

NATIONAL REPORT BY THE KINGDOM OF DENMARK

MARCH 2020

Enhanced Black Carbon and Methane
Emissions Reductions

Arctic Council Framework for Action

National Report to the Arctic Council
on
Black Carbon and Methane Emissions

Kingdom of Denmark
March 2020

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1. Black carbon emissions and future projections

1.1. Denmark's Black Carbon Emissions

The first Danish Black Carbon (BC) inventory was produced in 2010 and published in 2011 (Winther and Nielsen, 2008). This emission inventory related to fuel combustion for the historical years 1990 to 2008 and for the forecast years 2009 to 2030. The basis for inventory was the Danish TSP emission inventories and projections. The relevant emission factor information was based primarily on the European models GAINS and COPERT IV. Besides BC, the inventory also covered Organic Carbon (OC).

The Danish black carbon (BC) emission inventory is reported for the years 1990 onwards¹. The most recent emission inventory data is from 2017, where the total Danish BC emission of 4,030 tonnes (

https://cdr.eionet.europa.eu/dk/eu/nec_revised/inventories/envxgkiya/

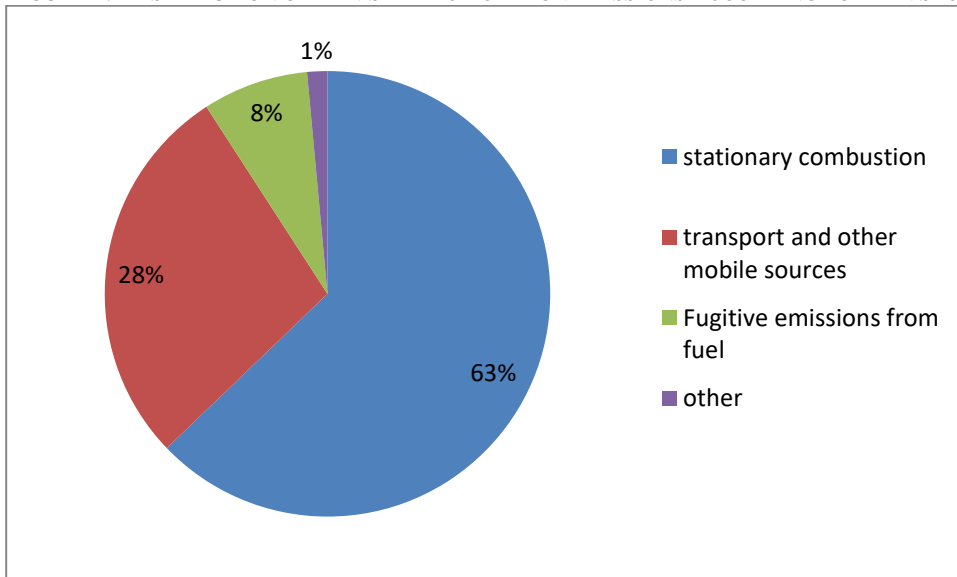
Annexes

Annex 1, table 1: Black carbon emission table, Denmark
(no projection available)

Pollutant_Unit	Sector	GNFR	Year					
			2013	2014	2015	2016	2017	2018
BC kt	1 Stationary combustion	A_PublicPower	0.02	0.01	0.01	0.01	0.01	0.01
		B_Industry	0.06	0.03	0.04	0.04	0.05	0.04
		C_OtherStationaryComb	1.10	1.07	1.17	1.22	1.23	1.23
	2 Industrial processes and product use	B_Industry	0.00	0.00	0.00	0.00	0.00	0.00
		E_Solvents	0.01	0.01	0.01	0.00	0.00	0.00
	3 Fugitive emissions from fuels	D_Fugitive	0.50	0.45	0.28	0.29	0.31	0.28
	4 Transport	F_RoadTransport	0.94	0.85	0.77	0.69	0.60	0.53
		G_Shipping	0.03	0.02	0.03	0.03	0.03	0.03
		H_Aviation	0.00	0.00	0.00	0.00	0.00	0.01
		I_Offroad	0.05	0.04	0.03	0.03	0.02	0.02
	5 Non-road mobile sources	I_Offroad	0.67	0.59	0.55	0.50	0.43	0.39
	7 Agriculture	L_AgriOther	0.02	0.02	0.02	0.02	0.02	0.03
	8 NATIONAL TOTAL	N_NATIONAL TOTAL	3.40	3.12	2.92	2.84	2.72	2.57

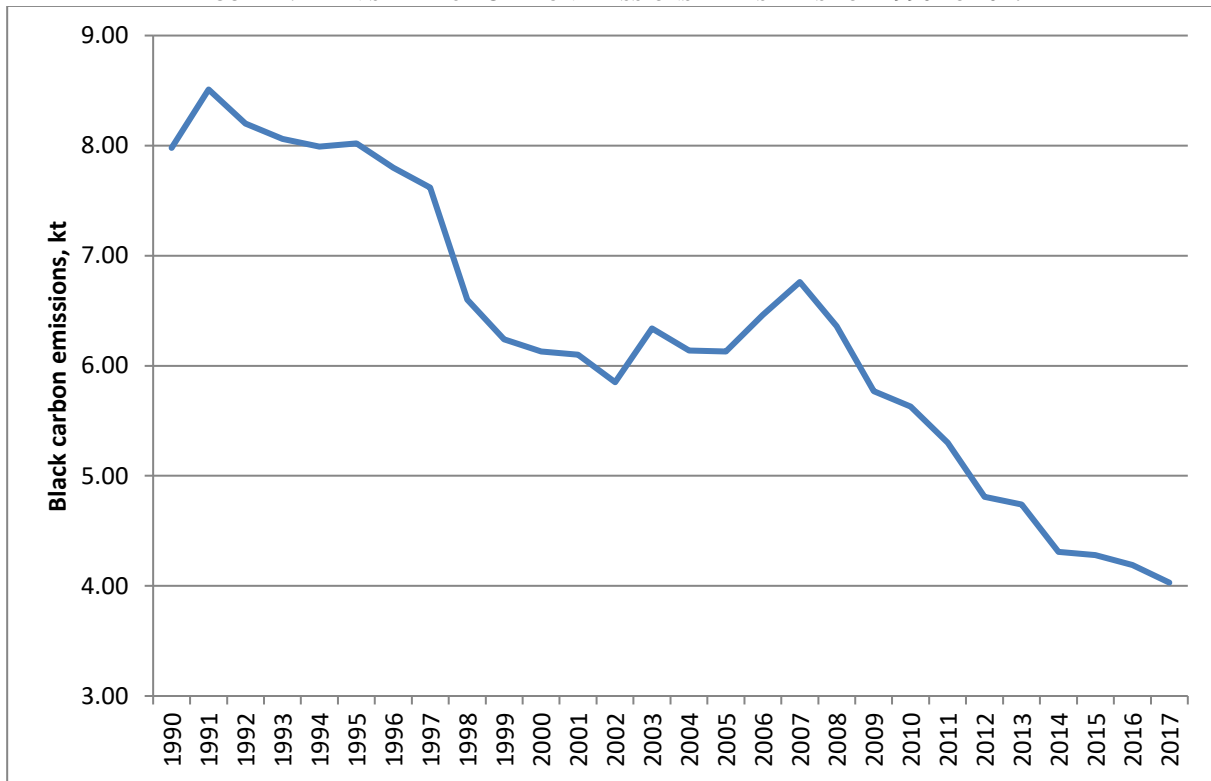
). The largest source is stationary combustion (mainly residential wood combustion), which accounts for 63 % of total national emissions. Other important sources are transport and other mobile sources and fugitive emissions from fuels accounting for 28 % and 8 %, respectively (Figure 1).

FIGURE 1: DISTRIBUTION OF DANISH BLACK CARBON EMISSIONS ACCORDING TO MAIN SECTORS IN 2017¹



From 1990 to 2017 the total Danish BC emission decreased by 49 % (Figure 2). The trend for non-industrial combustion is mainly controlled by the trend for the wood consumption in the residential sector. From road transportation vehicles exhaust particulate emissions are well below PM_{2.5}, and emissions of BC are thus affected by the regulation of PM. BC emissions from the transport sector decreased by 72 % from 1990 to 2017, mainly due to implementing of new EURO norms and improved technology. An important factor is the use of particle filters for heavy duty vehicles and passenger cars, which reduces the BC emissions effectively. BC emissions from fugitive emissions from fuels, which is mainly due to storage of coal, decreased by 70 % from 1990 to 2017, in line with the decrease of the coal consumption in electricity and heat production.

FIGURE 2: DANISH BLACK CARBON EMISSIONS TIME SERIES FOR 1990 TO 2017¹



From 2015 and onwards, Denmark has reported BC emissions annually to LRTAP. The inventory reported in 2019 is summarized in

2. Annexes

Annex 1, table 1: Black carbon emission table, Denmark
(no projection available)

Pollutant_Unit	Sector	GNFR	Year					
			2013	2014	2015	2016	2017	2018
BC kt	1 Stationary combustion	A_PublicPower	0.02	0.01	0.01	0.01	0.01	0.01
		B_Industry	0.06	0.03	0.04	0.04	0.05	0.04
		C_OtherStationaryComb	1.10	1.07	1.17	1.22	1.23	1.23
	2 Industrial processes and product use	B_Industry	0.00	0.00	0.00	0.00	0.00	0.00
		E_Solvents	0.01	0.01	0.01	0.00	0.00	0.00
	3 Fugitive emissions from fuels	D_Fugitive	0.50	0.45	0.28	0.29	0.31	0.28
	4 Transport	F_RoadTransport	0.94	0.85	0.77	0.69	0.60	0.53
		G_Shipping	0.03	0.02	0.03	0.03	0.03	0.03
		H_Aviation	0.00	0.00	0.00	0.00	0.00	0.01
		I_Offroad	0.05	0.04	0.03	0.03	0.02	0.02
	5 Non-road mobile sources	I_Offroad	0.67	0.59	0.55	0.50	0.43	0.39
	7 Agriculture	L_AgriOther	0.02	0.02	0.02	0.02	0.02	0.03
	8 NATIONAL TOTAL	N_NATIONAL TOTAL	3.40	3.12	2.92	2.84	2.72	2.57

Greenland and the Faroe Islands are exempted from obligations under the Gothenburg Protocol, and therefore do not report to LRTAP on BC. It has not been possible to provide a BC emission inventory for the Faroe Islands nor an updated projection of emissions for the Faroe Islands or Greenland. According to Winther & Nielsen (2011) the BC emissions for Greenland and the Faroe Islands count less than 1 % of the total BC emissions from the Kingdom of Denmark.

