Oslo

Appendix to Oslo's Climate budget 2023

English

Foto: Benjamin Pham

1 Introduction

The Climate Budget 2023 is the seventh in the series of climate budgets. The methods used for the assessments in the Climate Budget are improved and developed continually, and there is an ongoing need to update and improve the underlying knowledge base.

This appendix elaborates on the details behind the Climate Budget 2023, as described in Proposition 1/2023, the City Council's proposed budget for 2023 and the economic plan 2023-2026. These documents should therefore be read in context. The appendix describes the establishment of the emission limits, use of the baseline trajectory, choice of methods and analysis for calculating climate effects and potential, and the need for further reductions in emissions in order to achieve the emission reduction targets for Oslo. Co-benefits that the measures in the climate budget contribute to are also briefly described.

2 Developments in GHG emissions in Oslo from 2009 to 2020

The Norwegian Environment Agency's municipal emission inventory (Norwegian Environment Agency, 2022a) is used as a basis in the Climate Budget. The latest publication covers the period 2009-2020.

The emission inventory is broken down into nine emission sectors and 45 emission sources, and shows emissions for the years 2009, 2011, 2013 and 2015-2020. No emissions have been estimated for years prior to 2009.

The emission inventory includes emissions of the greenhouse gases carbon dioxide (CO_2), nitrous oxide (N_2O) and methane (CH_4). Greenhouse gases are converted to CO_2equivalents (CO_2eq) based on the warming potential of the gases (GWP values) in accordance with the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC 2007). The GWP values for CO_2, N_2O and CH_4 are 1, 298 and 25 respectively. CO_2 emissions from biogenic pulp (wood, etc.) are counted as net zero emissions.

2.1 Status of GHG emissions in Oslo

The emission inventory shows that total GHG emissions in Oslo amounted to around 1.08 million tonnes CO_2eq in 2020. From 2019 to 2020, emissions fell by 5.2%, primarily as a result of an increase in the proportion of electric cars and a reduction in vehicle-kilometres. The reduction in vehicle-kilometres is the result of restrictions in connection with the COVID-19 pandemic. The rise in emissions in 2017-18 was caused by an increase in emissions from diesel-powered motorised equipment and a reduction in the use of biofuels in road transport. In 2020, GHG emissions from the waste and wastewater, industry, oil and gas, aviation, heating and road transport sectors were at their lowest level since 2009. Compared with 2009 levels, emissions in Oslo have fallen by 25% (Figure 1).

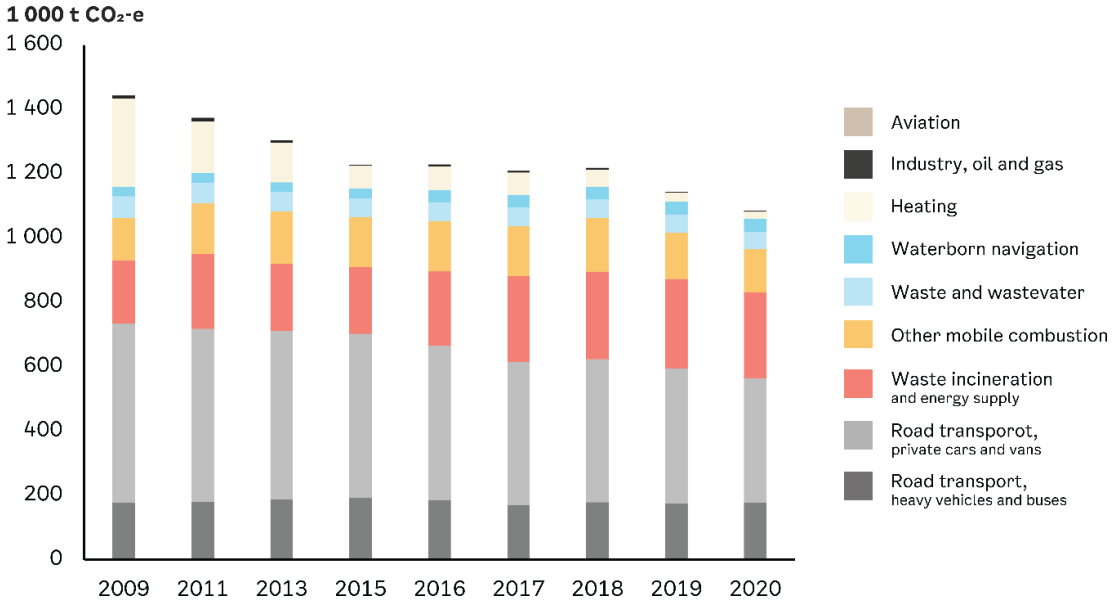

Figure 1: GHG emissions in Oslo by emission sector, 2009-2020

As Figure 2 shows, the largest emission sources in 2020 were road transport (52%), waste incineration and energy supply (25%, primarily the incineration of fossil waste), and other mobile combustion (12%).

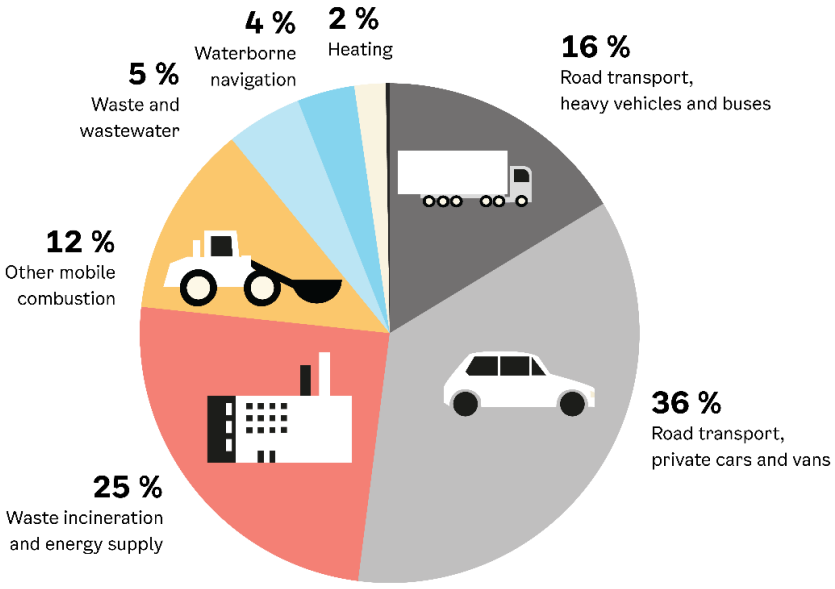

Figure 2: GHG emissions in Oslo by emission sector, 2020

2.2 Emission inventory for Oslo broken down by emission sector

Road transport

Emissions from road transport originate from cars, vans, heavy vehicles and buses, and amounted to just under 564,600 tonnes CO_2eq in 2020. This represents a decrease of 4.9% from 2019, equivalent to just under 30,000 tonnes CO_2eq. The decrease is primarily due to an increase in the proportion of electric cars and a reduction in vehicle-kilometres. A reduction in the in the use of biofuels made a contribution in the opposite direction. GHG emissions from road transport are the largest emission source in the municipality and accounted for 52% of total emissions in Oslo in 2020.

In 2020, cars and vans accounted for 48% and 20% of emissions from road transport in Oslo respectively, while heavy vehicles and buses accounted for 25% and 6% respectively. Emissions from cars fell by 9% from 2019 to 2020, while vans decreased by 4.5%. Emissions from heavy vehicles rose slightly by an amount corresponding to 2% from 2019 due to a reduction in biofuel blending, while buses saw a small reduction corresponding to 1%.

Emissions from road transport have fallen every year since 2009, with the exception of a 1.5% increase from 2017 to 2018. This increase was primarily the result of a decrease in the use of biofuels in Norway. In both 2019 and in 2020, emissions from road transport fell by just under 5% compared with the previous year.

Waste incineration and energy supply

The emissions sector waste incineration and energy supply includes emissions from waste incineration, other district heating, and electricity production and other energy supply. Oslo only has emissions from waste incineration and other district heating. Emissions from the sector amounted to around 266,600 tonnes CO_2eq in 2020. Almost all emissions originate from waste incineration, with the energy generated being used in district heating production. Emissions fell by 4.4% from 2019 to 2020, corresponding to approximately 12,000 tonnes CO_2eq. This reduction was primarily due to the fact that almost no fossil energy sources (peak load) were used in district heating production in 2020. At the same time, the use of peak loads varies from year to year, depending on electricity prices and temperature.

Other mobile combustion

Emissions from other mobile combustion originate from the use of duty-free diesel for non-road motorised equipment used in the construction, agriculture, forestry, transport and waste treatment sectors. Duty-free diesel used in snowmobiles is also included.

In 2020, emissions from the sector amounted to around 135,000 tonnes CO_2eq. Machinery linked to construction generated the largest emissions, accounting for almost 70,000 tonnes CO_2eq. 'Other industries' and 'Services related to transport' are the next two largest emission sources, both resulting in emissions of almost 30,000 tonnes CO_2eq in 2020.

Emissions from the sector fell by 6.8%, corresponding to just under 10,000 tonnes CO_2eq from 2019 to 2020. However, the calculation method used by the Norwegian Environment Agency to estimate emissions from other mobile combustion is subject to some uncertainty, which makes it challenging to explain both emission levels and trends in the sector. Emissions from other mobile combustion vary from year to year depending on the level of construction activity.

Heating

This emission sector includes emissions from the heating of commercial buildings and households, broken down between the emission sources 'fossil fuel heating' and 'wood-firing'. In 2020, emissions from the sector amounted to around 22,000 tonnes CO_2eq, a decrease of 21.1% from 2019. The reduction is linked to a sharp decline in the use of fossil fuel heating sources, a result of the ban on oil heating ban which entered into force on 1 January 2020.

The largest emission source in the sector is the use of LPG, which resulted in emissions of just over 12,300 tonnes CO_2eq in 2020. Emissions from the combustion of paraffin wax and wood-firing both accounted for just under 5,000 tonnes CO_2eq.

