10.5194/acp-20-5527-2020

4 Kühn et al. 2020. Effects of black carbon mitigation on Arctic climate. Atmos. Chem. Phys., 20, 5527–5546, https://doi.org/10.5194/acp-20-5527-2020, page 5532

5 Klimont, Z., et al. (2017). 'Global anthropogenic emissions of particulate matter including black carbon.' Atmospheric Chemistry and Physics 17(14): 8681-8723. (Table 8)

Stakeholder engagement in the process of developing the EUA-BCA Policy landscape report

The EU-funded Action on Black Carbon in the Arctic (EUA-BCA) has sought to contribute to the collective responses that reduce black carbon emissions in the Arctic and to reinforce cooperation to protect the Arctic environment.[6] This has been done by striving to identify ways of reducing emissions of black carbon in Arctic and EU countries and in Arctic Council Observer countries. EUA-BCA, led by the Arctic Council's Arctic Monitoring and Assessment Programme (AMAP) secretariat, has therefore engaged in interaction with a broad group of stakeholders and countries to raise awareness of the issue, identify feasible ways of taking action and to support related activities in international fora, including the Arctic Council and the Air Convention.

This policy landscape report has been developed by identifying actions that can enable effective policies or contribute to significant emission reductions. Initial ideas have been presented and discussed in workshops and conferences and through direct communication with relevant experts. The approach has been to find ways of aligning activities occurring under different policy umbrellas in such a way that they support and reinforce one another with the overall goal to effectively reduce emissions.

This policy landscape report is a part of the EUA-BCA final deliverables series including reports and digital products in support of policy actions and increasing national and international cooperation with the ultimate target of reducing negative Arctic impacts from black carbon emissions. This report is supported by an *Elements report*[7] in which detailed elaborations of the sector and area specific actions are presented. A summary document of this policy landscape report briefs policymakers on the most important outcomes. The policy landscape report and the summary will also be available in Russian. There is also a digital mapping of stakeholders and actions available on the EUA-BCA project website, which indicates policy actions, potential involvement of relevant stakeholders in their practical implementation and timelines of relevant upcoming events in respective policy and scientific fora.

6 https://eua-bca.amap.no/

7 https://www.ivl.se/download/18.1ee76657178f8586dfc16be/1621322838082/E0038.pdf

The areas of action

Supporting the build-up of capacity to monitor effectiveness of Arctic black carbon policy responses, EUA-BCA has explored ways of strengthening emissions reporting, observing systems and monitoring.

In support of engagement to action against emissions, the EUA-BCA work to develop this policy landscape report has focused on the following emission source sectors with emissions of special significance for the Arctic. Recent studies have confirmed that there is a '*strong relation between total global reduction in anthropogenic black carbon emissions and Arctic black carbon mass burdens*'.[8] For each of these source sectors (right column), specific actions have been identified.

Further, it is important to generally strengthen activities drawing attention to black carbon in the Arctic Council (i.e., in its working and expert groups), the Air Convention, the EU, and in other national and international bodies.

Emissions reporting, monitoring and observing systems provide a common frame for all the areas of action, but each with its own specific demands on measuring technologies, data collection and modelling.

For the emitting sectors, each area of action has its specific features. Gas flaring, shipping and diesel engines are all part of an oil- and gas dependent economy that in the long run is likely to be phased out, but which in the short and medium term will be regulated through policies for the mitigation of climate change and the protection of air quality.

Emissions from domestic heating are subject to air pollution control measures, but for this sector it is also important to recognize the impact of product design criteria on emissions.

Open agricultural burning can be addressed through agricultural policies that aim at reducing open burning as a part of the agricultural practice, action that can be motivated by concern for climate change, food security as well as air quality.

Gas flaring

Domestic heating

Shipping

Diesel/on and off-road

Open biomass burning

8 Kühn et al. 2020. Effects of black carbon mitigation on Arctic climate. Atmos. Chem. Phys., 20, 5527–5546

Turning targets into action

For each source of black carbon emissions, it is possible to identify specific and concrete actions that can reduce the emissions.

ACTIONS CAN INCLUDE:

- Establishment and improvements of monitoring and inventories that strengthen the knowledge base
- Non-binding policy statements that guide actors on future goals
- Legislative proposals that put demands on actors to make technical improvements reducing emissions
- Economic incentives for forerunners
- Information and guidance to change practice
- Funding of research and innovation

To put actions in place, scientific support and impact assessments are needed. AMAP synthesised what was known about the role of black carbon in the Arctic in 2015.[9] A large body of individual studies have been published since the previous review and a new AMAP review report has been published in 2021 with updated information on short lived climate forcers.

Assessments and studies provide the background for changes in policies and legislation that regulate or provide economic incentives for activities causing emissions. Impact assessments also provide a base for information and guidance, research and innovation, as well as the establishment and improvement of monitoring. An important role of the impact assessments is also to identify significant costs, benefits and co-benefits in associated policy areas.