2.1. Projections of Black Carbon Emissions for Denmark²

According to the latest available emission projection, the total Danish BC emissions are expected to decrease by 16 % from 2016 to 2020 28 % from 2016 to 2030 and by 28 % from 2016 to 2040³. From 2013 to 2025 Danish BC emissions are expected to decrease by 33 %. These numbers have not been adjusted for uncertainty. The predicted emission reductions are mainly due to expected reductions in emissions from small combustion, due to implementation of newer technologies and from transport and other mobile sources, due to lower emission limit values for particulate matter (

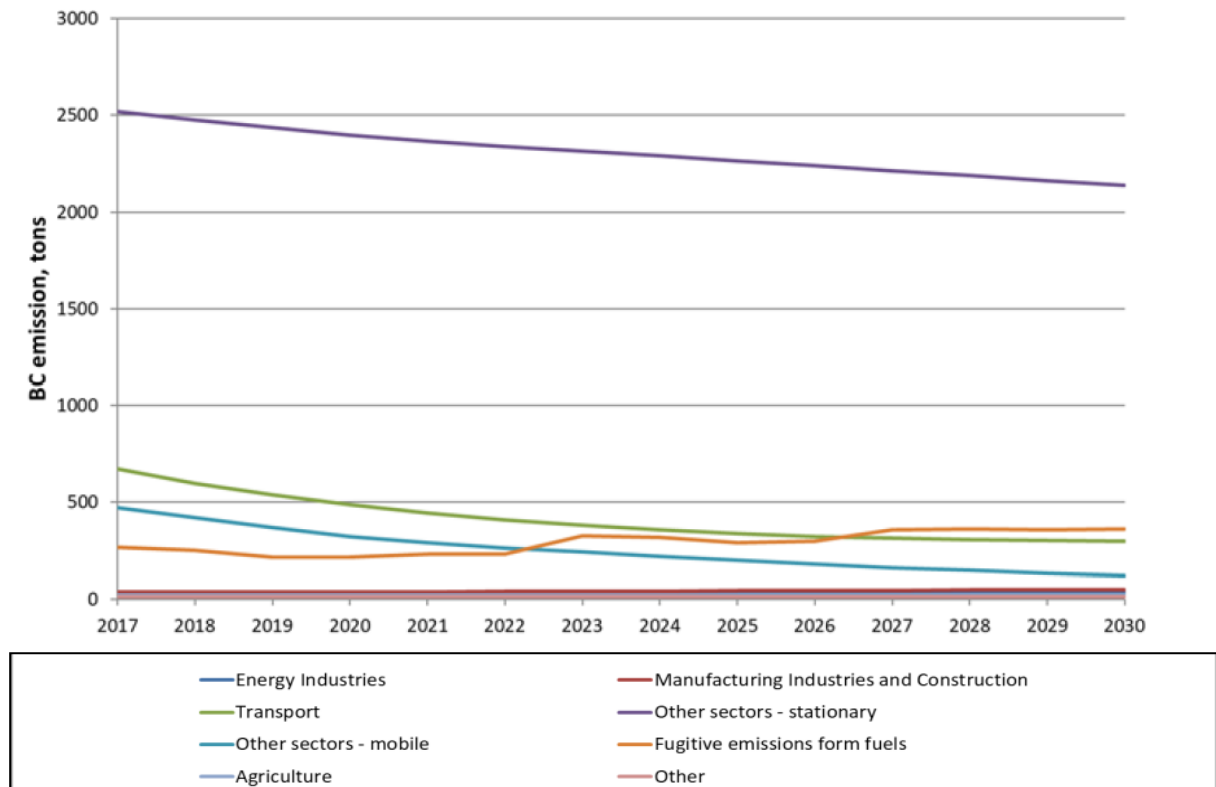
FIGURE 3).

FIGURE 3: PROJECTIONS OF DANISH BC EMISSIONS IN TOTAL AND FOR DIFFERENT SECTORS (NOT INCLUDING GREENLAND AND THE FAROE ISLANDS)³

² Projections are performed on a regular basis in Denmark, based on international guidelines. These projections are not scrutinized and accepted by the Danish Government as input for formal national obligations for future reductions

³

http://cdr.eionet.europa.eu/dk/un/clrtap/projected/envwmkrmg/Annex_IV_Projections_reporting_template.xls/mange_document og <http://cdr.eionet.europa.eu/dk/un/clrtap/iir/envwmkrwg/SR222.pdf>



The BC emissions from stationary combustion have increased in the historic years due to increasing wood combustion in residential plants. However, from 2015 to 2035 the BC emissions are expected to decrease due to a lower emission factor for wood combustion in residential plants. This is due to the replacement of old wood stoves and boilers with new technologies that give rise to considerably lower emissions.

In terms of BC the total exhaust emissions from road transport is expected to decline from 2016 to 2040 by 64 %, in particular due to the introduction of diesel particulate filters (DPF) for Euro 5 cars/vans, and Euro VI trucks/buses. The largest emission source is passenger cars, followed by light duty vehicles, heavy duty vehicles and buses.

Being a sub part of total PM, the decline in BC emissions from other mobile sources is driven throughout the forecast period by the general decrease in PM emissions for diesel fuelled machinery in the agriculture, forestry and industry sectors and the step-wise introduction of Stage V machinery from 2019/2020. In order to meet the Stage V PM emission standards for engines ≥ 19 kW, particulate filters are needed, which in addition are very efficient in removing BC.

2.2. Greenland’s Black Carbon Emissions

2.2.1. Total Black Carbon Emissions 1990-2017 for Greenland

Fishing, hunting and agriculture are the main sources of emissions of BC in 2017, contributing with 62 % of total emissions, see **Error! Reference source not found.** and **Error! Reference source not found.**. Among other important sources are: road transport with 9 %, shipping with 14 % and households with 10 % in 2017.

The total emissions of BC in Greenland have decreased by 38 % from 1990-2017.

It should be noted that the figures on energy consumption for 1990-2003 are generally subject to higher uncertainty than the period 2004-2017 due to changes in the statistical inventory.

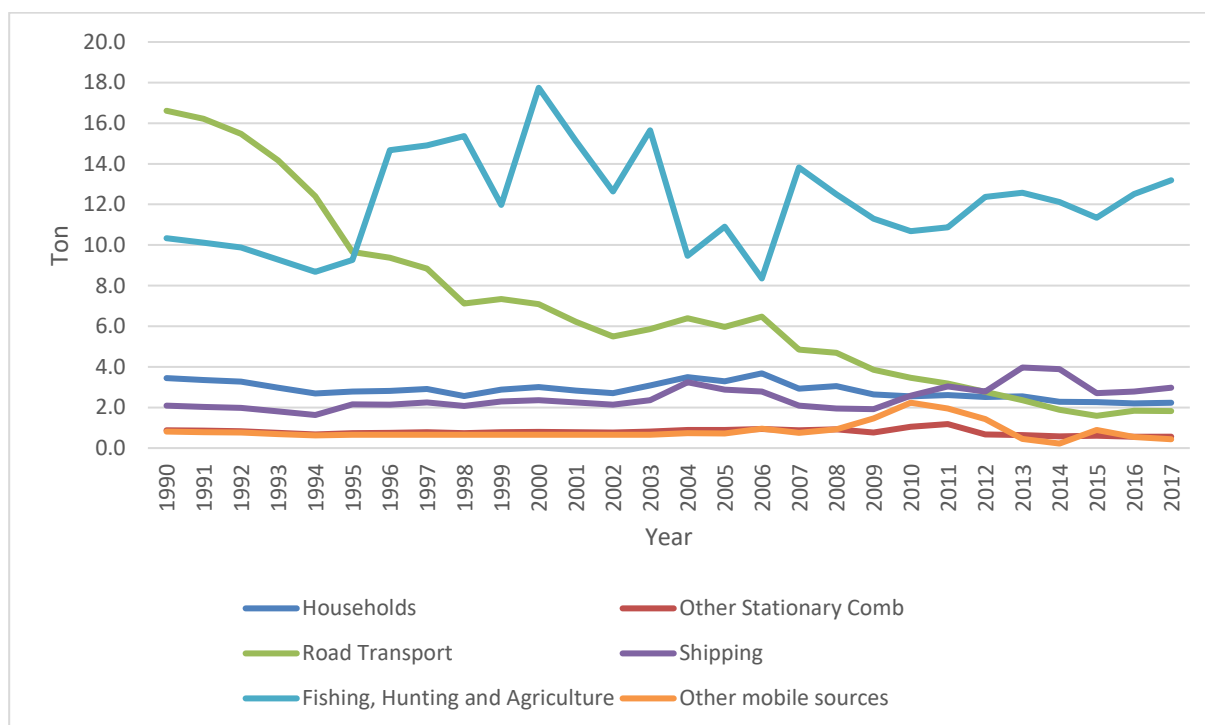


FIGURE 4: BLACK CARBON EMISSIONS IN GREENLAND, TIME-SERIES FOR 1990-2017.⁴

Households

Household emissions of BC have decreased by 35 % from 1990-2017, mainly because household consumption of gas oil heating has decreased due to better insulation, more efficient oil furnaces, and increasing use of public district heating based on hydropower and heat from power generation and waste incineration.

Road transport

Emissions of BC from road transport dropped 89 % from 1990-2017. More efficient particle filters in diesel oil vehicles is the primary reason for this significant decrease. The consumption of gas oil for road transport has decreased, while consumption of gasoline has increased significantly from 1990 to 2017.

Fishing, hunting and agriculture

Combined, fishing, hunting and agriculture is the largest contributor to emissions of BC in the period 1990-2017. Within this sector, fishing and hunting account for about 99 % of emissions while agriculture only contributes with less than 1 % of BC. Energy use for fishing and hunting increases and decreases throughout the period 1990-2015, peaking in 2000. As mentioned earlier, the figures for 1990-2003 are uncertain. From 1990 to 2017, energy consumption in hunting and fishing increased by 28 %.

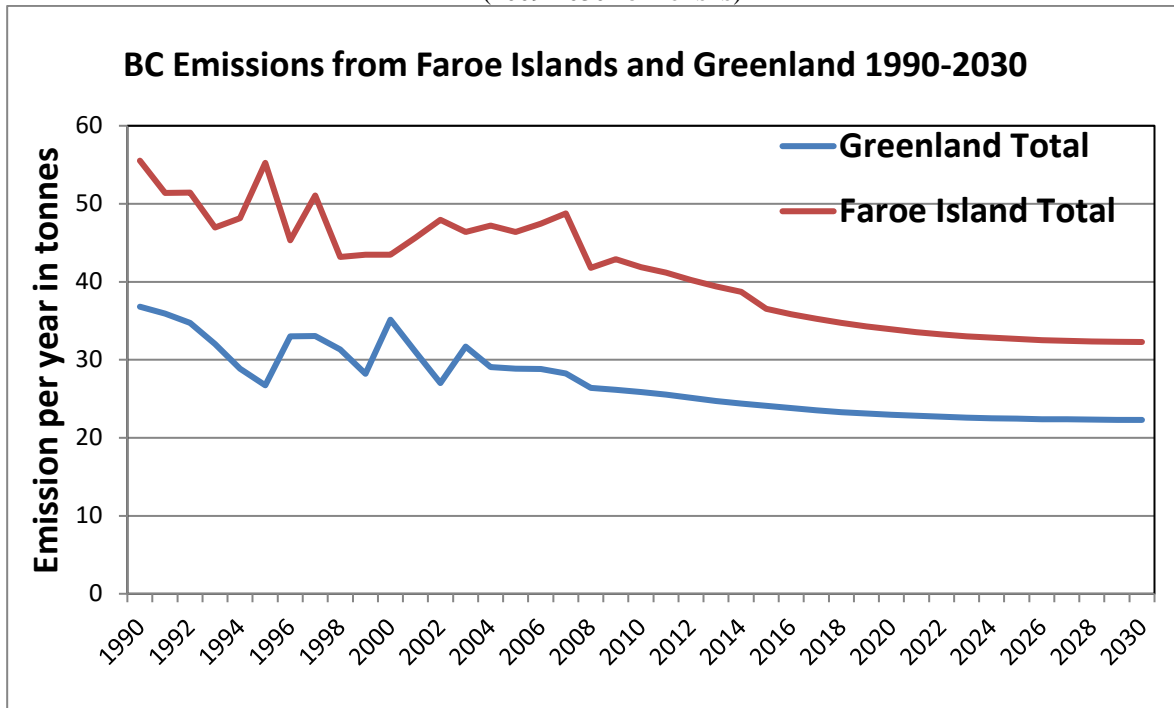
⁴ Lene Baunbæk, Grønlands Statistik. Emission af TSP, BC OC fra grønlandsk energiforbrug i perioden 1990-2016. and Ministry of Industry, Energy and Research from 2017

In total, agriculture, hunting, fishing and shipping account for 76 % of BC emissions.

2.3. Projections for Greenland and the Faroe Islands

A BC emission inventory for the Faroe Islands has not been made nor an updated projection for the Faroe Islands or Greenland. According to Winther & Nielsen (2011) the BC emissions for Greenland and the Faroe Islands count less than 1 % of the total BC emissions from the Kingdom of Denmark.