Waterborne navigation

This emissions sector includes waterborne commercial and passenger traffic within the municipality's borders. In 2020, emissions from the sector amounted to around 40,300 tonnes CO_2eq, a decrease of less than 1% from 2019. The effect of shore power will be taken into account, but only in 2020. The statistics prior to this will therefore be slightly too high.

In 2020, emissions from cruise traffic fell by over 80% compared with 2019, due to the COVID-19 pandemic. In addition, emissions from chemical tankers and general cargo ships have fallen somewhat. This may partly be due to the fact that there were fewer deliveries of aviation fuel to the Port of Oslo, due to a decrease in the number of flights as a result of the COVID-19 pandemic. Emissions from the passenger segment rose by 20% from 2019 to 2020 as a result of international ferries operating on the Oslo-Kiel route spending much more time within the municipal boundary than they did before the pandemic.

Industry, oil and gas

The emission sector 'industry, oil and gas' includes emissions from both industrial processes and combustion. Oslo only has emissions from combustion. In 2020, emissions in Oslo from industrial combustion amounted to just under 2,700 tonnes CO_2eq, a decrease of 12% from 2019. The facilities that have submitted reports to the Norwegian Environment Agency are FATLAND OSLO AS, GE Healthcare, Nordox and Tine Meieriet Oslo (Kalbakken facility). According to Norske utslipp, Nordox reduced its emissions from 2019 to 2020.

Statistics Norway estimates emissions from incineration plants that do not submit reports to the Norwegian Environment Agency. These emissions are excluded from the emission inventory, but are shown as additional information to the emission inventory as supplementary emissions estimated by Statistics Norway. These emissions have been omitted because of uncertainty linked to annual developments in these emissions, as Statistics Norway's estimates are based on a sample survey where not all enterprises are asked about energy consumption every year. In 2020, these emissions amounted to approximately 25,700 tonnes CO_2eq.

Waste and waste water

The Waste and waste water sector includes the emission sources waste landfill gas, biological treatment of waste and waste water. In 2020, emissions from the sector amounted to around 53,200 tonnes CO_2eq, a decrease of 3% from 2019.

Around 82% of emissions from the sector originate from landfill gas produced at closed landfill sites in Oslo. These landfills are the largest source of methane gas emissions in Oslo.

Aviation

Emissions from this sector originate from emissions from aircraft and helicopters during landing or take-off. In 2019, Oslo was attributed emissions of 0.2 tonnes CO_2eq as a result of the take-off and landing of helicopters at Rikshospitalet and Ullevål Hospital in Oslo. These emissions are not included in the inventory for 2020, so the time series in the Norwegian Environment Agency's emission inventory is not consistent for this emission source.

2.3 Uncertainty

Although the Norwegian Environment Agency's emission inventory is continually being improved, it remains subject to considerable uncertainty. Access to data varies between emission sources, and there will therefore be variations in the degree of reliability of the estimates in the emission inventory. The City of Oslo's Agency for Climate will continue its dialogue with the Norwegian Environment Agency in 2023. Future changes in the methods that are used will affect emissions throughout the time series, from 2009 through to the most recent emission year for which statistics are available.

In cooperation with the Norwegian Environment Agency, the Agency for Climate has reviewed the existing method and assessed the potential for using local data to create a more accurate historical time series. An analysis by CICERO (2020) commissioned by the Agency for Climate identified a consistent challenge that the municipal emission inventory does not reflect the effect of local measures implemented by the City of Oslo. This represents a major challenge, particularly in the emissions sector 'Other mobile combustion', where the climate effect of the use of biofuel in Oslo is not reflected in the inventory. There are also a number of minor emission sources that are not included in the Norwegian Environment

Agency's emission inventory, partly because of the lack of high-quality data. Minor industrial players who are not required to submit reports to the authorities are one example of this. It is important that the Norwegian Environment Agency further develops the emission inventory so that it reflects both actual GHG emissions in Oslo and the effect of the measures in the Climate Budget.

For this year's publication, the Norwegian Environment Agency improved the figures used to estimate emissions from construction machinery and motorised equipment. These emissions are now distributed based on Statistics Norway's energy balance, rather than sales statistics for petroleum products. The energy balance contains more accurate data regarding the industries that use duty-free diesel, and the quantities that they use. However, it does not contain a geographical breakdown of diesel consumption. The emissions are therefore distributed between the municipalities according to various distribution keys, which vary between the industries concerned. Despite the methodological improvements, the geographical distribution of emissions is still subject to considerably uncertainty.

As regards road transport, traffic volumes are modelled using the NERVE model, with traffic figures being obtained from RTM. RTM is a regional traffic model which is used in road traffic analyses for car traffic and public transport throughout Norway. For Oslo, the MODEL RTM Region East is used, which is a model which covers the whole of central Eastern Norway. Comparison with traffic counts in Oslo indicates that the figures for vehicle-kilometres produced by the model are too high. The emissions from road transport attributed to Oslo are therefore in all probability too high, especially as regards light vehicles. An analysis conducted by Urbanet Analyse (2020) on behalf of the City of Oslo's Agency for Climate showed that uncertainty in emissions calculated using the NERVE model can be reduced by using RTM23+. RTM23+ is a local model for the Oslo and Akershus region.

For calculating emissions from waste incineration, a national emission factor is used. This factor is based on a number of point-based measurements and assumptions concerning the composition of the waste. This factor is now several years old and reductions in the proportion of fossil waste in the residual waste will not be reflected in the emission figures unless an updated facility-specific emission factor is established. The Agency for Waste Management is working to obtain approval for a new emission factor based on its own waste analyses.

3 Emission limits towards 2030

The Climate Budget uses annual emission limits. These emission limits indicate the magnitude of reductions in emissions that the municipality is seeking to achieve each year compared with 2009. The emission limits are not independent targets, but a tool for steering towards a downward trend in emissions in order to achieve the emission reduction targets in 2023 and 2030. If the emission limits for one year are not achieved, emissions must be reduced more rapidly over the next few years in order to achieve Oslo's emission reduction targets.

In the Climate Budget 2023, the emission limits will start from the most recent emission inventory in 2020, with a straight line down to the target of a 52% reduction in emissions in 2023. The emission limits do not take into account adopted measures, with the exception of carbon capture at Klemetsrud. The Climate Budget 2022 reflected an expectation that the facility would be fully operational from 1 January 2026. Now that a funding solution is in place for the carbon capture facility, it has been clarified that the facility will be ready from June 2026, and is expected to achieve its full effect from 2028. The emission limits have been adjusted accordingly in this year's Climate Budget.

Year	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
Emission limits	-25%	-34%	-43%	**-52%**	-56%	-61%	**-73%**	-81%	-86%	-90%	-95%

4 The Climate Budget analysis

The Agency for Climate is responsible for both ensuring that calculation of measures are performed as consistently as possible across different sectors and for compiling the analyses. Key tasks include ensuring that all climate impacts are measured against the municipality's latest updated baseline trajectory, ensuring that underlying assumptions are as consistent as possible across sectors and measures, and doing necessary corrections to double counting of climate impacts.

4.1 Baseline trajectory - projection of emissions towards 2030 with current measures

Estimates of emission reductions as a result of measures in the Climate Budget are based on a baseline trajectory, which is a projection of changes in emissions in Oslo towards 2030 assuming no further climate measures are implemented after the end of 2021.

The baseline trajectory is based on the best available knowledge concerning historical GHG emissions (Norwegian Environment Agency, 2022a) and assumptions on how key variables that impact GHG emissions will develop towards 2030, such as population growth, technological advances and economic development. The baseline trajectory is updated annually to take account of the latest available knowledge. There is considerable uncertainty as to how the different variables and overall emissions will develop over time. Nevertheless, the results provide an indication of the key trends, and the structure behind the calculations forms a starting point that can be used for further analysis and estimates of the climate effect of different measures. The methodological memorandum on the baseline trajectory for Oslo (CICERO, 2022) contains detailed descriptions of prerequisites and assumptions for each sector.

The COVID-19 pandemic had major consequences for Oslo in 2020-2021. The pandemic resulted in an economic downturn, and may have impacted on factors such as population growth in Oslo and technological advances. Infection control measures to combat coronavirus have resulted in changes in travel habits and commercial activity, amongst other things. The long-term effects are hard to predict. High electricity prices, petrol prices and other consequences of the war in Ukraine, etc. may also be affecting GHG emissions in both the short and the longer term. Due to the recent nature of these shocks and corresponding lack of data the climate agency cannot correct for this uncertainty in the baseline trajectory or in the climate budget analysis.

Developments in emissions in the baseline trajectory assume that adopted central government and regional policies are implemented as planned without any delay. This is because the baseline trajectory includes the emission-reducing effects of approved central government and regional policies as of 1 January 2022. Measures from the City of Oslo's Climate Budget which were implemented before 1 January 2022 are also included. The baseline trajectory assumes that the local measures that are included will not require further follow-up in order to achieve their estimated emission-reducing effect. Adopted measures that require follow-up, through either appropriations or further processes, are included as approved measures in the Climate Budget. This is done to avoid having any measures in the baseline trajectory which require follow-up in the form of additional allocations, etc. in order to trigger the estimated emission-reducing effect.

The following measuresare included in the baseline trajectory:

- National ban on mineral oil for permanent building heating from 2020 (national)
- National ban on the use of mineral oil for temporary building heating and drying from 2022
- National biofuel quota obligation in aviation from 2020 (national)
- National biofuel quota obligation for road transport, with an increase to 2022 (national)
- The road toll payment system and charges as of 1 January 2022
- Electrification of Ruter's ferry routes to Nesodden
- Shore power for international ferries and cement ships established in Oslo by the end of 2021
- Extraction of landfill gas at the level that was established by the end of 2021

The local measures that have been implemented and included in the baseline trajectory will reduce emissions in 2030 by around 21,000 tonnes CO_2eq. However, this estimate does not include the climate effect of the existing road toll ring or the adopted measures in the Climate Budget, even though these measures have been developed over many years. For example, the road toll ring has since its inception in 1990 helped fund vital public transport projects, limited car traffic, and contributed to the transition to a more climate-friendly vehicle fleet. However, the effect is difficult to calculate due to, among other things, overlap with other local and central government electric car policies. It is therefore not possible to estimate the climate effect of the road toll ring in isolation. However, the effect is reflected in the baseline trajectory and has helped to ensure that emissions from road transport in Oslo have declined sharply (see below).