Policy amendments and new policies should be examined broadly to ensure coherence between policies. The identification of relevant policy processes is crucial in order to explore when and how changes affecting emissions can be introduced. Local changes of practice can be introduced gradually through numerous accumulating decisions, whereas legislative changes or international agreements often require lengthy negotiations to identify acceptable pathways for progress.

The processes that change policies need actors who actively pursue the change. These actors can be formally appointed or informally take on an active role. The momentum for change may require a gradual building process that proceeds through specific meetings and negotiations through which the need for a reform can develop.

No process of change proceeds without challenges. The challenges may relate to, for example, the position of stakeholders, the fairness of distribution of costs and benefits, vested interests or political tensions. The identification of key stakeholders is an important part of the recognition of potential challenges. Identification of challenges can guide the search for solutions and navigate past stumbling blocks on the route to agreement.

Links between various political processes and agreements help to highlight the co-benefits of emission reductions and to develop synergies that can reduce emissions further. Explicit linking of different international agreements such as the Air Convention and the International Convention for the Prevention of Pollution from Ships (MARPOL) can contribute to policy coherence, but a formal coupling of agreements may be challenging.

9 AMAP 2015. Black carbon and ozone as Arctic climate forcers, AMAP, Oslo, Norway.

Monitoring of black carbon that affects the Arctic

Effective international cooperation aiming to curb black carbon impacts in the Arctic will continue to benefit from systems that monitor Arctic black carbon at source and *in situ*. The tracking of progress in reducing Arctic-relevant black carbon emissions and the subsequent Arctic black carbon burden is dependent on adequate monitoring of northern hemispheric black carbon emissions together with measurements of ambient air black carbon and black carbon deposition at remote Arctic locations.

In an ideal black carbon monitoring scenario, countries, whose black carbon emissions affect the Arctic, would regularly compile and report national black carbon emissions inventories that are of high quality in terms of transparency, consistency, comparability, completeness and accuracy. Furthermore, monitoring of reported Arctic-relevant emissions would be complemented by regular sharing/reporting of black carbon measurement data from an adequate number of *in situ* Arctic monitoring stations which apply consistent maintenance and calibration programmes, as well as consistent/comparable measurement techniques and data quality control routines. Unfortunately, there is a rather large discrepancy between the current state of black carbon monitoring and the ideal scenario described above.

The EUA-BCA technical reports *Review of Reporting Systems for National Black Carbon Emissions Inventories*[10] and *Review of Observation Capacities and Data Availability for Black Carbon in the Arctic Region*[11] describe significant limitations in black carbon emissions reporting and Arctic black carbon observations, respectively. Under the Air Convention and the Arctic Council, a number of countries, whose emissions significantly impact the Arctic, have yet to report black carbon inventories, while for those inventories that have been reported, issues in terms of transparency, consistency, comparability, completeness and accuracy have been identified. In terms of Arctic black carbon observations, monitoring is severely limited by factors such as a lack of stations, intermittent station/measurement operations and insufficient data sharing and coordination. It is therefore clear that significant improvements in black carbon monitoring are required and that realising these improvements will require a significantly enhanced international effort and cooperation.

The following sections summarise specific opportunities for enhanced cooperation and action that would improve black carbon emissions reporting and Arctic black carbon observations.

Enhancing cooperation on black carbon emissions inventories

Nation states that are Parties to the Air Convention and/or are committed to the Arctic Council Framework for Action on Enhanced Black Carbon and Methane Emissions Reductions are formally encouraged to report their national black carbon emissions inventories under these fora. Member States of the EU on the other hand are obliged to report black carbon emissions under the NEC Directive, if national black carbon emissions inventories are available. Despite a large proportion of countries regularly submitting black carbon emissions inventories, the non-reporting countries represent a substantial data gap, particularly from an Arctic perspective. Russia has reported black carbon emissions under the Arctic Council Framework; however, it has yet to report these emissions under the Air Convention. Furthermore, China and India, countries who are Arctic Council Observers and whose emissions have a substantial impact on heat transfer to the Arctic, have yet to report black carbon inventories under the Arctic Council Framework. There is thus a pressing need to mobilise further regular voluntary reporting of black carbon emissions under the Air Convention, the Arctic Council and the EU.