FIGURE 5: BLACK CARBON EMISSIONS 1990-2030 FOR GREENLAND AND THE FAROE ISLANDS (2009-2030 FORECASTS)



3. Methane Emissions and Future Projections

3.1. Denmark's Methane Emissions

Denmark's methane emissions (CH₄) are estimated as part of Denmark's total greenhouse gas emissions reported annually to the European Commission and estimated as part of the Kingdom of Denmark's total greenhouse gas emissions (i.e. the sum of Denmark's, Greenland's and Faroe Islands' methane emissions) reported annually to the secretariat for the United Nations Framework Convention on Climate Change (UNFCCC).

In 2019, the annual inventory submission was submitted in April 2019 to the UNFCCC. Estimates of Denmark's emissions of methane contained in this document have been reported to the UNFCCC on 15 April 2019 – both as part of total methane emissions from Denmark, Greenland and the Faroe Islands under the UNFCCC⁵, as part of total methane emissions from Denmark and Greenland under the Kyoto Protocol⁶ and separately for Denmark⁷ as the latter is relevant in relation to Denmark's contribution to the joint EU target for the 2nd commitment period of the Kyoto Protocol (2013-2020)⁸.

The methane emissions are estimated according to the IPCC 2006 guidelines.

3.1.1. Total methane emissions 1990-2017

Anthropogenic methane (CH₄) emissions primarily stem from agriculture, landfills, and the energy sector, among which agriculture contributes the most by far.

In 2017, total anthropogenic methane emissions in Denmark amounted to 275 kilo tonnes, where agricultural activities contributed with 81.1 %, waste 13.4 % and the remaining emission sources including energy with 5.5 %, see Figure.

The emission of methane from agriculture derives from enteric fermentation (54.6 %) and management of animal manure (26.5 %). Since 1990, the emission of methane from enteric fermentation has decreased 7.6 % mainly due to the decrease in the number of cattle. However, this reduction is countered by an increase of 17.4 % in emissions from manure management caused by a change in housing type towards slurry-based systems. In later years, the emission from manure management has decreased due to changes in manure management, e.g. more biogas treatment and acidification of slurry.

The emission of methane from solid waste disposal has decreased significantly (61.4 %) from 1990 to 2017 due to a ban on landfilling of combustible waste in 1997 and an increase in the incineration of waste and extensive recycling thereby causing a decrease in the waste disposal on land.

The methane emission from the energy sector increases from mid 1990ties from public power and district heating plants increases due to the increasing use of gas engines in the decentralised cogeneration plant sector. Due to the liberalisation of the electricity market the use of gas

⁵ http://unfccc.int/files/national_reports/annex_i_ghg_inventories/national_inventories_submissions/application/zip/dnk-2017-crf-27may17.zip

⁶ http://unfccc.int/files/national_reports/annex_i_ghg_inventories/national_inventories_submissions/application/zip/dke-2017-crf-27may17.zip

⁷ http://unfccc.int/files/national_reports/annex_i_ghg_inventories/national_inventories_submissions/application/zip/dnm-2017-crf-07may17.zip

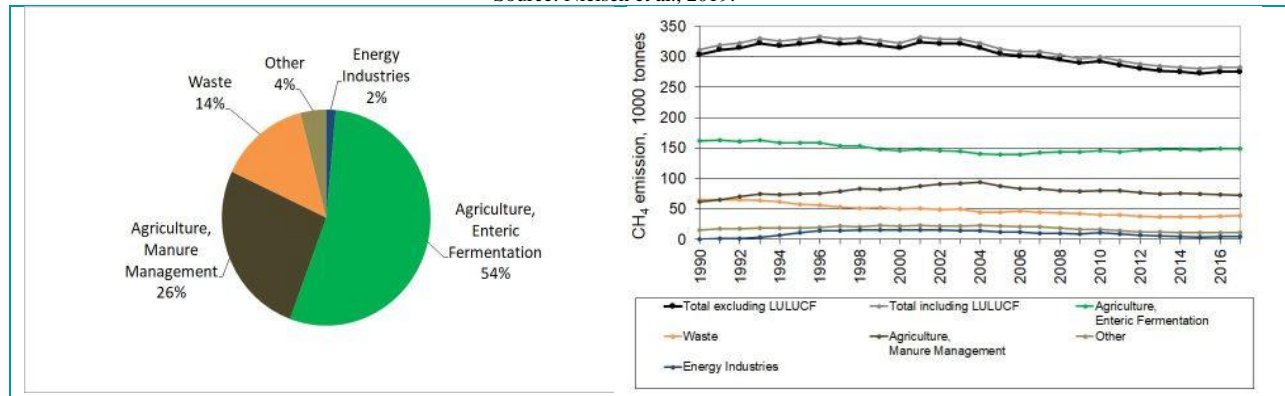
⁸ The 2nd commitment period adopted with the so-called Doha-amendment has no yet entered into force (http://unfccc.int/kyoto_protocol/doha_amendment/items/7362.php).

engines declined from 2005 onwards. The high emission from gas engines is caused by the fact that up to 3 % of the natural gas in the gas engines is not combusted.

In 2017, total CH₄ emissions were 9.4 % below the 1990 level.

FIGURE 6: DENMARK'S METHANE (CH₄) EMISSIONS BY SECTOR/SUBSECTOR (SHARE IN % IN 2017 AND TRENDS 1990-2017 IN KT CH₄)

Source: Nielsen et al., 2019.



3.1.2. Projections of Denmark's methane emissions 2016-2040⁹

Projections of Denmark's methane emissions are usually elaborated as part of projections of Denmark's total greenhouse gas emissions. The most recent projection of Denmark's greenhouse gas emissions is the "with existing measures" projection from August 2019.

This "frozen policy" scenario projects the development in emissions without additional policies and measures. From this projection the results regarding Denmark's methane emissions are shown in Table 3 and Figure 6.

The increase in methane emissions from agriculture after 2020 is primarily due to an increase in cattle stocks.

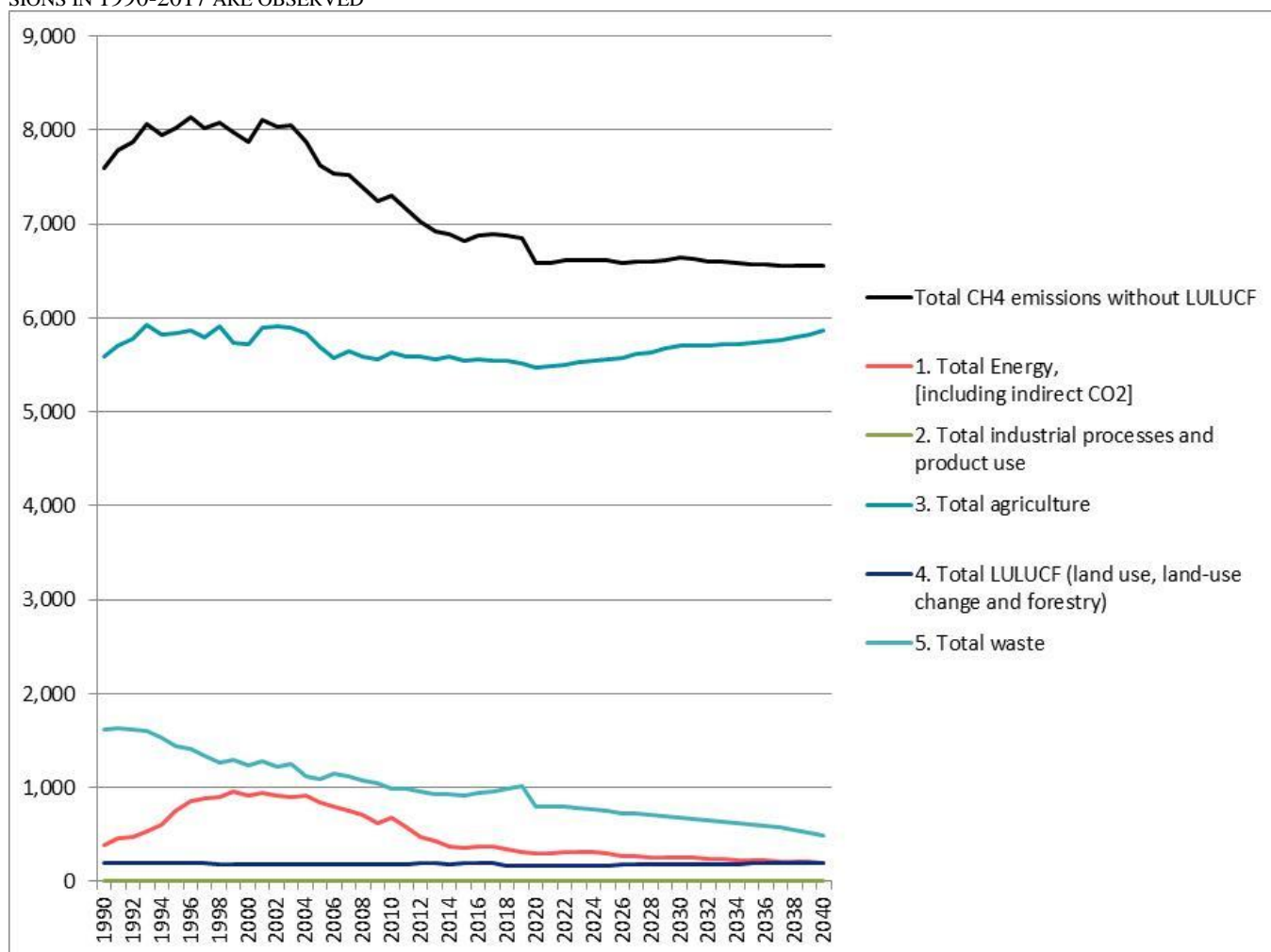
The next largest source of methane is landfills, from which emissions were reduced from 1990 to 2017 and will continue to decrease in the projection period primarily due to the decrease in formation of methane in old landfills after the ban on landfilling of combustible waste in 1997 and in the future also due to the new initiative with support for biocover on old landfills.

Methane emissions from the energy sector have, however, increased considerably until 1999 due to an increase in the use of gas-driven motors. This increase was followed by a stabilisation which seems to continue in the projection period.

Altogether total methane emissions decreased from 304 kt of CH₄ in 1990 to 275 kt of CH₄ in 2017, whereas the baseline projection for 2018-2040 shows a further decrease until 2020 followed by an almost constant development around 262 kt of CH₄ which is the projected level in 2040 if additional measures are not implemented.

⁹ Projections are performed on a regular basis in Denmark, based on international guidelines. These projections are not scrutinized and accepted by the Danish Government as input for formal national obligations for future reductions

FIGURE 7: PROJECTIONS OF DENMARK'S METHANE EMISSIONS IN KT OF CO₂ EQUIVALENTS 2018 – 2040, EMISSIONS IN 1990-2017 ARE OBSERVED



3.2. Greenland's Methane Emissions

3.2.1. Total methane emissions 1990-2017

The most significant source of anthropogenic CH₄ emissions is waste handling, which contributes with 46.1 % of total CH₄ emissions in 2015; see Figure 8. Agriculture accounts for 45 % of total emissions and the energy sector for 8.9 % of total CH₄ emissions in 2017.

The emission from agriculture derives from enteric fermentation (98 %) and management of animal manure (2 %). Since 1990 the number of sheep and reindeer has decreased. From 1990 to 2017 the emission of CH₄ from agricultural activities has decreased by 23.5%.

The emission of CH₄ from waste management derives from solid waste disposal (70.4 %) and incineration and open burning (29.6 %). From 1990 to 2017, the emission of CH₄ from solid waste disposal has increased by 5.1 %, while emission from waste incineration has decreased by 29.1 %. Overall, emissions of CH₄ from waste management have decreased by 8.0 % from 1990 to 2017.

FIGURE 8: CH₄ EMISSIONS IN GREENLAND, TIME-SERIES FOR 1990-2017.

