Agency for Climate

Oslo

30 March 2022

Greenhouse gas inventory for Oslo, 2009–2020

The Norwegian Environment Agency's (NEA) greenhouse gas inventory for each municipality is the basis for the preparation of the climate budget. On 18 January 2022, the NEA published the updated greenhouse gas inventory for the municipalities, with a correction for the energy supply sector, which was sent by email to the Oslo Agency for Climate on 14 March 2022. The greenhouse gas inventory has new figures for 2020, and updated numbers for the time series back to 2009. This memorandum summarises and comments on the development of greenhouse gas emissions in Oslo from 2009 to 2020 and explains the changes that have been put in place since the last greenhouse gas inventory was published.[1]

The greenhouse gas inventory shows that the greenhouse gas emissions in Oslo in 2020 amounted to approximately 1.08 million tonnes CO_2 equivalents. This is a reduction of 5.2 per cent from 2019. In the period from 2009 to 2020 the greenhouse gas emissions have never been as low as in 2020 and compared with the 2009 level the emissions are down by 25 per cent.

Emissions from all sectors have been reduced between 2019 and 2020. For the waste and wastewater, industry, oil, and gas, aviation, heating, and road traffic sectors the emissions in 2020 were at the lowest level for the 2009 to 2020 period. Emissions from vehicular traffic declined by 4.9 per cent, corresponding to somewhat less than 30 000 tonnes CO_2 equivalents, due to the increased proportion of electric cars and the addition of biofuel. Emissions from other mobile combustion dropped by 6.8 per cent and less than 10 000 tonnes CO_2 equivalents. The calculation method for emissions from other mobile combustion is nevertheless uncertain, which makes it challenging to explain both the emission level and trends in the sector. Emissions from heating dropped by 21.1 per cent, corresponding to almost 6000 tonnes CO_2 equivalents, due to a steep decline in the use of fossil heating sources. This decline is the result of the ban on oil-fired heating that has been in force as of 1 January 2020. Emissions from waste incineration and energy supply were reduced by 4.4 per cent, corresponding to approximately 12 000 tonnes of CO_2 equivalents, and is generally due to reduced use of fossil energy sources in distant heating production.

The greenhouse gas inventory shows continuous improvement. Changes have been made to the methods used in this year's published figures, but development is still needed. The NEA will continue its work in 2022. Adjustments may thus be expected in the figures to be published in December 2022. Adjustments that can be ascribed to changes in methods will affect the emissions in the whole time series, from 2009 to the most recent year with statistics.

[1] Published 2021

Agency for Climate
Climate Department
City of Oslo

Office address:
Olav Vs gate 4,
Postal address:
Rådhuset, 0037 OSLO

Telephone: +47 22 22 22 22
postmottak@kli.oslo.kommune.no
Org. No.: 876819902

Greenhouse gas inventory – background

Background and purpose

The greenhouse gas inventory is kept by the NEA, on assignment from the Ministry of Climate and Environment (in Norwegian KLD), in collaboration with Statistics Norway and the Norwegian Institute for Air Research (NILU). The project has now progressed from a development phase to an operative phase, focusing on annual updates. The Oslo Agency for Climate is one of several stakeholders in the working group for the project. The greenhouse gas inventory is based on calculations from Statistics Norway and reports made by businesses, which are delivered to the Norwegian Environment Agency. The Norwegian Institute for Air Research, Urbanet and the National Coastal Administration are other important suppliers of data for the inventory.

The ambition behind the greenhouse gas inventory is that all the local authorities in Norway will have access to information about the greenhouse gas emissions in their municipality, and at a level of detail that will enable them to assess their current standing and consider developments. An overarching goal of the inventory is that it should use data sources, which to the highest extent possible, indicate the situation and development on the local level. Consequently, the Oslo inventory sometimes uses different sources than those used in the national greenhouse gas inventory, as data on the national level is not always geographically distributed according to municipal and county boundaries.

What the greenhouse gas inventory includes

The greenhouse gas inventory shows the direct physical emissions occurring within the geographical boundary of a municipality. Indirect emissions that can be linked to the local authorities or the municipality's inhabitants through their consumption are not included. The emissions are limited geographically and placed in the municipality where the physical emissions take place.

The greenhouse gas inventory is distributed amongst nine emission sectors and 45 sources of emissions, shown in Attachment 1, and shows emissions for the years 2009, 2011, 2013 and 2015 to 2020. Emissions prior to 2009 have not been calculated because it is not possible to find good data sources that would give a reliable time series further back in time than this.

Emissions have been calculated for the greenhouse gases carbon dioxide (CO_2), nitrous oxide (N_2O) and methane (CH_4). The greenhouse gases have been converted into CO_2 equivalents using GWP values,[2] in accordance with the fourth main report from the IPCC (Intergovernmental Panel on Climate Change), to make it possible to compare the warming (greenhouse) effect of different greenhouse gases on the atmosphere, and to point out which emissions contribute most to global warming. The GWP values for CO_2, N_2O and CH_4 are respectively 1, 298 and 25.

[2] Global warming potential

Agency for Climate
Climate Department
Oslo Local Authority

Office address:
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Postal address:
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Org. No.: 876819902
oslo.kommune.no

Methodology

The greenhouse gas emissions are generally calculated according to statistics on activity levels and emission factors (emissions per unit of activity). Essential methodological changes between the two most recent publications by the NEA are described under the descriptions of the different emission sectors. See also the methodology memorandum from the NEA for more detailed information about the methods used to calculate the emissions.[3]

Some changes have been made to the methodology for the greenhouse gas inventory since the previous publication. Table 1 provides a brief overview of the changes in the methods in this year's publication.

Table 1: Overview of method changes in this year's publication

Emission sector and source	Method changes
Other mobile combustion	In 2022, the emissions have been distributed according to Statistics Norway's energy balance instead of sales statistics for petroleum products. The energy balance provides better information about which industries use duty-free diesel, and how much they consume. Due to this method change, emissions in Oslo are lower across the time series.
Heating	The gas emission source has been split into LPG and natural gas. Calculation of emissions from gas is updated with new distribution keys, which has resulted in emissions adjusted down from the source through the whole time period. In previous publications, emissions from gas have been distributed with the same key as heating oil. In this year's publication, the method to distribute LPG emissions has been changed by using information about the storage volume per municipality as a distribution key. There is no information about consumption per municipality, but storage volume is deemed to be a better distribution key.
Shipping	Adjustments have been made for Color Line's use of shore power in the 2020 numbers, but not for earlier years. The transition of the Nesodden ferries to electric power from January 2020 has also been adjusted for.
Waste and wastewater	A new method has been developed for calculating emissions from wastewater treatment. This method is similar to the one developed in the national greenhouse gas inventory and includes more emission sources than the method used in the previous publication. Waste facilities report information and cleaning requirements and release to water to the authorities. The calculation method uses reported data from the facilities.

3 https://www.miljodirektoratet.no/contentassets/684ed944b61948e8adbef6f3f5b699f7/metodenotat_klimagasstatistikk-for-kommuner.pdf/download

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Oslo Local Authority

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postmottak@kli.oslo.kommune.no
Org. No.: 876819902
oslo.kommune.no

Uncertainty

The ambition behind the greenhouse gas inventory is that all the municipalities in Norway will have access to information about the emissions of greenhouse gases in their municipality at a level of detail that makes it possible to assess the current standing and consider developments. The greenhouse gas inventory will point out, as far as feasible, the effect of implemented measures, even if the effect of each measure on its own will not always be visible because it is minor compared to the consequences of other development traits. The access to data sources describing the emissions status will vary from one emission source to the next, and there will accordingly be variations in how accurate the emissions calculations are.

The greenhouse gas inventory distributed by municipality are mainly based on known emissions points, calculation of emissions from local activities and national distribution keys. Emissions points refer to the exact location of the emission source when this is known. This method is used for emissions from activities in industry, oil, and gas and energy supply. Enterprises report their emissions data to the Norwegian Environment Agency. Emissions points and the calculation of emissions from activity data on the municipal level are allotted to the respective municipalities directly. Even if the data source provides a good picture of the emissions on the national level, it cannot indicate anything about emissions per municipality if the data source does not include information about where in Norway the emissions occur. Emissions may also be allotted to municipalities using distribution keys when data are missing about where the emissions take place. Distribution keys indicate how national emissions are distributed by municipality based on other indicators, such as municipality statistics, population figures, and local knowledge. Using distribution keys for national emissions could result in local measures to reduce emissions not necessarily being found and entered on the correct municipality in the greenhouse gas inventory.

The Norwegian Environment Agency points out that an overarching goal of the greenhouse gas inventory has been to use data sources which as far as possible show the development of emissions on the local level. If there are data sources of sufficient quality on the municipal level, these have been used in the greenhouse gas inventory distributed by municipality. An important premise for the development activities of the Norwegian Environment Agency so far has been that the improvements in methods must be implementable in all municipalities.

Local measures are insufficiently displayed for several emission sectors. This is because the methods and the data material used for the calculations do not reflect the effect, so it can be entered on the correct municipality. An example is that the emissions-reducing effect of Oslo's requirements to use biofuel is only partly shown in the inventory. The effect of reducing emissions due to increased use of biofuel in the building and construction sector is distributed equally on all Norwegian municipalities because the data material used does not distinguish between where the biofuel is used and what it is used for. This underlines the need to supplement the greenhouse gas inventory distributed according to the municipalities with local data to pinpoint the effects of local measures. It would improve the quality of the greenhouse gas inventory for the municipalities if the calculation method can be adapted. The Oslo Agency for

Climate and the Norwegian Environment Agency have agreed on bilateral collaboration on improvement in Oslo's greenhouse gas inventory, and Oslo is represented in the Norwegian Environment Agency's municipal working group[4] for the greenhouse gas inventory.

Attachment 3 shows the uncertainty assessment by the Oslo Agency for Climate for the various emission sectors.

In 2022, on assignment from the Ministry of Climate and Environment, the Norwegian Environment Agency will evaluate the greenhouse gas inventory for the municipalities. The project will give information from the municipalities about the use of the inventory and provide a systematic review of the utility value of various improvements, and how resource demanding these will be for those who must report or submit data (for example business and industry, public enterprises, and private individuals). The intention is to provide a better basis for the Norwegian Environment Agency to prioritise the development of greenhouse gas inventory for the municipalities in the years ahead. Table 2 shows planned method changes in the future.

Table 2: Future planned changes

Emission sector and source	**Planned method changes**
Other mobile combustion	The method has been significantly improved in this year's publication, but substantial uncertainty remains when it comes to the geographical distribution of the emissions. The Norwegian Environment Agency and Statistics Norway will continue to work on improving the calculation method so that the effect of measures implemented in the municipalities will be shown in the municipal inventory.
Fossil heating	The method has been significantly improved in this year's publication, but substantial uncertainty remains when it comes to the geographical distribution of the emissions. The Norwegian Environment Agency and Statistics Norway will continue to work on improving the calculation method so that the effect of measures implemented in the municipalities will be shown in the municipal inventory.
Energy supply: waste incineration	Emissions reported by the facilities will be assessed in terms of the method used throughout the time series.
Shipping	A new model is being used to show the use of shore power better. The intention is to avoid the necessity to make corrections by using local data.
Road traffic	Improve the data about traffic by using transportation models and other data which show local conditions in a better way.
Landfill	Continue collaboration with municipal authorities to include as much local data as possible.

[4] Together with Trondheim, Bergen, Kristiansand, Stavanger, and other active users of the inventory.

Status of greenhouse gas emissions in Oslo

In 2020, the greenhouse gas emissions in Oslo were approximately 1.08 million tonnes CO_2 equivalents. This is a reduction of 5.2 per cent from 2019. The greenhouse gas emissions from 2009 to 2020 have never been as low as in 2020 and compared to the 2009 level the emissions have dropped by 25 per cent. Figure 1 shows that the development of emissions has been declining since 2009, except for 2017 and 2018 when emissions increased slightly. This was due to an increase in emissions from building and construction, heavy vehicles, and delivery vans. The increase in emissions from road traffic was mainly due to reduced addition of biofuel.