Non-reporting or irregular reporting may indicate a lack of capacity in the respective countries; however, it would be prudent for working groups within the respective fora to reach out to these countries to discuss specific barriers to reporting. The Arctic Council with its expert group on black carbon and methane (EGBCM[12]) could be a suitable forum to initiate such a dialogue with the Arctic Council Observers China and India. Where assistance is needed, the capacity-building programme under the Air Convention could be strengthened with respect to black carbon emissions reporting and potentially enhanced through further co-beneficial cooperation between the Air Convention and the Arctic Council, as well as with the Climate and Clean Air Coalition. Furthermore, it should be noted that cooperation between countries/Parties within these fora could also provide solutions. Certain existing

10 https://www.amap.no/documents/doc/eua-bca-technical-report-2/1780

11 https://www.amap.no/work-area/document/3058

12 Arctic Council Expert Group on Black Carbon and Methane

bilateral partnerships or other initiatives could be utilised for this purpose and these could serve as inspiration for further cooperation on black carbon emissions inventories. The ongoing Russian-Swedish Air Cooperation could provide an important stimulus for renewed black carbon reporting by Russia under the Arctic Council, especially considering the Russian Arctic Council Chairmanship (2021–2023). Russian reporting under the Arctic Council could translate to Russian black carbon reporting under the Air Convention. The EU is furthermore active in emissions inventory development in the Western Balkans and EECCA,[13] through e.g. its EU IPA[14] and TAIEX[15] capacity building instruments. Considering the lack of regular black carbon reporting by some of Western Balkan/EECCA countries under the Air Convention, it may be possible to leverage these partnerships to assist these countries in compiling and reporting black carbon emissions inventories. Beyond the Air Convention, the Arctic Council and the EU NEC Directive, arguments can also be made for reporting of black carbon emissions within the domain of the UNFCCC and the Paris Agreement. As there is no explicit encouragement for black carbon inventories in the respective reporting guidelines for UNFCCC and the Paris Agreement, such inventory reporting within this forum over the next decade is not foreseen. The so-called modalities, procedures and guidelines for the Paris Agreement's enhanced transparency framework will not be reviewed until 2028. Nonetheless, paths taken between 2020 and 2030 could further the black carbon agenda within the UNFCCC-Paris Agreement domain and potentially lead to a future revision of the respective inventory reporting templates to include black carbon emissions. Of course, these paths will depend heavily on improved scientific understanding of the climate impacts of black carbon as synthesised in the IPCC's Assessment Reports (the sixth report is due in due in 2022) as well as the Methodology Report on Short-lived Climate Forcers of the Task Force on National Greenhouse Gas Inventories. Nonetheless, it is apparent that some Parties to the Paris Agreement view action on black carbon as an important part of their climate mitigation plans, as several countries referred to mitigation measures on black carbon in their first Nationally Determined Contributions (NDCs).

If action on black carbon becomes increasingly included in subsequent NDC submissions (updated every five years) – potentially facilitated within the Climate and Clean Air Coalition – a stimulus may be provided to enable voluntary reporting of black carbon emissions under the Paris Agreement sometime in the future. Indeed, it is worth noting that those countries referring to black carbon in their NDCs may have the possibility to include aggregate black carbon emissions in their tracking of progress tables that are to be included in their Biennial Transparency Reports (first round of submissions starting at the latest at the end of 2024). A decision, inter alia, on the contents and structure of these tables is envisaged at the 26th UNFCCC Conference of Parties at the end of 2021.

Mobilising increased voluntary reporting of black carbon emissions inventories represents an important step towards more complete emission inventories. Not only does this path contribute to filling immediate gaps in black carbon emissions monitoring, but it may also help generate the consensus needed for the potential future implementation of mandatory black carbon reporting obligations. Mandatory black carbon reporting is unlikely to be implemented in the short- to medium-term. However, capacity-building to enable increased voluntary reporting and other actions over the time horizon considered here may lay important foundations. The ongoing (2021–2022) review of the amended Gothenburg Protocol of the Air Convention represents an important opportunity to address, inter alia, whether the encouragement of voluntary reporting has produced a sufficient level of black carbon emissions reporting for decision-making purposes. The internal EU review of the NEC Directive (2025) is also likely to look further into black carbon aspects.

Given the geographical overlap between the Arctic Council and Air Convention domains, the EGBCM and AMAP could, together with CEIP and TFEIP, explore options for more precise reporting guidance under the AC Framework that is consistent with that under the Air Convention and develop corresponding recommendations as part of the continuous assessment of progress of implementation of the Arctic Council Framework. Such cooperation on harmonisation may be welcomed by the Arctic Council Member countries given that they are all Parties to the Air Convention, and that Canada and USA have undertaken voluntary efforts to harmonise their respective air pollutant emissions inventories with the European counterparts. Canada and USA are encouraged rather than obliged to report using the Air Convention reporting format. Nonetheless, Canada reports its air pollutant emissions including black carbon using the Air Convention reporting format and the USA is currently working on a crosswalk between its national inventory system and the Air Convention format. Finally, it is also important to highlight opportunities for further cooperation between the Air Convention and the European Commission to sustain and enhance recent efforts and plans to evaluate the quality of reported black carbon inventories as part of the NEC Directive- and the Air Convention stage 3 reviews.