The baseline trajectory shows an estimated reduction in GHG emissions of 39% in 2030 from 2009. Figure 3 shows historical emissions and projections of emissions towards 2030.

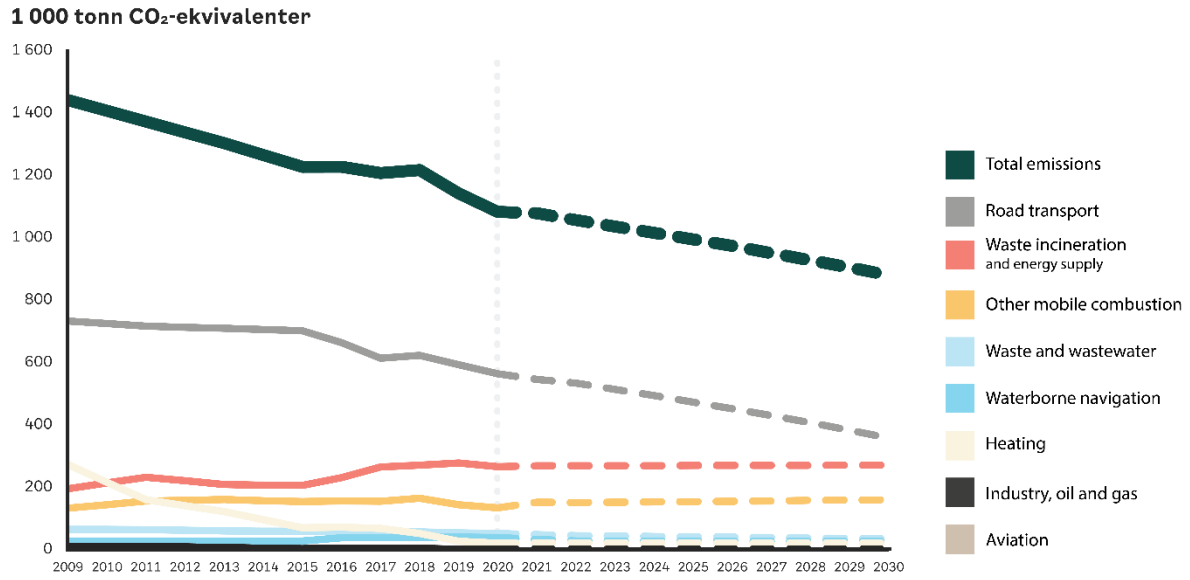

Figure 3: Development in historical emissions during the period 2009-2020 and emission projections for the period 2021-2030, assuming no additional measuresafter 2021

The reduction in emissions in the baseline trajectory is almost exclusively the result of a decline in emissions from road transport as a result of an increase in the proportion of zero-emission cars. Most of the decline comes from cars and some from vans, while emissions from heavy vehicles increase somewhat.

Emissions are also significantly reduced in the 'Waste and wastewater' sector. This is because the production of methane at closed landfills will gradually decrease as the waste decomposes and diminishes. In addition, emissions will fall in the 'Waterborne navigation' sector due to the closure of Stena Line's route to Frederikshavn in 2020 and the use of shore power.

In the 'Waste incineration and energy supply' and 'Other mobile combustion' sectors, a slightly rising emission trend towards 2030 is forecast as a result of both population growth and economic growth. In the remaining sectors, there are minor or insignificant changes in emissions between 2020 and 2030.

'Road transport' is still expected to be the largest emission sector in 2030, assuming continuation of the current measures, but 'Waste incineration and energy supply' and 'Other mobile combustion' are well on their way to taking over the position of dominant emission sectors in the baseline trajectory. However, measures such as carbon capture at Klemetsrud and the introduction of a fossil-free requirement for construction sites are not included in the baseline trajectory, and the actual outcome may therefore differ.

4.2 Estimating the climate effect of measures in the Climate Budget 2023

The calculations concerning measures in the Climate Budget only include direct GHG emissions within the municipality's boundaries. Any effects that the measures have on emissions outside the municipality (consumption-based emissions, such as the production of electric cars) are not taken into account in the calculations. This is consistent with the scope of the Norwegian Environment Agency's emission inventory.

The calculation of the climate effect of measures is based on assumptions concerning how the measures will affect various factors which result in GHG emissions. For some measures, actual activity data has been used as a basis for calculating the climate impact. For other measures, discretionary assessments have been made of how the measures will bring about changes in activity or behaviour. All prerequisites and assumptions are subject to uncertainty.

Estimates of the climate effect of measures are based on external analyses and models, along with a significant number of prerequisites and assumptions. Assessments concerning the rate of introduction and emission-reducing effect are generally carried out by the Agency for Climate in consultation with the associated responsible municipal entities and relevant external parties. The estimated climate effect presupposes that measures will be implemented as planned and without any delay.

The annual effect of measures is estimated as the reduction in GHG emissions compared with the emission level in the baseline trajectory for the same year. This approach enables us to estimate the additional effect of the new/strengthened measure compared to current policy. Estimating climate effects compared to a baseline trajectory ensures that the climate effect of measures are not overestimated.

The climate effects of the measures adopted in the Climate Budget for 2023 thus amount to the difference between the emission level in the baseline trajectory in 2023 and emissions after the measure has been implemented in the same year. The same applies to 2026.

Many of the measures in the Climate Budget affect the same emission sources. The climate budget analysis ensures that the effect of a measure is not counted twice or overestimated. This is a particularly relevant issue as regards road transport, because many of the measures affect the same activity, or offer incentives for the same technological change (such as the transition from fossil fuel to electric cars). For example, measures which reduce vehicle traffic must be taken into account when estimating the effect of a measure which increases the use of biofuels. Adjustment of the climate effect due to overlap is explained per sector where relevant.

A description is given below of how the effects of the adopted measures in the Climate Budget are estimated.

Waste incineration and energy supply

1. *Establishment of gas boiler for the production of district heating from landfill gas*

The reductions in emissions are estimated at 200 tonnes CO_2eq in 2023 and 300 tonnes CO_2eq in 2026. These estimates are based on forecasts from the Agency for Real Estate and Urban Renewal concerning the extraction of landfill gas that will be sent for combustion in the gas boiler from 2023 onwards. It is assumed that energy production from the gas boiler will replace the fossil fuel component of the average mix of energy sources that Fortum Oslo Varme (now Hafslund Celcio) has used in district heating production in recent years.

The specified climate effect is higher in 2026 than in 2023, since the gas boiler will likely not be fully operational until 2024. The maximum climate effect is expected to be achieved in 2024, but the effect will decrease towards 2030 due to reduced methane production in the closed landfills. Since no new waste is being added methane production will decrease the existing organic material in the landfill decomposes.

2. *Carbon capture at the Klemetsrud facility*

The reduction in emissions is estimated at 103,100 tonnes CO_2eq in 2026. The facility is expected to be ready to capture carbon in June 2026 and will therefore not achieve its full effect in 2026. The facility is expected to be fully operational by 2028. The reduction in emissions in 2028 is estimated to be just under 165,000 tonnes CO_2eq. This calculation is based on fossil CO_2 emissions from the Klemetsrud facility that have been reported to Norske utslipp and projections of waste volumes in the baseline trajectory from 2022 to 2030. The expected emission capture rate is 94%.

The facility will capture similar quantities of biogenic CO_2 (from biological material) as fossil CO_2. Since the COP26 climate summit in Glasgow, it has been possible to include the capture of biogenic CO_2 in the emission inventory. The Norwegian Environment Agency has confirmed that it will include this capture in both the national and municipal emission inventories. For Oslo, including the capture of biogenic CO_2 in the emission inventory will make emissions from waste incineration negative, despite the fact that there are still emissions from other waste incineration facilities in Oslo.

Waste and wastewater

3. Maintenance of landfill gas facilities at Rommen and Grønmo

The emission-reducing effect of the upgrades that were carried out up to and including 2020 at the landfill gas facilities is taken into account in the municipal emission inventory. The effects of improvements carried out before 2022 are included in the baseline trajectory.

At the same time, it is expected that the extraction of landfill gas can be increased after the establishment of a gas boiler at Klemetsrud (see the measure *Establishment of gas boiler for landfill gas*). This is both because the gas boiler will be capable of creating a greater negative pressure in the landfill and because the gas boiler will not be dependent on capacity in connection with the flaring of the methane gas. However, the potential magnitude of this effect is uncertain, and the climate effect has therefore not been quantified.

Road transport

Many of the measures for the road transport sector affect the same activity and/or emission source. The climate effects of the measures adopted in the Climate Budget have therefore been adjusted for overlap based on the order in the table (see table of adopted measures in the Climate budget). This means that the measures that appear first in the table have a greater climate effect in relative terms than the measures further down the table. This means for example that, after the effect of *New tariffs in the toll ring* has been calculated, the subsequent calculations will take into account the fact that new tariffs in the road toll ring have already reduced the number of vehicle-kilometres and increased the proportion of electric vehicles. As a result, the climate effect of subsequent measures is lower than if the effects of the measures were calculated in isolation.

4. New tariffs in the road toll ring

It is estimated that the new tariff scheme in the road toll ring that was introduced on 1 September 2022 will reduce GHG emissions from cars by around 17,200 and 18,200 tonnes CO_2eq in 2023 and 2024 respectively. This is the additional effect over and above the effect of the tariffs from 2021 that have already been taken into account in the baseline trajectory.

The calculation is based on an analysis which indicates that the new tariffs in the road toll ring will increase the proportion of electric light vehicles (cars and vans) by 4% in 2030 compared with the anticipated trend in the baseline trajectory. It is also estimated that the new tariffs will reduce road traffic levels by 5% (10% in the road toll ring) in 2030.

5. Procurement of zero-emission and fossil-free vehicles in the municipality

It is estimated that purchases of zero-emission and fossil-free vehicles in the municipality will result in an emission reduction of 1,100 tonnes CO_2eq in 2023 and 1,000 tonnes CO_2eq in 2026. The effect was estimated using data from the Agency for Improvement and Development which details the number of vehicles and the proportion of electric vehicles in the municipal vehicle fleet (Agency for Improvement

and Development, 2022). The estimate is based on all light vehicles and half of heavy vehicles being electric from 2022, while all remaining heavy vehicles use biodiesel.