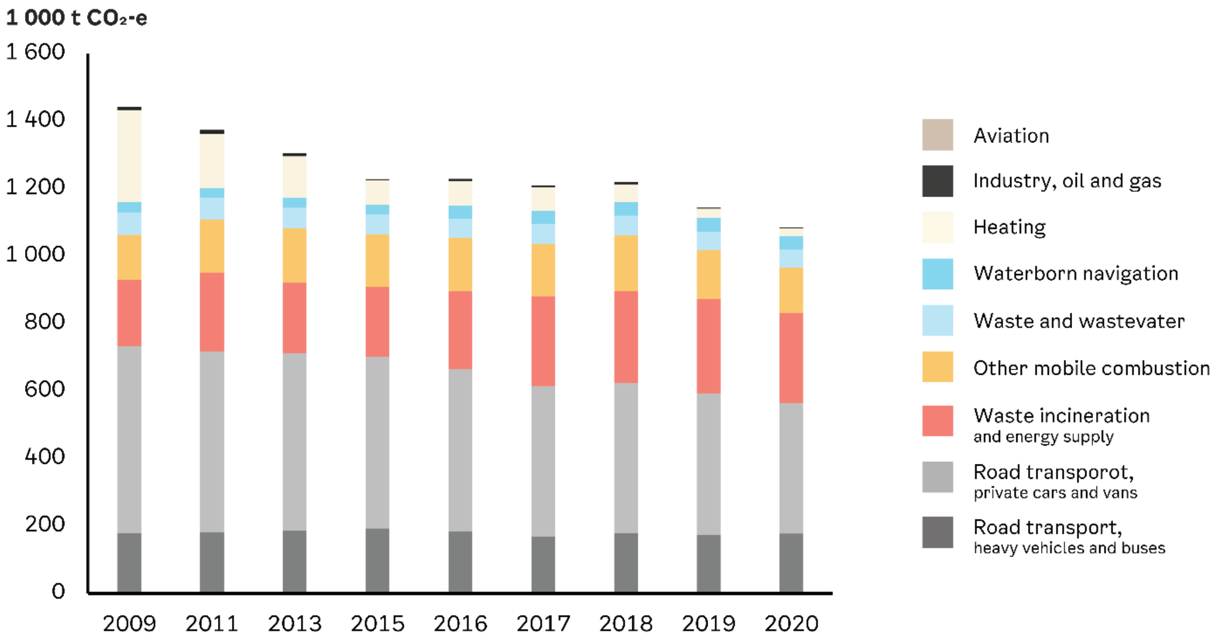

Figure 1: Greenhouse gas emissions in Oslo distributed according to emission sectors, 2009-2020

Emissions from all sectors have been reduced between 2019 and 2020. For the sectors waste and wastewater, industry, oil, and gas, aviation, heating, and road traffic the emissions in were at the lowest level in 2020 for the period from 2009 to 2020.

As shown in Figure 2, the emissions from road traffic constituted 52 per cent of the total greenhouse gas emissions in Oslo in 2020, thus being the largest source of emissions in the city. Emissions from passenger cars and delivery vans amounted to 36 per cent, and emissions from heavy vehicles and buses comprised 16 per cent. Waste incineration and energy supply amounted to 25 per cent of emissions, where the main source was incineration of fossil waste. Emissions from other mobile combustion and heating amounted to respectively 12 per cent and 2 per cent. The waste and wastewater sector amounted to 5 per cent of emissions in Oslo in 2020, while emissions from shipping and industry amounted to respectively 4 and 0.2 per cent. Emissions from aviation in this year's publication are set at 0 tonnes CO_2 equivalents in 2020, down from 0.2 tonnes CO_2 equivalents in 2019.

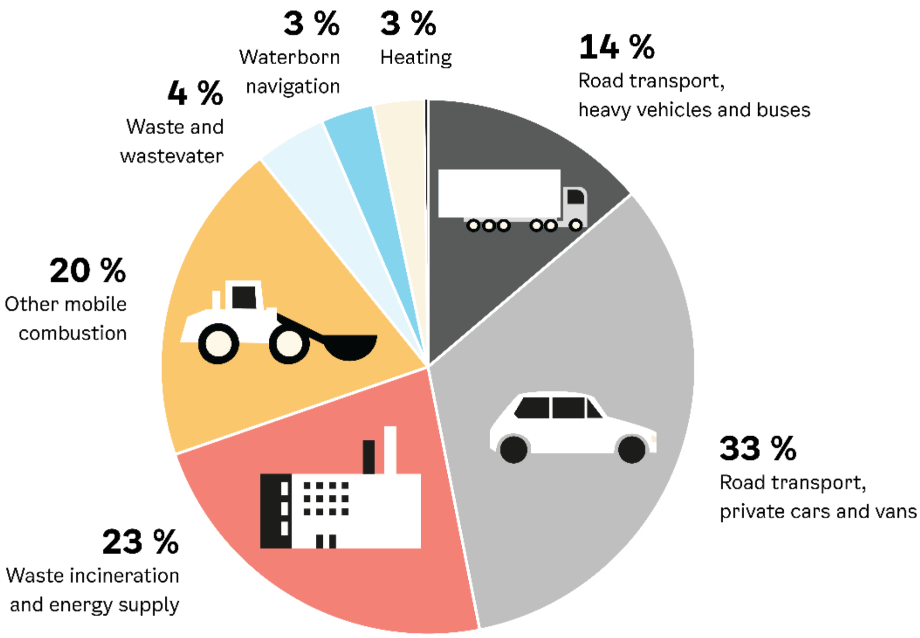

Figure 2: Greenhouse gas emissions in Oslo distributed according to emission sectors, 2020

Figure 3 shows the distribution of greenhouse gas emissions in Oslo distributed according to the greenhouse gases carbon dioxide, nitrous oxide, and methane in CO_2 equivalents in 2020. Ninety-three per cent of the greenhouse gas emissions, measured in CO_2 equivalents, are carbon monoxide, 2 per cent nitrous oxide and 5 per cent methane. Emissions of nitrous oxide mainly come from wastewater, waste incineration and road traffic. Emissions of methane generally come from landfill gas, as well as some from biological waste treatment, waste incineration and wood stoves.

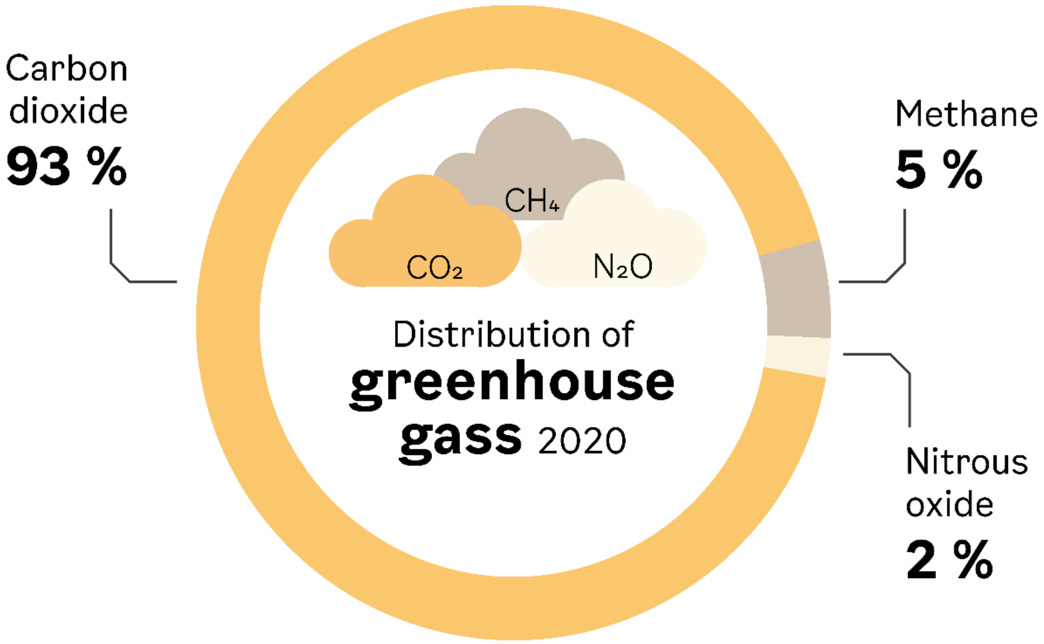

Figure 3: Distribution of greenhouse gas emissions in Oslo distributed according to the greenhouse gases carbon monoxide, methane, and nitrous oxide, 2020

The development of greenhouse gas emissions per sector in more detail

Figure 4 and Table 3 show greenhouse gas emissions per sector from 2009 to 2020.

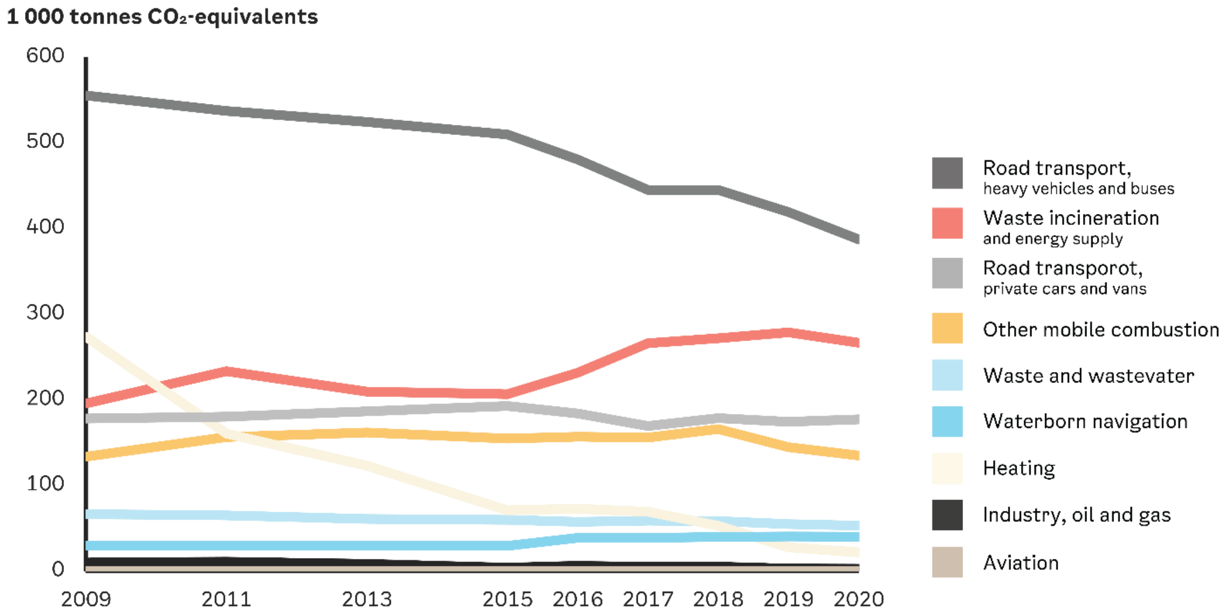

Figure 4: Greenhouse gas emissions distributed per emission sector, 2009-2020. Data are missing for the greenhouse gases for 2010, 2012 and 2014. The emission level has therefore been interpolated for these years.