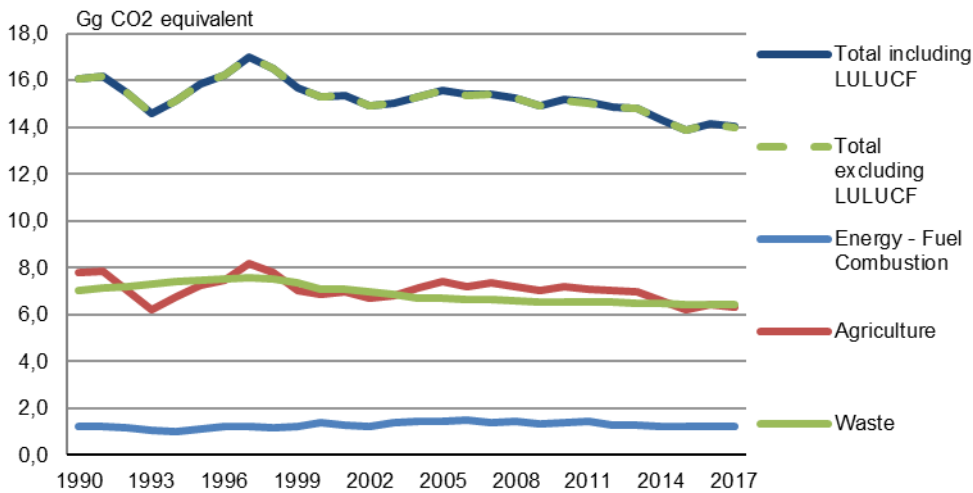
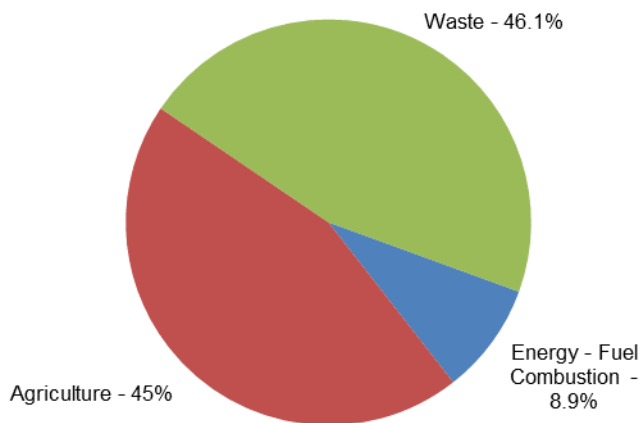


FIGURE 9: CH₄ EMISSIONS IN GREENLAND, DISTRIBUTION ACCORDING TO THE MAIN SECTORS IN 2017.



Natural CH₄ emissions have not been factored out in the above data. Thawing of permafrost caused by climate changes seems to result in significant emissions of methane.

3.2.2. Projections

Based on the rather constant trend since about 2000, the best estimate for a projection of CH₄ emissions is a constant level. It has not been possible to obtain projections for the number of livestock or waste production.

3.3. Faroe Island's methane emissions

3.3.1. Total methane emissions 1990-2017

The Faroe Islands' methane emissions are not reported separately under the UNFCCC in the Common Reporting Format (CRF), but are compiled and added to the CRF database before they are aggregated with the Danish and Greenlandic emissions data and formally submitted as part of the CRF for the Kingdom of Denmark (i.e. the sum of Denmark's, Greenland's and the Faroe Islands' emissions).

Methane, CH₄

In 2017 2 % of the total emission of greenhouse gases on the Faroe Islands was emission of CH₄. The absolute emission of CH₄ was 867 tonnes (Annex 2, table 5), which corresponds to 21,500 tonnes of CO₂ equivalents. 98 % of the CH₄ emissions were from Agricultural activity and 2 % from Energy, see Figure 10.

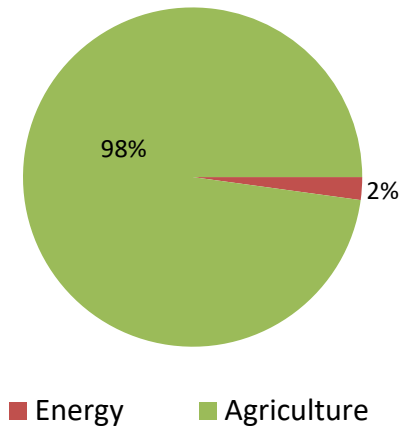


FIGURE 10: CH₄ EMISSIONS IN THE FAROE ISLANDS, 2017, BY SECTOR (%)

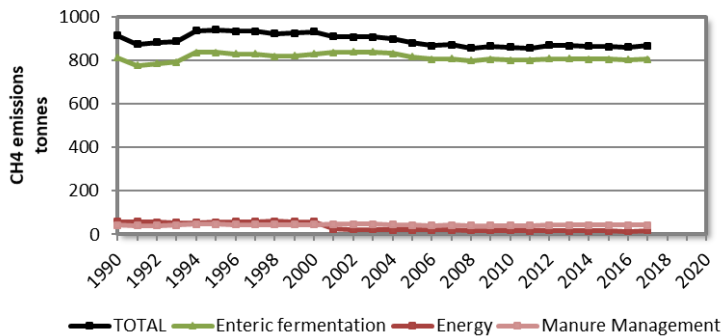


FIGURE 11 shows the emissions of methane in the Faroe Islands 1990-2017.

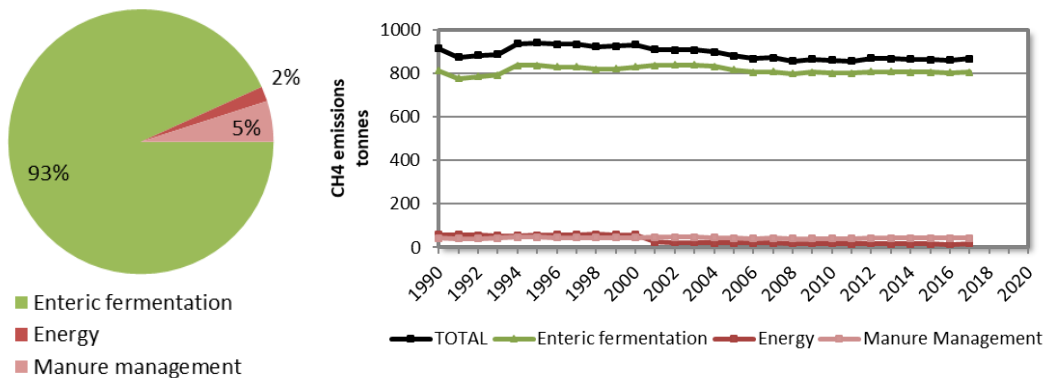


FIGURE 11: CH₄ EMISSIONS IN THE FAROE ISLANDS, BY SECTOR/SUBSECTOR AND DEVELOPMENT 1990-2017

SOURCE: NIELSEN ET AL. (2019).

3.3.1. Mitigation actions and their effects

Total emissions

In 2017 the total emission of greenhouse gases had increased by 9 % compared with the emission in 2005. This means that the emission shall be reduced with another 29 % before 2020 to fulfil the target. See 14.

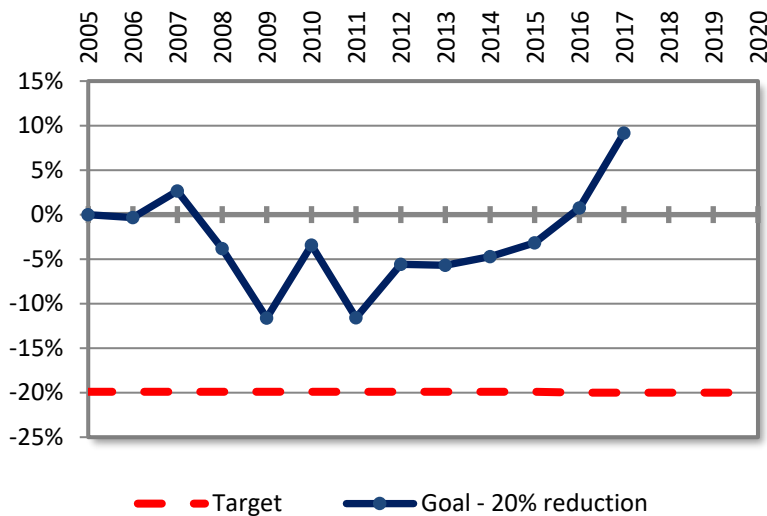


FIGURE 15: TOTAL EMISSIONS OF GREENHOUSE GASES IN THE FAROE ISLANDS 2005-2017, RELATIVE COMPARED WITH 2005 AND IN TONNES OF CO2 EQUIVALENTS

The total emission of greenhouse gases in Figure does not include emissions from foreign fishing vessels, and the totals are therefore not the same as the totals reported to IPCC (CRF).

As part of the reporting on progress in achievement of the quantified economy-wide emission reduction target, information on mitigation actions and their effects is shown in **Error! Reference source not found.8.**

4. National strategies and action plans

4.1. Governance structure regarding BC and methane

The Kingdom of Denmark consists of Greenland, Faroe Island and Denmark, whom each have their individual national strategies and action plans regarding BC and methane. In Denmark, the responsibility for BC and methane respectively is further divided between the Ministry of Climate, Energy and Utilities (Methane) and Ministry of Environment and Food (BC).

4.2. National action plans and sector based plans and projects, Denmark

4.2.1. Black Carbon

Denmark and the EU have taken considerable steps to ensure clean air. Particulate matter pollution has serious effects on public health and is therefore subject to considerable focus, and thereby also reduction of black carbon. Even though there has been significant progress, efforts to ensure cleaner air will continue.

A number of initiatives have resulted in substantial decreases in particulate matter and black carbon pollution in Denmark over the past 20 years. Today, wood-burning stoves are the largest Danish source of particle emissions and black carbon, and together with diesel exhaust particulate matter, they are a very significant source of pollutants harmful to health. In 2018 the Danish government launched a Climate and Clean air package, with a number of initiatives targeted at reducing air pollution from transportation, wood burning and agriculture. **Error! Reference source not found.**6 provides an overview of the most recent relevant national actions, initiatives and strategies that contribute to reducing BC emissions.