13 Eastern Europe, Caucasus and Central Asia, includes the following 12 countries: Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, the Russian Federation, Tajikistan, Turkmenistan, Ukraine and Uzbekistan

14 Instrument for Pre-Accession Assistance

15 Technical Assistance and Information Exchange instrument of the European Commission

Options for enhanced cooperation on Arctic black carbon observations

The Arctic Council Member countries are all Parties to the Air Convention and are members of the World Meteorological Organization (WMO). Within these fora, the programmes EMEP and Global Atmospheric Watch, respectively, are in place to coordinate and synthesise in situ monitoring of aerosols including black carbon. Furthermore, it is also worth pointing out the potential relevance of the EU Ambient Air Quality Directives to monitoring in the Arctic parts of the Scandinavian EU Member States, due to the requirements for monitoring the chemical speciation of fine particulate matter at background locations. As such, integration areas for enhanced cooperation and action on black carbon monitoring in the Arctic exist; however, it is important to note that these programmes have broad geographical- and multi-pollutant scopes rather than a focus on the Arctic and black carbon. Furthermore, it is worth noting that monitoring under the Air Convention EMEP protocol does not apply to the USA, Canada, and the eastern parts of Russia (~east of the Ural Mountains). Therefore, new impulses will be required to improve that state of in situ black carbon monitoring in the Arctic.

The Arctic Council represents the most obvious forum for enhancing cooperation on Arctic black carbon observations given that it is in the territories of the member countries where the extent and sustainability of in situ black carbon monitoring needs to be increased. Of course, individual Arctic infrastructure projects can be initiated by the AC member countries themselves or as joint projects in collaboration with other AC member and observer countries. In the Russian Arctic, expanded observational capacity could be stimulated in the near-term as the position as Chair of the Arctic Council passes to Russia for the 2021–2023 period. Russian Ministries have identified plans for increasing the national monitoring capability in the Arctic, and activities initiated under the Russian Academy of Sciences have also resulted in new black carbon monitoring activities in the Russian Arctic in recent years. Such action during the Russian period as Chair could moreover inspire further development of Arctic observational capacity in the other Arctic countries.

National action is critical to enhancing black carbon observations in the Arctic; however, it is also critical that the operation and expansion of Arctic black carbon observations in the different territories be coordinated and that the data are centrally collected and curated. The EMEP and GAW programmes can certainly contribute to this, although due to the broad scope of these programmes one can argue that a dedicated Arctic initiative is required. The expert- and working groups of the Arctic Council could be key in this respect. Particularly AMAP, which has the mandate and responsibility for monitoring and assessing environmental pollution in the Arctic and providing scientific input to inform policymaking.

At present, although the AMAP monitoring programme includes relevant components for monitoring greenhouse gases and air pollutants in the atmosphere, assessment of these data is undertaken with irregular periodicity. This lack of regular review of Arctic observational data means that coordinated (long-term) monitoring effort in the Arctic region relies mainly on national activities and voluntary reporting of resulting data to programmes such as EMEP, GAW and AMAP. An extension of the existing AMAP monitoring activities to include a regular update of data summarising the results of long-term Arctic monitoring data for black carbon may provide impetus for a more coordinated monitoring effort in the Arctic region and improved quality assurance of available data. Such an initiative would also better support certain monitoring aspects of the AC Framework Action. Indeed, AMAP could consider exploring and elaborating on such initiatives with the EGBCM, as part of the EGBCM's continuous assessment of progress of implementation of the Arctic Council Framework. Such preparatory work could elaborate a detailed gap analysis, highlighting the importance of monitoring, the current lack of stations, and critically develop and evaluate AMAP's monitoring implementation strategy. Preparatory work can also provide recommendations for enhanced implementation of the AC Framework action, e.g., an explicit and extended coordinating role for AMAP that supports the policy development under the Arctic Council prepared by the EGBCM. Under such an initiative, it would be critical that AMAP works closely with the task forces and expert groups of the Air Convention EMEP and WMO GAW programmes, as well as other relevant networks and programmes such as the EU´s ACTRIS initiative. Such cooperation would help maximise harmonisation of black carbon measurement methods and QA/QC procedures at monitoring stations not just within the Arctic but also globally. Furthermore, such cross-forum collaboration may open opportunities to further harmonise and streamline the reporting and sharing of data by utilising the data reporting formats and repositories already in place under the EMEP and GAW programmes.

Sector-specific actions

The following area-specific sets of action have been developed by considering the general aspects identified above. The areas of action differ in nature and therefore also the type of action will vary, from the development of formal decisions and agreements to general guidance on the information to be used in developing practice.

1. Gas flaring

Gas flaring in oil and gas refineries are, given current legislation and projections, expected to become the largest black carbon emission source by 2030 in the Arctic Council countries. Fortunately, the technically available black carbon emission reduction potential is also large. To fulfil this potential additional R&D, monitoring and technology standards are needed.