Table 3: Greenhouse gas emissions in Oslo distributed according to emission sector [tonnes CO_2 equivalents], 2009-2020

Emission sector	2009	2011	2013	2015	2016	2017	2018	2019	2020
Other mobile combustion	133 697	156 535	161 872	154 756	156 985	155 998	165 924	144 809	134 985
Waste and wastewater	66 485	65 091	60 991	59 906	57 514	58 975	58 410	54 864	53 155
Waste incineration and energy supply	195 817	233 437	209 644	206 657	231 635	266 139	271 885	278 790	266 614
Industry, oil, and gas	9 980	11 000	8 458	4 179	6 271	4 916	5 305	3 040	2 686
Aviation	0,2	0,9	0,8	0,7	0,5	0,4	0,2	0,2	0,0
Heating	273 710	160 533	123 108,3	70 945,9	72 886,9	69 356,8	53 016,1	27 812,3	21 955,4
Shipping	29 487	29 487	29 487	29 486	38 807	38 715	40 028	40 511	40 267
Road traffic - heavy vehicles and buses	178 230	180 314	186 574	192 821	184 062	169 433	178 612	174 385	177 253
Road traffic – passenger cars and delivery vans	555 473	537 374	524 471	509 784	480 677	445 189	445 156	419 329	387 318
Total	1 442 878	1 373 772	1 304 605	1 228 535	1 228 839	1 208 723	1 218 335	1 143 540	1 084 233

Road traffic

The Norwegian Environment Agency uses a calculation model, the NERVE model [Norwegian Emissions from Road Vehicle Exhaust], to quantify emissions from road traffic on the municipal level in Norway. The Norwegian Institute for Air Research (NILU) has jointly developed the model with Urbanet Analyse on assignment from the Norwegian Environment Agency. The model is described in a separate memorandum.[5]

Emissions from road traffic 2009 - 2020

The emissions from road traffic in Oslo were somewhat less than 564 600 tonnes CO_2 equivalents in 2020. This is a drop of 4.9 per cent from 2019 and is mainly due to an increase in the number of electric vehicles and reduced driving. Reductions in the adding of biofuel has had the opposite effect. The emissions from road traffic have dropped each year since 2009, except for an increase of 1.5 per cent from 2017 to 2018. This increase was mainly the result of a reduction in the amount of biofuel added in Norway. In 2019 and in 2020 emissions from road traffic dropped by almost 5 per cent from the preceding year. Greenhouse gas emissions from road traffic accounted for 52 per cent of the total emissions in Oslo in 2020, the largest source of emissions in the municipality.

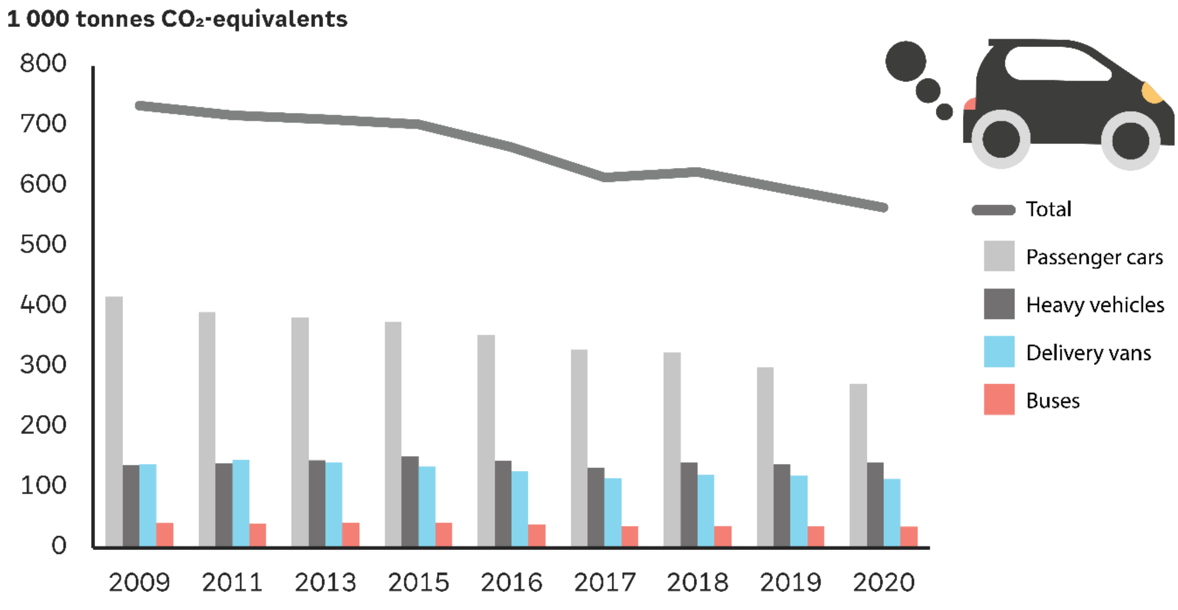

Figure 5: Emissions from road traffic, in total and distributed according to emission source, 2009-2020

Figure 6 shows the proportion of greenhouse gas emissions per emission source for road traffic in Oslo in 2020. Passenger cars were responsible for the largest emissions, followed by heavy vehicles and delivery vans.

[5] https://nilu.brage.unit.no/nilu-xmlui/bitstream/handle/11250/2569414/NILU%2bNR%2b28-2018.pdf?sequence=2&isAllowed=y

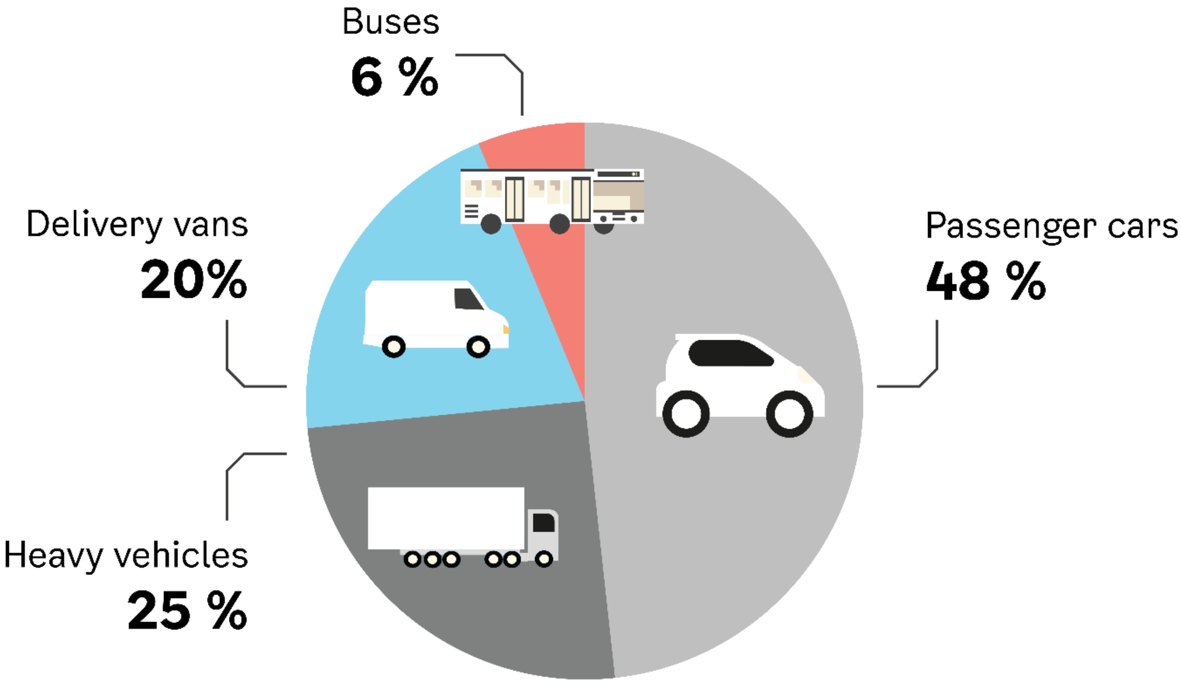

Figure 6: Proportion of greenhouse gas emissions per emission source for road traffic in Oslo, 2020

Passenger cars comprised 48 per cent of emissions from road traffic in Oslo, corresponding to 272 500 tonnes CO_2 equivalents. This is a decline of 9 per cent from 2019. This is due to the increased proportion of electric vehicles and reduced driving.

Emissions from delivery vans comprised 20 per cent, amounting to 114 800 tonnes CO_2 equivalents in 2020. This corresponds to a drop of 4.5 per cent from 2019. Less driving by delivery vans, and the increased proportion of electric vehicles, contributed to the decline in emissions. Reductions in the adding of biofuel had the opposite effect.

Heavy vehicles contributed 25 per cent of emissions from road traffic in 2020, corresponding to 142 100 tonnes CO_2-equivalents. This is an increase in emissions of 2 per cent compared to 2019 and is due to reductions in the adding of biofuel. Less driving contributed to this increase not being larger than it was.

Buses caused 6 per cent of greenhouse gas emissions from road traffic, amounting to approximately 35 100 tonnes CO_2 equivalents. This was a drop of 0.9 per cent from 2019 and was due to transition to electric buses and reduced traffic work. Reductions in the adding of biofuel had the opposite effect.

Biofuel

Adding biofuel to regular fuel dropped to 14 per cent in 2020, from 16 per cent in 2019. This decline is due to changes in the turnover requirements and the road use tax charged on biofuel, which came into force on 1 July 2020. Companies selling fuel kept within the turnover requirements for biofuel in 2020. Based on preliminary figures from Statistics Norway, the adding of biofuel dropped further to 13.7 per cent in 2021.

Agency for Climate
Climate Department
Oslo Local Authority

Office address:
Olav Vs gate 4
Postal address:
Rådhuset, 0037 OSLO

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postmottak@kli.oslo.kommune.no
Org. No.: 876819902
oslo.kommune.no

Traffic volume (km)

The greenhouse gas inventory shows that the total traffic volume measured in kilometres declined by 4.6 per cent in 2020 compared to 2019. The total traffic volume in Oslo, the number of kilometres driven by passenger cars, heavy vehicles, delivery vans and buses, is shown in Table 4. For passenger cars the traffic volume is approximately 4.4 per cent lower in 2020 compared to 2019. For delivery vans, heavy vehicles and buses the traffic volume dropped by respectively 6.4, 1.5 and 1.5 per cent. The drop in traffic was largely due to the coronavirus epidemic. Measures to protect from infection have been an important factor for traffic trends in 2020, particularly for light vehicles. The numbers therefore come from a model calculation and are therefore somewhat uncertain.

Table 4: Driving in the municipality (1000 km), 2009-2020

	2009	2011	2013	2015	2016	2017	2018	2019	2020
Passenger cars	2 150 894	2 129 359	2 199 692	2 293 556	2 319 166	2 312 940	2 311 996	2 310 855	2 209 539
Delivery vans	656 021	692 122	685 502	664 134	663 687	660 507	651 062	676 100	632 847
Heavy vehicles	162 391	163 234	166 920	171 114	172 570	172 026	171 425	172 807	170 161
Buses	37 721	37 917	38 773	39 747	40 085	39 959	39 819	40 141	39 526
Total	**3 007 027**	**3 022 632**	**3 090 887**	**3 168 551**	**3 195 508**	**3 185 432**	**3 174 302**	**3 199 903**	**3 052 074**

The Oslo Agency for Climate has checked the numbers against the road traffic index. According to the road traffic index, the total amount of traffic dropped by 4.7 per cent in Oslo from 2019 to 2020,[6] and rose by 1.4 per cent from 2020 to 2021.[7] This suggests that the emissions may rise for 2021. These numbers are based on fixed national counting points, and therefore show the changes in the number of vehicles passing. The road traffic index, which measures Oslo as a geographic district, for 2020 is on the level for traffic volume in the greenhouse gas inventory.

In addition to the road traffic index, the Norwegian Public Roads Administration also has the city index which has been designed to indicate traffic development for light vehicles in urban areas with urban growth agreements. According to the urban index for light vehicles for Oslo and Akershus, traffic declined by 6.9 per cent from 2019 to 2020 and rose by 2.4 per cent from 2020 to 2021.[8] During the entire period from 2018 to 2021 the urban index declined by 4.9 per cent. The urban index is a measure of the zero-growth goal and refers to light vehicles.

Development of the proportion of electric vehicles

Figure 7 shows the development in the proportion of electric passenger cars, indicating that the traffic volume for passenger cars has risen steeply in recent years in the largest cities in Norway. Oslo has had a significant increase in the proportion of electric vehicles in the traffic volume since 2013.

