

National Report by Finland 2017

Enhanced Black Carbon and Methane Emissions
Reductions – Arctic Council Framework for Action

Emissions of black carbon and methane in Finland

2017 national submission to the Arctic Council

22.12.2017

Contact persons:

Kaarle Kupiainen
Finnish Environment Institute (SYKE)
kaarle.kupiainen@ymparisto.fi
+358 400 148 766

Elina Rautalahti
Ministry of the Environment
elina.rautalahti@ymparisto.fi
+358 400 143 953

Writing team at the Finnish Environment Institute (SYKE):
Kaarle Kupiainen, Jari Kolehmainen, Mikael Hildén, Niko
Karvosenoja

National Submission of Finland on emission of black carbon and methane to the Arctic Council

Outline:

Introduction

1. Summary of current black carbon emissions to CLRTAP and future projections
2. Summary of current methane emissions to UNFCCC and future projections
3. Summary of National Actions, National Action Plans, or Mitigation Strategies by sector
4. Highlights of best practices or lessons learned for key sectors
5. Projects relevant for the Arctic
6. Other relevant information

References

Annexes

Introduction

This document is the Finnish national submission to the Arctic Council reporting the emissions and summaries of national actions of black carbon and methane according to the Framework document "ENHANCED BLACK CARBON AND METHANE EMISSIONS REDUCTIONS, AN ARCTIC COUNCIL FRAMEWORK FOR ACTION". The framework document included guidance for the preparation of the national submissions (Annex 1), which has been used in preparing this document.

1. Summary of current black carbon emissions to CLRTAP, where appropriate, and future projections

Finland has submitted historical BC emission data 2000-2015 to CLRTAP in February-April 2017. The detailed submission can be accessed from:

http://www.ceip.at/ms/ceip_home1/ceip_home/status_reporting/2017_submissions/

and

http://webdab1.umweltbundesamt.at/download/submissions2017/FI_NFR2017.zip?cgiproxy_sk_ip=1

The emission summary in Fig. 1 has been created based on the national submissions with following aggregation: 1) The NFR level emission data was aggregated to GNFR level. 2) the GNFR level emission data was further aggregated based on information in Annex 2 and is presented in a table in Annex 3.

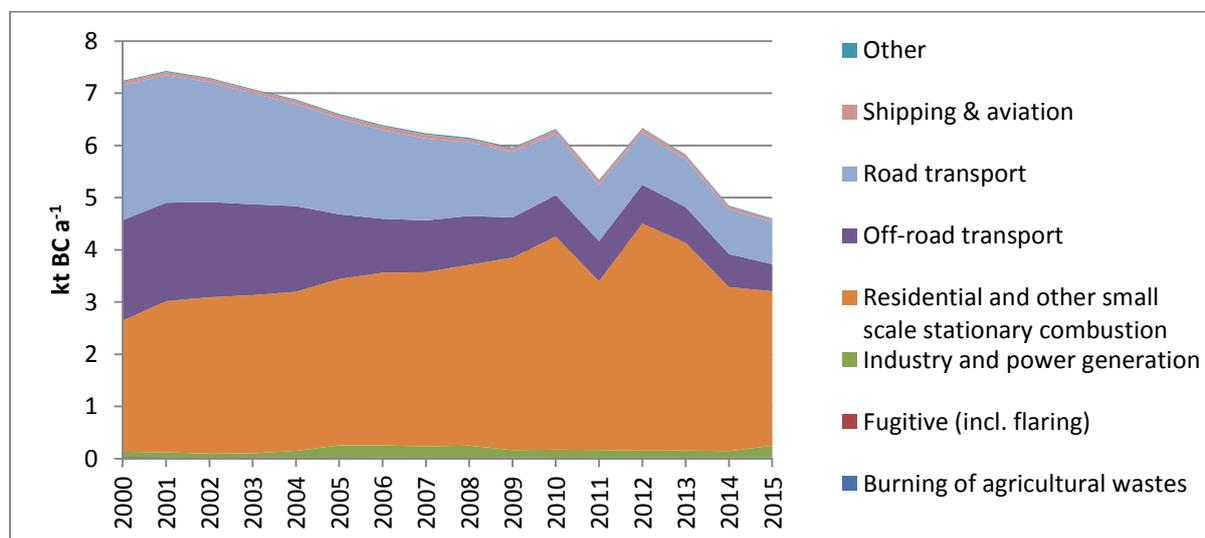


Figure 1. Historical emissions in 2000-2015 of black carbon in Finland split by aggregated sectors.

The household wood use data is currently under review by Statistics Finland and Natural Resources Institute Finland (LUKE) for the heating season 2015/2016. The previous review was made for the heating season 2007/2008. These reviews, based on household questionnaires, are important as they are used for adjusting the annual wood use estimates made by Statistics Finland, which also form the basis for the emission inventory calculations. The latest review study with more detailed results will be ready in April 2018, but preliminary findings were made

available for this report. According to the preliminary findings there is no need to revise the wood use estimate or the emission inventory.

Fig. 2 shows the black carbon emission projections as estimated by the Finnish Regional Emission Scenario model, FRES, (Karvosenoja, 2008) for the current (2016) Finnish governments' energy and climate strategy's WAM scenario. The FRES model is maintained and hosted at the Finnish Environment Institute (SYKE) and it is serving as an official tool in the UNECE TFIAM and the Arctic Council. The FRES model is a separate system than the CLRTAP emission inventory but the model has been harmonized with the emission inventory for overlapping years. It has also been used for analyzing effects of Finnish governments' energy and climate strategies to emissions of several air pollutants. The assessment of future development is estimated to be relatively sensitive to uncertainty especially in wood use estimates that influences *Residential and other small scale stationary combustion* sector (Suoheimo et al. 2015).

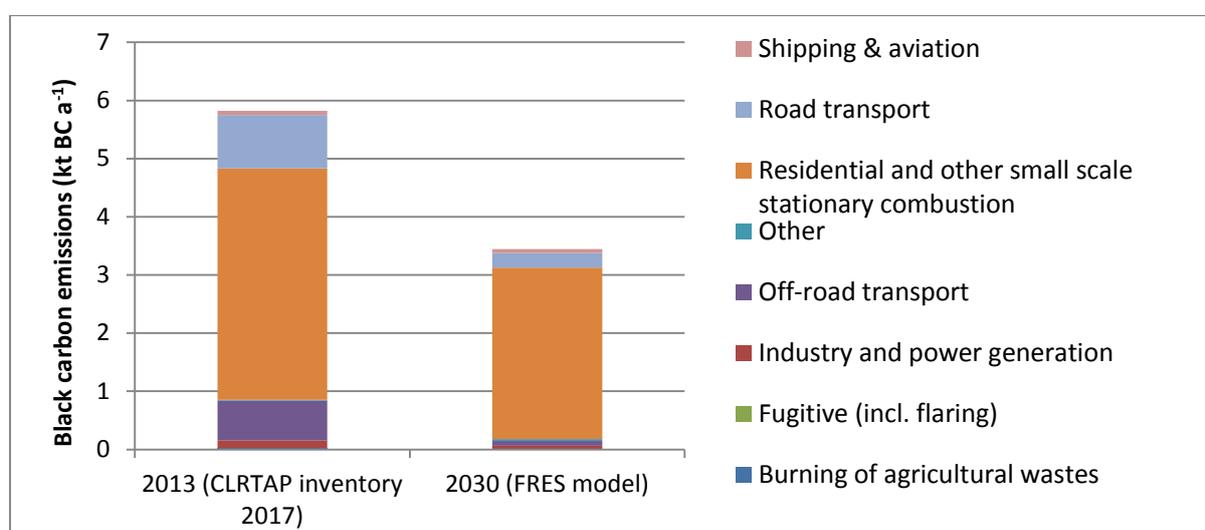


Figure 2. Black carbon emissions 2013 (CLRTAP emission inventory) and 2030 (FRES model) following the WAM scenario of the Finnish governments' 2016 energy and climate strategy.

Finnish black carbon emissions in 2013 and 2025

The Arctic Council aspirational collective goal to reduce black carbon emissions highlights the years 2013 and 2025. Table 1 presents the black carbon emissions in Finland for these priority years. Table 1 includes the emission estimates as in the 2017 EGBCM Summary of Progress and Recommendations report that were based on the 2015 CLRTAP emission inventory and the government's 2013 Energy and Climate Strategy, as well as the information presented in this report that is based on the 2017 CLRTAP emission inventory and the government's 2016 Energy and Climate Strategy. Both projections anticipate a reduction in emissions by 2025, but less so in the 2016 strategy due to a smaller emission reduction in the "Residential and other small scale stationary combustion" sector.

Table 1. Finnish black carbon emissions (kt a⁻¹) in 2013 and baseline projections for 2025.

	2013	2025	Reduction (%)	Remarks
2017 EGBCM Summary of Progress and Recommendations	5.8	3.6	-38 %	2025 according to the Government's 2013 Energy and Climate Strategy

report				
2017 CLRTAP inventory and FRES model	5.8	4.0	-31 %	2025 according to the Government's 2016 Energy and Climate Strategy

2. Summary of current methane emissions to UNFCCC and future projections

Finland has submitted CH₄ emission trend data 1990-2015 in CRF format to UNFCCC in April 2014. The detailed submission can be accessed from:

http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/10116.php

The emissions in Fig. 3 are shown by main sector and based on the national submissions based on data provided on Tables 10s2, 10s2.2 and 10s2.3. The data is presented in a table in Annex 4.