6. *Establishment of zero-emission zone within the car-free city living area (excluding Grønland and Tøyen)*

The emission-reducing effect of the measure has been estimated on the basis of Norconsult's (2021) report on the effect of introducing various zero-emission zones in Oslo. The report assumes that the zero-emission zone will result in a reduction in the number of vehicle-kilometres amongst fossil fuel-powered cars, vans and heavy vehicles. The estimate is based on a linear decrease in the number of kilometres travelled within the car-free urban living area from 2024, which corresponds to the decrease that Norconsult estimated for 2023-2025. This will result in an emission reduction of 6,400 tonnes CO_2eq in 2026.

7. *Incentives to promote cycling and walking (subsidies, climate-friendly commuting programme, infrastructure for cycling)*

It has not been possible to specify the emission-reducing effect of the measures intended to stimulate an increase in cycling and walking. This is because there is no basis for determining the amount by which the measures will reduce car traffic over and above other measures in the Climate Budget that affect the same emission sources.

8. *Improve public transport (improve accessibility, new trams, improvements to the Oslo Metro, etc.)*

It has not been possible to specify the emission-reducing effect of the measures intended to contribute to improvements in public transport. This is because there is no basis for determining how much the measures will reduce car traffic by over and above the other measures in the Climate Budget that affect the same emission source. However, a well-developed public transport system is both a cornerstone of being able to develop Oslo into a low-emission city and fundamental for implementing other measures, such as the removal of parking spaces.

9. *Facilitate the use of sharing solutions (car sharing, e-bike sharing, etc.)*

An increase in the use of sharing solutions will reduce emissions, but it has not been possible to determine what this measure will contribute in terms of emission reductions. This is because there is insufficient knowledge and data to quantify the amount by which the measures will reduce car traffic compared with the other measures in the Climate Budget which affect the same emission source.

10. *Parking measures(increase tariffs, remove parking spaces, new parking regulations, etc.)*

Parking measures will reduce GHG emissions, but the effect of the measures has not been calculated, as there is insufficient knowledge or data sources available which can be used to quantify how much the measures will reduce passenger car traffic by over and above the other measures in the Climate Budget that affect the same emission source.

11. *Reduce the transport of bulk materials and waste*

Reductions in the transportation of bulk materials and waste will reduce GHG emissions, but the effect of the measure has not been quantified as there is insufficient knowledge and data sources available which can be used to quantify how much the measures will reduce heavy transport by over and above the other measures in the Climate Budget that affect the same emission source.

12. *Establish charging infrastructure for cars*

This measure will facilitate the transition to electric vehicles, but does not result in direct emission reductions. No climate effect of the measure has therefore been calculated.

13. *Incentives for zero-emission taxis from 2025 (requirements, subsidies, charging infrastructure, etc.)*

Subsidies for home charging for taxi drivers and the establishment of charging infrastructure in the city are prerequisites for the requirement that all taxis in Oslo must be zero-emission from 1 November 2024.

Based on best judgement, it is assumed that the requirement will result in the phasing-in of electric taxis equivalent to a share of 30% in 2022, 60% in 2023, and 80% in 2024 before 1 November 2024. This will give an emission-reducing effect of 5,800 tonnes CO_2eq in 2023 and 9,600 tonnes CO_2eq in 2026.

The effect has been estimated on the basis of figures for annual vehicle-kilometres for taxis in Oslo from Statistics Norway (2022c), with an estimated growth in traffic consistent with the baseline trajectory. Actual data for the renewable share in the vehicle fleet from 2018 to 2022 was taken from the taxi centres (Department of Urban Environment, 2021b; Oslotaxi, 2022). It has not been possible to obtain complete data concerning the share of renewables in 2021 and 2022 due to deregulation of the number of taxi permits. It is assumed that the proportion of zero-emission taxis without the requirement (the zero alternative) will develop more slowly than the development in electric cars in the baseline trajectory. This is because taxis are used more continuously and need to be charged more frequently than ordinary cars.

14. *Requirement for zero-emission goods deliveries on behalf of the municipality, and*
15. *Incentives for zero-emission vans (establish/subsidies for charging infrastructure, freight consolidation centres, loading facilities, parking, etc.)*

The emission-reducing effect of all these measures has been estimated collectively because they all contribute to reducing emissions from vans. Calculating an overall estimate for the measures reduces the level of uncertainty. The emission-reducing effect of the measures is estimated at 900 tonnes CO_2eq in 2023 and 400 tonnes CO_2eq in 2026. The effect was calculated based on sales figures for electric vans in Oslo up to June 2022 (OFV, 2022).

In the calculation, it is estimated that 54% of vans operating in Oslo in 2030 could be electric, 14 percentage points above the level assumed in the baseline trajectory. However, it is estimated that measures will contribute to an increase in the proportion of electric vans by just 0.5 percentage points above the baseline trajectory in 2026. The reason why there is an expectation of a high proportion of electric vans in the baseline trajectory is that no distinction is made between cars and vans in the road traffic models that were used as a data source. As the proportion of electric cars is already high in Oslo, this means that the proportion of electric vans is at a relatively high level in the baseline trajectory.

16. *Procurement of zero-emission buses for public transport*

The emission-reducing effect of using zero-emission buses in public transport is estimated at 14,000 tonnes CO_2eq in 2023 and 20,700 tonnes CO_2eq in 2026. This effect was calculated based on figures from Ruter concerning vehicle-kilometres using different fuels, along with data on the use of electric buses in future Oslo contracts (Ruter, 2021). The calculation is based on the assumption that all buses will be electric in Oslo South from 1 January 2022, in Oslo Inner City from 1 January 2023, and in Oslo Northeast and Østensjø from 1 January 2024. The bus route over the Ulvøybrua bridge cannot be converted to electric operation because the bridge is unable to support the weight of electric buses. The calculation is based on the anticipated number of kilometres in the various contracts and the overall proportion of zero-emission traffic.

Ruter's buses operate in both Oslo and Viken. The city buses primarily operate in Oslo, while the regional buses mainly operate in Viken, but they also serve Oslo bus terminal. To ensure that the climate effect is not overestimated, only the city buses are included in the calculation of the effect. This will probably result in the potential for reductions being somewhat underestimated, as the regional buses also operate in Oslo.

17. *Procurement of zero-emission transport for persons with disabilities*

The climate effect of transport for persons with disabilities becoming zero-emission or switching to biogas has been estimated at 800 tonnes CO_2eq in all years from 2021 towards 2030. The effect was calculated using figures for vehicle-kilometres travelled by transport for persons with disabilities where biogas/electricity has replaced diesel as a fuel. It is estimated that 10% of the vehicle-kilometres are operated by electric minibuses, while the remainder is based on biogas.

18. *Incentives for zero-emission tour and express buses (establish/subsidies for charging infrastructure)*

Establishment and subsidies for charging infrastructure are facilitating measures that do not result in direct reductions in emissions and have therefore not been quantified. The municipality is working to influence the bus industry into switching to zero-emission solutions through dialogue, networks such as Industry for Climate, etc. It has not been possible to determine the number of electric coaches operating in Oslo, or how many kilometres they travel within the municipal boundary. No emission-reducing effects of the measures have therefore been estimated.

19. *Requirement for the use of zero-emission trucks on assignments carried out on behalf of the municipality and*
20. *Incentives for zero-emission heavy transport in Oslo (exemptions inside the road toll ring, establish/subsidies for charging infrastructure, provision of land for energy stations, etc.)*

The emission-reducing effect of these measures has been calculated collectively because they all contribute to reducing emissions from heavy transport. Calculating an overall estimate for the measures reduces the level of uncertainty.

The climate effect of the measures is estimated at 2,400 tonnes CO_2eq in 2023 and 14,000 tonnes CO_2eq in 2026. These calculations are based on the trend in the number of registered electric and biogas-powered trucks in Oslo (OFV, 2022). As regards electric trucks, exponential growth is expected towards 2025, after which growth will level off somewhat. Further linear growth is expected for biogas-powered trucks throughout the period towards 2030. A ceiling has been set according to which the proportion of electric and biogas-powered vehicles cannot exceed 45% of new car sales during the period towards 2030, as surveys from Hafslund (2021) and ZERO (2021) indicate that not all areas of the truck market will be electrified by 2025. The calculation assumes that all existing measures will continue at full strength. Establishment and subsidies for charging infrastructure are facilitating measures that will not result in direct emission reductions, but the provision of adequate charging facilities for heavy vehicles is considered to be particularly important for ensuring that the trend continues.

Other mobile combustion

21. *Zero-emission requirement for municipal construction sites*

The emission-reducing effect of the requirement is estimated at 11,900 tonnes CO_2eq in 2023 and 14,800 tonnes CO_2eq in 2026. Construction sites will be fossil-free from 2020 and zero-emission from 2025. The calculation is based on the assumption that the City of Oslo accounts for 20% of turnover in the construction market (Entreprenørforeningen for bygg og anlegg, 2019). The effect therefore corresponds to a 20% reduction of the emissions from construction in the baseline trajectory from relating to construction from 2025. From 2020, an increasing proportion of zero-emission operations and a declining proportion of biofuels have been assumed.

22. *Fossil-free construction site regulation in zoning plans*

The climate effect is estimated at 17,900 tonnes CO_2eq in 2023 and 38,600 tonnes CO_2eq in 2026. The requirement covers central government and private construction projects, and it is estimated that these projects account for 80% of construction activity in Oslo (Entreprenørforeningen for bygg og anlegg, 2019). The rate of phasing-in assumed in the calculation is based on a survey conducted by the Agency for Planning and Building Services concerning the number of zoning plans that will be covered by the requirement in the years towards 2030. The survey estimates that the requirement will cover 34% of construction sites in 2023, 74% in 2026 and 86% in 2030. The climate effect was estimated by assuming zero emissions from construction sites covered by the requirement with the above implementation rate.