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[6] https://www.vegvesen.no/globalassets/fag/trafikk/trafikkdata/vegtrafikkindeksen-2020-12.pdf
[7] https://www.vegvesen.no/globalassets/fag/trafikk/trafikkdata/vegtrafikkindeksen_2021-12.pdf
[8] https://www.vegvesen.no/globalassets/fag/trafikk/trafikkdata/byindks_oslo_2018-2021-12.pdf

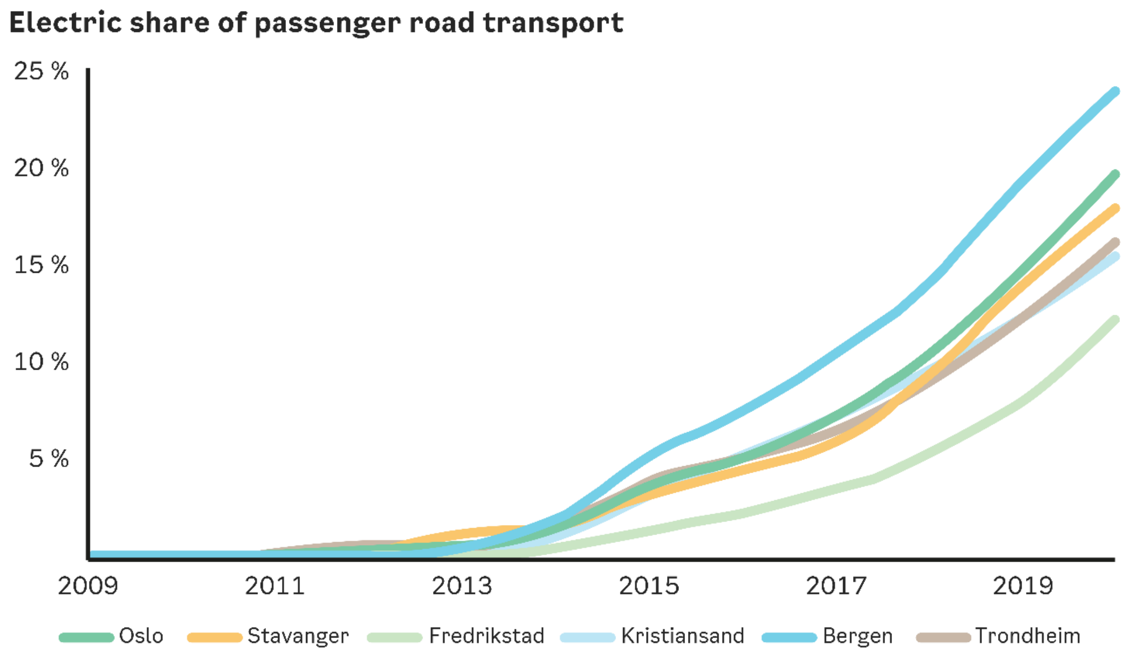

Figure 7: Development in the share of electric cars in the traffic volume of passenger cars, 2009-2020 (Norwegian Environment Agency, 2022)

According to the greenhouse gas inventory, the proportion of traffic with electric passenger cars increased from 14.6 per cent in 2019 to 19.7 per cent in 2020. There was also an increase from 1.6 per cent in 2019 to 2.3 per cent in 2020 in the proportion of traffic with electric delivery vans. In total, this gives a proportion of electric vehicles in traffic of 16 per cent in 2020 for light vehicles. Table 5 shows the development in the proportion of traffic with electric passenger cars and delivery vans in Oslo for the period from 2009 to 2020.

Table 5: Development in the proportion of electric passenger cars and electric delivery vans in the total traffic volume for respectively passenger cars and delivery vans, 2009-2020

	2009	2011	2013	2015	2016	2017	2018	2019	2020
Proportion electric passenger cars	0.1 %	0.2 %	0.5 %	3.6 %	5.2 %	7.2 %	10.4 %	14.6 %	19.7 %
Proportion electric delivery vans	0.0 %	0.0 %	0.1 %	0.2 %	0.5 %	0.8 %	1.2 %	1.6 %	2.3% %

In comparison, the proportion of registered electric passenger cars in Oslo and Akershus was respectively 15.7 and 12.6 per cent in 2019 (annual average). The average for 2020 was respectively 20.1 and 15.8 per cent in Oslo and Akershus according to the OFV [Norwegian Road Federation].[9] Since many vehicles from Akershus are used in Oslo to a high degree, these are relevant figures for emissions in Oslo. Table 6 shows the proportion of electric vehicles at the end of the year, taken from the Norwegian Road Federation. When comparing Norwegian Road

[9] https://www.ofvstatistikk.no/

Federation figures with the greenhouse gas inventory it is most useful to use figures that are annual averages for the proportion of electric vehicles. The proportion of registered vehicles and the proportion of kilometres driven is not directly comparable (mostly because electric vehicles are driven more than fossil fuel vehicles), but the figures from the Norwegian Road Federation and the greenhouse gas inventory appear to agree generally for passenger cars. For registered electric delivery vans in Oslo and Akershus, the proportion was respectively 4.9 and 1.8 per cent in 2019 (annual average). The average in 2020 was respectively 6.4 and 2.35 per cent in Oslo and Akershus. The proportion of electric delivery vans is higher than the proportion of the distance driven by electric vehicles. This may indicate that the proportion of electric delivery vans has been set too low in the greenhouse gas inventory.

Table 6 shows figures for the proportion of registered electric vehicles in Oslo. Note that these figures show the proportion of electric vehicles at the end of the year, thus the figures are not directly comparable to the proportion of traffic volume of electric vehicles from the greenhouse gas inventory, shown in Table 5.

Table 6: Proportion of electric vehicles of all vehicles in Oslo at the end of the year (Statistics from the Norwegian Road Federation, 2022). The figures are from the end of the year. When comparing with the greenhouse gas inventory we use the annual average.

	2015	2016	2017	2018	2019	2020	2021
Proportion electric passenger cars Oslo	4.7 %	6.7 %	9.4 %	13.4 %	18.0 %	22.1 %	27.7 %
Proportion electric delivery vans, Oslo	1.4 %	1.9 %	2.7 %	4.0 %	5.7 %	7.0 %	10.0 %

The Oslo Agency for Climate has also examined the proportion of electric vehicles passing toll ring. In 2020 the proportion of light electric vehicles passing through toll ring was 25 per cent, versus 23 per cent in 2019 (the proportion of all electric vehicles passing toll rings was respectively 23 and 21 per cent in 2020 and 2019). In 2021 the proportion of light electric vehicles was 29 per cent. Here it is important to point out that electric vehicles may be overrepresented in passing the toll rings due to the discount advantages. This therefore does not necessarily mean that the electric-vehicle proportion of the traffic volume in the greenhouse gas inventory is underestimated. Both these figures nevertheless suggest that the emissions may be lower in 2021, which we show using a simplified calculation: We assume that the traffic volume in total increased by 2.4 per cent[10] in 2021. Biofuel turnover was in total 14.0 per cent in 2020 and 13.7 per cent in 2021. But in 2021 there was far more biofuel added to petrol than to diesel compared to 2020. This means that the emissions from petrol-driven vehicles (generally passenger cars) will drop and the emissions from diesel vehicles will rise. From the Norwegian Road Federation, we know that the electric proportion increased by the following per cent points for the different vehicle categories from 2020 to 2021 (annual averages):

[10] https://www.vegvesen.no/globalassets/fag/trafikk/trafikkdata/byindeks_oslo_2018-2021-12.pdf

Table 7: Estimate of changes in electric-vehicle proportion, biofuel added and road traffic emissions from 2020 to 2021

	Increase in electric-vehicle proportion from 2020 to 2021 (biogas included for trucks)	Estimated change in biofuel addition (Norwegian Tax Administration[11] and Statistics Norway[12])	Estimated change in emissions from road traffic from 2020 to 2021
Buses	1.38 %	-2.2 %	3.2 %
Passenger cars	4.85 %	2.1 %	-4.5 %
Heavy vehicles	0.52 %	-2.2 %	4.0 %
Delivery vans	2.14 %	-1.6 %	1.9 %
Sum			-0.6 %

Based on these assumptions, emissions from road traffic will be reduced by approximately 3300 tonnes, corresponding to a drop of approximately 0.6 per cent from 2020 to 2021.

Where traffic originates

According to the model used as the basis for the greenhouse gas inventory, 82 per cent of traffic in the municipality originated in Oslo. Adjacent municipalities, such as Bærum, Lørenskog, Lillestrøm and Nordre Follo, accounted for respectively 6, 3, 3 and 2 per cent. The remainder originated in other municipalities.

Waste incineration and energy supply

The emission sector of waste incineration and energy supply comprises emissions from the sources waste incineration, other distant heating and electricity generation and other energy supply. Oslo has no emissions from generating electricity and other energy supply.

Figure 8 shows the emissions from waste incineration and energy supply from 2009 to 2020. Emissions from waste incineration and energy supply were 266 600 tonnes CO_2 equivalents in 2020. This represents a drop of more than 12 000 tonnes from the preceding year, corresponding to 4.4 per cent. The reduction is mainly due to reduced use of fossil energy to produce distance heating. The emission figures have been adjusted for the entire period due to an error in the data material. An updated greenhouse gas inventory with adjusted figures is expected to be published by the Norwegian Environment Agency in April 2022.

[11] Received by e-mail on 18 February 2021
[12] https://www.ssb.no/statbank/table/11174/

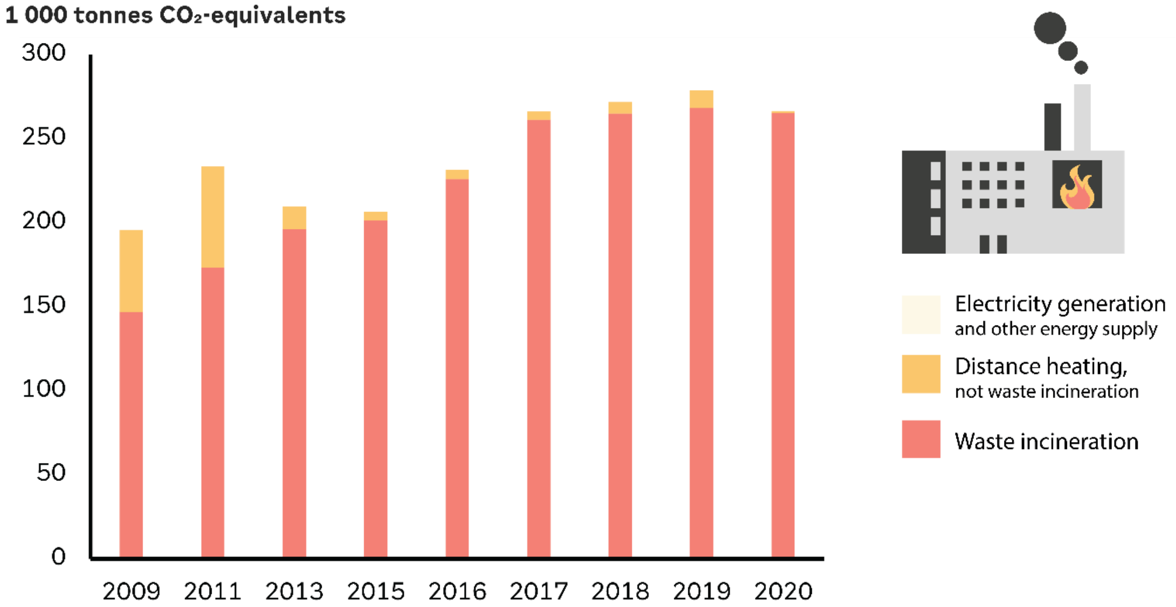

Figure 8: Emissions from waste incineration and energy supply, 2009-2020

Waste incineration

In the period from 2009, the emissions from waste incineration have increased due to an increase in the population and a subsequent increase in the amount of waste. As shown in Table 8, there was still a small drop from 2019 to 2020 in the total amount of waste, corresponding to 0.8 per cent. Emissions from this source include incineration of waste, as well as some use of additional fuel.