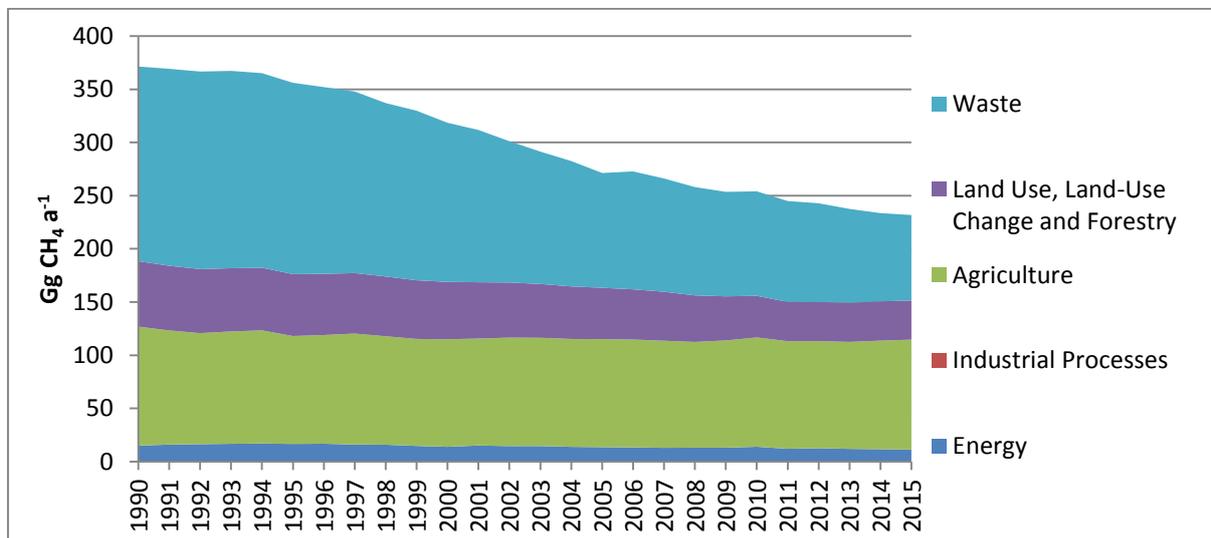


Figure 3. Methane emissions in 1990-2015 in Finland by aggregated sector.

Table 2 shows the projected methane emission reductions for the priority sectors in 2020 and 2030 as percentages relative to 2014, following the WAM scenario of the Finnish governments' 2016 energy and climate strategy (Ministry of Economic Affairs and Employment, 2017; Huttunen, 2017). Total emissions are expected to reduce 16 percent by 2030, mostly due to changes in the Waste and Agriculture sectors (Table 2).

Table 2. Projected methane emission reductions (%) for priority sectors in 2020 and 2030 relative to 2014, following the WAM scenario of the Finnish governments' 2016 energy and climate strategy.

%	2020	2030
Agriculture	0 %	-8 %
Energy	0 %	0 %
Waste	-33 %	-36 %
Total	-14 %	-16 %

3. Summary of National Actions, National Action Plans, or Mitigation Strategies by sector

3.1 Actors and responsibilities concerning black carbon and methane

The tasks and responsibilities related to black carbon and methane are handled by several different Ministries, research and expert organizations as well as regional and local authorities. There are regular contacts between the different authorities to ensure coordination concerning inventories, policy development and follow up of measures. Table 3 lists the actors related to black carbon and methane issues and describes their tasks and responsibilities.

Table 3. Actors related to black carbon and methane issues and their tasks and responsibilities

Actor	Task related to black carbon and methane
Ministry of the Environment	Overall responsibility for regulation related to air quality, pollutants and waste management. National focal point for the Convention on Long-range Transboundary Air Pollution and leadership of Arctic Council work and working groups dealing with black carbon and methane. Building regulations on heating. National Coordinator of the national intermediate term climate plan focusing on the sectors outside the emission trading scheme.
Ministry of Economic Affairs and Employment	Overall responsibility for energy policy and coordinator of energy and climate strategies. Responsible for the Emission Trading Scheme. Funding for innovations in low emission energyproduction.
Ministry of Agriculture and Forestry	Overall responsibility for forestry management, including coordination of for bioeconomy strategy development and the development of agriculture and rural policies and innovations.
Ministry of transport and Communications	Overall responsibility for transport policies, including action to reduce negative environmental impacts and greenhouse gas emissions from transport.
Ministry for Foreign Affairs	Overall coordination of Finnish participation in international Arctic policies and the Arctic Council chairmanship. Support for development cooperation with projects reducing emission of BC or methane
Governmental research and expert organizations	Finnish Environment Institute (Black carbon inventory, reporting on emissions from waste management, modelling of emissions of black carbon) Statistics Finland (Overall coordination and reporting of greenhouse gas emissions, including methane inventory) Natural Resources Institute LUKE (Data on wood use, including use of firewood) Finnish Meteorological Institute FMI (Atmospheric modelling, distribution patterns of black carbon) VTT (Modelling of energy use and energy projections) National Institute of Health and Welfare (health impacts of BC)
Universities	Research related to black carbon and methane emissions and ways to

	reduce emissions.
Municipalities, including the Helsinki Metropolitan area	Local strategies and regulation of air quality and implementation of air quality standards and waste management

The Finnish Climate Panel

The Finnish Climate Panel (<http://www.ilmastopaneeli.fi/fi/in-english/>) is an independent, interdisciplinary think tank of top-level Finnish scholars from research institutes and universities. The Panel provides scientific advice for policy-making and reinforces interdisciplinary insight in the operation of different sectors. The Panel also serves as an advisor to the Finnish ministerial working group on energy and climate policy. The panel has initiated several research projects, ao. “Black Carbon as Radiative Forcing: The Global and Regional Effects of Emissions and Possible Emission Reductions” in 2014.

3.2 National strategies and action plans

Finland does not have a separate strategy or action plan for black carbon or SLCPs, but they are indirectly addressed via several strategies on energy, transport, agriculture, climate and air pollution. This section provides a short summary on key strategies in place.

Climate Act

The national Climate Change Act (609/2015) entered into force on 1 June 2015. The Act lays down provisions on the planning system for climate change policy and monitoring of the implementation of climate objectives. The aim of the planning system is to contribute to the fulfilment of the obligations binding on Finland for reducing and monitoring greenhouse gas emissions and to take national measures to mitigate climate change and adapt to it. The Act also lays down a long-term greenhouse gas emission reduction target of at least 80% by 2050, compared to the 1990 levels.

According to the Climate Change Act, a long-term plan for climate change mitigation will be made once every ten years, and a medium-term plan once per parliamentary electoral term. The medium-term plan covers sectors outside emissions trading scheme (transport, housing and agriculture) and aims to set more concrete and detailed measures than the long-term plan.

National Energy and Climate Strategy

The Government and Parliament make the major decisions concerning Finland’s energy and climate policy. The ministerial working groups have been responsible for preparing and updating the national strategies on energy and climate policy, completed in 2001, 2005, 2008, 2013 and 2016. The National Energy and Climate Strategy specifies the key objectives and policy outlines until 2030 concerning both the emissions trading sectors and the non-emissions trading, i.e. the so-called effort sharing sectors.

Energy and Climate Roadmap 2050 adopted in 2014

Finland has drawn up a strategy called Energy and Climate Roadmap 2050¹. This long-term strategy provides guidelines to reduce 80-95 % of greenhouse gas emissions by 2050. The roadmap concentrates on the energy sector, which produces 80 % of greenhouse gas emissions. It is not intended to produce delineated pathways towards 2050; instead, work on the roadmap consists of studying alternatives for reducing carbon emissions and the impact of these alternatives on cost-effectiveness of emission reductions and competitiveness of the society. The roadmap focuses on both energy production and consumption as well as shortly on agriculture. Use of wood fuel in boilers and stoves for heating of households is likely to continue also in the 2050 perspective.

Medium term climate change policy plan

The first medium term climate change policy plan was completed in September 2017. Together with the National Energy and Climate Strategy adopted at the end of 2016 it implements the climate and energy policy objectives set in Prime Minister Sipilä's Government Programme. The medium term climate change policy plan applies only to the effort sharing sectors identified in the European Union's Effort Sharing Regulation (ESR), which comprise transport, agriculture, individual heating of buildings, waste management and F-gas emissions. Besides these, the plan examines the linkages between the sectors and cross-cutting themes, including the role of consumption, local work on climate change issues and public procurement. In the policy plan, there is a section regarding the Arctic. Special mentions included are information collecting, promoting Arctic issues in international climate debate and notions about black carbon effects in Arctic as well as agreed actions to reduce black carbon emissions.

National Arctic strategy

Finland has a national Arctic strategy (2013) in order to define its position regarding to economic, environmental, political stability and international co-operation aspects. The strategy reminds that every third person living above 60th parallel is Finnish, thus Finland has a great interest concerning the region, including Arctic warming. Concerning environmental aspects, the strategy highlights Finnish expertise in environmental research, cleantech, oil spill response and education as well as national work on black carbon and methane. In addition, Finland actively presses enforcement and further development of agreements concerning oil safety, biodiversity, climate change and corporate responsibility. One of the defined goals is to include climate change mitigation and adaptation in Finnish international efforts.