IMPORTANT ACTIONS INCLUDE:

- Promotion of R&D into field measurement data on actual black carbon emission rates for a diverse range of flares relevant for the Arctic region,
- Close monitoring and reporting of progress within the World Bank Zero Routine Flaring by 2030 initiative, and
- Defining common environmental standards for black carbon emitted in oil and gas production.

There is a need to perform field measurement campaigns to acquire a better knowledge of how black carbon emissions are affected by the type of flare, rate of gas flaring, composition of the gas and local weather conditions. Measurement techniques are available, and such an initiative could be twinned with measurement campaigns on methane.

The World Bank Zero Routine Flaring Initiative focuses on reducing emissions from the oil and gas sector and could be enhanced, inter alia by improving the gas flaring monitoring and reporting routines by the signatories. As of yet, the initiative has not engaged in any specific Arctic gas flaring sites despite Arctic states being signatories to the initiative. Available data suggests that gas flaring volumes have increased in several countries although flaring per unit of oil production has decreased. A better overview of the implementation of new policies and regulations is needed in order to enhance international learning on how to achieve real emission reductions. The Zero Routine Flaring Initiative only requires self-reporting of gas flaring volumes, so independent monitoring of gas flaring via e.g. satellite observations need to be developed further. In order to focus actions, it is also important to gain a deeper understanding of the role of flaring in the production at different sites.

Furthermore, given an improved understanding of how black carbon is formed during gas flaring, it is possible to establish international low-emissions standards with respect to black carbon. Both flaring technology manufacturers and oil and gas producers can be encouraged to construct and deploy low-emission technologies to be used for unavoidable flaring. Several paths for encouragement are available. For the oil and gas producers it is for example conceivable to attach the use of low-emission flaring technologies into operating permits or to mandate the use of low-emission technologies in the field development plan approval process. The manufacturers can be regulated via BAT/BREF specifications for the sector or via other processes supporting environmental performance standards.

The Arctic Contaminants Action Programme (ACAP) of the Arctic Council provides a base for exploring concrete actions on flaring. The Arctic Council can become a leading policy forum for endorsing actions leading to the reduction of flaring in the Arctic region.

2. Small-scale domestic heating

Emissions from small-scale domestic heating are one of the most important sources of black carbon within the Arctic region. Emissions from small-scale heating are diffuse and caused by private households or small local boilers for district heating. The control of these emissions is difficult: households are not under direct regulation and control of agencies, and cost-effectiveness in terms of emission reduction is not a central driver of decisions. Instead, what matters is the access to fuel and assurance of comfortable use.

IMPORTANT ACTIONS, CONSIDERING THE SPECIAL FEATURES OF THE AREA, INCLUDE:

- Enhancing the international exchange of experience in providing economic incentives to replace old heating equipment and disseminating information on the benefits and techniques of 'Correct Burning',
- Incentivising energy efficiency improvements in buildings, and
- Encourage countries to set higher emission requirements on stoves and boilers as well as to phase out old ones still in use.

The actions differ from those identified for several other sectors in emphasising the role of individual households and local communities. Studies have identified the importance of correct fuel handling and operation and maintenance of stoves, fireplaces or boilers. If this information is fully taken up by households, emissions could be reduced significantly. Changes in practice are notoriously difficult to accomplish, but for example chimney sweepers can act as 'fireplace consultants' providing hands-on information to households. As an alternative or complementary measure, one can also provide targeted information through fuel providers, with step-by-step instruction pamphlets. Outside the behavioural change interventions, it is also important to further consider the use of technology-specific economic incentives (investment subsidies or scrapping rewards) or even restricting the use of obsolete technologies.

As examples of conceptually suitable policy processes, the EU has legislation directly addressing emissions from small-scale domestic heating under the framework of the EU Ecodesign Directive. The Arctic Council ACAP has supported actions that aim at reducing emissions from residential wood combustion and Nordic funding has been directed to reduce emissions from local district heating boilers. These demonstration activities are essential in developing the awareness base for wider policy and legislative change. Further, both national and international economic incentives have been employed for the renewal of local district heating to improve both local air quality and energy efficiency.

3. Shipping

Emissions from shipping can increase in the Arctic with the expanding use or opening of new arctic shipping routes. Regulations by the International Maritime Organization (IMO) can curb the increase and even reduce emissions of black carbon. National or sub-national regulations for specific sea areas can also contribute to a reduction of emissions and encourage the development and deployment of low emitting technologies.

IMPORTANT ACTIONS INCLUDE:

- To further develop a standardised black carbon sampling, conditioning and measurement protocol within IMO,
- Advancing international regulations to reduce black carbon emissions from shipping, and
- Progressing with emission reductions through national and sub-national actions, mainly through regulations for ports and specific shipping routes or areas and R&D support.