23. *Facilitate zero-emission handling of goods and cargo at the Port of Oslo*

The emission-reducing effect of the transition to the zero-emission handling of goods and cargo at the Port of Oslo is estimated at 300 tonnes CO_2eq in 2023 and 2,000 tonnes CO_2eq in 2026. The calculation is based on data from the Port of Oslo concerning the consumption of diesel by operators at the port in 2018. Furthermore, it was assumed that 60% of cranes and machinery at the port will be zero-emission by 2025, and that 95% will be zero-emission by 2030.

24. Procurement of zero-emission machinery for the City of Oslo's machinery fleet

The emission-reducing effect of switching the City of Oslo's machinery fleet to zero-emission is estimated to be 1,300 tonnes CO_2eq in 2023 and 2,900 tonnes CO_2eq in 2026. The calculation is based on figures reported by the municipal entities concerning diesel, biodiesel and electricity consumption by construction machinery towards 2021 inclusive. The development in the use of the various fuels is projected using the same growth rate as in the baseline trajectory for other industries within other mobile combustion, and is based on the requirement that all the municipality's machinery must be zero-emission from 2025.

25. Incentives for zero-emission motorised equipment and events (subsidies, electricity for events)

The transition to zero-emission motorised equipment and zero-emission events which have previously used diesel generators is estimated to reduce emissions by 500 tonnes CO_2eq in 2023 and 700 tonnes CO_2eq in 2026. Each of the two measures accounts for around half of the overall effect. The calculation for electricity used for events is based on the number of litres of diesel that were replaced by electricity at Kontraskjæret, Rådhusplassen and Vaterland in 2019 (litres per operating day) and projected based on the expected the number of events and the establishment of more electrical power outlets in the future. The calculation of the effect of subsidies for zero-emission motorised equipment is based on the number of commitments made in 2021. Subsidies are only given for machinery that uses less than 10,000 litres of diesel per year. Consumption may vary, and it is assumed that on average each subsidy contributes a reduction of 7,500 litres of diesel per year. Nine applications were approved in 2021. This is expected to increase going forward, but to be conservative the Agency for Climate has assumed that 15 projects are funded yearly from 2023 to 2030.

Waterborne navigation

26. Procurement of zero-emission high-speed ferries

The procurement of zero-emission high-speed ferries is estimated to have an emission-reducing effect of 1,400 tonnes CO_2eq in 2026. Procurement of the high-speed ferries will take place during 2024. The full annual effect has therefore been included from 2025. The calculation is based on which routes are to be electrified, fuel consumption figures reported by Ruter, and the emissions that they represent in the baseline trajectory.

27. Establish shore power for container, tanker and cruise ships

The climate effect of establishing shore power for container, tanker and cruise ships is estimated at 1,900 tonnes CO_2eq in 2026. The effect calculation is based on information from the Port of Oslo concerning the timing of establishment and the use of shore power for the various categories of ship.

4.3 Approach to different calculations and the assessment of uncertainty

The methods used to calculate the effect of the different measures is chosen based on the type of measure that is being assessed, but this choice is also often limited by data and the computational tools that are available. The Agency for Climate either uses in-house resources or consultants to evaluate emission effects. These analyses can be based on project analyses, various models (e.g. transport models) and expert assessments.

Inhouse procurement and projects

It is often easier to assess the climate effect of the municipality's own procurements and projects than it is for other measures. In this regard, project analyses are often used and there is little uncertainty regarding what is to be carried out (actors' behaviour). Information is often available on the technology that has been adopted and the activity that is being replaced (e.g. switching from a diesel car to an electric car). This also applies to major projects over which the municipality has no direct control, but detailed project analyses are available (e.g. carbon capture at Klemetsrud). Such calculations are subject to considerably less uncertainty than assessments of other measures.

Regulatory requirements

As a general rule, although it is more challenging to assess the effects of introducing requirements than the effects of inhouse procurement or projects, it is still simpler than to assessing the effect of economic instruments. This is also reflected in the uncertainty in the calculations for the various measures. Nevertheless, it is important to be aware that there are exceptions to this generalisation.

When an activity is regulated through a ban or a technology requirement, it can be relatively easy to know how economic actors will adapt. This is particularly true of a technology requirement. In order to estimate future reductions in emissions as a result of these types of requirements, we normally use activity data and an emission factor as our starting point, and assume that the emissions will cease when the requirement enters into force. For example, when calculating the zero-emission taxi requirement, we start with figures for the number of kilometres travelled by fossil fuel taxis and assume that the use of such taxis will cease by 1 November 2024 when the requirement enters into force. When estimating the effect of regulations, the greatest uncertainties are often linked to the quality of activity and emission data, and adaptation to the requirement before the legislation enters into force.

Economic instruments

It can be particularly difficult to assess the effect of changes in economic instruments such as road tolls or subsidies, as well as transport measures such as the construction of cycle paths or the introduction of zero-emission zones. Common to these is that they affect many, often smaller, economic actors, and that there may be many different ways for them to adapt to the new instruments. The estimates are thus generally subject to greater uncertainty than estimates of the effects of requirements or inhouse procurement, particularly because there is considerable uncertainty associated with the behaviour and technological choices of some actors.

A combination of transport models, price elasticities and expert assessments are used to estimate emission reductions triggered by these instruments. For example, price elasticities are used to calculate reductions in emission from changes in road toll charges. To assess zero-emission zones, Norconsult uses, inter alia, results from the RTM23+ transport model. As regards other measures such as the package of incentives for zero-emission heavy transport, which covers everything from exemptions from road tolls to subsidies for charging infrastructure, the effect calculation is based on an expert assessment. Such an expert assessment takes into account historical trends, future technological advances and a barrier analysis.

Assessment of uncertainty in measure calculations

The calculations are subject to varying degrees of uncertainty. In Table 1, we present a brief description of the level of uncertainty in the calculations. The level of uncertainty in the calculations is considered to be high, medium or low. These are discretionary assessments made by the Agency for Climate based on the types of data sources that are available and the way in which emissions are calculated in the emission inventory.

An assessment has also been included of the impact that the uncertainty may have on the effect that has been calculated. If the uncertainty in the calculation is considered to amount to more than 10,000 tonnes CO_2eq, the effect is considered to be high. Uncertainty in the range 5,000-10,000 tonnes CO_2eq is categorised as a medium consequence, while uncertainty of less than 5,000 tonnes CO_2eq. is categorised as minor.

Table 1: Level of uncertainty for each measure in the Climate Budget 2023

No.	Measure	Description of uncertainty
1	Establishment of gas boiler for the production of district heating from landfill gas Uncertainty: Low Consequence: Low	There is little uncertainty associated with the project, and the calculation is based on actual measurements of landfill gas extraction combined with reliable forecasts for future extraction.

2	Carbon capture at the Klemetsrud facility Uncertainty: Low Consequence: High	Mature carbon capture technology will be used at Klemetsrud, and there is little uncertainty over the amount by which this technology will be able to reduce emissions from the facility. The facility has also treated a stable quantity of waste in recent years, indicating that the level of uncertainty in the calculation is low. Nevertheless, there is potential to overestimate the effect in the short term as a result of potential delays in start-up. Despite the low level of uncertainty in the figures, the potential consequences are considerable as the facility accounts for such a high proportion of Oslo's total GHG emissions.
3	Maintenance of landfill gas facilities at Rommen and Grønmo	Not calculated
4	New tariffs in the road toll ring Uncertainty: High Consequence: High	The price elasticities used to calculate reductions in emission are subject to considerable uncertainty and are a few years old. Amongst other things, they do not reflect technological advances in the electric car market in recent years or the strained energy situation that we are seeing at present with high petrol, diesel, and electricity prices. This greatly increases the level of uncertainty in the calculations. The measure also accounts for a relatively high proportion of the estimated total potential for emission reductions, and the consequences are therefore considered to be considerable.
5	Procurement of zero-emission and fossil-free vehicles in the municipality Uncertainty: Low Consequence: Low	The municipality has high-quality data regarding its own vehicles and the replacement of vehicles. Nevertheless, there is uncertainty linked to when different vehicle models will become available and can be delivered, which may affect how quickly electric vehicles can be phased in. The effect may be somewhat overestimated due to the fact that the Fire and Rescue Service has been granted dispensation to use fossil fuel-powered vehicles. However, the level of uncertainty is considered to be low.
6	Establishment of zero-emission zone within the car-free city living area (excluding Grønland and Tøyen) Uncertainty: High Consequence: Medium	The introduction of a zero-emission zone can affect the behaviour of thousands of individuals who may adapt to the measure in different ways. Such estimates are always subject to considerable uncertainty. The climate effect that is specified is an example calculation performed by Norconsult which is based on, amongst other things, the results from the run of a regional transport model (RTM23) whose main purpose was not to assess a zero-emission zone. These factors make the uncertainty considerable. Nevertheless, the measure does not account for a very high proportion of the total potential for emission reductions, and the consequences are therefore considered to be medium.
7	Incentives to promote cycling and walking (subsidies, climate-friendly commuting programme, infrastructure for cycling)	Facilitating measure
8	Improve public transport (improve accessibility, new trams, improvements to the Oslo Metro, etc.)	Facilitating measure
9	Facilitate the use of sharing solutions (car sharing, e-bike sharing, etc.)	Facilitating measure
10	Parking measures(increase tariffs, remove parking spaces, new parking regulations, etc.)	Not calculated
11	Reduce the transport of bulk materials and waste	Not calculated
12	Establish charging infrastructure for cars	Facilitating measure
13	Incentives for zero-emission taxis from 2025	There is uncertainty associated with the number of taxis in Oslo going forward due to the deregulation of taxi permits in 2020, the distances that taxis travel, the effect of COVID-19 on travel behaviour, and the level of demand for taxis