Finland actively participates the Arctic council's working groups and expert groups, some of which concentrate on or address black carbon and methane. At the moment, in 2017 to 2019, Finland has the Arctic Council presidency. Finland actively implements the Framework for Actions on Enhanced Black Carbon and Methane Emissions Reductions, which promotes actions on national, Arctic Council and international levels.

NEC-directive and National Air Pollution Control Programme

¹ <https://tem.fi/documents/1410877/3437254/Energy+and+Climate+Roadmap+2050+14112014.pdf>

A new EU directive, National Emissions Ceilings Directive (NEC) came in to force on Dec. 31st 2016. It sets national emission reduction commitments for Member States for five important air pollutants: nitrogen oxides (NO_x), non-methane volatile organic compounds (NMVOCs), Sulphur dioxide (SO₂), ammonia (NH₃) and fine particulate matter (PM_{2.5}). If the ceiling is exceeded, measures must be taken to lower emissions. Residential, transport and energy sectors are key emitters of both fine particles and black carbon. Some parts of the directive have already been adopted (a part concerning reporting to the Commission). All other parts are to be adopted by Jun. 30 2018.

A crucial part of the new regulation is to draw up National Air Pollution Control Programmes that should contribute to the successful implementation of air quality plans established under the EU's Air Quality Directive. Black carbon, among others, is also included in the programme and its reporting scheme. The Finnish National Air Pollution Control Programme will be drafted in 2018. A committee to manage the will be appointed in December 2017 but the work has already begun by focused new research to fill knowledge gaps. An important part is to study Finnish wood-operated sauna stoves for there are abundant amount of them in the country. Other research subjects include the amount of wood burned in stoves, assessing health impacts of the pollutants, and economic impact of small particles. Finnish Environment Institute (SYKE) has estimated that NEC's requirements for air quality have already been mostly met by other regulations² (i.e. Industrial Emissions Directive and regulation of car emissions). However, close monitoring is still needed for the new research clarifies our understanding of the pollutants, their sources and amounts.

3.3 National black carbon reduction efforts and regulation by sector

Transport

According to the emission inventory (see Section 1, Figure 1) the Transport sector contributed 30 percent of the Finnish black carbon emissions in 2015.

Existing Regulatory instruments

General

Idling a motor vehicle for more than two minutes (below -15°C four min.) while not driving has been forbidden for 25 years (from 1992) by national legislation (1542/1991; 1266/2002).

The amount of Sulphur in gasoline and diesel have been limited to 10 mg/liter (1206/2010) and 0.1 weight-% for ship traffic on Baltic Sea control area³. These limits are relevant for black carbon emissions, as the presence of sulfur in fuel disallows the use of advanced exhaust gas purification technologies.

² http://www.ymparisto.fi/fi-FI/Ymparisto/Ilmasto_ja_ilma/Ilmansuojelu_ja_otsonikerroksen_suojelu/Kansainvalinen_yhteistyö_ja_EUasiat

³ <http://www.worldshipping.org/industry-issues/environment/air-emissions/nox-sox-pm>

Transport Euro-standards for light passenger and commercial vehicles, heavy duty vehicles, off-road vehicles and machinery

Current European legislation on emissions from transport is covered by a series of amendments to the 1970 Directive 70/220/EEC that have introduced stringent requirements for emissions. The particulate matter limit values have reduced in all stages and the latest amendment introducing the stages, e.g. the Euro 5 (2008/9) and Euro 6 (2014) for light passenger and commercial vehicles, eventually introduces particle filters for diesel vehicles, which are expected to reduce the emission levels significantly (as an example an 80% reduction between the Euro 4 and Euro 5 levels for diesel vehicle emissions).

Equivalent standards are in force for heavy duty vehicles as well as for off-road vehicles and machinery. For heavy duty vehicles the initial directive is 88/77/EC, defining the technical aspects of heavy-duty diesel engines. Euro I standards were set in 1992, followed by Euro II in 1996. The latest standards are Euro V (from 2008) and Euro VI (2013/2014). The newest Euro VI scheme introduced *particle number emission* limits (PN). Another black carbon related measurement, *particulate matter* (PM), has been in the scheme since Euro I. From initial Euro I standard, the PM limit has been decreased by 98 %⁴.

For off-road vehicles and machinery the regulations were introduced in directive 97/68/EC. Contemporary legislation in Europe is “Stage IV”, which has come into effect in 2014. The legislation practically enforces engine manufacturers to use SCR (Selective Catalytic Reduction, using urea or ammonia to convert NO_x into harmless products) for engines larger than 75 kW. However, to achieve acceptable particle emissions level, a particle filter is not always necessary, the current scheme allowing 2.5 times more emissions than on-road heavy-duty vehicles⁵. In 2018 and 2019 “Stage V” legislation (EU 2016/1628) comes into effect. As with on-road vehicles, the new legislation includes a new measurable component, amount of small particles (PN, particle number). Additionally, the legislation will include smaller than 19 kW engines, which have been previously unregulated.

Following the introduction of the emission limits and consequently diesel particulate filters, significant reductions are expected in PM and black carbon emissions in the transport sector. To ensure that the emissions remain on a relatively low level is important to assure that the current technologies deliver the reductions also in the long term and that the legislation is introduced in a timely basis. Finland has been and is implementing the European vehicle emission standards according to the agreed timetable as well as by participating for further development of the European emission standards for non-road engines.

National strategy towards traffic decarbonization

Ministry of Transport and Communications published in 2013 its Environmental Strategy for Transport (2013-2020), which aims to achieve sustainable and technically advanced transport in Finland. The Environmental Strategy also contains an update of the Ministry's Climate Policy Programme (ILPO). The key measures expected to reduce emissions of greenhouse gases and air pollutants, including black carbon, are (Table 4 summarizes relevant actions for each area):

⁴ <https://www.dieselnet.com/standards/eu/hd.php>

⁵ <https://www.dieselnet.com/standards/eu/nonroad.php>

- Promoting the use of alternative fuels and low-emission vehicle technologies
- Modernization of the passenger car fleet (i.e. the government scrappage program in 2015).
- Improving the energy efficiency in transport
- Directing the growth of passenger traffic volumes in urban areas to more environmentally friendly transport modes

Table 4. Summaries of actions for the ILPO area.

Competence area:	Regulatory	Economic	Information	Overall assessment
ILPO Section Instrument				<i>"Small" and "large" refers to significance within the sector</i>
Promoting the use of alternative fuels and low-emission vehicle technologies				
<i>Biofuels</i>	Increasing the share of biofuels up to 20 % by 2020 by increasing biocomponent ⁶ and selling more full-bio products		Promoting use of bio-based alternatives	<i>Biofuels may decrease PM emissions and therefore BC emissions.</i>
<i>New car allowance</i>		A full-electric car will receive a 2 000 € allowance, while converting a vehicle to a gas-powered model, the allowance will be 1 000 € and to an ethanol-powered model 200 €		<i>Transition to low-emission vehicles may reduce BC emissions from traffic significantly; magnitude of the effect depends on how quickly the new technologies are adopted.</i>
Updating the passenger car fleet				
<i>Scrappage program</i>		Government pays for scrapping old vehicle and buying a new low-emission one. The allowance is 1 000 € for vehicles <110 g/km CO ₂ and up to 2 000 € for ethanol, methane and electric-powered models. Additional importer share is possible (Government Bill 156/2017 vp).		<i>It has been estimated that about 7 400 cars will be scrapped due to the allowance and 3 300 of them would not have been purchased without it. BC trend depends on which type of vehicles will be replaced.</i>
Improving the energy efficiency in transport				
<i>Educating drivers</i>	In Finnish driving schools, there is a compulsory training on economic driving style.		In the short term, the key action to increase energy efficiency is to educate drivers towards economic driving style.	<i>Driving style effect for BC probably quite small.</i>
<i>More energy efficient car fleet</i>	EU emission limits are tightening, forcing car manufacturers to produce more fuel-efficient models. Allowing energy efficient and low emitting vehicles the use of bus lanes.	Additional instruments used in Finland are taxation, and lowering of parking fees for low-emission cars,	The goal of Finnish government's energy and climate policy is to improve the energy efficiency of passenger cars and vans by 30 % by 2030.	<i>Efficiency itself does not affect much BC. However, new car models emit significantly less PM and BC.</i>
Directing the growth of passenger traffic volumes in urban areas to more environmentally friendly transport modes				

<i>Increase the use of public transport</i>		New rail projects: Vantaa Ring Rail line, Helsinki-Espoo Western metro & LRT, Tampere tram		<i>Some benefits already seen as a consequence of the Helsinki Western metro line. Rails replace not only cars, but buses as well, reducing BC</i>
<i>Mobility as a Service (MaaS)</i>	Reorganizing traffic regulations to allow new companies and concepts to enter the transportation business.		MaaS heavily based on information services.	<i>Emerging service, in the future reductions in the passenger car traffic may reduce BC.</i>
<i>Encourage walking and cycling</i>	Improve light traffic infrastructure and to plan urban structure to allow shorter distances to work, schools, services etc.		In National Strategy for Walking and Cycling 2020, walking and cycling is to be increased by 20 %.	<i>Some potential to reduce BC, especially through urban planning, shortening distances, and by increasing cycling trips.</i>

In the following paragraphs, each ILPO area is presented with more detail.