Table 8: Amounts of waste [tonnes] for incineration and emissions [tonnes CO2- equivalents] distributed on facilities, 2009-2020

Facility	Source	2009	2011	2013	2015	2016	2017	2018	2019	2020
Haraldrud regeneration facility (REG)	Amount of waste [tonnes]	97 208	104 899	109 345	110 481	105 654	103 063	100 401	101 340	106 000
	Emissions [tonnes CO_2 equivalents]	52 407	50 546	47 744	51 170	50 459	47 002	47 219	48 350	49 840
Fortum Oslo Varme AS – Klemetsrud	Amount of waste [tonnes]	144 347	199 767	287 303	298 445	329 386	343 564	335 417	342 339	323 118
	Emissions [tonnes CO_2 equivalents]	71 775	101 109	125 134	131 666	157 357	193 174	192 205	195 359	184 848
Fortum Haraldrud Varmesentral	Amount of waste [tonnes]	39 238	38 067	40 689	32 445	31 895	37 021	44 854	42 847	53 754
	Emissions [tonnes CO_2 equivalents]	22 885	21 779	23 280	18 563	18 248	21 181	25 662	24 514	30 754
Total	Amount of waste [tonnes]	280 793	342 733	437 337	441 371	466 935	483 648	480 672	486 526	482 872
	Emissions [tonnes CO_2 equivalents]	147 067	173 434	196 158	201 398	226 064	261 356	265 086	268 223	265 443

Distance heating except for waste incineration

The source includes emissions from the use of fossil fuel in the production of distance heating, i.e., all emissions from distance heating not stemming from waste incineration. The emissions from distance heating without including waste incineration amounted to less than 1200 tonnes CO_2 equivalents in 2020, a drop from 10 600 tonnes CO_2 equivalents in 2019. This corresponds to a drop of almost 90 per cent. According to figures reported by Fortum, the emissions in 2021 were approximately 6600 tonnes CO_2 equivalents. Table 9 shows the development of emissions from distance heating except for waste incineration. Variation in the emissions is generally linked to temperature variation, where the use of gas (LNG) under peak load conditions increases substantially when the weather is cold, and prices of electric power are high. The Fortum distance heating network consists of heating stations in Gaustad, Hasle, Hoff, Holmlia, Rikshospitalet, Rodeløkka, Skøyen, Tokerud, Ullevål, Ulven, Vika and Økern.

Table 9: Greenhouse gas emissions from production of distance heating, not including waste incineration, distributed per facility [tonnes CO_2 equivalents], 2009-2020

Facility	2009	2011	2013	2015	2016	2017	2018	2019	2020
Fortum fjernvarmenett verk	48 750	59 476	12 680	4 705	5 155	4 635	6 097	10 263	1 096
Nydalen	-	528	553	358	260	148	703	305	75
Bogerud Varmesentral	-	-	161	125	70	-	-	-	-
Haugerud Varmesentral. Obos	-	-	4 077	3 094	3 803	-	-	-	-
Total	48 750	60 003	17 471	8 282	9 288	4 783	6 799	10 568	1 172

Other mobile combustion

From 2019 to 2020 the emissions for other mobile combustion dropped by 6.8 per cent, then comprising 12 per cent of the total emissions in the municipality. Emissions from other mobile combustion stem from use of duty-free diesel for non-roadworthy motor tools used in building and construction, agriculture, forestry, transport-related services, and waste treatment. Duty-free diesel used by snowmobiles is also included. Emissions from building and construction gave the largest emissions from this sector in 2020, almost 70 000 tonnes CO_2 equivalents. "Other industries" and "Transport-related services" are the two next largest sources of emissions, both with emissions of almost 30 000 tonnes CO_2 equivalents in 2020.

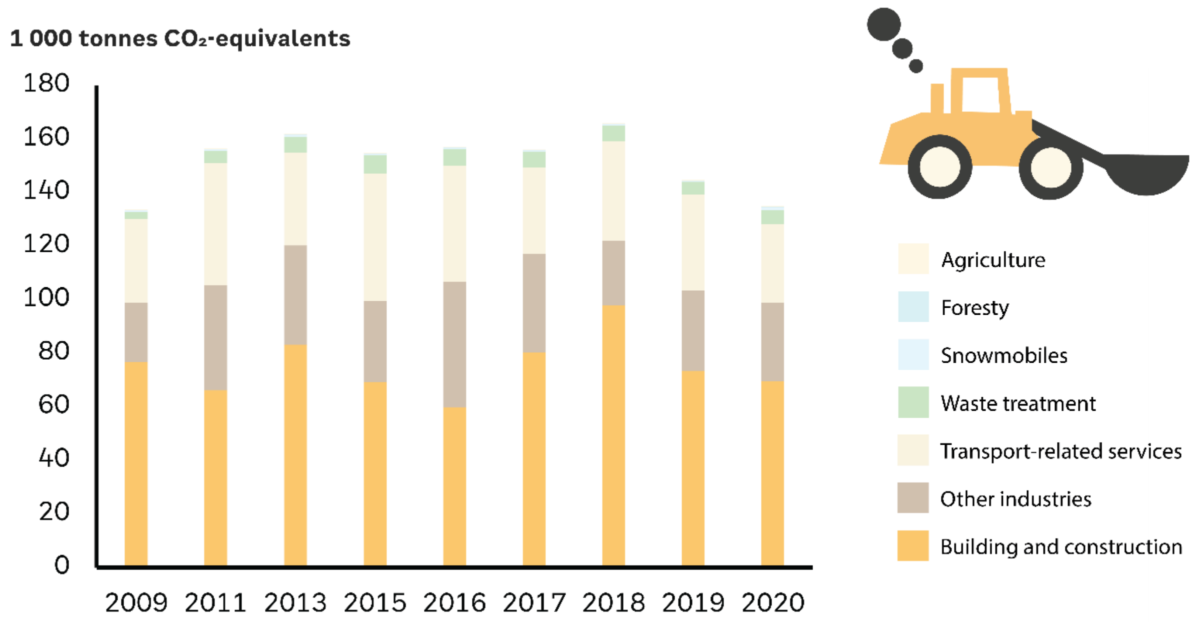

Figure 9: Emissions from the sector other mobile combustion, 2009-2020

Agency for Climate
Climate Department
Oslo Local Authority

Office address:
Olav Vs gate 4
Postal address:
Rådhuset, 0037 OSLO

Telephone: +47 22 22 22 22
postmottak@kli.oslo.kommune.no
Org. No.: 876819902
oslo.kommune.no

The method for calculating emissions from duty-free diesel was updated in 2022. The new method calculates emissions based on Statistics Norway's energy balance, rather than the sales statistics used previously. The energy balance statistics offer better information about which industries use duty-free diesel, and how much they use. Conversely, it does not indicate geographical distribution of diesel consumption. The emissions are therefore distributed across municipalities using diverse distribution keys, varying according to the business/industry in question.

Building and construction

Emissions from this sector have dropped from 75 600 to 68 600 tonnes CO_2 equivalents between 2009 and 2020.

The distribution key used to calculate emissions from machinery used in building and construction sites uses results from the *EmSite* model, which has been developed by the Norwegian Institute for Air Research (NILU).

EmSite uses a national database with information about placement, times and affected areas for all building activities. It additionally uses information from machine registers and knowledge about soil conditions and weather data to calculate energy requirements for various machines at different stages in building processes. The results from the model give information about the consumption of petrol, gas and diesel by time and location, and are distributed according to building and demolishing buildings and construction work. The information is summarised to estimate the total emissions the municipalities have from building and construction work. It is challenging that there is no national database for building and construction work, and emissions from such work are therefore not included in the results to this point in time.

Although significantly improved, the *EmSite* model still does not show the effect of local climate measures, such as Oslo's requirement for sustainable biodiesel.

Transport-related services

Services related to transport are one of the two next largest emission sources in the mobile incineration sector. Such services include motor tools used in the operation of bus depots, railway stations, freight terminals, bridges, roads, and tunnels. This sector also includes services used in the operation of harbours, boat pilots and docking activities, pipelines, and shipping. These emissions are distributed in accordance with Statistics Norway's employment figures for this industrial area. Emissions have dropped from 31 200 to 29 200 tonnes CO_2 equivalents between 2009 and 2020.

Other industries

Other industries includes all those industries that use duty-free diesel, and which do not sort under agriculture, forestry, building and construction, transport-related service, or waste treatment. This comprises everything from heavy industry to hotels and catering and military services. The emissions were around 29 300 tonnes CO_2 equivalents in 2020, an increase of 7 000 tonnes CO_2 equivalents since 2009.

Snowmobiles

Emissions from snowmobiles are calculated according to registered snowmobiles in the Norwegian municipalities and distributed according to the location where they are registered. The assumption here is that all snowmobiles are driven 850 km per year. The emissions from snowmobiles are calculated to be 924 tonnes CO_2 equivalents in 2020, double the amount of 2019.

Heating

The emission sector includes emissions from heating offices and industrial buildings and households, distributed on the emission sources fossil fuel heating and wood burning. In 2020, the emissions from the sector amounted to 22 000 tonnes CO_2 equivalents, whereof only 0.06 per cent of the emissions came from municipal buildings, according to information from the Norwegian Environment Agency. The emissions from heating mainly stem from the combustion of gas (LPG).

A new method has been used this year for distributing emissions from gas (LPG and natural gas) for heating in the municipalities. Oslo has no emissions from natural gas. For emissions from LPG this gave a reduction of emissions in Oslo during the entire period from 2009. For 2019 this corresponded to a downward adjustment of LPG emissions somewhat below 50 per cent.

Figure 10 shows the development in emissions from heating.

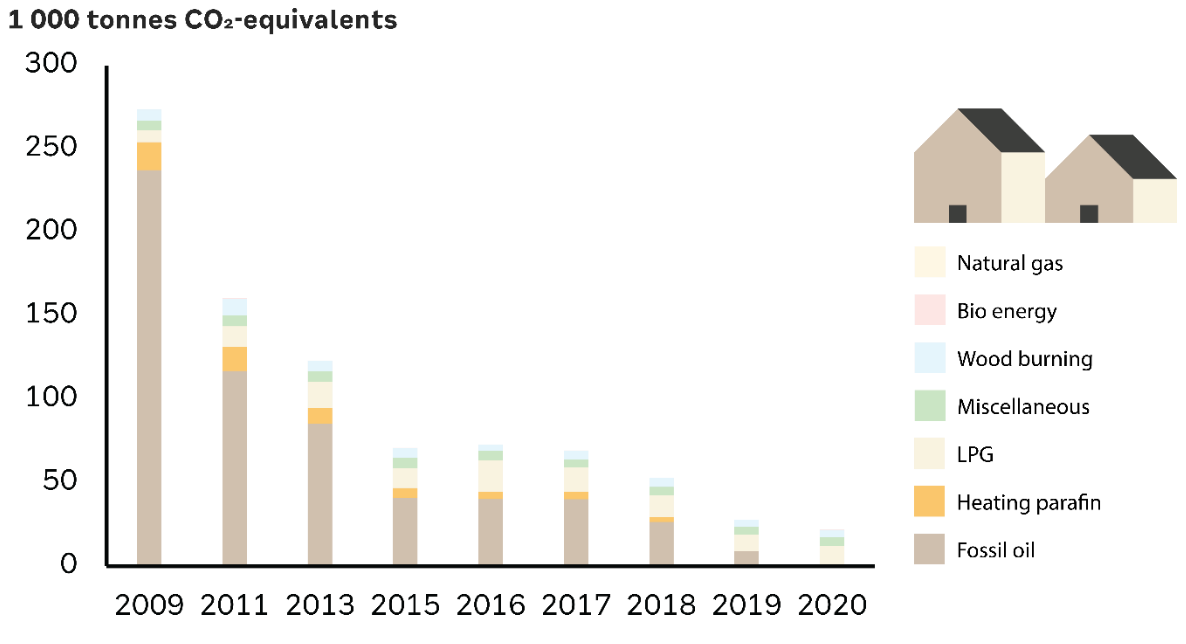

Figure 10: Emissions from heating, 2009-2020

Fossil heating

Emissions from fossil heating in 2020 were just under 17 400 tonnes CO_2 equivalents, a drop of 28 per cent from 2019. Since 2009, the emissions from fossil heating have decreased by as much as 93 per cent. Generally, the reduction in the use of oil for heating has led to the steep decline in emissions from fossil heating in this period. This reduction is most certainly a consequence of the ban on using mineral oil for heating buildings, which came into force as of 1 January 2020.[13] The ban applies to oil and paraffin for heating. Emissions from paraffin heating were eliminated in 2020, but some emissions from fossil oil persisted, corresponding to 55 tonnes CO_2 equivalents due to exemptions from the ban.