	(requirements, subsidies, charging infrastructure, etc.) Uncertainty: Medium Consequence: Low	over the next few years, as well as how rapidly the phasing-in of zero-emission will take place. The full effect of the measure will be achieved when the requirement enters into force on 1 November 2024. Due to the poor quality of the data that is available, the level of uncertainty is considered to be medium.
14 and 15	Requirement for zero-emission goods deliveries on behalf of the municipality and Incentives for zero-emission vans (establish/subsidies for charging infrastructure, freight consolidation centres, loading facilities, parking, etc.) Uncertainty: High Consequence: Low	The calculation of climate effect is based on an assessment of the trend in the number of registered electric vans. Such analyses are always subject to considerable uncertainty. Relatively moderate assumptions have been made regarding the development in the proportion of electric vehicles, indicating that it is more likely that the effect is underestimated. The measure accounts for a small proportion of the total potential for emission reductions, and the consequences are therefore considered to be low.
16	Procurement of zero-emission buses for public transport Uncertainty: Low Consequence: Medium	The uncertainty is considered to be low, as the calculation is based on reported figures for fuel consumption and a review of when Ruter will enter into new contracts based on zero-emission vehicles. Nevertheless, the consequences are considered to be medium, as the measure accounts for such a high proportion of the potential for emission reductions.
17	Procurement of zero-emission transport for persons with disabilities Uncertainty: Low Consequence: Low	The level of uncertainty in the calculation is considered to be low. It is directly based on figures from Ruter concerning the number of kilometres travelled by special vehicles in 2019. Nevertheless, there is some uncertainty associated with annual fluctuations in the figures for annual vehicle-kilometres, as well as the emission factor for the vehicles if they had been diesel-powered.
18	Incentives for zero-emission tour and express buses (establish/subsidies for charging infrastructure)	Not calculated
19 and 20	Zero-emission requirement for trucks on assignments carried out on behalf of the municipality and Incentives for zero-emission heavy transport in Oslo (exemptions inside the road toll ring, establish/subsidies for charging infrastructure, provision of land for energy stations, etc.) Uncertainty: High Consequence: High	The estimate of climate effect is based on an assessment of the development in the number of registered electric and biogas trucks. Such analyses are always subject to considerable uncertainty. As regards trucks, the level of uncertainty is particularly high as regards technological advances and the behaviour of actors over the coming years. The measure accounts for a high proportion of the estimated total potential for emission reductions, and the consequences are considered to be high.
21	Zero-emission requirement for municipal construction sites Uncertainty: High Consequence: Medium	Even though it concerns the municipality's own projects, the underlying data for GHG emissions relating to construction sites is inadequate in some respects. The calculations are based on the assumption that the City of Oslo's projects account for 20% of emissions, a figure which is both uncertain and fluctuates annually. It is also uncertain whether we will be able to achieve 100% zero-emission from 2025. This means that the level of uncertainty is considered to be high.

22	Fossil-free construction site regulation in zoning plans Uncertainty: High Consequence: High	The figures for GHG emissions from construction sites are of poor quality, as we do not know how much fossil fuel is actually being consumed. The calculation is based on an estimate that private and state owners account for 80% of the emissions stated in the Norwegian Environment Agency's emission inventory for the construction sector. The percentage share is both uncertain and will fluctuate from year to year. The phasing-in rate that is assumed is based on the proportion of gross living area (BRA) that will be covered by the requirement. This does not take construction sites into account. In the emission inventory, emissions for construction sites are also broken down based on a model that only covers construction sites. This means that both the inventory and this estimate may be subject to considerable uncertainty as regards the proportion of emissions that originates from construction sites. The measure accounts for a high proportion of the estimated total potential for emission reductions, and the consequences are considered to be high.
23	Facilitate zero-emission handling of goods and cargo at the Port of Oslo Uncertainty: Medium Consequence: Low	The estimated climate effect is based on figures from the Port of Oslo concerning fuel consumption. The uncertainty in the calculation particularly relates to the phasing-in rate. The port has a goal of becoming a zero-emission port by 2025, but there is considerable uncertainty regarding the types of machinery that will be available in the future and when they will become available.
24	Procurement of zero-emission machinery for the City of Oslo's machinery fleet Uncertainty: Medium Consequence: Low	The municipality has high-quality data regarding the replacement of its own machinery. Nevertheless, there is uncertainty linked to when different types of machinery will become available and can be delivered, which will affect the rate of phasing-in of the measure.
25	Incentives for zero-emission motorised equipment and events (subsidies, electricity for events) Uncertainty: Medium Consequence: Low	The calculation is based on an assessment of the number of people who will use the grant scheme and choose to buy zero-emission motorised equipment in the future. Such assessments of trends are always subject to considerable uncertainty. The level of uncertainty in the calculation of electricity consumption for events is considered to be relatively low, as the calculation is based on actual changes in the consumption of fossil fuel sources.
26	Procurement of zero-emission high-speed ferries Uncertainty: Low Consequence: Low	The calculation is based on the ferries that are to be replaced and fuel consumption figures for existing ferries. The level of uncertainty is considered to be low, as the data is of high quality.
27	Establish shore power for container, tanker and cruise ships Uncertainty: Low Consequence: Low	The calculations of emission reductions for ships are based on figures of actual electricity consumption, as well as the Port of Oslo's assessment of the phasing-in of shore power facilities. The calculation for these is therefore considered to be relatively reliable. However, there is some uncertainty as regards the extent to which the shore power facilities will actually be used, which increases the level of uncertainty further.

5 Potential for further emission cuts and opportunities for target attainment

5.1 Assessment of whether Oslo will achieve the 2023 emission reduction target

The Norwegian Environment Agency's latest update concerning the emission inventory for municipalities covers the period from 2009 to 2020. We therefore do not yet know whether or not the emission limits for 2021 have been achieved. In order to achieve the emission limits set for 2021 and 2022, as well as the 2023 emission reduction target, the annual reductions must be approximately 130,000 tonnes CO_2eq from 2020 to 2023. This presupposes that the emission limits are achieved every year. Between 2018-2019 and 2019-2020, emissions were cut by 60,000 - 75,000 tonnes CO_2eq per year. The annual emission reductions before 2018 vary greatly from year to year and are considered to be less relevant

for comparative purposes, even though 2020 was an abnormal year as a result of the COVID-19 pandemic.

An almost doubling of emission reductions during the period towards 2023 compared with 2018-2019 and 2019-2020 is considered to be both very challenging and unlikely. In light of both the above and the potential for emission reductions from the calculations of measures, the Agency for Climate considers it unlikely that the emission reduction target of a 52% reduction will be achieved in 2023. This will also apply even though there are several measures for which the effect cannot be calculated, and despite the fact that several of the measuresin the Climate Budget are not reflected in the municipal emission inventory.

During the period from 2023 to 2030, emissions must be cut by almost 65,000 tonnes CO_2eq, in addition to the emission reductions from carbon capture at Klemetsrud, if the emission limits are to be achieved. This annual reduction in emissions is considered to be achievable in light of the emission reductions during the periods from 2018 to 2019 and 2019 to 2020.

There are several measures which we expect to have a greater effect going forward than they have had to date, such as the initiative relating to zero-emission heavy transport. Both the market and the business sector also have a completely different focus on zero-emission solutions now than they did a few years ago, and exponential growth is anticipated in several zero-emission technologies. This indicates that the emission limits from 2023 to 2030 could be more than achieved. However, there is reason to believe that there will be a "backlog" of unachieved emission reductions from the period from 2020 to 2023, which could increase the distance to the emission limits after 2023.

Given the latest emission inventory from the Norwegian Environment Agency, total emissions must amount to around 72,000 tonnes CO_2eq in 2030 if Oslo is to achieve its emission reduction target of a 95% reduction in emissions compared with the 2009 level. It may be challenging to eliminate the final emissions towards 2030 relating to minor emission sources, emissions of methane and nitrous oxide from biogenic sources and, for example, from products that have few applications, meaning few incentives for zero-emission technology. As the largest emission sources have been eliminated, the annual reduction in emissions may therefore level off. As developments in markets, technology, political decisions and other national and international events will also affect emission levels in Oslo, it is challenging to assess whether the annual emission limits are attainable both in the longer term and as regards the target for 2030.

5.2 Potential for further emission cuts

The figure in the Climate Budget showing the climate-related effect of adopted and identified measures towards 2030 provides an estimate of how close the City of Oslo can get to the emission reduction target for 2030 using existing known measures which have not yet been implemented. The calculations are subject to considerable uncertainty, yet they show the possible development in emissions if these initiatives are implemented in full. The figures for the figure are shown in Table 2 below.

Table 2: Numerical basis for the figures in the Climate Budget; estimated annual emission reductions resulting from adopted measures and identified measures, and differences between the emission limit and the estimated annual effect

Year	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Adopted measures	-27%	-29%	**-33%**	-37%	-39%	**-49%**	-54%	-58%	-60%	-62%
Identified measures	-	-	**-36%**	-40%	-48%	**-59%**	-66%	-73%	-76%	-79%
Emission limits	-34%	-43%	**-52%**	-56%	-61%	**-73%**	-81%	-86%	-90%	-95%

If all identified measures are implemented, emissions in 2030 can be reduced by 79% compared with 2009, while adopted measures will reduce emissions by 62%. This will results in emissions gaps of 16 and 33 percentage points respectively. In other words, it will be necessary to both strengthen existing measures and identify new measures in order to reach the target.

In some sectors, it will not be possible to cut all emissions by 2030, for example because of residual emissions of methane and nitrous oxide from biogenic emission sources or because there is unlikely to be sufficient technological advances or profitability in the implementation of measures by 2030. As regards sectors and emission sources where zero-emission technologies are already available, this means that such technologies must be fully implemented in order to reduce emissions in line with Oslo's emission reduction target for 2030, although there are currently many barriers to achieving this. Against this background, roadmaps have been drawn up for each emission sector showing the possible trend in emissions for each sector that will be necessary to achieve the overall emission reduction target for 2030. In these roadmaps, the road transport, waste and waste water sectors, waste incineration and energy supply sectors will each have residual emissions of between 10,000 and 40,000 tonnes CO_2eq in 2030. The remaining sectors will each have residual emissions of less than 5,000 tonnes CO_2eq.

A description is given below of the identified measures and how the effect has been calculated, as well as the reductions that will be required in order for Oslo to achieve its emission reduction target in 2030.

Assessments have been made of how the measures as a whole will affect the level of activity, the choice of technology and the choice of fuel for the various emission sectors. Nevertheless, there is considerable uncertainty associated with possible overlaps between measures, and the uncertainty associated with the overlap between the identified measures in this analysis and the measures actually adopted in the Climate Budget.