Promoting the use of alternative fuels and low-emission vehicle technologies

Finland has decided to increase the share of biofuels up to 20 % by 2020⁶. The aim is achieved by increasing the amount of biocomponent in traditional fuels and promoting the use of bio-based fuels (i.e. E85, biodiesel). In 2030, the biofuel share is to be at least 30 %⁷ and total energy used in traffic should be 40 % renewable⁸ (including electric vehicles). These aims are stricter than current EU-limits, which require 10 % bio-share by 2020.

Finnish companies have developed second- or third-generation bio-based diesel fuels that are compatible for all diesel engines (i.e. UPM's "BioVerno," made of wood; Neste MY, made of biowaste). It has been observed that renewable fuels cause less small particle emissions than their fossil equivalents, potentially decreasing black carbon emissions as well. For example, according to Neste, its renewable diesel produces up to 33 % less particle emissions than traditional diesel⁹. For gasoline engines, renewable biocomponents have also been developed (i.e. UPM BioVerno naphta; Neste MY petrol), allowing an increase of the share of biocomponent from today's 10 % ethanol blending.

According to the government's proposal, in 2018-2021 a full-electric car will receive a 2 000 € allowance, while converting a vehicle to a gas-powered model, the allowance will be 1 000 € and to an ethanol-powered model 200 €¹⁰.

Updating the passenger car fleet

The government had allocated 3 M€ for a scrappage program in 2015 (and an additional 5 M€, when the original funds ran out). Citizens got a compensation of up to 1500€ (1000€

⁶ https://www.vero.fi/syventavat-vero-ohjeet/ohje-hakusivu/56210/biopolttoaineen_jakeluvuorot/

⁷ <http://mmm.fi/metsat/puun-kaytto/liikenteen-biopolttoaineet>

⁸ <http://valtioneuvosto.fi/sipilan-hallitus/hallitusohjelma>

⁹ https://www.nestemy.com/assets/media/pdf/Neste_RenewDiesel_WhitePaper-FINAL.pdf

¹⁰ https://www.eduskunta.fi/FI/vaski/HallituksenEsitys/Sivut/HE_156+2017.aspx

government share, 500€ importer share) for the purchase of a new car with CO₂ emissions less than 120 g/km, provided that their old car of over 10 years of age was handed over for scrapping.

The project has raised a lot of interest among the citizens and a bill has been submitted to the parliament about a follow-up project¹¹ (1.1.-31.8.2018) with more resources (8 M€) and stricter emission limit (<110 g/km). It has been estimated that about 7 400 cars will be scrapped due to the allowance and 3 300 of them would not have been purchased without it, thus people driving older vehicles producing more emissions. Additionally, about 30 % of the sold cars would be higher-emission models without the allowance and its strict CO₂ limit. In the new scheme, purchasing a vehicle powered by ethanol or methane, or a rechargeable hybrid, will increase the allowance up to 2 000 € (and possibly additional 500 € importer share).

Improving the energy efficiency in transport

In the short term, the key action to increase energy efficiency is to educate drivers towards economic driving style. Additionally, keeping the car in good shape, tire pressures right and favor low rolling resistance tires increase the efficiency. In Finnish driving schools, there is a compulsory training on economic driving style.

In longer term, a shift towards more efficient car fleet is necessary. The goal of Finnish government's energy and climate policy is to improve the energy efficiency of passenger cars and vans by 30 % by 2030¹². Achieving this goal is supported by tightening EU's emission limits, forcing car manufacturers to produce more fuel-efficient models. Additional instruments used in Finland are taxation, lowering of parking fees for low-emission cars, and allowing use of bus lanes.

Directing the growth of passenger traffic volumes to more environmentally friendly transport modes in urban areas

A key step towards traffic decarbonization is to promote more efficient transport modes. Increasing the use of public transport – capable of moving a large number of people – improves the efficiency and lowers per-passenger energy use. There have been several projects to increase the availability, speed and convenience of public transport, for example the Western metro line and light rail (LRT) in Helsinki-Espoo, the Ring Rail Line (“Kehärata”) in Vantaa and Tampere tram project. The goal is that despite the cities grow, the passenger car traffic would not. The Western metro line in the Helsinki metropolitan area, which has been in use for few weeks, has already demonstrated its effect reducing amount of passenger-car traffic.

A long-term aim pursued in transport policy is a change that would turn mobility into a service (Mobility as a Service, MaaS information-based emerging instrument). Transport services are meant to be converted into a service package along the lines of the communications service sector. Finland is a pioneer in this "mobility as a service" thinking. The Finnish government

¹¹ <http://valtioneuvosto.fi/paatokset/paatos?decisionId=0900908f80569aa8>

¹² <https://tem.fi/documents/1410877/2148188/Bernerin%20Besitys%20Bstrategiasta%2024112016.pdf/417a5710-4ceb-4e94-95b0-4a7f4785fc05>

supports MaaS, and is reorganizing traffic regulations to allow new companies and concepts to enter the transportation business.

Mobility will to a greater extent become a service in which physical mobility and digital services merge into a high-quality door-to-door service that meets the users' needs. In the future various transport service chains should work seamlessly together. The need of an own car is reduced, the existing cars would operate more efficiently and the public transport becomes an attractive alternative, given that the first and last kilometer could be provided in an innovative way.

The final step in order to increase environmentally friendly transportation is to encourage walking and cycling. According to National Strategy for Walking and Cycling 2020¹³, the amount of walking and cycling trips is to be increased by 20 % compared to 2005 – meaning around 300 million trips more. The key solutions to achieve this goal is to improve light traffic infrastructure and to plan urban structure to allow shorter distances to work, schools, services etc.

Municipal level actions

Municipalities are the key actors to develop light traffic friendly environment. For example Helsinki is heavily constructing new cycling and walking lanes (i.e. “Baana” projects), restructuring traffic patterns to allow more fluent light traffic and providing city bikes that can be rented for short-term use. Helsinki also discounts parking fees for low-emission cars and allow them to use bus lanes. The Western metro line in the Helsinki metropolitan area – as mentioned above – has already lowered the amount of cars during its few-week lifetime.

In Kuopio, some of the main streets in the city center have been partially converted to walking streets as well as some other streets with less traffic. Turku has announced a traffic system development program (LJS 2035) including improvements in public transport, enhancing several streets towards light traffic friendliness, and providing better information services for cyclists and public transport users. In co-operation with Turku University of Applied Sciences there is also an ongoing project to test electric buses.

In other cities, there are similar projects towards traffic decarbonization, for example in Jyväskylä (cycling promotion program) and Tampere (trams, electric buses).

Residential and other small scale stationary combustion

According to the emission inventory (see Section 1, Figure 1) Residential and other small scale stationary combustion sector contributed 64 percent of the Finnish black carbon emissions in 2015. Table 5 summarizes residential combustion-related black carbon mitigation instruments in Finland.

Table 5. Residential combustion-related black carbon mitigation instruments in Finland.

Competence area:	Regulatory	Economic	Information	Evaluation
Area of action				

¹³ <http://urn.fi/URN:ISBN:978-952-243-234-6>

<i>Instrument</i>				
Regulatory instruments				
<i>Ecodesign</i>	The European Union's Ecodesign directive (2009/125/EC) has introduced a pan-European regulation on solid fuel boilers (LOT 15) and room heaters using solid fuels (LOT 20) that includes emission limit values			<i>Estimated impact on BC by 2030 is relatively low in Finland (4 % by 2030) due to long lifetime of stoves and already BC-efficient stoves.</i>
<i>The Neighbourhood Act</i>	A property, a building or an apartment shall not be used in a way that causes excessive stress to the neighbourhood with harmful substances like soot, filth, dust, smells, etc.			<i>Mostly local effects, however may speed up transition to improved fireplace designs.</i>
<i>The Health Protection Act</i>	Preventing, reducing and removing factors in the environment that might present health hazards. The person in charge is obligated to rectify the situation. The Act also covers smell, dust and smoke.			<i>Concentrated on health and therefore PM. BC reduction might be a favorable side-effect.</i>
<i>The Environmental Protection Act and the Waste Act</i>	Based on these Acts municipalities can issue their own regulations concerning small scale combustion and waste burning in residential settings. Following an inspection, the municipal authority can regulate the use of a stove or as an extreme measure prohibit its use. Waste burning, i.e. open burning of garden waste, in residential setting can also be prohibited.			<i>Potentially beneficial regarding to PM and therefore BC.</i>
<i>The Public Order Act</i>	The Public Order Act (12/2003) authorises the municipalities to regulate the use of solid fuels in specific areas.			<i>The Act regulates burning of campfires and other open-flame burning. Effects are local in nature.</i>
Information instruments, national level				
<i>Manual of wood combustion</i>			Information aimed to improve burning conditions. Conducted in 2008 by National Supervisory Authority for Welfare and Health, Valvira	<i>Poor burning practices in stoves increase BC emissions several-fold. Potentially effective mitigating BC.</i>
<i>Respiratory Health in Finland, Heli ry information project</i>			In 2007 Heli ry organized public information events in several locations in Finland	<i>More health than emission-related. Possible BC reductions as a favourable side-effect</i>
<i>Chimney sweep guidance portal</i>			Helsinki Region Environmental Authority, Finnish Environment Institute and the Central Association of Chimney Sweeps developed web portal with guidance for municipalities on how to conduct a burn right campaign.	<i>Web portal information is expected to be diffused into municipalities and further towards chimney sweeps and finally fireplace users. Municipalities need proactivity. If the information flow penetrates end-users, might</i>