Since the last publication, the gas emission source has been split into LPG and natural gas. The category fossil heating consists of the emission sources fossil oil, heating paraffin, LPG, natural gas, bio energy and miscellaneous other.

The emissions from LPG were 12 300 tonnes CO_2 equivalents in 2020, an increase of 22 per cent from 2019. The distribution key for these emissions has been improved in this year's publication, resulting in a downward adjustment in the emissions for the entire period. The source "miscellaneous" in 2020 accounted for less than 4900 tonnes CO_2 equivalents and concerned combustion of paraffin wax and landfill gas.

Table 10 shows the fossil emissions distributed according to emission sources in the sector heating.

Table 10: Emissions per emission source for fossil emissions from heating [tonnes CO_2 equivalents], 2009-2020

Emission source	2009	2011	2013	2015	2016	2017	2018	2019	2020
Miscellaneous	5 512	6 366	6 335	6 054	5 812	5 049	5 070	4 728	4 860
Bio energy	124	153	132	133	128	151	145	143	136
Fossil oil	237 308	117 004	85 447	40 947	40 253	40 132	26 576	8 939	55
Heating paraffin	16 787	14 261	9 421	5 879	4 282	4 343	2 692	112	0
LPG	7 195	12 557	15 657	12 014	18 733	14 631	13 233	10 095	12 326
Natural gas	0	0	0	0	0	0	0	0	0
Total fossil emissions	273 710	160 533	123 108	70 946	72 887	69 357	53 016	27 812	21 955

The emissions from fossil heating are calculated by Statistics Norway based on the national sales statistics for petroleum products (Table 11185 in Statistics Norway's statistics bank). The sales statistics provide information about sales in Norway distributed according to type of energy, industry, and county, and for a large proportion also information about the postal number where the energy was delivered. In the cases where the delivery address is lacking, Statistics Norway has attempted to link the buyer to the Central Register of Establishments and Enterprises (VOF). If no information about the business-register organisation number exists, the stated county is used for the sale and distributed across the municipalities by population. Statistics Norway uses this information to distribute the national emissions from fossil heating by municipality.

[13] https://lovdata.no/dokument/SF/forskrift/2018-06-28-1060

The sales statistics do not provide information about delivery address for sales of LPG. Emissions from LPG (liquid petroleum gas) are therefore distributed across municipalities according to the storage volume in each municipality. The Norwegian Directorate for Civil Protection (DSB) has information about volume and placement where LPG is stored with volumes higher than 0.4 m^3. This information can be used to find the current total storage volume for LPG used for heating in each municipality. Storage volumes used for temporary storage, fuel or other consumption are not included. Storage volume does not indicate the consumption or turnover in the storage units, but it is assumed that quantity to some extent reflects the amount of consumption. There is no historic data material about storage volumes further back than 2019. The distribution for 2019 has been used for the years from 2009.

Wood burning

The emissions from wood burning amounted to approximately 4600 tonnes CO_2 equivalents in 2020, an increase of 20 per cent from 2019. Households are the source of 99 per cent of the emissions, while 1 per cent comes from holiday houses or cottages. Emissions from wood burning have shown no clear trend since 2009. Emissions from wood burning come from nitrous oxide and methane, as the CO_2 emissions from wood burning are calculated as net zero emissions.

For emissions from wood burning, data are used from Statistics Norway's statistics for wood consumption in households on the county level and vacation homes on the regional level. The emissions are calculated using the MetVed[14] model designed by the Norwegian Institute for Air Research on assignment from the Norwegian Environment Agency. The model was refined in 2020, with new emission factors, additional parameters, and a new and enhanced description of time variation.[15]

Shipping

This emission sector comprises all shipping and sea transportation in the municipality. The emissions inventory for shipping are calculated by the National Coastal Administration based on AIS transmitters, and Oslo has also reported figures for electricity consumption for ships in port, which are used to correct the emissions figures against shore power.

There are no significant changes in the emissions inventory for shipping from 2019 to 2020. The figures from the Norwegian Environment Agency have been corrected for Color Line's use of shore power in 2020, but not retrospectively. This means that the figures from 2019 and earlier are too high. Data obtained from Det Norske Veritas (DNV) show that the emissions have increased by approximately 15 per cent from 2019 to 2020 (5000 tonnes CO_2 equivalents) because DNV has corrected for Color Line's use of shore power earlier. The increase is due to ferry lines serving foreign destinations having remained within the municipal boundary far more than when in regular service.

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[14] https://www.miljodirektoratet.no/Documents/publikasjoner/M1261/M1261.pdf
[15] https://hdl.handle.net/11250/2690095

The Norwegian Environment Agency is planning to adjust for shore power retrospectively.

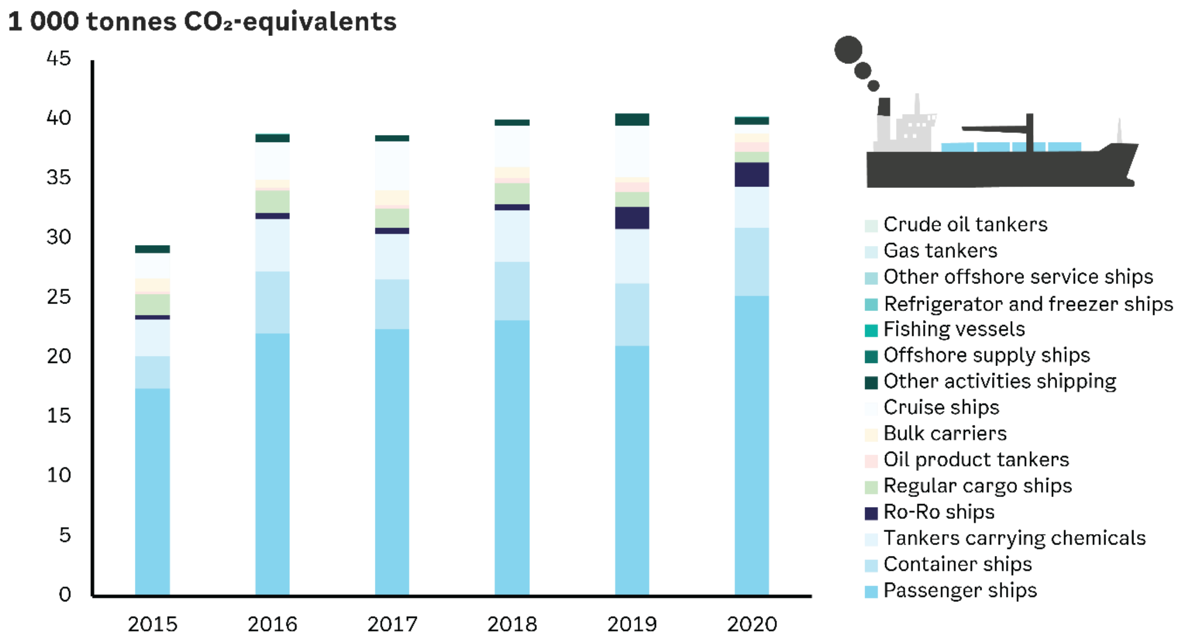

Figure 11: Emissions from shipping, 2015-2020

Cruise traffic has been reduced by more than 80 per cent (approximately 3500 tonnes CO_2 equivalents). This expected decline is due to the coronavirus pandemic. Moreover, emissions from tankers carrying chemicals and general cargo ships are somewhat reduced (approximately 1500 tonnes CO_2 equivalents). This may in part be due to a reduced number of deliveries of airplane fuel to Oslo harbour due to the drop in air traffic during the coronavirus pandemic.

Emissions from the passenger segment have increased by 20 per cent (approximately 4000 tonnes CO_2 equivalents) from 2019 to 2020. This is because the ferries with foreign destinations such as Kiel have spent far more time within the municipal border than before the pandemic. The total increase in emissions from passenger ships is 64 per cent (10 000 tonnes CO_2 equivalents). Color Line has used shore power as much as possible. Oslo harbour modified the facility at Revierkaia so that Color Fantasy has used shore power during large parts of the year (April-December).

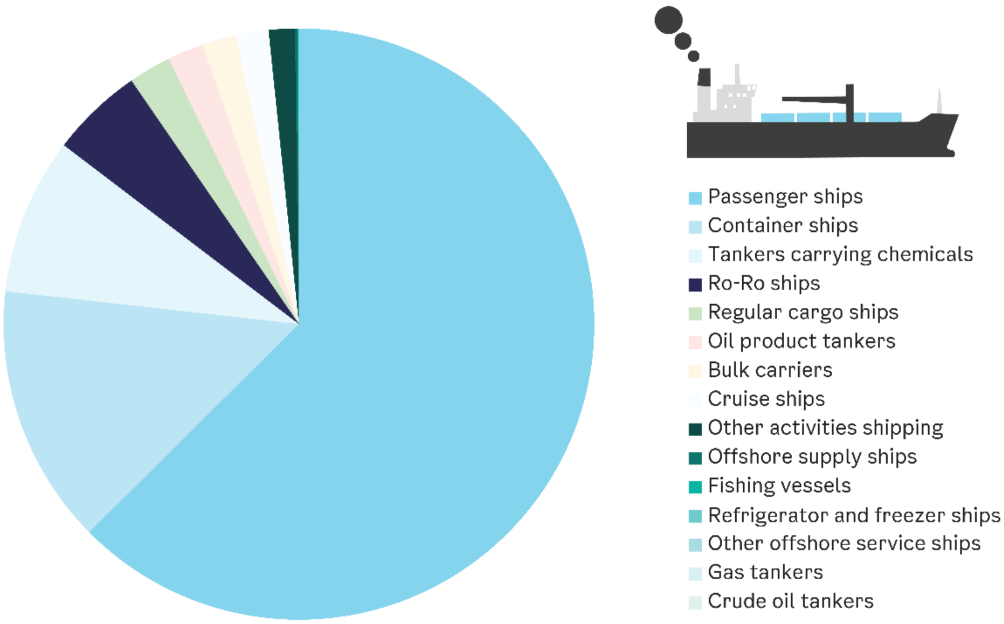

Figure 12: Proportion of greenhouse gas emissions per emission source for shipping in Oslo, 2020

Industry, oil, and gas

The emission sector industry, oil, and gas includes emissions from the processing and combustion industry. Oslo only has combustion emissions. Oslo has no oil or gas activities, no facilities subjected to quotas and no emissions from the processing industry. The emissions from industry, oil, and gas extraction are mainly calculated according to figures reported to the Norwegian Environment Agency.

Emissions from the combustion in industry in 2020 were under 2700 tonnes CO_2 equivalents, a drop of 12 per cent from 2019. The Oslo Agency for Climate has examined this change and concluded that the decline is due to reduced emissions from Nordox. The facilities that have reported to the Norwegian Environment Agency are FATLAND OSLO AS, GE Healthcare, Nordox and Tine meieriet Oslo (Dairy Enterprise), Kalbakken division.