IMO is the main policy forum for global measures to reduce pollution from international shipping. The IMO's Marine Environment and Protection Committee has been considering the Arctic impact of black carbon emissions from international shipping since 2011. The key components of its current work plan are first to develop a standardised black carbon sampling, conditioning and measurement protocol that can be used as a reference in order to make accurate and comparable measurements of black carbon, and second to consider regulations and other means to reduce black carbon emissions from marine diesel engines. One step in this direction is the gradual phasing out of the use of heavy fuel oil in Arctic Waters agreed upon in 2020.

National and sub-national regulations for single sea areas or even ports have historically contributed to improved environmental performance of shipping, including the reduction of air pollutants. A combination of strategic planning, regulations and support for R&D activities and piloting, such as that carried out by the Arctic Council's working groups PAME[16] and ACAP. PAME is actively engaged in the identification of elements for the revision of the Arctic Council Arctic Marine Strategic Plan that extends until 2025 and ACAP engages in piloting of specific actions. In combination these may help to reduce black carbon emissions from shipping further. National and sub-national developments will also support the international work at the level of IMO and the Arctic Council.

16 Arctic Council working group for Protection of the Arctic Marine Environment

4. On and off-road transport and stationary engines

Black carbon emissions from internal combustion engines used in on- and off-road transport as well as electricity generation are globally important, and their use may increase in the Arctic with expanding economic activity. Off-road vehicles and diesel generators may be essential for livelihoods in remote locations. Important characteristics of on- and off-road engines are that they are non-point sources and mobile. Further, vintage or super-emitting engines are responsible for a large part of the emissions. Significant transport emission reductions have already been achieved through mandatory standards, and black carbon emission rates of engines following the most recent EU and US standards are only a fraction of that from older engines. Further progress can still be made by enforcing the most recent standards, scrapping vintage vehicles and by developing technologies further.

IMPORTANT ACTIONS INCLUDE:

- Ensuring annual engine exhaust maintenance testing,
- Stricter regulation of international trade of second-hand vehicles,
- Encourage countries to control and stop the use of ad-blue emulators and chip engine tuning equipment, and
- Harmonisation and enforcement of engine emission standards in the Arctic region.

These actions would gradually phase out obsolete technologies from the vehicle fleet and stationary engines. Global technology development that is not limited to the Arctic is important. Thus, the main policy fora are those within which engine standards are set, for example the EU and the US. The particular Arctic aspects need to be considered. Off-road and stationary engines are compared to other regions important in the Arctic region, and the demanding engine operating conditions in the Arctic needs special consideration.

5. Open biomass burning

Open biomass burning is globally a highly significant source of black carbon emissions. Exposure to smoke from open burning is a serious health concern, particularly for small children, pregnant women, the elderly, and those with lung or heart conditions. The most extensive wildfires on the northern hemisphere occur in Russia, Canada and Alaska, but many other countries have also experienced serious wildfires. Climate change is projected to increase the risk of wildfires.

Open burning on croplands is completely anthropogenic, whereas wildfires in forests, shrubland or on peatland are triggered especially during high fire hazard conditions due to both natural phenomena (lightning etc) and anthropogenic activities. Prescribed burning is considered an anthropogenic activity and may be carried out to reduce fuel load in forests or as a special management action to maintain specific fire dependent ecosystems in areas where effective fire control has greatly reduced wildfires. Agricultural policies can be used to reduce open burning, whereas the occurrence and magnitude of wildfires can be reduced through combinations of forest policies, awareness raising and improved risk management. Better monitoring of the occurrence of open burning will improve the base for policy action.

IMPORTANT ACTIONS INCLUDE:

- Further developing agriculture practices and extension services for farmers to minimize open burning of agricultural residues,
- Sharing information systems and awareness raising to prevent wildfires,
- Enhancing capacity and skills to fight wildfires as part of disaster risk management, and
- Monitoring and surveillance systems of wildfires.

Policy integration and cross compliance across policy areas can help motivation for reducing open biomass burning in agriculture since it would be beneficial for food production, climate change and air quality. To achieve changes in practice, sustained long-term efforts are needed that also include extension services and demonstration activities that can overcome resistance to change.

Wildfires are a matter for policies and policy fora dealing with disaster risk reduction, emergency management and civil protection as well as policies on resource management. By bringing these policy areas closer to one-another, progress can be made in reducing the risk and impact of wildfires even though wildfires are also natural ecosystem processes. Advancing climate change underlines the need for adaptation pathways that deal with increasing risks and develop capacities and skills that are needed to manage wildfires. Monitoring and surveillance systems that help to detect fires at a stage when they are still manageable are important, as are operational tools that can assist the actual firefighting activities.