				<i>have an effect on BC.</i>
<i>Brochure distribution initiative</i>		Estimated cost 0.02-0.31 € per household.	Chimney sweeps distribute brochures advising to burn right. Currently ongoing (2017-2018)	<i>Amount of delivered brochures is quantifiable, so the effect size could be assessed. A good possibility to have some effect on BC.</i>
Information instruments, regional and/or municipal level				
<i>Urban Woodshed project</i>			The campaign promotes appropriate guidance about how to build a shed to keep firewood dry in small city plots. Specially designed woodshed models available for ordering and self-building.	<i>Dry wood produce less emissions, so the campaign probably has some impact on air quality and also BC.</i>
<i>Helsinki Air Quality Plan</i>			The main objective is to reduce traffic nitrogen dioxide emissions, but the plan also aims to generally improve the air quality in Helsinki, including small-scale combustion. 2017-2024. The plan includes Urban Woodshed and KIUAS projects. Measuring air quality in single-family dwelling areas and promoting studies about emissions from saunas.	<i>Stresses the importance of clean air in urban setting. Air quality improvements probably decrease BC.</i>

Regulatory instruments

Ecodesign-directive

The European Union's Ecodesign directive (2009/125/EC) has introduced a pan-European regulation on solid fuel boilers (LOT 15) and room heaters using solid fuels (LOT 20) that includes emission limit values. The directive is expected to be beneficial from the particulate matter, including black carbon.

Ecodesign requirements for solid fuel local space heaters come into force on 1st January 2022 (for boilers in 2020). After this date, all new residential heating stoves must comply with emission limits set in EU regulation 2015/1185. The new regulation excludes sauna stoves. Boilers have own requirements specified in the EU regulation 2015/1189. It has been estimated that in Finland the Ecodesign requirements decrease only 4 % of black carbon emissions by 2030, mostly due to long lifetime of existing stoves and already happening transition towards low-emission models¹⁴.

Finnish building regulations include requirement for adequate construction of stoves. They must also be maintained properly and swept regularly.

Information instruments

¹⁴ <http://www.ymparisto.fi/download/noname/%7BA2C08958-043C-466A-A9BE-DF2FC7EA09E%7D/109745>

Information campaigns aimed at influencing how people store wood fuel and operate their stoves can be a cost efficient way to raise people's awareness about emissions and impacts of small scale combustion and to guide people towards operating their stoves right and as a results reduce the emissions, including black carbon.

National and municipal level actions

Information campaigns are often carried out by regional and local actors and the motivation has been health effects of particulate matter. First information campaigns were conducted in 2007-2013:

- 2012-2013 Information campaign in the Helsinki region (Helsinki Region Environmental Services Authority)
- 2008 Manual for wood combustion (National Supervisory Authority for Welfare and Health, Valvira)
- 2007 Public information events in several locations in Finland (Organization for Respiratory Health in Finland, Heli ry)

After these campaigns the Helsinki Region Environmental Authority, Finnish Environment Institute (SYKE) and the Central Association of Chimney Sweeps developed a web portal with guidance for municipalities on how to conduct "burn right" campaigns. The portal is included in the web pages of the Association of Finnish Local and Regional Authorities. Chimney sweeps play an active role in handing out the guidance documents and instructing people on how to use their stoves appropriately. Several municipalities and regions have utilized the material and have conducted their own campaigns all over the country. The latest campaign is conducted on the national level and takes place during the 2017-2018 heating season with all Finnish chimney sweeps nationwide distributing brochures that guide people towards more environmentally sound burning practices.

Helsinki Region Environmental Services Authority (HSY) has conducted an information campaign called "Urbaani puuvaja" (Urban Woodshed, www.urbaanipuuvaja.fi). The campaign guides citizens towards correct storing of firewood by providing instructions on how to build an appropriate wood shed to keep firewood dry in small city plots. Use of dry wood increases energy efficiency and reduces particulate emissions, including black carbon. In co-operation with Aalto University and TTS, HSY has published a construction manual for do-it-yourself sheds as well as specially designed ready-built model, made available for purchase by company Halkotupa Oy. The project includes guidance for storing and burning wood, production of leaflets, videos etc. material about wood burning, a photo competition to encourage people to engage more sustainable wood use as well as an extensive information campaign to raise awareness about the project and its products. Some of the materials are in English, i.e. a brochure (<https://www.hsy.fi/sites/Esitteet/EsitteetKatalogi/dry-firewood.pdf>) and a video (<https://www.youtube.com/watch?v=IhqB0Ft0n78>).

Some of the above-mentioned information campaigns are also conducted by municipalities and regional organizations. In addition, several municipal level actions and strategies target particle emissions rich in black carbon. One example is Helsinki Air Quality Plan 2017-2024. The plan aims to generally improve the air quality in Helsinki, including areas with high impact of small-scale combustion. Concerning the latter, the plan includes actions to measure air quality in

single-family dwelling areas and to conduct the Urban Woodshed and KIUAS campaign (see above).

It should be noted that in Helsinki region up to 90 % of single-home residential dwellings have some sort of stoves. However, only 2 % of the dwellings use wood as the main heat source. According to a survey by the HSY (2014), the most abundant stoves in Helsinki were heat accumulating stoves (also known as masonry stoves, 37 %) and sauna stoves (18 %) ¹⁵. Despite the lower share, sauna stoves were estimated to produce up to 67 % of the residential-burning BC emissions due to poorer burning conditions.

Industry and power generation

According to the emission inventory (see Section 1, Figure 1) Industry and power generation sector contributed 5 percent of the Finnish black carbon emissions in 2015.

Regulatory instruments

Large combustion plants

Large Combustion Plants directive (LCP, 2001/80/EC) was an EU-wide directive that limited the amount of Sulphur dioxide, nitrogen oxides and particulate matter produced in large-scale power plants (>50 MW). The directive has been superseded by the Industrial Emissions Directive (IED, 2010/75/EC), which combines multiple previous directives regulating emissions from various sectors. Large combustion plants are covered by Chapter III (with Annex V). The stricter limits approved by EU member states on April 2017 will have to be met by 2021. However, there is some flexibility: if applying BAT (Best Available Technology) causes disproportionately high costs compared to environmental benefits, the regulation can be exempted in such case.

Medium combustion plants

The EU's Clean Air Policy package consists of two directives, NEC and MCP (for NEC, see section 3.2). MCP (Medium Combustion Plants)–Directive sets pollution limits for medium to small-scale heat and power plants with 1 to 50 MW thermal input. The directive puts limits on Sulphur dioxide (SO₂), Nitrogen oxides (NO_x) and particles.

The new regulation affects biomass-powered plants, bioenergy being the foremost renewable energy solution in Finland. For SO₂ and NO_x, the national regulation (PIPO; government decree 750/2013) already puts stricter limits than MCP for the plants. However, this is not the case for particles (PM), including black carbon. The biggest difference between PIPO and MCP PM limit is in existing small (1 to 5 MW) plants, the new limit being only 17 % of previously allowed emissions. Therefore, longer adaptation time until 2030 has been approved with a set of gradually tightening rules.

Field burning of agricultural waste

¹⁵ https://www.hsy.fi/sites/Esitteet/EsitteetKatalogi/Julkaisusarja/2_2016_Tulisijojen_kaytto_ja_paastot_2014.pdf

Burning crop residues is practiced as a means of clearing land rapidly and inexpensively and allowing tillage practices to proceed unimpeded by residual crop material. Burning of crop residues leads to the emission of a number of atmospheric pollutants, including black carbon. Burning also affects the quality of soil, leading to adverse effects on crop. Legislation within the EU has largely outlawed the practice of field burning agricultural wastes. In Finland, the field burning practice has ended.

3.4 National methane emissions reduction efforts and regulation by sector

Table 6 summarizes actions and initiatives in Finland to address methane (CH₄) emissions.

Table 6. Actions and initiatives to address methane (CH₄) emissions in Finland.