4.2.1.1. Mobile and stationary sources

Measure	Objective and content of measure	Substance reduced	Expected reduction effect in tonnes
Stop on the sale of fossil cars in 2030	Stop on the sale of fossil cars in 2030	NO _x , PM _{2.5} , BC, CO ₂	CO ₂ : 3-4 million
Green transition of private cars	Target that all new cars in 2035 are zero emission cars (electric etc.)	NO _x , PM _{2.5} , CO ₂	N/A
Six measures here and now to promote electric cars etc. + green car committee	Promote electric cars	NO _x , PM _{2.5} , BC, CO ₂	N/A (expected major effect of target in 2030)
End to CO ₂ emissions and air pollution from busses from 2030	By 2025 all new busses must be green. By 2030 all busses must be green.	NO _x , PM _{2.5} , BC, CO ₂	CO ₂ : 1.5 million PM _{2.5} : 360 tonnes* NO _x : 13,000 tonnes*
By 2030 all taxis must be zero emission taxis.	Energy requirements for taxis are enhanced in 2019, 2022 and 2025 in order to ensure, that no new taxis emit CO ₂ and air pollution from 2025. Taxi companies using green taxis are guaranteed a license + advantages for green taxis.	NO _x , PM _{2.5} , BC, CO ₂	CO ₂ : 0.4 million tonnes PM _{2.5} : 65 tonnes**: NO _x 970 tonnes*
Environmental zones up to date	New environment requirements for trucks, busses, and light goods vehicles from 2020-2025	NO _x , PM _{2.5} , BC, CO ₂	PM _{2.5} : 77 NO _x : 2,225

Scrapping system diesel cars	Fund of DKK 100 million for temporary increase of scrapping premium for old diesel cars from before 2006	NO _x , PM _{2.5} , BC, CO ₂	CO ₂ : 15,000 PM _{2.5} : 40 NO _x : 250
Enforcement and control of NO _x fraud with trucks	DKK 6 million for intensified development and enforcement efforts	NO _x	N/A
Continuation of control with sulphur pollution from ships	DKK 12 million for enforcement of sulphur rules from 2019 to 2022 As per 1 January possible to publish the most serious violations of the sulphur rules.	SO ₂	N/A
International cooperation on environment-friendly cruise ships	DKK 10 million from 2019 to 2022 for an international cooperation project to promote more environment-friendly cruise ship tourism in the Baltic Sea region in cooperation with the industry, local authorities, and tourist organisations	NO _x , SO ₂ , PM _{2.5} , BC	N/A

4.2.1.2. Residential heating

Wood burning			
Measure	Objective and content of measure	Affected substance	Expected reduction effect in tonnes
Maintain particle requirements for new wood burning stoves	Requirements for new wood burning stoves were enhanced in 2015 and 2017	PM _{2.5} , Black carbon, dioxin etc.	
Scrapping system for old wood burning stoves	DKK 46 million allocated to new scrapping system for old wood burning stoves	PM _{2.5} , Black carbon, dioxin etc.	Will cause approx. 15-20,000 old stoves to be replaced with new ones
Replacement of old wood burning stoves upon transfer of ownership of private homes	Wood burning stoves from before 2003 scrapped or replaced upon transfer of ownership of private homes	PM _{2.5} , Black carbon, dioxin etc.	PM _{2.5} : 535 in 2030 (Accumulated effect: 9,340)
Stepwise phasing out of old wood burning stoves – national or municipal	Inspired by German model. Not decided. It has been chosen to focus on phasing out upon transfer of ownership of private homes.	PM _{2.5} , Black carbon, dioxin etc.	PM _{2.5} : 3,000 in 2030
Campaigns and nudging for correct firing and ecolabelled stoves	Correct firing and more ecolabelled stoves will reduce emissions	PM _{2.5} , Black carbon, dioxin etc.	N/A
Financial subsidies for technology development	Continued subsidy for the development of wood burning stoves with lower emissions, filters, etc. through the Environmental Technology Development and Demonstration Programme.	PM _{2.5} , Black carbon, dioxin etc.	N/A

4.2.2. Methane

See Annex 3 for overview of national climate relevant actions with effect on Denmark's methane emissions.

4.2.2.1. Energy Sector (Mobile and stationary sources + Oil and gas)

In 2017, total emissions of methane from the energy sector accounted for 5% of the sector's greenhouse gas emissions, corresponding to about 0.4 million tonnes CO₂ equivalents. Many small sources contribute to this overall relatively minor source of greenhouse gas emissions. The biggest single contribution comes from gas-fired CHP plants, which emit unburnt natural gas. With a view to minimising the emissions, a 1998 Statutory Order, in force from 2006 to 2013, has limited emissions of nitrogen oxides, unburnt carbon hydrides, including methane, and carbon monoxide etc.. However, the limit value for unburned hydro carbons was removed in a revision of the Statutory Order entering into force on 7 January 2013.

Taxes on energy, mineral oil, gas, coal and electricity are through the reduction of energy consumption also contributing to the reduction of Danish methane emissions.

4.2.2.2. *Biogas*

Biogas from digestion of manure and organic wastes carries a number of advantages when used to substitute fossil energy: reductions in emissions of greenhouse gases, better utilization of manure as fertiliser, recycling and use of organic wastes for energy and fertiliser purposes etc.

In order to stimulate expansion of the biogas sector the subsidy on the sales price of electricity production based on biogas was adjusted by the Energy Policy Agreement of 22 March 2012. The Agreement resulted in an amendment to the Promotion of Renewable Energy Act of 27 December 2008.

The Energy Policy Agreement continued funding biogas for combined heat and power (CHP) and introduced subsidy equality so that biogas sold to the natural gas grid would receive the same subsidy as biogas used at CHP plants. In addition the agreement also introduced a new subsidy when biogas is used in industrial processes, as a fuel for transport or for the production of heat.

As part of the Danish Rural Development Programme 2007-2013, financial aid has been provided to investments in biogas plants in 2010 and in 2012. In 2012 support was awarded to both new and existing biogas plants to the amount of DKK 262 million.

The latest projection from the Danish Energy Agency expects an increase in biogas production from 4 PJ in 2007 to 21 PJ in 2020 from all biogas plants (Denmark's Energy and Climate Outlook 2019, Danish Energy Agency, August 2019).

The biogas production is expected to result in a reduction of the annual emissions of methane and CO₂ including the reduced CO₂ emissions from substitution of fossil fuels, primarily natural gas.

The 1st allocation of the budget under the National Green Climate Fund in June 2017 included an earmarking of 9,0 million DKK for developing solutions in existing biogas plants and associated suppliers of feedstock with a view to reduce the retention time of manure. This is expected to increase the production of biogas per unit input of manure while at the same time reducing emissions of methane.

In 2019 a targeted effort to reduce methane emissions from Danish biogas plants was initiated. The total reduction effect of this initiative over the period 2021-2030 is estimated at approximately 1.1 million tonnes CO₂ equivalents (accumulated annual reductions).

4.2.2.3. *Agriculture and animal husbandry*

Methane emissions mainly stems from the agricultural sector, contributing, in 2017, with 81% of total Danish CH₄ emissions, corresponding to 5.5 million tonnes CO₂ equivalents (Nielsen et al., (2019)). The methane is formed through enteric fermentation in farm animals and from conversion of carbohydrates in manure.

Danish agriculture's biggest contribution to the methane emissions comes from dairy cows. In the digestion process, methane is a by-product of the fermentation of feed in the rumen, primarily from grass and roughage fodder. In addition, methane is formed during conversion of manure under anaerobic conditions if the temperature is sufficiently high. These conditions normally occur in manure stores and housing systems with liquid manure or deep litter.

The emission of methane from agriculture has remained more or less stable in the period from 1990 to 2017. At present, the number of dairy cows in Denmark is projected to increase slightly in combination with an increased milk production per dairy cow, which again cause the feed intake and thus the methane emissions from enteric rumen fermentation to rise. At the same time, the CH₄ emissions from manure are expected to slightly decrease due to an increasing share of the manure expected to be treated in biogas plants or acidified during storage.

4.2.2.4. *Solid waste*

The direct contribution of the waste sector to greenhouse gas emissions consists primarily of methane from the decomposition of organic waste that takes place at landfill sites. Of the waste sector's 14% share of total methane emissions in 2017, solid waste disposal contributed with 8.6 percentage points, biological treatment of solid waste with 4.6 percentage points and wastewater treatment and discharge with 0.7 percentage points. Please note that all incineration of waste in Denmark is associated with energy utilisation, which is why the emission of CO₂ from the incineration of plastic waste is included under the energy sector.

In previous years, efforts within the waste sector have been based on the Action Plan for Waste and Recycling 1993-97, which included targets on waste treatment up to the year 2000. The plan did not relate directly to the waste sector's contribution to methane emissions (CH₄), but included a number of initiatives that are of relevance to waste products containing industrial gases (HFCs and SF₆), besides an objective concerning stopping landfilling combustible waste.

Nor did the subsequent waste plan, Waste 21, which covers the period 1998-2004, relate directly to the waste sector's possibilities for contributing to solution of the problem of greenhouse gas emissions. The plan aimed at stabilising the total quantities of waste in 2004, and increasing recycling and reducing the environmental burden from the environmentally harmful substances in waste, including the industrial gases. With respect to waste incineration, the objective was to adjust incineration capacity to what was absolutely necessary to ensure best possible energy utilisation, maximum CO₂ displacement and regional self-sufficiency. The plan thus contributed indirectly to reduction of greenhouse gas emissions.

The objective in Waste 21 was for 64% of all waste to be recycled, 24% to be incinerated and not more than 12% to be landfilled.

That objective was already reached in the year 2000, and according to the Danish Environmental Protection Agency's Waste Statistics 2000 (ISAG) total waste in that year amounted to about 12.8 million tonnes.

Waste Strategy 2005-08 was issued in September 2003. The Waste Strategy aimed at decoupling growth in waste amounts from economic growth. The Strategy also aimed at preventing the loss of resources in waste and environmental impacts from waste, as well as better quality waste treatment and an efficient waste sector. Finally, the strategy aimed at reducing waste amounts sent to landfill to 9% in 2008 and increasing recycling to 65% of all waste.

The most important initiatives regarding greenhouse gases in the Strategy were improvement of landfills and increased collection of plastic packaging for recycling.

The first part of the Waste Strategy 2009-12 was issued in March 2009 and the second part was issued in June 2010. The recycling target for all waste was still 65%, and the target for overall waste amount sent to landfills was reduced to 6%.

The current waste strategy (Denmark without Waste I + II) reflects a general change of focus in Denmark to considering waste as a resource. The Danish waste strategy includes 1) a Resource Strategy for Waste Management which focuses on increasing recycling and 2) a Waste Prevention.

The Resource Strategy for Waste Management 2013-18 (Denmark without Waste I) includes 50% recycling of seven fractions (organic, paper, cardboard, glass, plastic, wood and metal) of household waste in 2022. The strategy focuses on organic waste from households and the service sector, recovery of shredder waste, construction and demolition waste and phosphorous in sewage sludge.

It is estimated that the initiatives in the strategy will lead to a decrease in the amount of incinerated waste (820.000 tonne less in 2022).

The Waste Prevention Strategy (Denmark Without Waste II) 2015-20 includes a number of initiatives with a special focus on food waste, textiles, electronic equipment, packaging and construction.

Both the Resource Strategy for Waste Management and the Waste Prevention Strategy have the purpose of keeping materials and products in circulation thus reducing primary production of materials and products, which is often energy demanding. The two strategies thus lead to indirect greenhouse gas savings, which are not directly quantifiable.

The latest figures for waste in Denmark are in the Danish EPA Waste Statistics 2016. Total waste (excluding soil) in 2015 was 11.3 million tonnes of which 69% was recycled, 27% incinerated, and 4% landfilled¹⁰.

The waste sector's contribution to the direct reduction of greenhouse gas emissions consists mainly in:

- banning the landfilling of organic waste,

¹⁰ <https://www2.mst.dk/Udgiv/publikationer/2018/06/978-87-93710-39-9.pdf>

- utilising gas from closed as well as existing landfills,
- optimising the oxidation of gas in landfill covers (biocovers),
- recovery of shredder waste from landfills.

On the top of this there are measures that indirectly reduce greenhouse gas emissions:

- increasing recycling of plastic-, paper-, cardboard-metal-, WEEE-, wood-, and glass-waste, that will substitute primary production of materials
- using waste (except for plastics) as an energy source in dedicated incineration plants
- digestion of organic waste to produce biogas.

An overview of the detailed measures implemented in the pursuance of these objectives is given in Table 4.26. The emission of methane from Danish landfills is calculated to have been 65,000 tonnes gross in 1990, decreasing to approximately 39,000 tonnes in 2017, corresponding to a 26 per cent reduction.

As a consequence of the municipal obligation to assign combustible waste to incineration, from 1 January 1997, methane emissions from the Danish landfills will continue to decrease in the years ahead.

According to the Danish Energy Authority's inventory Biogas, Production, Forecast and Target Figures, there were 25 gas plants at Danish landfills in 2002. These installations produced 10,000 tonnes of methane annually, compared to approx. 1,700 tonnes in 1993. In 2004, methane recovery from landfills amounted to 7,700 tonnes methane. The same study shows that, through optimising existing gas plants, a further 1,800 tonnes methane per year could be recovered over the next five years. Furthermore, the establishment of new gas-collection equipment at five landfills could contribute with additional 1,300 tonnes methane per year over the next five years.