Within the Arctic Council the Working Group on Emergency Prevention, Preparedness and Response has so far largely focused on marine safety but is now increasingly paying attention also to wildfires. This development will open new connections between policy areas in the Arctic and will also contribute to the progress in reducing emissions of black carbon.

Outlook

In this report, and in the more detailed elements report, we have presented an overview of cross-sectoral actions that can be helpful in the identification and verification of effective policies to reduce black carbon emissions, as well as dedicated actions that would enable or directly reduce emissions from five key source sectors. Several of the actions would be expediated by international coordination or alignment of priorities. Monitoring of black carbon in ambient air and inventories of black carbon emissions from anthropogenic sources are in various forms and with varying regularity already ongoing in several international organisations. Here, sharing of best practices and co-ordination of reporting formats are examples of international coordination that would pave the way for improving the monitoring mechanisms required for effective future emission reduction. Other examples are definitions of internationally common environmental standards for gas flaring technologies or sharing best practices in how to increase the uptake of clean burning practices among households. More examples include increasing the level of engagement at IMO for directly controlling black carbon emissions from marine diesel engines, implementing emission standards for international trade of vehicles, and sharing information systems and campaigns for raising awareness to prevent wildfires.

For international coordination or alignment of priorities it is of interest to learn which countries are already engaged in the actions presented here, since these countries could lead and support coordination efforts and thus constitute the basis for *coalitions-of-the-willing*. In EUA-BCA we have made informal enquiries into this question. On the EUA-BCA web page we have made an effort to tentatively identify countries and international organisations that have indicated ongoing efforts on the actions presented in this policy landscape report. On aggregate the current indications from the enquiries are that efforts related to international harmonisation of black carbon measurement methods and emission inventory capacity building are most common of the cross-sectional actions. For the specific emitting sectors, the most commonplace initiatives appear to be work on defining common environmental standards for gas flaring, programmes to accelerate replacement of old wood burning equipment and energy efficiency improvements for households, national and sub-national regulations setting limits on black carbon emissions from shipping, controlling the use of high-emitting vehicles, and sharing information systems and awareness raising to prevent wildfires.

Specific *windows-of-opportunity* may open for policy initiatives when existing policies, instruments, targets, objectives, etc. have run their course and reached their target year or milestone. In the timeline displayed (Figure 2) we show indications on the most prominent target years for various types of international policies with explicit focus (at least technically) on emissions of fine particulate matter. Such policies are consequently relevant in terms of black carbon impacts on the Arctic.[17] On the EUA-BCA web site we also present a corresponding overview of important national policies for selected countries. Over the next 10 years there are numerous target years for several initiatives by countries, expert organisations and international organisations for almost all the actions presented in this report. As examples, France is expected to shut down all remaining coal power plants by 2022. In 2023 the Barents Euro-Arctic Cooperation work program will promote black carbon awareness and examples from outcomes of projects in the Barents region. 2025 is the target year of the Arctic Council Fairbanks Declaration on BC and methane reduction and also the implementation year of Euro 7/VII vehicle engine exhaust emission standards in the EU. But the busiest policy target year appears to be 2030. This year is the target year for at least 4 Arctic region countries, as well as for the EU NEC Directive, the World Bank Zero Routine Flaring initiative, and a procedural review of the UNFCCC Paris Agreement. It is also the reporting year for the human health related UN-goals for Sustainable Development.

17 Åström, S. and K. Kindbom (2021). EUA-BCA Stakeholder Analysis Report.