Competence area:	Regulatory	Economic	Information	Evaluation
Sector				
Instrument				
Waste				
<i>The Landfill directive</i>	The directive (1999/31/EC) regulates use and characteristics of a landfill site. The foremost aim is to prevent environmental damage of landfills. Methane -relevant part is Annex I sect. 4, requiring all landfills receiving biodegradable waste to collect gas.			<i>Dumpsites cause significant methane emissions. In fact, if no action is taken dumpsites will be generating 8-10% of man-made greenhouse gases by 2025. Therefore the restrictions imposed by the directive are extremely important to mitigate CH₄</i>
<i>The government decree on landfills</i>	The government decree on landfills (331/2013) prohibits the disposal of organic waste to landfills from 2016 onwards. The waste legislation sets additional targets for recycling and recovery of certain other waste streams			<i>Organic waste handling is important to reduce CH₄ emissions from landfills</i>
<i>Waste handling facilities</i>			In 2016, two new waste handling facilities were put into service. The plants use mechanical (the other also biological) handling to pretreat waste flows in order to secure safe and high-quality recycling and restrict organic waste ending up to landfills.	<i>Organic waste handling is important to reduce CH₄ emissions from landfills</i>
<i>National waste plan</i>	The new national waste plan, "From recycling to circular economy" (required by EU-legislation 2008/98/EY) is currently under political process for approval.	Plans are to build one additional waste-burning facility as well as increase the capacity of pretreating and recycling.	The goal is that in 2030 waste handling is a part of Finnish circular economy, saving natural resources, bringing jobs and further reducing the amount of waste. Also several complementary actions	<i>The waste plan ensures that the declining trend of landfill usage and emissions continues. An important initiative to address future CH₄.</i>

			planned.	
<i>Ämmässuo and Seutula landfill cases</i>			As a case example Helsinki Region Environmental Services Authority (HSY) has started to collect methane from its abandoned landfills (Ämmässuo, Seutula).	<i>Collecting CH₄ from abandoned landfills effectively addresses their CH₄ emissions</i>
<i>Helsinki wastewater monitoring</i>			Possible sources of waste-related methane are wastewater purification plants. In HSY's purification plant (Viikinmäki), close monitoring action has been taken since 2012.	<i>Collecting information might prove to be useful in development of new practices. Currently no effect on direct CH₄ emissions.</i>
Agriculture				
<i>Rural development plan</i>	Rural Development Plan (RDP) for the Finnish Agriculture for 2014-2020 that was approved by the European Commission in December 2014. The programme is enforced via a number of legislation and decrees issued by the government of Finland.			<i>Rural CH₄ emission reduction initiative could address methane emissions. The reduction might be significant due to the large share of agriculture in total CH₄ produced.</i>
<i>Climate programme on agricultural sector</i>			The programme presents a list of actions that aim to guide the agriculture sector to reduce its greenhouse gas emissions, ao. CH ₄ . Most relevant measures for CH ₄ suggest energy efficiency measures and the use of renewable fuels and biogas for energy production in farms. Additionally the programme points out dietary changes for milk cows as an additional potential measure.	<i>Significant CH₄ reductions expected.</i>
<i>Investment support of biogas plants</i>		Local biogas plants reduce CH ₄ emissions, converting them into energy. In 2016, the amount of support was 40 % if the produced energy was used within the farm and 30 % if sold outside		<i>More CH₄ burned for energy means less CH₄ to escape freely into the atmosphere. Additionally the harvested energy reduces CH₄ elsewhere.</i>
<i>Maatalouden ravinteet hyötykäyttöön-project</i>		A project devoted to minimizing agricultural waste and maximizing circulation.		<i>The aim is elsewhere (water, nutrients) but CH₄ production could be reduced as well.</i>
Energy				
<i>European legislation and small-scale burning initiative</i>	LCP/IED, MCP and Ecodesign on clean burning – has also impacts on energy production methane emissions.		Information campaigns promoting better burning practices for citizens correspondingly addresses small-scale burning emissions.	<i>More efficient combustion practices lead to less CH₄ emissions. However, energy sector is a minor CH₄ producer.</i>

Waste

Regulatory instruments

The government decree on landfills (331/2013) prohibits the disposal of organic waste to landfills from 2016 onwards. The waste legislation sets additional targets for recycling and recovery of certain other waste streams (municipal waste, construction and demolition waste, packaging waste, waste paper, waste from electrical and electronic equipment, batteries as well as end-of-life vehicles).

The EU Landfill directive (1999/31/EC) regulates use and characteristics of a landfill site. The foremost aim is to prevent environmental damage of landfills. Pretreatment requirements also serve to minimize the amount of waste ending up on the landfills. Methane emission-relevant part of the legislation is section 4 of Annex I, requiring all landfills receiving biodegradable waste to collect gas. In addition, the document Guidance on landfill gas control was accepted in 2013. While not binding, the guidance helps authorities and operators in their effort of effective methane collection.

National efforts

Landfills are mostly responsible for CH₄ emissions in the Waste sector. According to National inventory report, the emissions have decreased about 54% in the period 1990-2015¹⁶ because: (1) the landfilled amounts of municipal solid waste have decreased following the increasing energy use of wastes (this trend is expected to continue in future), and (2) the amounts of recovered methane have increased significantly, especially at the beginning of 2000 following the regulations of landfill gas recovery (Council of State Decree 861/1997 on Landfills).

In 2016, two new waste handling facilities were put into service. The plants use mechanical (the other also biological) handling to pretreat waste flows in order to secure safe and high-quality recycling and restrict organic waste ending up to landfills.

The new national waste plan, "From recycling to circular economy" (required by EU-legislation 2008/98/EY) is currently under political process for approval. The goal is that in 2030 waste handling is a part of Finnish circular economy, saving natural resources, bringing jobs and further reducing the amount of waste. Plans are to build one additional waste-burning facility (current situation in 2017 nine facilities) as well as increase the capacity of pretreating and recycling. Complementary actions include ICT-based tracking system, education on circular economy, developing EU-regulation to allow better reuse of waste materials and promoting the decrease of food waste.

Municipal level actions

¹⁶ https://www.stat.fi/static/media/uploads/tup/khkinv/fin_un_nir_2015_2017-04-15.pdf

Landfills cause significant methane emissions. In fact, if no action is taken landfills will be generating 8-10% of man-made greenhouse gases by 2025¹⁷. In Helsinki region, Helsinki Region Environmental Services Authority (HSY) has started to collect methane from its abandoned landfills (Ämmässuo, Seutula). In Ämmässuo, the collected gas is also utilized while in Seutula it is flared.

Possible sources of waste-related methane are wastewater purification plants. In HSY's purification plant (Viikinmäki), close monitoring action has been taken since 2012.

Agriculture

Regulatory instruments

Some of the actions promoting energy efficiency and use of renewables for energy production in agricultural sector listed in the climate programme are already included in the Rural Development Plan (RDP) for the Finnish Agriculture for 2014-2020 that was approved by the European Commission in December 2014. The programme is enforced via a number of legislation and decrees issued by the government of Finland.

National efforts

Cattle produce the major part of the emissions from enteric fermentation in Finland, thus the 33% decrease in the number of cattle since has influenced both emissions from enteric fermentation.

Methane emissions from manure management have increased by 24% between 2012 and 1990, despite the decrease in the number of animals. This is mostly due to an increase in the number of cattle and swine kept in slurry-based manure management systems, which have tenfold methane emissions compared with solid storage or pasture.

The Ministry of Agriculture and Forestry has prepared a climate programme in 2014 (MMM, 2014). It presents a list of actions that aim to guide the agriculture sector to reduce its greenhouse gas emissions, ao. CH₄. Most relevant measures for CH₄ suggest energy efficiency measures and the use of renewable fuels and in farm production of biogas for energy production in farms. Additionally the programme points out dietary changes for milk cows as an additional potential measure.

One of the government's primary funding initiative regarding emissions from agricultural waste is investment support for local biogas plants to reduce CH₄ emissions, converting them into energy. In 2016, the amount of support was 40 %¹⁸ if the produced energy was used within the farm and 30 % if sold outside.

¹⁷ ISWA Tiedote ~9.11.2017

¹⁸ <http://www.kierre.info/2017/05/12/biokaasun-tuotanto-maatiloilla/>

Aim in another government's project "Maatalouden ravinteet hyötykäyttöön" is circulation of nutrients from agricultural waste. At least 50 % of manure and wastewater should be in advanced processing by 2025¹⁹. Although the primary objective is related to water and nutrient control, processing biomass properly also reduces CH₄ emissions. As a part of the program, a funding of 12M€ has been granted for developing innovative technologies and logistic solutions. The results are not known yet, but it is possible that some of the innovations lead to reduced methane emissions.

Energy

Regulatory instruments

Previously mentioned EU-regulation – LCP/IED, MCP and Ecodesign on clean burning – has also impacts on energy production methane emissions. Information campaigns promoting better burning practices for citizens correspondingly addresses small-scale burning emissions.

National efforts

Energy is a relatively minor sector in total CH₄ emissions compared with Waste and Agriculture. Largest emission sources are transport and residential sector. Emissions in transport sector have reduced significantly since 1990's following the improvements in engine technologies, including exhaust after treatment and energy efficiency.

Emissions from the residential sector have increased due to increased activity. Measures to enhance energy-efficiency of buildings can be expected to indirectly influence emissions of methane (reduce the need of fuel). Such measures are included in the National Energy and Climate Strategy (latest update 2013) following the European Union's Energy Efficiency Directive (EED).

3.5 International Activities

In the 2012 revision of the multi-pollutant protocol of the UN/ECE Convention on Long-range Transboundary Air Pollution, Finland was in favour of including legal elements for black carbon. Finland also contributes actively to the work on short-lived climate pollutants launched by the Arctic Council and the Nordic Council of Ministers as well as the Climate and Clean Air Coalition (CCAC), where Finland will participate in the heating and cooking stove initiative. Finland is also a participant in development cooperation projects within the framework of the Global Alliance for Clean Cookstoves as well as a partner country in the Global Methane Initiative (GMI). Finland is also following the IMO's work on black carbon emissions from shipping in the Arctic and has contributed by providing research based information on measurement methods as well as influence of fuel and engine characteristics on black carbon emissions.

¹⁹ <http://mmm.fi/ravinteetkiertoon>

4. Highlights of best practices or lessons learned for key sectors

Burn right information campaigns

Information campaigns aimed at influencing how people store wood fuel and operate their stoves can be a cost efficient way to raise people's awareness about emissions and impacts of small scale combustion and to guide people towards operating their stoves right and as a results reduce the emissions, including black carbon. Many municipalities and regions all over the country have conducted such campaigns utilizing material collected to a centralized web portal. The utilization of chimney sweeps in handing out the guidance documents and instructing people on how to use their stoves appropriately has been considered good, since people generally acknowledge and value the expertise of the chimney sweeps.