However, optimisation of existing plant and establishment of new gas plants will probably require subsidies. The previous subsidy scheme to promote gas collection at landfills was discontinued at the end of 2001.

Only a few landfill gas plants are expected to be established in the future. The maximum quantity of methane recovered peaked in 1998 at about 13,200 tonnes. The quantity of methane recovered will continue to fall gradually over many years.

The total quantity of waste incinerated rose from 2,216,000 tonnes in 1994 to 3,068,000 tonnes in 2015, i.e. an approximately 57% increase. This is a slight decrease compared to 2006 where 3,489,000 tonne of waste was incinerated. The energy produced from the incineration plants is included as part of the renewable energy production in the Danish energy statistics. The international greenhouse gas inventories include greenhouse gases from incineration of the content of oil-based products, such as plastics in waste.

In accordance with the targets in the waste strategies, waste incineration plants are designed so as to optimise energy utilisation.

Besides the direct effect of waste management on greenhouse gas emissions, the emissions are also affected indirectly through recycling of paper, cardboard, plastic, metals, etc. which means less energy consumption and thus less CO₂ emissions during production of raw materials and new products.

The implementation of national waste plans and fulfilment of targets has necessitated the implementation of a wide range of measures.

In 1996 the Statutory Order on Waste was amended to introduce a municipal obligation to assign combustible waste to incineration (corresponding to a stop for disposal of combustible waste at landfills). As a result of this, large quantities of combustible waste that used to be disposed of at landfills are now either recycled or used as fuel in Danish incineration plants.

Besides the traditional regulation via legislation, statutory orders, and circulars, the waste sector is regulated by means of a range of policies and measures, including taxes and charges, grant schemes and agreements.

A tax on landfilling and incineration of waste was introduced in Denmark in 1987. Since 1993 the tax has been differentiated to reflect the political priorities of the different forms of treatment. It thus costs most to dispose of waste, less to incinerate the waste and nothing in tax to recycle waste. The waste tax has been increased several times and today (March 2015) the waste tax is DKK 475 per tonne waste disposed of at landfills and the energy tax associated with incineration of waste is 60,9 DKK/GJ (equalling an approximated average of DKK 330 per tonne waste for incineration). The size of the taxes thus provides an incentive to recycle as much of the waste produced as possible and to use non-recyclable, combustible waste as fuel in energy production instead of disposal of the waste at landfills.

Weight-and-volume-based taxes (e.g. on various packaging, carrier bags and PVC film) encourage a reduction in packaging consumption and thus the quantities of waste. The weight-based tax is based on an index that reflects the environmental burden of the materials used.

Under the Danish EPA's "Programme for Cleaner Products etc.", grants were made for projects that reduced the environmental burden in connection with development, production, sale and use of products or in connection with the management of the waste generated during the product's entire lifecycle. Furthermore, support could be granted to waste projects aiming at reducing the problems in connection with disposal of waste. A total of approximately DKK 100 million for the part of the programme related to waste was allocated for the 5-year period 1999 to 2003.

In 2005 the Programme for Cleaner Products etc. was replaced by the Danish government's "Enterprise Scheme" which refunds CO₂ taxes to business. The waste part of this programme was aimed exclusively at enterprises. A total of DKK 33 million for the five-year period 2004 to 2008 was earmarked for the waste part of the scheme. The subsidies were to be used to reduce the environmental impact of waste.

In 2005, the Danish EPA also supported initiation of a development project aiming at documenting the oxidation of methane in landfill biocovers. By applying covers mainly consisting of compost, optimal oxidation in covers can be ensured and methane emissions from landfills can be reduced. If the reduction can be documented it can be credited to the CO₂ accounts. This bio-cover project was carried out by the Technical University of Denmark with funding from the EU LIFE Programme. The bio-cover project has established a viable methodology

for documentation of the reduction of greenhouse gas emissions gained by installation of a bio-cover system on a landfill. The methodology consists of a logical order of tasks using well documented measuring technologies. The demonstration project also proved that several obstacles may occur in relation to the biocovers on landfills which can prevent an efficient greenhouse gas reduction, and the project has obtained an understanding of which precautions should be taken.

The most important obstacles are:

- a) Ability to control point gas releases,
- b) Ability to distribute the landfill gas to active parts of the bio-cover system, and
- c) Ability to obtain a spatially even gas distribution to active parts of the bio-cover.

Due to the obstacles the goal of reaching a 90% reduction of the methane emission was not reached; the obtained reduction was in the 20-30% range.

To address the obstacles and to improve the method, another biocover-project was initiated in 2007 as part of the Enterprise Scheme. The project was performed on another landfill, and was taking the identified difficulties into account. A reduction of the methane emission of 79-93 % was reported in the project.

Based on the promising results of the latest large scale biocover-project combined with a low shadow price, approximately 180 mio. DKK has been allocated to a Subsidy programme for biocovers at landfill sites. The subsidy programme is expected to run from 2016 – 2019, and the estimated reduction in methane-emission in the year 2020 was initially 300,000 t CO₂-equivalents. However, the realised effects could be lower than initially estimated.

In 2007 subsidies from the enterprise scheme were given for establishing methane recovery and test pumping at 11 landfill sites. The results were reported in 2011 and showed a reduction of the emission of methane over a five year period equalling 84,435 tonnes of CO₂ equivalents.

The goal in the EU Packaging Directive of increasing the collection of plastic packaging waste for recycling to 22.5% was met in 2008 through an amendment to the Statutory Order on Waste requiring municipalities to improve the possibilities of people and enterprises to separate and deliver plastic packaging waste for recycling. This meant an increase in recycling of about 12,000 tonnes in 2012 compared to 2008.

Furthermore, producer responsibility obligations have been introduced concerning waste electrical and electronic equipment (WEEE) and batteries due to new EU Directives resulting in higher collection and recycling rates of these used products. The aim is to increase recycling of metals significantly, resulting in energy savings compared to extraction and refining of virgin materials.

On the basis of the EU Landfill Directive, demands on the establishment and operation of landfills in Denmark have been tightened with Statutory Orders No. 650 of 29 June 2001, No. 252 of 31 March 2009, No. 719 of 24 June 2011 and No. 1049 of 28th of August 2013 on landfills. According to the Statutory Orders on landfills, methane in landfills for mixed waste must be monitored. From landfills where significant amounts of biodegradable waste are disposed of, methane gas must be managed in an environmentally-sound way.

An amendment to the Statutory Order on Waste in 2000 means that municipalities must now assign non-recyclable waste PVC and impregnated wood to landfill. The objective is to avoid adding PVC and impregnated wood to incineration with the consequential pollution of flue gas and slag. Work is being carried out to develop new treatment methods in order to utilise the resources in waste. When these methods have been developed and new plants established, it is expected that the Statutory Order on Waste will be amended so that PVC and impregnated wood is assigned to these plants and landfilling is avoided. However, due to higher costs related to the establishment of temporary storage capacity at landfills in comparison with the cost of transportation and incineration at incineration plants abroad with excess capacity, in particular in Germany, the most common solution for impregnated wood waste has been export for incineration.

It is not possible to make a quantitative estimate of the effects of the various measures for the waste area. The objectives in the national waste plans are related to waste amounts and their treatment. The developments are monitored through the annual waste statistics. However, changes in the treatment of waste cannot immediately be converted into changes in emissions of greenhouse gases.

4.3. National action plans and sector based plans and projects, Greenland

As described in 1.3 and 2.2, there are various important sources of BC and CH₄ in Greenland. A number of actions have been taken to increase the level of available information on these sources and to describe possible measures.

4.3.1.1. Road transport

The number of electric and hybrid cars in Greenland has increased from approximately zero to about 200 in the last seven years. The government actively promotes the use of electric cars by exempting them from levies.

4.3.1.2. Heating

New standards for insulation of new buildings are negotiated at the moment. The standards are expected to lead to better insulation of new buildings.

4.3.1.3. Maritime transport

Naalakkersuisut (The Government of Greenland) has stated its support for International Maritime Organization's (IMO) ban on the use and carriage of HFO in the Arctic region.

Several of Greenland's larger towns have well developed district heating networks, using heat generated from hydropower, heat waste from diesel power generators, and heat from waste incineration.

4.3.1.4. Renewable energy

High basic energy demand and the expected emergence of an industrial sector indicate that Greenland's energy consumption is likely to increase over the coming years.

During the last decades, it has been a consistent priority to expand the use of renewable energy. Today, about 18 % of the total energy consumption is from renewable sources (and waste incineration) and approximately 70 % of the national energy supply of heat and electricity is based on renewable energy of which about 92 % is hydropower and about 8 % waste

incineration. For electricity alone, more than 80 % of supply is based on hydropower. Concurrently, potentials for solar energy, wind energy, are being explored. Efforts include a pilot-project in form of a hybrid power system in the village Igaliku. The hybrid system consists of solar PV panels, micro wind turbines, battery storage as well as a diesel generator for back-up power. The pilot-project will contribute to knowledge and experience regarding wind and solar in the arctic, and to the use of small hybrid systems.

The government of Greenland published a comprehensive sector plan for energy and water supply in 2017.

The main themes of the sector plan are fair and equal prices for all, regardless of where in Greenland people choose to live, a transition to 100% renewables, and modernisation of the energy sector.

For Greenland to meet its goal of 100% renewable energy, it will undergo a modernisation of its energy sector, which includes a push to increase energy efficiency throughout the energy sector. Modernisation plans also include monitoring the development of cable technology, with the purpose of connecting some of the larger cities on the west coast, thus maximising the use of current and future hydropower plants. Connecting parts of the west coast would be especially important if some of the large industrial-scale hydropower potential is realised.

In addition to emission reductions, the shift to renewable energy sources is associated with reduced dependence on imported fossil fuels and positive effects on the local and regional environment. Improving the efficiency of the current energy production and supply system is cost-effective and does at the same time reduce GHG emissions.

4.3.1.5. Solid waste

The government of Greenland is working on a new Waste Management Plan. Future plans include building two new waste incinerator plants based on BAT principles, and to transport household waste from all towns to treatment at the new incinerator plants.

From 2014 to 2019 waste was removed from 18 landfills. The landfills are still in use, but with the new Waste Management Plan establishing monitored landfills will be a priority.

4.4. National action plans and sector based plans and projects, Faroe Island

The Faroe Islands have no specific policy for reducing emission from the Agriculture sector nor the Waste sector. In order to reduce the methane emissions substantially, the number of sheep and cattle must decrease, which does not seem feasible in near future, since livestock is crucial in food production. Thus The Faroe Island's efforts regarding methane emissions are to be seen as part of the Faroe Island's efforts regarding greenhouse gas emissions in general.

4.4.1. Climate policy and policy-making process

The Climate Convention was ratified by the Realm, and therefore it also applies for the Faroe Islands. When ratifying the Kyoto Protocol the Danish government took a territorial reservation for the Faroe Islands.

In the spring 2008, the Faroese Government started a process formulating a Climate Strategy, and in the autumn 2008, a catalogue¹¹ of potential options to reduce emissions of greenhouse gases was published.

In December 2009, the Faroese Parliament adopted the Faroese Climate Policy. All the political parties in the Parliament adopted the policy.

The principal aim of this policy is to decrease the Faroese dependency on oil and fossil fuels and to increase the use of renewable energy sources significantly. In this way, achieve the ambitious and realistic target of reducing emissions of greenhouse gases by at least 20% in 2020, compared with the level of emissions in 2005.

In a move to follow international recommendations, the Faroese Government has decided that the Faroe Islands shall be part of the Paris Agreement.

The Faroe Islands are covered by the Kingdom of Denmark's ratification of the Paris Agreement. The Faroe Islands will, in accordance with the Paris Agreement, define and notify a separate Faroese emission reduction target. This will be communicated in addition to the Nationally Determined Contribution (NDC), which Denmark has already communicated as a part of the EUs NDC.