Additional emissions calculated by Statistics Norway for the combustion facilities not reporting to the Norwegian Environment Agency have been excluded from the greenhouse gas inventory but are shown as supplemental emissions calculated by Statistics Norway in the additional information. The reason why these emissions are omitted is that there is uncertainty relating to the annual development of emissions on the municipal level, as they are based on a survey of selected respondents where not all enterprises are asked about energy consumption each year. Table 11 shows supplemental emissions calculated by Statistics Norway. Since the previous publication, the figures for 2009, 2018 and 2019 have been marginally changed. The reason is that Statistics Norway has revised the method used to calculate the emissions from industry and removed some emissions categories from the statistics. The Norwegian Environment Agency assumes that these emissions have been included in the heating sector.

Agency for Climate
Climate Department
Oslo Local Authority

Office address:
Olav Vs gate 4
Postal address:
Rådhuset, 0037 OSLO

Telephone: +47 22 22 22 22
postmottak@kli.oslo.kommune.no
Org. No.: 876819902
oslo.kommune.no

Table 11: Additional emissions calculated by Statistics Norway for combustion facilities not reporting to the Norwegian Environment Agency [tonnes CO_2 equivalents], 2009-2020

	2009	2011	2013	2015	2016	2017	2018	2019	2020
Total emissions	17 732	16 577	19 208	19 163	17 041	23 307	25 076	32 195	25 734

Waste and wastewater

The sector waste and wastewater comprises the emission sources landfill gas and biological waste and wastewater treatment. Emissions are calculated according to the amount of organic waste, and therefore only include emissions of methane and nitrous oxide. A new method has been developed for emissions from wastewater cleaning for this year's publication. The method, corresponding to the method developed in the national greenhouse gas inventory, includes more emission sources than the method used in the previous publication. Wastewater facilities report information about cleaning requirements and release to water to the authorities. The calculation methods use as much reported data from the facilities as possible. The changes in the calculation methods lead to an increase in greenhouse gas emissions for all the municipalities over the entire time series, but for Oslo this increase is minor.

The emissions from waste and wastewater dropped by 3 per cent from 2019 to 2020, corresponding to 1700 tonnes CO_2 equivalents. Table 12 shows the emissions from the sector from 2009 to 2020.

Table 12: Emissions from the waste and wastewater sector distributed per emission source [tonnes CO_2 equivalents], 2009-2020

	2009	2011	2013	2015	2016	2017	2018	2019	2020
Landfill gas	61 945	57 985	54 730	52 391	48 922	50 659	50 234	47 683	43 481
Wastewater	2 492	5 030	3 950	5 558	4 002	4 336	4 376	4 621	5 288
Biological waste treatment	2 049	2 076	2 311	1 957	4 589	3 980	3 800	2 560	4 385
Total emissions	**66 485**	**65 091**	**60 991**	**59 906**	**57 514**	**58 975**	**58 410**	**54 864**	**53 155**

An error has been found in the figure for waste in 2009, where the emissions of methane is set at -97 tonnes CO_2 equivalents. This data material has been reported from the facility in 2009. The error does not greatly impact the total emissions from the source in 2009. The Norwegian Environment Agency has confirmed the intention to rectify the error. This does not have a significant effect on the total emissions from these figures.

Landfill gas

Emissions of landfill gas concerns methane gas from municipal landfills. This emission source comprises 75 per cent of emissions of methane gas in Oslo.

The emissions from this sector are calculated using a method based on the Intergovernmental Panel on Climate Change's standard model (IPCC, 2006b), which is used in the national greenhouse gas inventory. The method calculates the theoretical emissions based on waste amounts in landfills in the municipality. Emissions from the sector is then calculated by deducting the outtake of methane. For Oslo three landfill facilities are included in the greenhouse gas inventory: Stubberud, Rommen and Grønmo.[16]

Eiendoms- og byfornyelsesetaten (EBY - the Property and Urban Renewal agency) in Oslo has contributed local data for waste deposited at Grønmo and Rommen landfills. This data material is used directly in the model for calculating emissions. The waste amount for Stubberud has been estimated according to amounts deposited at Rommen and the development of waste composition on the national level as there is no available information about amounts deposited at Stubberud.

The Grønmo and Rommen facilities both have systems for methane outtakes. The methane outtake started in 1991 and 1996 for respectively Grønmo and Rommen. The EBY has also here contributed local data for methane outtake from 1991 to 2020 for both facilities, but there is uncertainty about the data for the methane outtake from Grønmo from 1991 to 1999. Theoretical emissions have been estimated to be lower than the reported methane outtake from Grønmo in these years. The Norwegian Environment Agency has therefore adjusted the figures for the methane outtake from Grønmo from 1991 to 1999, based on the proportion of methane outtake in 2000 in relation to emissions. The methane outtake from Grønmo has been set at 76 per cent of emissions from 1991 to 1999. Table 13 shows the methane outtake from Grønmo and Rommen for 2009 to 2020, while Table 14 shows how the emissions have been calculated.

Table 13: Methane outtake from Grønmo and Rommen [tonnes CH_4], 2009-2020

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Grønmo	1 702	1 652	1 532	1 381	1 297	1 212	1 057	1 054	820	704	701	759
Rommen	168	95	99	138	106	121	115	119	129	125	108	111
Total	1 870	1 747	1 630	1 519	1 403	1 333	1 172	1 172	949	828	809	870

Table 14: Calculation of emissions from landfills in Oslo [tonnes CH_4], 2009-2020

	2009	2011	2013	2015	2016	2017	2018	2019	2020
Theoretical emissions	4 627	4 210	3 837	3 502	3 348	3 201	3 062	2 929	2 803
Methane outtake	1 870	1 630	1 403	1 172	1 172	949	828	809	870
Emissions	**2 757**	**2 580**	**2 434**	**2 330**	**2 176**	**2 252**	**2 234**	**2 120**	**1933**

[16] Stubberud: used for waste deposits from 1947 to 1963;
Rommen: received waste from 1959 to 1969;
Grønmo: received waste from 1969 to 2006.

Biological treatment of waste

Under biological treatment of waste, emissions are included from home composting, composting facilities and biogas plants. Oslo, however, has no emissions from home composting.

The emissions from composting facilities are shown in Table 15, which includes both methane and nitrous oxide emissions. The emissions are calculated according to the amount of organic waste composted on the national level and are then distributed across municipalities with composting facilities using local data for composted amounts. Emissions are only calculated from municipalities with home composting programmes (grant schemes etc.). The composting facilities only started reporting data as part of KOSTRA reporting in 2016. Reported data in 2016 for all the future years are used to calculate the emissions, and the emissions have been calculated schematically back in time. In Oslo there was no programme for home composting in 2016. The data show that there is one facility in Oslo, Sørlimosen, which was established in 2016.

The historical figures for composted amounts in this year's publication have been reduced compared to last year. Changes for Oslo refer to composted amounts for 2020 that are included in calculations for earlier years in the time series. Last year, notification was given that since there continued to be uncertainty about the figures reported by the facilities and the time series was short (the facilities started reporting in 2018/2019), in 2021 they wanted to update the method and use the figures from the facilities for the entire time series. The Norwegian Environment Agency has confirmed that the method had not been updated as planned because the reports from the facilities did not agree with what has been reported to the authorities in recent years. The Norwegian Environment Agency continues to work on this and hopes to be able to use the new method in the next publication.

Table 15: Emissions and activity data from composted waste amounts, 2016-2020

	2016	2017	2018	2019	2020
Emissions [tonnes CO_2 equivalents]	2 455	1 840	1 736	335	1 912
Composted amounts [tonnes]	14 314	10 727	10 124	1 954	11 147

When it comes to emissions from the production of biogas, they are calculated according to the amount of biogas produced with an emission factor of 5 per cent of the total amount of biogas produced. This is in line with the international guidelines (the Intergovernmental Panel on Climate Change 2006 (IPCC)). The methane emissions from biogas facilities may be lower. Notification was given that this factor would be updated in 2021 in conjunction with a new method for the national greenhouse gas inventory, but this has not been done yet. The Norwegian Environment Agency has confirmed that this is included in the plan for the national greenhouse gas inventory for 2022. There is no adequate data set with information about the amount of produced biogas at the various plants in Norway, so the calculation is based on reports from the plants. In the cases where the plants have not reported to the Norwegian Environment Agency, data are used from the reports of waste companies or from the market report written by Rambøll in 2016.

Table 16 shows the produced amount of biogas and subsequent greenhouse gas emissions. Emissions from biogas only include emissions of methane gas. In Oslo biogas is produced by Bekkelaget Vann AS (BEVAS).

Table 16: Biogas production by Bekkelaget Vann AS (BEVAS), 2009-2020

	2009	2011	2013	2015	2016	2017	2018	2019	2020
Emissions [tonnes CO_2 equivalents]	2 049	2 076	2 311	1 957	2 134	2 140	2 064	2 225	2 474
Produced biogas [tonnes methane]	1 639	1 661	1 848	1 566	1 707	1 712	1 651	1 780	1 979

Historically produced biogas from Bekkelaget Vann AS has increased since the previous publication due to an error in the calculation of amounts of methane in the previous publication. The produced amount of biogas is reported in Nm,[3] while in the calculation it was assumed that it was reported in Sm^3. This has now been corrected.

Wastewater

Emissions from wastewater include methane emissions from inhabitants with closed tanks for black water and grey water and from industrial wastewater, and nitrous oxide from the denitrification process in wastewater treatment facilities, and nitrogen released from cleaning facilities, housing connected to untreated wastewater pipelines and from closed tanks. CO_2 emissions from wastewater is biogenic in origin and is counted as net zero emissions. The emissions are calculated according to data reported to the Norwegian Environment Agency and data from Statistics Norway.

A new method has been developed for calculating emissions from wastewater treatment. The new method corresponds to the method developed in the national greenhouse gas inventory and includes additional emission sources to the methods used in the last publication. Wastewater facilities report information about cleaning requirements and release of water to the authorities. The calculation method uses data reported from the facilities as much as possible. The changes in the calculation method have led to an increase in greenhouse gas emissions for all municipalities for the entire time series. For the emissions from wastewater in Oslo, this caused an increase of 27 per cent in 2019, corresponding to less than 1000 tonnes CO_2 equivalents in this year's publication compared to the publication in 2020. Table 17 shows emissions from wastewater in 2009-2020.

Office address:
Olav Vs gate 4
Postal address:
Rådhuset, 0037 OSLO

Telephone: +47 22 22 22 22
postmottak@kli.oslo.kommune.no
Org. No.: 876819902
oslo.kommune.no

Table 17: Emissions from wastewater [tonnes CO_2 equivalents], 2009-2020

	2009	2011	2013	2015	2016	2017	2018	2019	2020
Emissions	2 492	5 030	3 950	5 558	4 002	4 336	4 376	4 621	5 288

Aviation

In 2019, Oslo was assigned emissions of negligible 0.2 tonnes CO_2 equivalents from aviation, while emissions in 2020 are set to zero. The emissions in 2019 were due to helicopter take-off and landing at Oslo University Hospital and Ullevål Hospital in Oslo. It is uncertain why these emissions were excluded in 2020.

Emissions from this sector are geographically distributed and include emissions from the departure and approach phases of aircraft (fixed wing and helicopters) landing or taking off. The emissions are related to flight activities of Oslo inhabitants and business and industry, and are accordingly allocated to others, such as Ullensaker municipality, where Oslo Airport Gardermoen is located. Emissions from aviation in Ullensaker municipality were 126 700 tonnes CO_2 equivalents in 2020. This is a drop of 55 per cent from 2019, resulting from less travel due to the coronavirus pandemic. Compared to the 2009 level, this is a drop of 39 per cent. It is nevertheless reasonable to expect travel activities to increase to the pre-pandemic level in the coming years. In 2019 emissions from aviation in Ullensaker had increased by 33 per cent compared to the 2009 level.

Attachment 1: Overview of sectors and emission sources in the greenhouse gas inventory

Table listing sectors and emission sources included in the greenhouse gas inventory.