Use of integrated assessment of multiple pollutants and impacts in formulating national policies

Finland has been active in developing emission inventories of black carbon and methane as well as integrated assessment tools to estimate future emissions, impacts and mitigation costs of different policy options. Such frameworks have been useful in identifying the relevant source sectors and potential mitigation measures, including their costs, to support formulation of policies in both national and international fora.

5. Projects relevant for the Arctic

During the last decade several research projects and programmes have included individual projects on fine particulates and black carbon also extending to their health and climate effects have been conducted. For example the state research institutes - the Finnish Environment Institute (SYKE), the Finnish Meteorological Institute (FMI), VTT Technical Research Centre and the National Institute for Health and Welfare (THL) - and the universities of Helsinki and Eastern Finland have participated in several of these studies. These institutes have also participated in international or EU-wide projects. Example of a recently finalized project focusing on black carbon is the MACEB project (Mitigation of Arctic warming by controlling European black carbon emissions, 2010-2013) that received funding from the EU Life+ programme (more information <http://www.maceb.fi/>).

Helsinki Region Environmental Services Authority (HSY) did an emission inventory of black carbon in 2010. It was found that residential wood burning caused 16 % of black carbon emissions, the rest caused by traffic and, to much lesser extent, energy production (1 %) ²⁰. It was measured that in heat accumulating stoves, BC emissions increased several-fold if the combustion was poor.

From 2009, HSY has also begun to measure BC concentrations in its monitoring stations, continuously in three of them all located in Helsinki. HSY publishes the results yearly as a part of its air quality report. In 2016 report, it was noted that BC-levels in the city region were 2-10 times higher than in its surroundings, indicating greater amount of traffic and fireplaces in the urban area ²¹. Measured concentrations are presented as annual averages in Fig. 4.

²⁰ https://www.hsy.fi/sites/Esitteet/EsitteetKatalogi/Julkaisusarja/5_2014_Emission-inventory-of-black-carbon.pdf

²¹ <https://www.hsy.fi/sites/Esitteet/EsitteetKatalogi/Raportit/ilmanlaatu-paakaupunkiseudulla-2016.pdf>

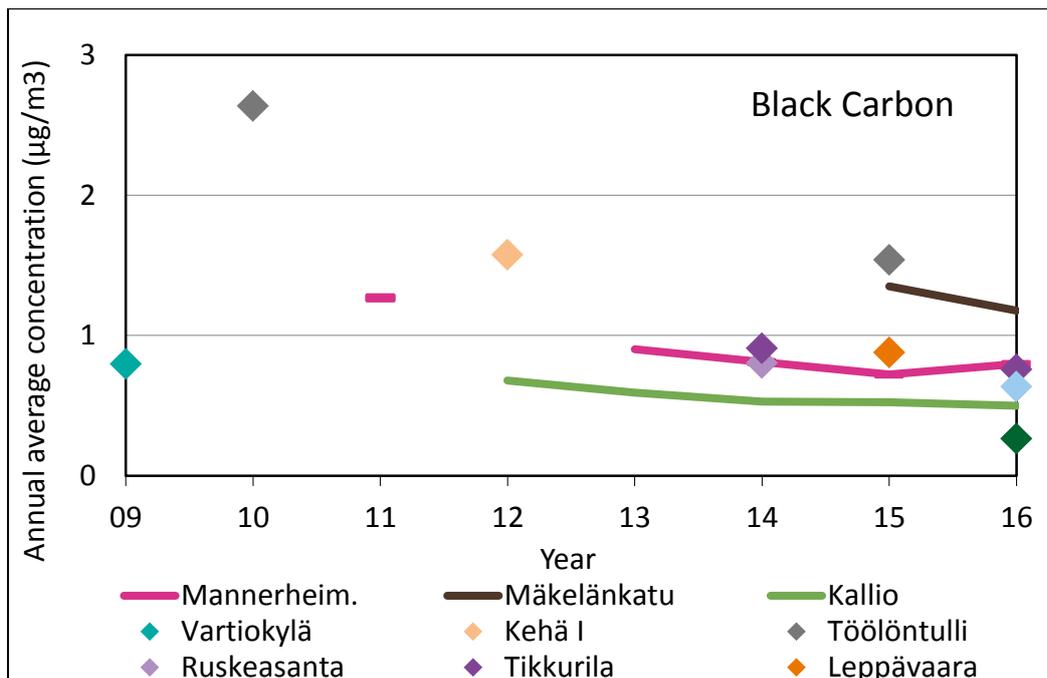


Figure 4. Measured annual average concentrations of black carbon ($\mu\text{g}/\text{m}^3$) at the HSY monitoring stations in the Helsinki Metropolitan Area in the period of 2009 to 2016.

ACAPWOOD project

Finland was co-leading the Arctic Contaminants Action Program's (ACAP) ACAPWOOD project together with Norway. The project provided several recommendations to reduce black carbon emissions from woodstoves: in addition to new-generation stoves, the report recommends information campaigns, supporting transition from wood stoves to pellet stoves and information sharing between Arctic countries to learn the best practices. BC restrictions, also proposed by ACAP, closely fall into the same category as Ecodesign-requirements (which regulate particulate matter). The project pointed out that uncertainty associated with existing BC emission inventories makes it difficult to target mitigation efforts precisely. Existing PM measurements, for example, are mainly concerned with health effects so they might ignore the fact that even scarcely populated areas where the emission concentrations are low, contribute to overall BC inventory and therefore Arctic warming.

KIUAS project

The KIUAS-project will be conducted in 2017-2019 and it will focus on developing measurement protocols suitable for monitoring emissions from sauna stoves as well as providing information about emissions of current and low-emitting sauna stoves.

NABCEA project

Novel Assessment of Black Carbon in the Eurasian Arctic: From Historical Concentrations and Sources to Future Climate Impacts (in short NABCEA) project, funded by the Academy of Finland, studies with several measurement and modelling methods the black carbon levels in the atmosphere, snow and ice and lake sediments of Northern Eurasia and the Arctic.

Current major national research Programmes

The Academy of Finland's Arctic Academy Programme (ARKTIKO, 2014–2018, Academy of Finland funding share: 15M€, <http://www.aka.fi/arktiko>) aims to study and understand the change factors affecting the development of the Arctic region, the transformation process, and the dynamics of change. Examples of projects relevant for black carbon and methane:

- Keeping the Arctic White: Regulatory Options for Reducing Short-Lived Climate Forcers in the Arctic (WHITE)
- Carbon Balance under Changing Processes of Arctic and Subarctic Cryosphere (CARB-ARC)
- Long-Term Effects of Fire on Carbon and Nitrogen Pools and Fluxes in the Arctic Permafrost and Subarctic Forests (ARCTICFIRE)

Tekes – the Finnish Funding Agency's "Arctic Seas" programme (2014-2017, TEKES funding share 45 M€, <http://www.tekes.fi/en/programmes-and-services/tekes-programmes/arctic-seas/>). Project relevant for black carbon and methane:

- Shipping Emissions in the Arctic (Black Carbon) (SEA-EFFECTS BC)

Atmospheric measurements in the Arctic area

Finnish Meteorological Institute (FMI) operates a measurements station in Pallas, Finland, which is part of the Global Atmospheric Watch (GAW) Program of the World Meteorological Organization (WMO). Black carbon and methane are part of the extensive measurement infrastructure of the Pallas station. FMI co-operates with AARI (Russia) and NOAA (United States) to maintain a measurement station in Tiksi, Russia. Black carbon and methane measurements have been part of the measurement program. FMI and AARI are extending the black carbon and methane measurements to Cape Baranov, Russia.

6. Other information if available (e.g., climate, health, environmental, economic effects of emissions and mitigation)

Health effects

Specific studies on estimating the health effects of black carbon in Finland have not been conducted. However, Ahtoniemi et al (2010) studied the health effects of fine particle emissions in Finland for the year 2000 and concluded following:

- The effects caused by primary fine particle emissions from domestic wood combustion and traffic were estimated to be over 1000 premature deaths annually.
- The emission-exposure relationship, expressed as intake fraction, showed that the traffic emissions have higher potential to expose people than domestic wood combustion emissions. The differences between different domestic wood combustion sub-sectors were also significant.

Climate effects

Two recent national projects have studied the effect of Finnish black carbon emissions on Arctic and global climate (the MACEB project, Finnish Climate Panel project on black carbon, Laaksonen et al 2014, see also Ch. 5). The projects reported following findings:

- Finnish emissions have a significant influence on black carbon surface air concentrations over most of the southern Finland. Outside Finland, the contribution of Finnish emission to black carbon surface air concentrations and black carbon burden is in practice minor or negligible.
- According to climate simulations the climate effect of Finnish emissions of black carbon occurs mostly due to earlier melt of snow and ice.
- The relative contribution of Finnish black carbon emissions to the global snow albedo effect is estimated to be about 1%, whereas to the global indirect and direct climate effects about 0.1%.
- Emission reductions occurring during winter are more effective in reducing the climate effects than reductions during summer. Additionally the cooling effect of organic carbon and sulphates is practically negligible during winter.