In 2019, the Faroese Ministry of Health and the Interior presented a proposal for a new Climate Policy for the Faroe Islands 2020 to 2030¹². The aim of the proposal is to reduce greenhouse gas emissions from land based sources by 45% in 2030 compared to the emissions in 2010.

Recognizing that technical solutions to reduce emissions from fishing vessels are not yet fully developed, no exact reduction target has been set for fishing vessels until 2030. The aim though is to reduce emissions by 50 % in 2050 compared to emissions in 2005, which is the International Maritime Organization's (IMO) goal for shipping.

4.4.2. Policies and measures and their effect

The Faroe Islands will fulfil its obligations by accelerating the shift to renewable energy aiming to become completely self-sufficient in green energy. The Government aims for all power production from renewable sources by 2030. In 2017 renewable energy was less than 6 % of total energy supply in the Faroe Islands. However, there is unexploited potential, especially in wind and in a longer perspective in wave and solar power. See also annex 4.

4.4.2.1. Wind farms

SEV, the Public Power Company, owned by the Faroese municipalities, is responsible for production, transmission and distribution of nearly all power in the Faroe Islands. SEV announced its plans to reach 100% green energy power production by 2030, when the company officially opened the Húsahagi 11 MW wind farm on 9 October 2014. The wind farm at Húsahagi is, with its revolutionary battery system, which in terms of minutes and seconds balances the energy output to the grid, the first concrete step on the green course. The battery

¹¹ *Skjótt syftir seiðir og tunga takið (Easy picking and the long haul)*. <http://www.us.fo/Default.aspx?ID=14087>

¹² *Veðurlagspolitikkur Føroya 2020-2030*. <https://www.himr.fo/fo/kunning/tidindi/landsstyrvinnan-fingid-uppskot-til-endurskodadan-vedurlagspolitikk-2020-2030/>

system enables higher yield from wind energy. A hundred percent green power production will reduce the emission of GHG with 90,000 tonnes CO₂ equivalents.

The Faroe Islands is surrounded by plentiful and unstable winds, with an average annual wind above 10 m/s on several locations. Energy production from wind is unstable and closely correlated to the changeable weather patterns in the Faroe Islands. The challenge is that wind alone cannot be the sole source of supply; rather the wind needs to be coupled with more stable production sources, such as hydropower.

Wind farms are relatively easy and quick to build, as well as being an inexpensive form of production, and more energy from wind is certainly a part of the plan. This will most likely happen in conjunction with energy storage that can store excess wind energy, and then release the stored energy onto the grid, when wind production is low.

The first 0.2 MW wind turbine was erected in 1993 and was regarded as a test engine. In 2003, the private company Røkt installed 3 x 0.66 MW Vestas turbines in the area above Vestmanna. Two years later SEV installed five turbines in Nes (Eysturoy) and in 2014, 13 turbines were erected in Húsahagi near the capital Tórshavn. The total yearly production from the 22 turbines is 55- 60 GWh and the reduction in CO₂ equivalents is 25,000 tonnes.

Plans are in place to construct three new windfarms in 2020 with a total capacity of 42 MW and the emissions of CO₂ equivalents will be reduced by 75,000 tonnes.

The greatest challenge in the future is to ensure a balance between demand and production. The challenge grows with increasing production from unstable sustainable sources – such as wind, hydro, and solar. It is therefore important to develop systems to secure a balanced, sustainable production every hour of the day, all year round, while maintaining security of supply.

In the short term, the thermal plants will secure supply and balancing the grid, when supply from green sources is insufficient. With developments in technology, the green sources in conjunction with energy storage will be able to take over the security of supply from the thermal plants for longer periods, such as in the summer period.

The work to reach 100% green energy on shore in the Faroe Islands by 2030 is based on three main principles. First, the security of supply must be maintained unconditionally, second, all investments must be financially viable, and third is the consideration for the environment. To make the right decisions at the right time is crucial on the green course.

The tangible plan for the green course is a flexible project with the aim to securely and with great care to select the best and least impacting green solutions for the Faroe Islands.

4.4.2.2. Heating of household and other buildings

In order to make use of the increased power production from wind, electricity will replace heating oil in space heating of houses and buildings. A normal family house use 2,500 litre of heating oil and the emission is 8 ton CO₂ a year. A heat pump will reduce the emission with 5 ton, taking into account that a part of the electricity will come from diesel engines. Today there are installed 300 ground source pump and 1,000 air to water / air-to-air heat pumps. The CO₂ reduction is 8,000 ton/year.

4.4.2.3. *District heating*

Since 1990, parts of the houses in Tórshavn get heat from a District Heating System. The energy originates from incineration of waste and waste heat from the diesel power station in Sund outside Tórshavn. Today 1,320 houses are connected and the reduction of CO₂ is 10,500 ton/year.

4.4.2.4. *Regulation on taxes*

The total demand for electric power in the Faroe Islands increases both due to normal economic growth and due to changes in energy usage, which is envisaged within domestic transport and heating when the switch from oil and petrol to electric energy takes place in years to come. Electric energy demand is expected to increase from around 350 GWh in 2018 to around 600 GWh by 2030, where all the production shall come from renewable resources.

In order to decarbonise the heat and transport sector the government introduced financial incentives by lowering the tax on electric vehicles and promoting heat pumps by removing VAT on the installation.

4.4.3. *Progress in achievement of quantified economy-wide emission reduction targets and relevant information*

In 2008 the Faroese government published the report *Skjótt syftir seiðir og tunga takið* (Easy pickings and the long haul), listing an array of possible measures to reduce greenhouse gas emissions. Together with the climate policy, these documents are the fundament in reaching the reduction targets for greenhouse gas emissions.

5. Best practices and projects (Toolbox)

5.1. Black Carbon

The lessons learned in Denmark regarding reduction of black carbon are:

- Prioritising reduction efforts with synergies to reduction of particles, for general health reasons.
- A good effect from extra tax on diesel cars without particle traps and low emission zones for heavy duty vehicles.
- Reduction of particle emissions from residential biomass stoves and boilers is a long term process, but can be accelerated with a combination of incentives and programmes, including support schemes for scrapping. In 2019 a scrapping scheme for old wood stoves (EURO 6.1 million) was launched. Citizens, who had an old wood stove from 1995 or before, could apply for EURO 300 if scrapping the old stove. The scheme will end in 2020 and is estimated to contribute to the scrapping of about 20,000 old wood stoves.
- The development of new technologies that reduces air pollution has been given high priority by the Environmental Technology Development and Demonstration Support Programme (MUDP). MUDP started in 2008 and is still ongoing. A large number of projects on reduction of particle emissions and black carbon from wood-stoves and shipping have received financial support.

5.2. Methane

The lessons learned in Denmark regarding reduction of methane emissions are:

- The ban on landfilling of waste from 1997 has significantly reduced methane emissions from landfills – and will continue to do so.
- Such a ban was possible due to the increased waste incineration capacity with energy utilization as part of Denmark's energy planning and expansion of district heating networks.
- Methane emissions from landfills have also been reduced through recovery of methane for energy purposes or flaring where energy utilization was too costly.
- Research projects have proven that low concentration methane emissions from landfills can be reduced with the establishment of biocovers – a measure which is under implementation. However, preliminary results show that the effect might be less than initially estimated.
- Significant increases in methane emissions from agriculture have been avoided - to a large extent – due to the establishment of biogas plants.

6. Annexes

Annex 1, table 1: Black carbon emission table, Denmark
(no projection available)

Pollutant_Unit	Sector	GNFR	Year					
			2013	2014	2015	2016	2017	2018
BC kt	1 Stationary combustion	A_PublicPower	0.02	0.01	0.01	0.01	0.01	0.01
		B_Industry	0.06	0.03	0.04	0.04	0.05	0.04
		C_OtherStationaryComb	1.10	1.07	1.17	1.22	1.23	1.23
	2 Industrial processes and product use	B_Industry	0.00	0.00	0.00	0.00	0.00	0.00
		E_Solvents	0.01	0.01	0.01	0.00	0.00	0.00
	3 Fugitive emissions from fuels	D_Fugitive	0.50	0.45	0.28	0.29	0.31	0.28
	4 Transport	F_RoadTransport	0.94	0.85	0.77	0.69	0.60	0.53
		G_Shipping	0.03	0.02	0.03	0.03	0.03	0.03
		H_Aviation	0.00	0.00	0.00	0.00	0.00	0.01
		I_Offroad	0.05	0.04	0.03	0.03	0.02	0.02
	5 Non-road mobile sources	I_Offroad	0.67	0.59	0.55	0.50	0.43	0.39
	7 Agriculture	L_AgriOther	0.02	0.02	0.02	0.02	0.02	0.03
	8 NATIONAL TOTAL	N_NATIONAL TOTAL	3.40	3.12	2.92	2.84	2.72	2.57

Annex 1, table 1: BLACK CARBON EMISSIONS IN GREENLAND FOR 1990-2017 (TONS).¹³

	1990	1995	2000	2005	2010	2011	2015	2017
Households	3,4	2,8	3,0	3,3	2,5	2,6	2,3	2,2
Other Stationary Comb	0,9	0,7	0,8	0,9	1,0	1,2	0,6	0,6
Road Transport	16,6	9,7	7,1	5,9	3,4	3,2	1,6	1,8
Shipping	2,1	2,1	2,4	2,9	2,6	3,0	2,7	3,0
Fishing, Hunting and Agriculture	10,3	9,3	17,7	10,9	10,6	10,8	11,3	13,2
Other mobile sources	0,9	0,8	0,8	0,8	2,3	2,1	1	0,4
Total	34,3	25,3	31,8	24,7	22,6	22,9	19,5	21,4

¹³ Lene Baunbæk, Grønlands Statistik. Emission af TSP, BC OC fra grønlandsk energiforbrug i perioden 1990-2016 and Ministry of Industry, Energy and Research from 2017

ANNEX 2, TABLE 1: PROJECTIONS OF DENMARK'S METHANE EMISSIONS IN KT OF CH₄ AND KT OF CO₂ EQUIVALENTS 2018 – 2040, EMISSIONS IN 1990-2017 ARE OBSERVED.

Source: 1990-2017: The National Inventory Report (NIR and CRF), *Nielsen et al. (2019)*, DCE, April 2019.
2018-2040: Projection of greenhouse gases 2018-2040, *Nielsen et al. (2019)*, DCE, [to be published]

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1990	1995	2000	2005	2010	2015	2017	2020	2025	2030	2035	2040
	CH ₄	CH ₄	CH ₄	CH ₄	CH ₄	CH ₄	CH ₄	CH ₄	CH ₄	CH ₄	CH ₄	CH ₄
	(kt)	(kt)	(kt)	(kt)	(kt)	(kt)	(kt)	(kt)	(kt)	(kt)	(kt)	(kt)
Total CH₄ emissions without LULUCF	304	321	315	305	292	273	275	263	264	266	263	262
1. Total Energy,	16	30	37	34	27	14	15	12	12	10	9	8
A. Fuel combustion activities (sectoral approach)	11	23	27	24	21	10	11	10	8	7	7	6
1. Energy industries,	1	11	15	12	11	3	4	4	3	3	3	3
a. Public electricity and heat production	1	11	15	12	11	3	4	4	3	3	3	3
b. Petroleum refining	0	0	0	0	0	0	0	0	0	0	0	0
c. Manufacture of solid fuels and other energy industries	0	0	0	0	0	0	0	0	0	0	0	0
2. Manufacturing industries and construction	0	0	1	1	1	1	1	1	1	1	1	1
3. Transport	3	3	2	1	1	0	0	0	0	0	0	0
4. Other sectors	6	8	9	9	8	6	6	5	4	4	3	2
a. Commercial/institutional	0	1	1	1	1	0	0	0	0	0	0	0
b. Residential	5	6	5	6	6	4	4	4	3	2	2	1
c. Agriculture/forestry/fishing	1	2	3	2	2	1	1	1	1	1	1	1
B. Fugitive emissions from fuels	5	7	10	10	6	4	4	2	4	3	2	2
1. Solid fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	5	7	10	10	6	4	4	2	4	3	2	2
a. Oil	1	2	3	3	2	1	1					
b. Natural gas	2	3	5	5	3	2	2					
c. Venting and flaring	1	2	3	2	1	1	1					
2. Total industrial processes and product use	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
3. Total agriculture	223	233	229	227	226	222	222	219	222	228	229	235
A. Enteric fermentation	162	159	145	139	145	147	149	152	160	169	169	169
B. Manure management	62	74	83	88	80	75	72	66	63	59	60	66
4. Total LULUCF (land use, land-use change and forestry)	8	8	8	7	7	8	8	7	7	7	8	8
5. Total waste	65	58	49	44	40	37	39	32	30	27	24	20
A. Solid waste disposal	61	53	43	36	31	26	24	21	18	15	13	11
1. Managed waste disposal sites	61	53	43	36	31	26	24	0	0	0	0	0
B. Biological treatment of solid waste	2	2	4	5	7	9	13	9	10	10	9	6
1. Composting	1	2	3	3	4	4	4					
2. Anaerobic digestion at biogas facilities	0.2	0.6	1.2	2.0	2.7	4.4	8.3					
C. Incineration and open burning of waste	0	0	0	0	0	0	0	0	0	0	0	0
D. Wastewater treatment and discharge	2	2	2	2	2	2	2	2	2	2	2	2
E. Other	0	0	0	0	0	0	0	0	0	0	0	0