Aviation and industry have marginal emissions in Oslo, and Oslo has few measures which can be used to cut emissions in these sectors. The sectors are therefore not discussed further below. In order to reduce emissions from industry, the Agency for Climate has concluded that an increase in carbon tax could play a key role.

Road transport

In 2020, emissions from light and heavy vehicles accounted for 36% and 16% of total emissions respectively. This corresponds to 564,600 tonnes CO_2eq. Figure 4 shows that road transport is expected to generate emissions of around 510,000 tonnes CO_2eq in 2022. If all adopted measures are implemented and phased in at the estimated rate, emissions could be cut to 266,000 tonnes CO_2eq in 2030. If the identified measures are also implemented, emissions could be reduced to around 155,000 tonnes CO_2eq in 2030. This corresponds to a 79% reduction in emissions in the transport sector in 2030 compared with 2009 levels.

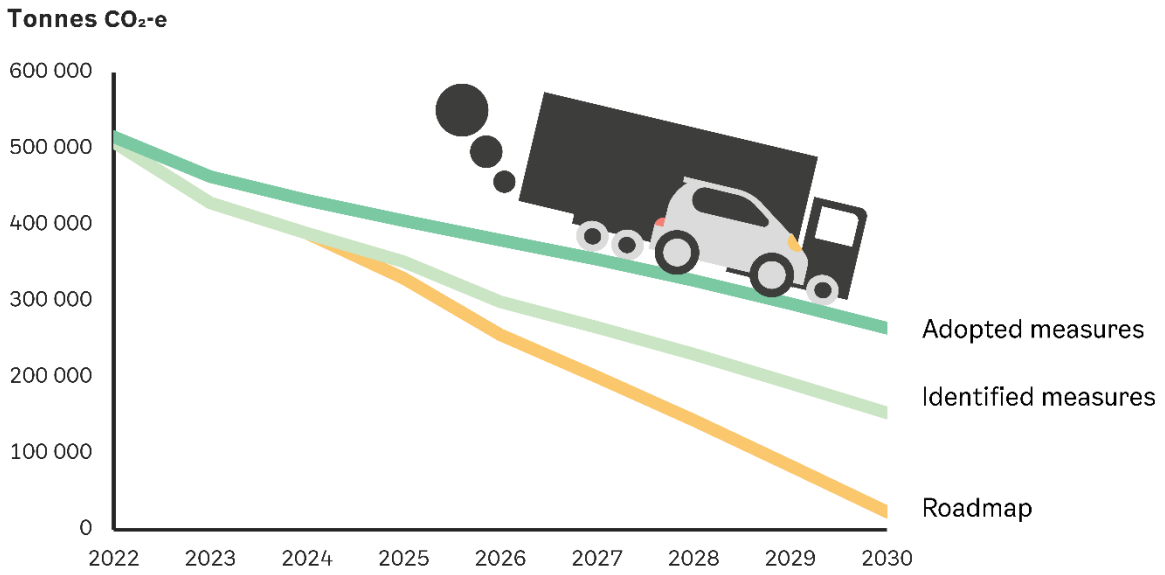

Figure 4: Roadmap for Road transport, 2022-2030

Although there are many barriers to eliminating emissions from the entire transport sector, this is a sector where the necessary technology to achieve such a transition is or will be available. In order to achieve the required reduction, it will be necessary to use electricity, biogas and hydrogen across all vehicle categories. No assessment has been made of the measures that could contribute to triggering this. The residual emissions originate from through traffic, where becoming zero-emission by 2030 is expected to be challenging.

The identified measures included in the figure are as follows:

Higher tariffs in the road toll ring (+NOK 100)
A further increase in tariffs in the road toll ring could result in emission reductions beyond the effects of the recently negotiated tariffs in Oslo Package 3. Renegotiation of Oslo Package 3 is planned for 2024.

The calculation is based on a study by Norconsult (2020) that analyses how a gradual price increase in the road tolls towards +NOK 100 per passage for fossil fuel cars in 2030, would affect the uptake of electric vehicles and vehicle-kilometres travelled by cars and vans. It was only possible to obtain figures for cars and vans. This means that no effect has been assumed for zero-emission heavy vehicles and buses for this measure. The climate effect is therefore likely underestimated. To include the impact relating to heavy vehicles and buses, a more thorough study will be necessary.

Norconsult (2020) shows that the measure could increase the share of electric vehicles in 2030 from 63% to 85% for cars. In the case of electric vans, it is assumed that the measure will result in an increase from 40% to 58% by 2030. In isolation, it is estimated that this measure could contribute to a reduction in emissions from road transport of just under 45,000 tonnes CO_2eq by 2030.

Zero-emission zone within Ring 2 from 2026

If the City Council adopts a larger zero-emission zone than a zone within the Car-free city living area, it could result in further reductions in emissions. The status of the work on a zero-emission zone is that the City Council is now open to the possibility of a payment zone, rather than just a prohibition zone. The Norwegian Public Roads Administration submitted its recommendation for further work on a zero-emission zone in September (Norwegian Public Roads Administration, 2022). The report is currently being reviewed by the Ministry of Transport.

The calculations were taken from a report by Norconsult (2021) on the emission effects of zero-emission zones in Oslo. The calculations show that a zero-emission zone within Ring 2 from 2026 could have an emission-reducing impact within the City of Oslo's boundaries of 31,000 tonnes CO_2eq. Such a zone would also have an impact outside the boundaries of the City of Oslo, as the vehicles which are converted will also be used outside the municipality's boundaries. Norconsult has calculated the overall effect of a zero-emission zone within Ring 2 from 2026 to be a reduction in emissions of up to 73,000 tonnes CO_2e. The figures refer to the isolated impact of a zero-emission zone, and have not been assessed with regard to other newmeasures such as for example an increase in tariffs in the road toll ring, etc.

In the analysis, the Agency for Climate has deducted the effect of establishing a zero-emission zone within the Car-free city living area from 2024, which is an adopted measure in the Climate Budget.

Carbon tax for road transport equivalent to NOK 2,000 in 2030 without compensatory measures

The Government has announced that it wishes to increase carbon tax to NOK 2,000 in 2030. This tax is intended to stimulate a reduction in car use and accelerate the transition to zero-emission solutions. Until now, the road use tax has been reduced slightly in order to compensate for the increase in carbon tax. Reducing road use tax results in lower prices at the pumps and reduces the effect of the increase in carbon tax. The Government has not announced whether it will compensate for the increase in carbon tax by reducing the road use tax in future budgets. The City of Oslo has argued that deductions from the road use tax or other compensatory measures should be avoided in order to maintain an adequate climate effect.

The calculation is based on the assumption that higher fuel prices as a result of the tax will reduce the use of fossil fuel-powered cars, vans, heavy vehicles and buses. It is estimated that a higher carbon tax will reduce the use of fossil fuel cars by 2.6%, result in the transfer of freight to sea and rail of 2.5%, and reduce heavy transport by 20% as a result of logistics optimisation by 2030. In total, this is estimated to amount to an isolated reduction of around 45,000 tonnes CO_2eq by 2030, with the largest reduction coming from heavy vehicles.

However, these estimates are based on the Institute of Transport Economics' model runs for the Climate Cure 2030 report from the Norwegian Environment Agency and electricity and fuel prices dating from 2019 (TØI, 2020). An increase in carbon tax of NOK 2,000 per tonne corresponds to around NOK 4 per litre (incl. a deduction from biofuel blending). Petrol prices have recently increased well beyond this figure. There is therefore reason to assume that much of the effect that has been estimated as a result of a higher carbon tax will occur in any case, even with higher electricity prices. On the other hand, the general population and the business sector may react differently to the announcement of an increase in the tax over time versus petrol and diesel prices which will not necessarily remain stable and high towards 2030. Deliveries of new zero-emission vehicles are currently subject to delays, which may slow down the replacement of the vehicle fleet. We do not have any analyses available which take into account recent changes in petrol and diesel prices. However, we will be able to see the effect of this over time in the emission inventory prepared by the Norwegian Environment Agency and will consider the effect in more detail if new transport model runs are performed in connection with updates to the baseline trajectory.

Increase in the biofuel quota obligation to 40% in road transport in 2030
An increase in the biofuel quota obligation to 40% in road transport in 2030 was studied as part of Climate Cure 2030, and the Norwegian Environment Agency has distributed a proposal to increase the biofuel quota obligation for consultation in the spring of 2022 (Norwegian Environment Agency, 2022d). The City of Oslo has been working with other stakeholders to obtain approval in the revised national budget for 2022 for the establishment of a national register for the use of biofuels over and above the quota obligation in order to secure a climate effect for those purchasing 100% sustainable biofuels.

The calculation shows the emission-reducing effect in Oslo of increasing the biofuel quota obligation to 40% within road transport in 2030. Advanced biofuels are counted twice, which means that only half of the volume is needed in order to fulfil the requirement if these fuels are used. The calculation assumes an increase in the quota obligation to 40% towards 2030 as studied in Climate Cure 2030, with the

assumption that only advanced biofuels will be sold from 2025 onwards. The climate effect has been calculated based on the difference between the quota obligation and the biofuel share in the baseline trajectory. In the baseline trajectory for Oslo, the share of biofuels in road transport has been set to 12.25% for the period from 2022 to 2030. A quota obligation of 40% in 2030 would result in a 20% real volume after the double-counting of advanced biofuels. Thus an increase in 7,75%, which corresponds to around 20,000 tonnes CO_2eq in 2030.

Areas for charging and refuelling infrastructure
The lack of charging infrastructure is one of the biggest barriers to the transition to electric commercial transport, while the non-availability of land is the biggest barrier to the establishment of charging facilities. It is therefore crucial that sufficient land is secured for publicly available fast charging. In addition, land is also required for the storage of bulk materials, refuelling stations for hydrogen and biogas, and freight consolidation centres, in order to cut emissions from heavy vehicles. The measure is a facilitating measure and no climate effect has therefore been calculated.

Access to public transport lanes for zero-emission/biogas-powered heavy vehicles
Access to public transport lanes for zero-emission and biogas trucks could give companies an additional incentive to invest in such vehicles. A study will be carried out by the Norwegian Public Roads Administration to assess such a scheme. The study is being carried out in cooperation with the Department of Urban Environment, Ruter and the Agency for Climate. The climate effect of the measure has not been calculated.