References

Ahtoniemi P., Tainio M., Tuomisto J. T., Karvosenoja N., Kupiainen K., Porvari P., Karppinen A., Kangas L., Kukkonen J. 2010. Health Risks from Nearby Sources of Fine Particulate Matter: Domestic Wood Combustion and Road Traffic (PILTTI). National Institute for Health and Welfare REPORT 3/2010.

Expert Group on Black Carbon and Methane 2017. Summary of Progress and Recommendations. Arctic Council 2017. 46 p.

Laaksonen, A., Kupiainen, K., Kerminen V.-M., 2014. Musta hiili ilmastopakotteena: Päästöjen ja mahdollisten päästövähennysten globaalit ja alueelliset vaikutukset. Loppuraportti kansalliselle Ilmastopaneelille.

<http://www.ilmastopaneeli.fi/uploads/reports/BLACK%20CARBON%20AS%20RADIATIVE%20FORCING%20%E2%80%93%20GLOBAL%20AND%20REGIONAL%20EFFECTS%20OF%20EMISSIONS%20AND%20POSSIBLE%20EMISSION%20REDUCTIONS.pdf>

Statistics Finland 2017. Greenhouse Gas Emissions in Finland 1990-2015. National Inventory Report under the UNFCCC and the Kyoto Protocol. 27 April 2017. 530 p.

https://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/10116.php

Suoheimo P., Grönroos J., Karvosenoja N., Petäjä J., Saarinen K., Savolahti M., Silvo K. 2015. Impacts of the implementation of the Revision of National Emission Ceilings Directive and the Proposed Medium Combustion Plants Directive in Finland. Reports of the Finnish Environment Institute 6/2015. 74 p. in Finnish with and English Abstract.

Huttunen, R. (ed) 2017. Government report on the National Energy and Climate Strategy for 2030. Publications of the Ministry of Economic Affairs and Employment 4/2017. 119 p. (In Finnish with an English abstract)

Ministry of Economic Affairs and Employment, 2017. Background report of the National Energy and Climate Strategy for 2030. 1.2.2017 (updated 2.2.2017). 168 p. (In Finnish)

Annex 1. Guidance for National Submissions

This guidance is intended to provide clarity for the initial launch and implementation of the Arctic Council Framework. As this Framework creates a first-time reporting and review function that will occur periodically over multiple chairmanship cycles of the Arctic Council, this initial guidance is intentionally simple and flexible, and may need to be further refined and clarified over time as more experience is gained.

Arctic States and participating Arctic Council Observer States are requested to provide information following this guidance, taking into account national circumstances.

Each Arctic State, and participating Arctic Council Observer States, should submit, to the degree possible, the following to the Arctic Council Secretariat:

1. Summary of current black carbon emissions to CLRTAP, where appropriate, and, if available, future projections
2. Summary of current methane emissions to UNFCCC and, if available, future projections
3. Summary of National Actions, National Action Plans, or Mitigation Strategies by sector
4. Highlights of best practices or lessons learned for key sectors
5. Projects relevant for the Arctic
6. Other information if available (e.g., climate, health, environmental, economic effects of emissions and mitigation)

Further guidance for each of these elements is provided here:

Summary of current black carbon emissions to CLRTAP, as appropriate, and, if available, future projections

In the national submission to the Arctic Council Secretariat, each Arctic State and participating Arctic Council Observer States should have the option of including: a) a high-level summary of their black carbon emissions as submitted to CLRTAP or that is generally consistent with relevant guidelines under CLRTAP; b) the same submission as provided to CLRTAP; or c) notification to the Secretariat that the black carbon emission inventory has been submitted to CLRTAP and where it can be collected from CLRTAP's public website. The sectoral breakout of black carbon emissions is expected to be consistent with relevant CLRTAP guidelines, where applicable. States not submitting inventories to CLRTAP may wish to provide a high-level summary of national black carbon emissions. Future black carbon emission projections, if available, should generally cover the same sectors as provided in the emissions inventory, and should extend from the latest available baseline year out to the next 10-30 years.

Summary of current methane emissions to UNFCCC and, if available, future projections

In the national submission to the Arctic Council Secretariat, each Arctic State and participating Arctic Council Observer States should have the option of including: a) a high-level summary of their methane emissions as submitted to UNFCCC; b) the same inventory as submitted to UNFCCC; or c) notification to the Secretariat that the greenhouse gas (including methane) inventory has been submitted to UNFCCC and where it can be collected from UNFCCC's public website. The sectoral breakout of methane emissions is expected to be consistent with the inventories submitted to UNFCCC.

Future anthropogenic methane emission projections, if available, should generally cover the same sectors as provided in the emissions inventory, and should extend from the best available baseline year out to the next 10-30 years.

Summary of National Actions or National Action Plans or Mitigation Strategies by sector

Each Arctic State and participating Arctic Council Observer States should provide brief information about key mitigation actions occurring in each sector, but should have flexibility in how such information is summarized. For example, information on national actions, brief summaries of action plans, or brief descriptions of mitigation strategies can be included. Summaries of methane mitigation actions contained in National Communications to the UNFCCC may be used for this purpose.

Highlights of best practices or lessons learned for key sectors

In the national submission to the Arctic Council Secretariat, each Arctic State and participating Arctic Council Observer States may wish to highlight successes, progress, and/or lessons learned in reducing emissions and implementing mitigation strategies for particular sources and sectors.

Projects relevant for the Arctic

In the national submission to the Arctic Council Secretariat, each Arctic State and participating Arctic Council Observer States may wish to highlight particular demonstration, research, atmospheric modeling, or mitigation projects that address either emissions characterization, emission reduction potential, mitigation implementation feasibility, mitigation costs, and/or environmental, health, and climate effects. This may include projects occurring under the Arctic Council or projects occurring outside of Arctic Council Working Groups, including in other multi-national fora.

Other information if available (e.g., climate, health, environmental, economic effects of emissions and mitigation)

In the national submission to the Arctic Council Secretariat, each Arctic State and participating Arctic Council Observer States may wish to highlight particular analyses and assessments that could contribute to improved understanding of climate, health, environmental and/or economic effects of current or projected levels of emissions, and the effects of mitigating emissions.

Annex 2. Aggregation used in summarizing the Finnish national submission to CLRTAP on historical emission of black carbon

Aggregated sectors	NFR Aggregation for Gridding and LPS (GNFR)
Industry and power generation	A_PublicPower
Industry and power generation	B_Industry
Residential and other small scale stationary combustion	C_OtherStationaryComb
Fugitive (incl. Flaring)	D_Fugitive
Other	E_Solvents
Road transport	F_RoadTransport
Shipping & aviation	G_Shipping
Shipping & aviation	H_Aviation
Off-road transport	I_Offroad
Other	J_Waste
Other	K_AgriLivestock
Field burning of agricultural wastes	L_AgriOther
Other	M_Other

Annex 3. Emission of Black Carbon in Finland 2000-2015 (Source: CLRTAP inventory 2017.

http://www.ceip.at/ms/ceip_home1/ceip_home/status_reporting/2017_submissions/)

Gg BC a ⁻¹	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Field burning of agricultural wastes	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.03	0.03	0.02	0.02	0.02	0.02	0.03	0.02	0.02
Fugitive (incl. Flaring)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Industry and power generation	0.10	0.09	0.07	0.08	0.12	0.23	0.23	0.21	0.22	0.14	0.16	0.15	0.13	0.13	0.12	0.22
Other	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.02	0.02	0.02	0.01	0.02	0.01	0.01
Residential and other small scale stationary combustion	2.51	2.90	3.00	3.03	3.05	3.19	3.31	3.34	3.46	3.69	4.08	3.23	4.35	3.98	3.14	2.96
Road transport	2.59	2.44	2.29	2.13	1.96	1.83	1.70	1.57	1.41	1.26	1.17	1.08	1.00	0.92	0.85	0.82
Off-road transport	1.93	1.88	1.82	1.74	1.64	1.24	1.03	0.99	0.94	0.77	0.79	0.77	0.75	0.68	0.63	0.52
Shipping & aviation	0.07	0.06	0.07	0.07	0.06	0.07	0.07	0.08	0.06	0.07	0.08	0.08	0.08	0.07	0.06	0.05
Total	7.24	7.43	7.30	7.08	6.88	6.60	6.39	6.23	6.15	5.96	6.32	5.34	6.34	5.82	4.85	4.60

Annex 4. Emissions of Methane in Finland 1990-2015 (Source: UNFCCC inventory 2017.
https://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/10116.php)

Gg CH ₄ a ⁻¹	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Energy	15	16	16	17	17	17	17	16	16	15	14	15	15	15	14	14	13	13	13	13	14	12	13	12	12	11
Industrial Processes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Agriculture	112	107	104	106	106	101	102	104	102	101	101	101	102	102	101	102	101	101	99	101	103	101	101	101	102	103
Land Use, Land-Use Change and Forestry	62	61	60	59	59	58	58	57	56	55	54	53	52	51	49	48	47	46	44	41	39	37	37	37	37	37
Waste	183	185	186	185	183	180	176	171	163	159	150	143	133	124	118	108	111	106	102	98	98	95	93	88	83	80
Other	NA																									
Total	371	369	367	367	365	356	352	348	337	330	319	312	301	291	283	271	273	266	258	254	254	245	243	238	234	232