Agency for Climate
Climate Department
Oslo Local Authority

Office address:
Olav Vs gate 4
Postal address:
Rådhuset, 0037 OSLO

Telephone: +47 22 22 22 22
postmottak@kli.oslo.kommune.no
Org. No.: 876819902
oslo.kommune.no

Emission sector	Emission source
Industry, oil, and gas	Industry, oil, and gas
Waste incineration and energy supply	Waste incineration Distance heating, except for waste incineration Electricity production and other energy supply
Heating	Fossil oil Heating paraffin LPG Natural gas Bioenergy Miscellaneous Wood burning
Road traffic	Passenger cars Delivery vans Heavy vehicles Buses
Shipping	Bulk carriers Cruise ships Fishing vessels Gas tankers Tankers carrying chemicals Refrigerator and freezer ships Container ships Offshore supply ships Oil product tankers Passenger ships Ro-Ro ships Crude oil tankers Regular cargo ships Other offshore service ships Other activities shipping
Aviation	Domestic aviation Aviation abroad
Other mobile combustion	Building and construction Waste treatment Agriculture Forestry Transport-related services Other industries Snowmobiles
Agriculture*	Digestion processes husbandry Fertilizer processing Agricultural areas

Agency for Climate
Climate Department
Oslo Local Authority

Office address:
Olav Vs gate 4
Postal address:
Rådhuset, 0037 OSLO

Telephone: +47 22 22 22 22
postmottak@kli.oslo.kommune.no
Org. No.: 876819902
oslo.kommune.no

Waste and wastewater	Landfill gas Biological treatment of waste Wastewater

* Oslo has no waste from agriculture, but the emission sector is included in this list to show how the greenhouse gas inventory are prepared and published in their entirety by the Norwegian Environment Agency.

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Attachment 2: Emissions in Oslo, 2009-2020 (tonnes CO_2 equivalents)

Emission sector / emission source	2009	2011	2013	2015	2016	2017	2018	2019	2020
Other mobile combustion	**133696.5**	**156534.7**	**161872.2**	**154755.7**	**156984.6**	**155998.2**	**165923.8**	**144808.6**	**134984.7**
Other industries	22308.1	39242.8	37148.8	30260.8	46820.8	36878.6	24074	30166.3	29296.7
Waste treatment	2538.3	4457.3	5977.8	6750.6	6122.8	5846.8	5770.4	4820.2	5298.2
Building and construction	76656.1	66131.9	83096.4	69109.9	59903.2	80265.2	97841.9	73318.7	69618.5
Agriculture	254	266	254.8	230	237.3	236.1	243	246.7	250.4
Forestry	181.7	190	264.2	148.1	164.4	76.4	202.4	101.8	358
Transport-related services	31182.5	45687.1	34618.1	47748.9	43233.6	32190.8	37325	35694.5	29238.9
Snowmobiles	575.8	559.6	512.1	507.4	502.5	504.3	467.1	460.4	924
Waste and wastewater	**66485.1**	**65091.4**	**60990.6**	**59905.8**	**57513.7**	**58974.9**	**58409.6**	**54864.4**	**53154.9**
Landfill gas	61944.9	57985.4	54729.7	52391.3	48922.3	50659.1	50233.6	47683.2	43481.4
Wastewater	2491.6	5029.6	3950.4	5557.6	4002.1	4336.1	4375.7	4621	5288.1
Biological waste treatment	2048.6	2076.4	2310.5	1956.9	4589.3	3979.7	3800.3	2560.2	4385.4
Waste incineration and energy supply	**195816.8**	**233437.3**	**209643.9**	**206657.2**	**231635.1**	**266139.2**	**271885.4**	**278790.4**	**266614.4**
Waste incineration	147067.1	173434.2	196157.7	201398.4	226063.5	261355.9	265086.2	268222.8	265442.7
Distance heating, not waste incineration	48749.7	60003.1	17471.1	8282.0	9288.2	4783.2	6799.2	10567.7	1171.7
Industry, oil, and gas	**9980.2**	**11000.2**	**8458.3**	**4179.1**	**6271.4**	**4916.3**	**5304.7**	**3039.9**	**2685.8**
Industry, oil, and gas	9980.2	11000.2	8458.3	4179.1	6271.4	4916.3	5304.7	3039.9	2685.8
Aviation	**0.2**	**0.9**	**0.8**	**0.7**	**0.5**	**0.4**	**0.2**	**0.2**	**0**
Domestic aviation	0.2	0.9	0.8	0.5	0.4	0.4	0.2	0.1	0
Aviation abroad	0	0	0	0.2	0.1	0	0	0.1	0
Heating	**273710**	**160533.1**	**123108.3**	**70945.9**	**72886.9**	**69356.8**	**53016.1**	**27812.3**	**21955.4**
Miscellaneous	5512.2	6365.9	6334.8	6054	5811.9	5048.6	5069.8	4727.8	4859.8
Bioenergy	124	152.7	131.9	133.4	128.1	150.8	144.8	143.4	136
Fossil oil	237308.1	117003.6	85447.3	40946.7	40253.3	40131.9	26575.6	8939.4	55.4
Heating paraffin	16787.3	14261.4	9421.3	5879.1	4281.9	4342.7	2692.4	112.1	0
LPG	7195.4	12557	15657.1	12013.5	18733.4	14631.4	13232.7	10095	12326.2
Natural gas	0	0	0	0	0	0	0	0	0
Wood burning	6783	10192.5	6115.9	5919.2	3678.3	5051.4	5300.8	3794.6	4578
Shipping	**29486.5**	**29486.5**	**29486.5**	**29486.3**	**38807.3**	**38715.3**	**40027.5**	**40510.6**	**40267.4**
*Estimate shipping	29486.5	29486.5	29486.5	0	0	0	0	0	0
Other activities shipping	0	0	0	606.1	655.1	507.1	525.9	990.6	577.2
Other offshore service ships	0	0	0	0	0	1.9	0	0	0
Bulk carriers	0	0	0	1090.7	706.5	1288.5	929.2	428.7	743.6
Cruise ships	0	0	0	2173.4	3157	4098.7	3473.6	4349.1	727.5
Fishing vessels	0	0	0	1.9	14.9	0.2	0	0	26.2
Tankers carrying chemicals	0	0	0	0	0	0	0	0	0

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Refrigerator/freezer ships	0	0	0	3059.9	4408.6	3844.1	4348.4	4547.4	3453.5
Container skips	0	0	0	2739.6	5223.4	4129.9	4926.7	5269	5717.8
Offshore supply ships	0	0	0	39.8	0	1.9	2.7	0	56.7
Oil product tankers	0	0	0	215.5	219.7	251.1	390.5	800.5	800.5
Passenger ships	0	0	0	17423.6	22060.4	22455.5	23139	21011.6	25195.2
Ro-Ro cargo	0	0	0	404.2	466.1	499	504.5	1839.3	2035.9
Crude oil tankers	0	0	0	0	0	0	0	0	0
Regular cargo ships	0	0	0	1730.1	1895.6	1637.4	1786.3	1273.5	932
Road traffic	**733702.3**	**717688.1**	**711044.8**	**702604.1**	**664739.4**	**614621.6**	**623767.9**	**593713.5**	**564570.8**
Buses	41126.2	40494.4	41273.4	41269.3	39320.9	36014.7	36464.3	35450.2	35136
Passenger cars	416810.8	391295.4	382538.1	374714.6	353600.1	329160.4	324365.3	299104	272476.9
Heavy vehicles	137103.5	139819.6	145300.5	151551.3	144741.5	133418.1	142147.2	138934.7	142116.6
Delivery vans	138661.8	146078.7	141932.8	135068.9	127076.9	116028.4	120791.1	120224.6	114841.3
Total	1442877.6	1373772.3	1304605.4	1228534.8	1228838.9	1208722.7	1218335.2	1143539.9	1084233.4

Attachment 3: Uncertainty assessment per sector

Table with brief overview of uncertainty per emission sector.

Emission sector	**Uncertainty (levels red=high; yellow=medium; green=low)**
Road traffic	The Oslo Agency for Climate has assessed that there is some uncertainty concerning these emissions. Uncertainty about emissions calculated in the NERVE model can be reduced if RTM23+ is used.
Waste incineration and energy supply	The Oslo Agency for Climate has assessed that there is some uncertainty concerning these emissions, particularly for waste incineration. Emission factors are based on point measurements and assumptions about the composition of the waste and the proportion of fossil material. Reduced fossil proportions in the waste will not always be shown in the emissions figures, unless the emission factor has been updated. In connection with on-going waste reports, measures to improve local emissions data will be assessed.
Other mobile combustion	Significant improvement has been made of the methodology for this emission source, but the Oslo Agency for Climate continues to assess these emissions as uncertain. In their method memorandum, the Norwegian Environment Agency and Statistics Norway write that in spite of the improvements made to the method, significant uncertainty remains concerning the geographical distribution of the emissions, but that they will continue to improve the calculation methods. The new method calculates emissions based on Statistics Norway's energy balance rather than the sales statistics used previously. This gives greater reliability than before. The energy balance has better information about which industries are using duty-free diesel, and how much they use. On the other hand, it does not include geographical distribution of the consumption of diesel. Emissions are therefore distributed across the municipalities using different distribution keys that varying according to type of industry/business. The distribution key for the building and construction industry is based on a newly developed model from the Norwegian Institute for Air Research, based on construction activities (EmSite) which shows emissions in a much more reliable way than earlier. The calculation method nevertheless still has some uncertainties, such as the effect of local climate measures. Construction activities are not included in EmSite, thus also giving uncertainty about the figures. The distribution key for "Transport-related services" is distributed across municipalities according to employment figures in the industry (SSB, 12539, 2021). This includes operation of railway stations, bus depots and freight terminals, roads, bridges, tunnels etc., and services related to operation of pipelines and sea transport, including the operation of ports. The distribution key for "other industries" gives a somewhat unequal result. The most certain figure is assumed to be the one relating to industry. The other sub-categories here are distributed according to the population or sales statistics, which are assumed to be relatively uncertain.

	Emissions from agriculture and forestry in Oslo are small but may have flaws because tractors have been distributed between municipalities based on fully cultivated areas. As there is little cultivated area in Oslo, it is assumed that there may be somewhat higher emissions from tractors in Oslo than included in the greenhouse gas inventory.
Heating	The Oslo Agency for Climate has assessed that these emissions have low to some uncertainty. Emissions from LPG are divided across the municipalities according to the storage volume in each municipality. The storage volume does not indicate consumption or turnover in the storage units. But it is assumed that quantity to some extent reflects the amount of consumption, and that the uncertainty in this calculation is significantly reduced in this year's publication. Distribution of emissions from the other fossil emission sources uses sales statistics as the data ground. Sales sub-dealers are distributed across the municipalities based on population numbers.
Shipping	The Oslo Agency for Climate has assessed that these emissions have low uncertainty. This year's publication has been improved by adjusting for the use of shore power based on local data for Color Line's ships. Provisionally, adjustment has only been made for 2020, but the Oslo Agency for Climate is planning to adjust further back in time.
Industry, oil, and gas	The Oslo Agency for Climate has assessed that the emissions have low uncertainty. Supplemental emissions calculated by Statistics Norway are shown as additional information.
Waste and wastewater	The Oslo Agency for Climate has assessed that the emissions have low uncertainty. Local data are used to calculate emissions from landfills. Lacking a national factor for emissions from biogas production, the standard factor from the IPCC of 5 per cent is used. In reality, methane emissions from biogas facilities may be somewhat lower than 5 per cent. This may affect the actual emissions figures, creating some uncertainty in the emissions calculations.
Aviation	The Oslo Agency for Climate has assessed that these emissions have low uncertainty.

Virksomhetsnavn
Bydel eller avdeling
Oslo kommune

Besøksadresse:
Gatenavn 789, 0123 Oslo
Postadresse:
Pb. 1234 Stedsnavn, 0123 Oslo

Telefon: +47 22 22 22 22
postmottak@abc.oslo.kommune.no
Org. Nr.: 976820037
oslo.kommune.no