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1990	1995	2000	2005	2010	2015	2017	2020	2025	2030	2035	2040
	CH ₄	CH ₄	CH ₄	CH ₄	CH ₄	CH ₄	CH ₄	CH ₄	CH ₄	CH ₄	CH ₄	CH ₄
	(kt CO ₂ eq)	(kt CO ₂ eq)	(kt CO ₂ eq)	(kt CO ₂ eq)	(kt CO ₂ eq)	(kt CO ₂ eq)	(kt CO ₂ eq)	(kt CO ₂ eq)	(kt CO ₂ eq)	(kt CO ₂ eq)	(kt CO ₂ eq)	(kt CO ₂ eq)
Total CH₄ emissions without LULUCF	7,596	8,022	7,871	7,629	7,308	6,822	6,885	6,577	6,608	6,641	6,570	6,559
1. Total Energy,	388	750	916	846	679	362	373	303	299	255	227	203
A. Fuel combustion activities (sectoral approach)	265	577	669	606	521	261	274	246	208	185	166	151
1. Energy industries,	16	285	367	311	275	86	101	96	75	69	68	67
a. Public electricity and heat production	15	284	366	309	274	84	100	95	73	67	66	65
b. Petroleum refining	0	1	1	0	0	0	0	0	0	0	0	0
c. Manufacture of solid fuels and other energy industries	0	0	1	1	1	1	1	1	2	1	1	1
2. Manufacturing industries and construction	8	10	27	22	14	14	18	17	17	17	17	17
3. Transport	79	76	55	37	20	12	11	9	9	9	9	9
4. Other sectors	160	203	218	234	211	149	143	123	107	89	71	58
a. Commercial/institutional	4	17	23	22	18	11	11	6	6	6	6	5
b. Residential	122	141	129	155	155	112	106	93	77	59	42	29
c. Agriculture/forestry/fishing	34	44	65	58	38	26	27	24	24	24	24	24
B. Fugitive emissions from fuels	123	173	247	240	158	101	99	58	90	71	61	52
1. Solid fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	123	173	247	240	158	101	99	58	90	71	61	52
a. Oil	31	47	63	71	44	29	25					
b. Natural gas	61	83	115	119	81	48	49					
c. Venting and flaring	31	44	68	51	33	24	26					
2. Total industrial processes and product use	2	3	3	4	2	4	2	3	3	3	2	2
3. Total agriculture	5,586	5,831	5,719	5,684	5,638	5,539	5,546	5,468	5,560	5,704	5,731	5,865
A. Enteric fermentation	4,039	3,967	3,631	3,483	3,631	3,667	3,731	3,812	3,990	4,219	4,219	4,219
B. Manure management	1,544	1,861	2,086	2,197	2,005	1,869	1,812	1,653	1,568	1,482	1,509	1,643
4. Total LULUCF (land use, land-use change and forestry)	193	190	188	186	185	190	192	165	174	182	190	198
5. Total waste	1,620	1,439	1,233	1,094	989	917	963	803	746	680	611	488
A. Solid waste disposal	1,536	1,331	1,073	909	772	653	593	536	446	374	321	279
1. Managed waste disposal sites	1,536	1,331	1,073	909	772	653	593					
B. Biological treatment of solid waste	40	62	111	135	167	214	317	213	245	249	233	152
1. Composting	35	46	81	85	100	104	110					
2. Anaerobic digestion at biogas facilities	6	16	30	50	67	109	207					
C. Incineration and open burning of waste	0	0	0	0	0	0	0	0	0	0	0	0
D. Wastewater treatment and discharge	41	43	46	47	48	49	51	52	53	54	55	56
E. Other	2	3	2	2	2	2	2	2	2	2	2	2

ANNEX 2, TABLE 2: EMISSION TRENDS CH₄ – INVENTORY 2017 - SUBMISSION 2019 - FAROE ISLANDS.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1990	2000	2010	2015	2016	2017
1. Energy	0,06	0,06	0,02	0,02	0,02	0,02
A. Fuel combustion (sectoral approach)	0,06	0,06	0,02	0,02	0,02	0,02
1. Energy industries	0,00	0,00	0,00	0,00	0,00	0,00
2. Manufacturing industries and construction	0,00	0,00	0,00	0,00	0,00	0,00
3. Transport	0,05	0,05	0,01	0,00	0,00	0,00
4. Other sectors	0,01	0,01	0,01	0,01	0,01	0,01
5. Other						
B. Fugitive emissions from fuels	NO	NO	NO	NO	NO	NO
1. Solid fuels	NO	NO	NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	NO	NO	NO	NO	NO	NO
C. CO ₂ transport and storage						
2. Industrial processes	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE
3. Agriculture	0,85	0,87	0,84	0,85	0,85	0,85
A. Enteric fermentation	0,81	0,83	0,80	0,81	0,80	0,81
B. Manure management	0,04	0,05	0,04	0,04	0,04	0,04
C. Rice cultivation	NO	NO	NO	NO	NO	NO
D. Agricultural soils	NE	NE	NE	NE	NE	NE
E. Prescribed burning of savannas	NO	NO	NO	NO	NO	
F. Field burning of agricultural residues	NO	NO	NO	NO	NO	NO
G. Liming						
H. Urea application						
I. Other carbon-containing fertilizers						
J. Other						
5. Waste	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE
A. Solid waste disposal	NE	NE	NE	NE	NE	NE
B. Biological treatment of solid waste	NO	NO	NO	NO	NO	NO
C. Incineration and open burning of waste	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE
D. Waste water treatment and discharge	NE	NE	NE	NE	NE	NE
E. Other						
6. Other (as specified in summary 1.A)						
Total CH₄ emissions without CH₄ from LULUCF	0,91	0,93	0,86	0,86	0,86	0,87

ANNEX 3: NATIONAL CLIMATE RELEVANT ACTIONS WITH EFFECT ON DENMARK'S METHANE EMISSIONS

ANNEX 4: PROGRESS IN ACHIEVEMENT OF FAROE ISLANDS' QUANTIFIED ECONOMY-WIDE EMISSION REDUCTION TARGET: INFORMATION ON MITIGATION ACTIONS AND THEIR EFFECTS

Table 3 Progress in achievement of the quantified economy-wide emission reduction target: information on mitigation actions and their effects												
FO	Name of mitigation action ^a	Sector(s) affected ^b	GHG(s)	Objective and/ or activity affected	Type of	Status of implementation ^d	Brief description ^e	Start	Implementing entity	Estimate of mitigation impact (not cumulative, in kt CO2 eq)		
no.										20XX ^f = 2001 2020	20XX ^f = 2015 or annual average	2030
1-1	Better insulation of houses and buildings,	Energy - Heating	CO2, CH4, N2O	Reduce fossile fuel consumption in buildings	Regulatory	Partly implemented. Partly planned			Ministry of Health and Interior	NE	NE	NE
1-2	Improve the possibilities of funding for energy saving	Energy - Heating	CO2, CH4, N2O	Reduce fossile fuel consumption in buildings	Economic - regulatory	Implemented			Ministry of Finance	NE	NE	NE
1-3	District Heating - Waste Heat from garbage and power production	Energy - Heating	CO2, CH4, N2O	Reduce fossile fuel consumption in buildings	Regulatory	Implemented	200 houses in 1995 and 1100 houses in 2015		Municipality	2.4	9	
1-3	Requirements for oil burners, boilers, inspection, heat pumps, district heating and energy systems etc.	Energy - Heating	CO2, CH4, N2O	Reduce fossile fuel consumption in buildings	Regulatory	Partly implemented. Partly planned			Ministry of Health and Interior	NE	NE	NE
1-4	Certification requirements for installation, inspection and maintenance of heating and energy systems	Energy - Heating	CO2, CH4, N2O	Reduce fossile fuel consumption in buildings	Regulatory	Partly implemented. Partly planned			Ministry of Health and Interior	NE	NE	NE
1-5	Prohibit the import and sale of non-efficient electricity and energy equipment, in conformity with laws in neighbouring countries.	Energy - Heating	CO2, CH4, N2O	Reduce fossile fuel consumption in buildings	Regulatory	Planned			Ministry of Health and Interior	NE	NE	NE
1-6	Heat Pump. Ground source heat pump campaign and from 2017 VAT exemption	Energy - Heating	CO2, CH4, N2O	Reduce fossile fuel consumption in buildings	Regulatory	Implemented			Ministry of Health and Interior and Ministry of Finance		3	
2-1	Registry fees of motor vehicles shall encourage drivers to buy vehicles with low or no CO2 emissions.	Energy - Transport	CO2, CH4, N2O	Reduce fossile fuel consumption in transport. The law on registry fees of motor vehicles shall encourage drivers to buy and register vehicles with low or no CO2 emissions.	Regulatory	Implemented			Ministry of Finance	NE	NE	NE
3-1	Encourages competition on the green electricity market.	Energy - Public Electricity Production	CO2, CH4, N2O	Reduce prices on green electricity	Regulatory	Implemented			Ministry of Health and Interior	NE	NE	NE
3-2	Further develop the use of renewable energy sources in the electricity production including windpower	Energy - Public Electricity Production	CO2, CH4, N2O	Reduce fossile fuel consumption		Implemented	Wind Parks build: 2003 2,0 MW, 2005 4,7 MW and 2014 11,7 MW		SEV and Røkt. Ministry of Health and Interior	NE	25.2	NE
3-3	Two new Wind Parks	Energy - Public Electricity Production	CO2, CH4, N2O	Reduce fossile fuel consumption		Implemented	5 MW Wind Porkeri and 15 MW Wind Eiði		Ministry of Health and Interior		45	
<p>Note: The two final columns specify the year identified by the Party for estimating impacts (based on the status of the measure and whether an ex post or ex ante estimation is available). Abbreviations: GHG = greenhouse gas; LULUCF = land use, land-use change and forestry. ^a Parties should use an asterisk (*) to indicate that a mitigation action is included in the 'with measures' projection. ^b To the extent possible, the following sectors should be used: energy, transport, industry/industrial processes, agriculture, forestry/LULUCF, waste management/waste, other sectors, cross-cutting, as appropriate. ^c To the extent possible, the following types of instrument should be used: economic, fiscal, voluntary agreement, regulatory, information, education, research, other. ^d To the extent possible, the following descriptive terms should be used to report on the status of implementation: implemented, adopted, planned. ^e Additional information may be provided on the cost of the mitigation actions and the relevant timescale.</p>												

Table 3