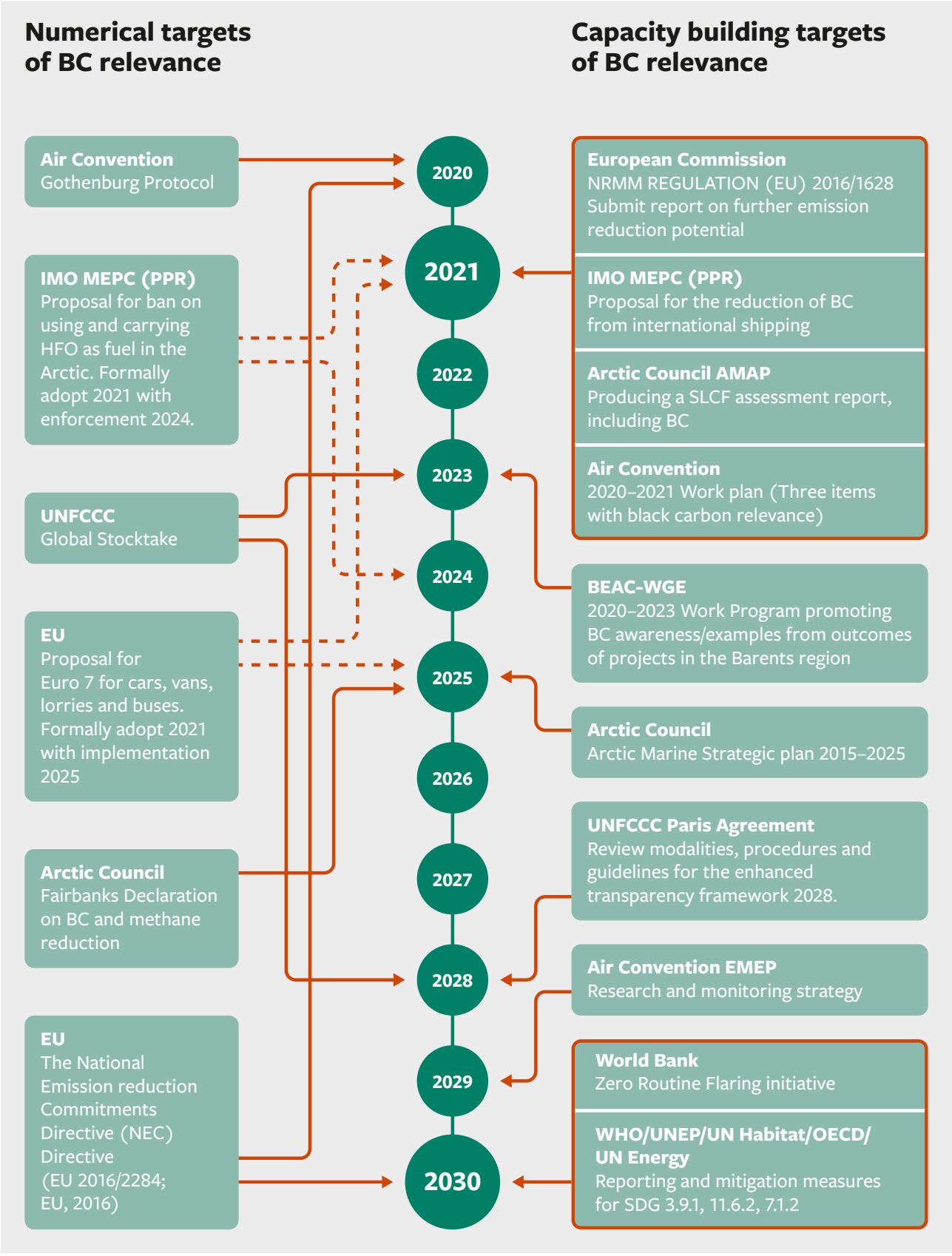
Numerical targets of BC relevance
Capacity building targets of BC relevance
Air Convention
Gothenburg Protocol
IMO MEPC (PPR)
Proposal for ban on using and carrying HFO as fuel in the Arctic. Formally adopt 2021 with enforcement 2024.
UNFCCC
Global Stocktake
EU
Proposal for Euro 7 for cars, vans, lorries and buses. Formally adopt 2021 with implementation 2025
Arctic Council
Fairbanks Declaration on BC and methane reduction
EU
The National Emission reduction Commitments Directive (NEC) Directive (EU 2016/2284; EU, 2016)
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030
European Commission
NRMM REGULATION (EU) 2016/1628 Submit report on further emission reduction potential
IMO MEPC (PPR)
Proposal for the reduction of BC from international shipping
Arctic Council AMAP
Producing a SLCF assessment report, including BC
Air Convention
2020–2021 Work plan (Three items with black carbon relevance)
BEAC-WGE
2020–2023 Work Program promoting BC awareness/examples from outcomes of projects in the Barents region
Arctic Council
Arctic Marine Strategic plan 2015–2025
UNFCCC Paris Agreement
Review modalities, procedures and guidelines for the enhanced transparency framework 2028.
Air Convention EMEP
Research and monitoring strategy
World Bank
Zero Routine Flaring initiative
WHO/UNEP/UN Habitat/OECD/ UN Energy
Reporting and mitigation measures for SDG 3.9.1, 11.6.2, 7.1.2

Figure 2

Conclusions

Black carbon emission reduction would reduce air pollution, including transboundary air pollution, and it would affect radiative forcing in the Arctic area. There are, however, significant uncertainties, in particular due to other particles co-emitted with the black carbon. Some of these may have a cooling effect through cloud formation.[18]

The actions that reduce uncertainties by developing the knowledge base and by strengthening systematic monitoring and reporting should receive high priority as they will guide future actions in the different sectors. The actions that can reduce emissions of black carbon are important since they provide multiple benefits in terms of reduced air pollution, increased resource efficiency and reduced climate change.

The detailed analysis of policy actions to reduce black carbon emissions shows that the specific actions that strengthen the ability to reduce emissions of black carbon will often need to be supported by activities that bridge policy organisations or areas. This bridging is needed within the Arctic Council and its working and expert groups, between the Arctic Council and the Air Convention, and between other international policy initiatives.

18 See footnote 7 (Kuhn et al) above

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