Waste incineration and energy supply

Waste incineration and energy supply accounted for 25% of emissions in Oslo in 2020. This corresponds to 266,600 tonnes CO_2eq. Emissions from the sector in Oslo primarily originate from waste incineration (both commercial and household waste), with some residual emissions from the use of fossil fuels for the production of district heating. Around 80% of the emissions originate from Hafslund Celsio's waste-to-energy facilities at Klemetsrud and Haraldrud, while the remainder originates from the Agency for Waste Management's energy recovery facility at Haraldrud. These emissions stem from the incineration of fossil fractions in the waste, such as plastic and synthetic textiles. Emissions can be reduced either by using carbon capture or by reducing the fossil material that is incinerated through, for example, greater sorting of plastic and textiles.

Figure 5 shows that a relatively flat development in emissions is projected towards 2025 inclusive. From 2026 onwards, it is assumed that emissions will be reduced significantly as a result of carbon capture at Klemetsrud. With the implementation of the identified measures(see the discussion below), emissions in the sector could be reduced by 90% by 2030, and the necessary reduction in emissions in the sector achieved. The residual emissions in 2030 originate from emissions from waste incineration. Carbon capture is expected to remove around 94% of fossil CO_2. Greater sorting of plastics and textiles could result in further reductions, but some emissions of CO_2 will still remain. In addition, there will be some emissions of methane and nitrous oxide, which will be difficult to reduce. This means that there will be around 20,000 tonnes of CO_2eq residual emissions in the sector in 2030. This analysis only includes fossil emissions. A carbon capture plant at Klemetsrud will also capture approximately the same amount of CO_2 from biomass. Carbon capture of biogenic emissions (bio-CCS) can contribute to negative emissions from waste incineration in the municipality.

A description of the identified measures is presented after the figure.

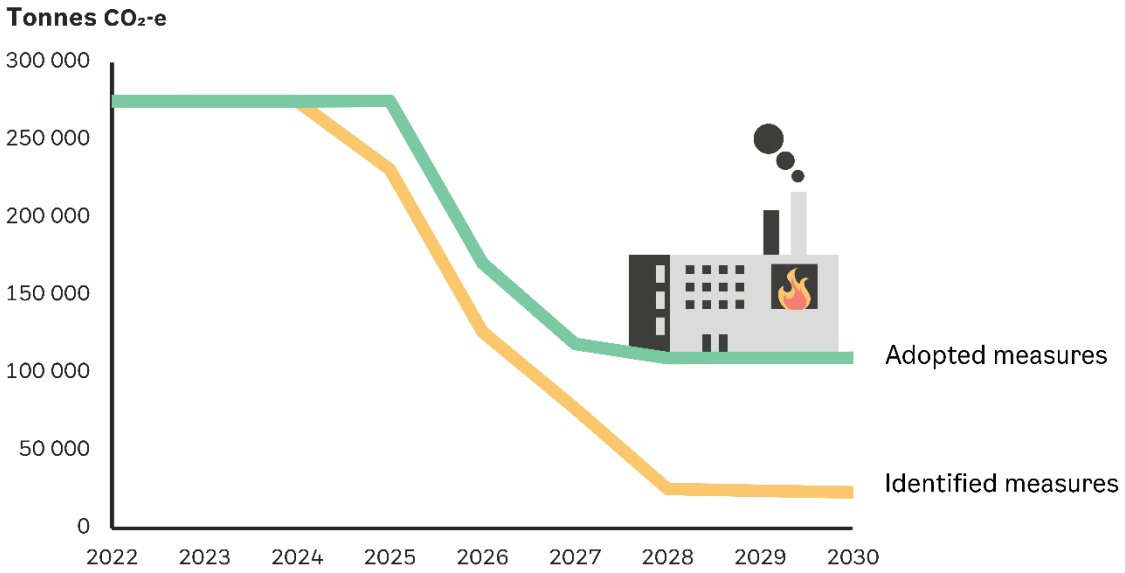

Figure 5: Roadmap for Waste incineration and energy supply, 2022-2030

The identified measures included in the figure are as follows:

Carbon capture from all household waste from the City of Oslo
In order for Oslo to achieve its emission reduction target, emissions from incineration of Oslo's household waste at Haraldrud must also be reduced. Current emissions amount to around 50,000 tonnes CO_2eq. The City Government's Department for Environment and Transport has commissioned the Agency for Waste Management to assess the options open to the City of Oslo as regards the incineration of household waste with carbon capture. The Agency for Waste Management will identify all realistic alternatives and investigate and assess the effects of the alternative solutions. In the roadmap the climate agency has assume treatment with carbon capture from 2028 with a 90% efficiency rate. This would reduce emissions by around 45,000 tonnes CO_2eq.

Sorting facility for household waste from the City of Oslo
Greater sorting of plastic in household waste prior to incineration will reduce emissions. The Norwegian Environment Agency has recently proposed amendments to the National Waste Regulations which would tighten the requirements for waste management by the municipalities. Amongst other things, the Norwegian Environment Agency has recommended a gradual phasing-in of percentage targets for the sorting of plastics of 50, 60 and 70% in 2025, 2030 and 2035 respectively (Norwegian Environment Agency, 2022c). Sorting household waste in an advanced sorting facility is the only identified measure which can ensure that Oslo will meet the stricter requirements. The Agency for Waste Management has assumed that a new sorting facility would be capable of removing at least 80% of the plastic from household waste. Accordingly, a sorting plant could, in isolation, cut direct emissions by around 20,000-30,000 tonnes CO_2eq. (Agency for Waste Management, 2022). The roadmap assumes an effect of this magnitude from 2025 onwards. If the waste is treated using carbon capture from 2028 onwards (see above), the effect of a single-steam sorting facility would be reduced to around 2,500 tonnes CO_2eq during the period 2028-2030. This double counting is taken into account in the figure. It should be noted that an increase in plastic recycling will also reduce indirect emissions by replacing virgin plastics, an effect that is not reflected in Oslo's emission inventory.

Increased textile recycling
The Agency for Waste Management is working to assess how the sorting of textiles can be optimised. The Norwegian Environment Agency has announced that it is considering introducing a requirement for textiles to be collected separately from 2025 (Norwegian Environment Agency, 2022). It is assumed that

the sorting of textiles could increase from around 56% at present to around 85% (Agency for Waste Management, 2022). This will result in an emission reduction of 2,000-3,000 tonnes CO_2eq in 2025. In the roadmap, the effect is corrected for overlap and is thus reduced to around 300 tonnes CO_2eq. from 2028 if the household waste is also treated using carbon capture. It should be noted that an increase in reuse and recycling of textiles will reduce indirect emissions by replacing virgin materials, an effect that is not reflected in Oslo's emission inventory.

Reduce emissions from incineration of industrial waste at Hafslund Oslo Celsio's plant at Haraldrud
In 2020, just over 50,000 tonnes of industrial waste was incinerated at Hafslund Oslo Celsio's facility at Haraldrud. This resulted in emissions of almost 30,000 tonnes of fossil CO_2. There are currently no plans for reducing emissions from the facility. The alternatives for reducing these emissions are to ensure that the waste is treated using carbon capture, to reduce the fossil content of the waste, or to use renewable fuels only. In the roadmap, we estimate a reduction in emissions of around 27,000 tonnes CO_2eq in 2028, equivalent to treatment with carbon capture.

Improvements in the sorting of fossil waste in other countries and municipalities (the EU's revised Waste Framework Directive)
The market for waste is regional and crosses national borders. Both household and commercial waste from other municipalities and countries are incinerated at Hafslund Oslo Celsio's facilities. The type of waste incinerated at the facilities in the future will depend on the competitive situation in the market. As a result of the proposed new waste regulations (see the description of the sorting facility), Norwegian municipalities and companies will also be required to improve the sorting of plastics, as well most international actors due to the sorting requirements in the EU's revised Waste Framework Directive. As a result, the volumes of plastic incinerated at the facilities in Oslo will probably decline over time, almost regardless of whether the waste originates from a neighbouring municipality or one of our neighbouring countries. The Agency for Climate has estimated that these regulations could reduce emissions in Oslo by between 7,000 and 16,000 tonnes CO_2eq in 2030. In the roadmap, the effect is corrected for overlap and is thus reduced to around 2,000-6,000 tonnes CO_2eq from 2030 if the household waste is also treated using carbon capture. An increase in recycling will also reduce indirect emissions by replacing virgin materials, an effect that is not reflected in Oslo's emission inventory.

District heating without the use of fossil fuels
District heating production in Oslo primarily uses energy from renewable sources and waste incineration. Natural gas is still used during periods with high electricity prices or low temperatures. The quantity used varies from year to year and from season to season, depending on temperature and electricity prices. The measure aims to replace the use of natural gas with renewable sources such as biogas. The roadmap includes an effect of district heating production becoming completely fossil-free in 2025, which corresponds to an emission reduction of around 5,000 tonnes CO_2eq.

Other mobile combustion

In 2020, the sector 'Other mobile combustion' accounted for 12% of total emissions in Oslo. This corresponds to 135,000 tonnes CO_2eq. Half of these emissions originated from construction, while the remainder originated from non-road machinery and vehicles used in industry, freight terminals, ports, waste treatment, etc.

Figure 6 shows that the estimated emissions from the sector amount to just under 140,000 tonnes CO_2eq in 2022. If all adopted measures are implemented with the anticipated phasing-in, emissions could be cut to around 90,000 tonnes CO_2eq by 2030. If the identified measures are also implemented, emissions could be reduced to around 80,000 tonnes CO_2eq. This is a 60% reduction in 2030 compared with 2009 in the sector.

The emission gap includes emissions from various types of machinery used at waste facilities and freight terminals, as well as in industry and other sectors. This is machinery which likely could switch to electrical operation. However, this category covers a wide array of types of machinery. These will probably be specialised machines for which few zero-emission solutions are currently available. The

roadmap can therefore be considered to be very optimistic, but still necessary if Oslo is to achieve its emission reduction target for 2030.

A description of the identified measures is presented after the figure.

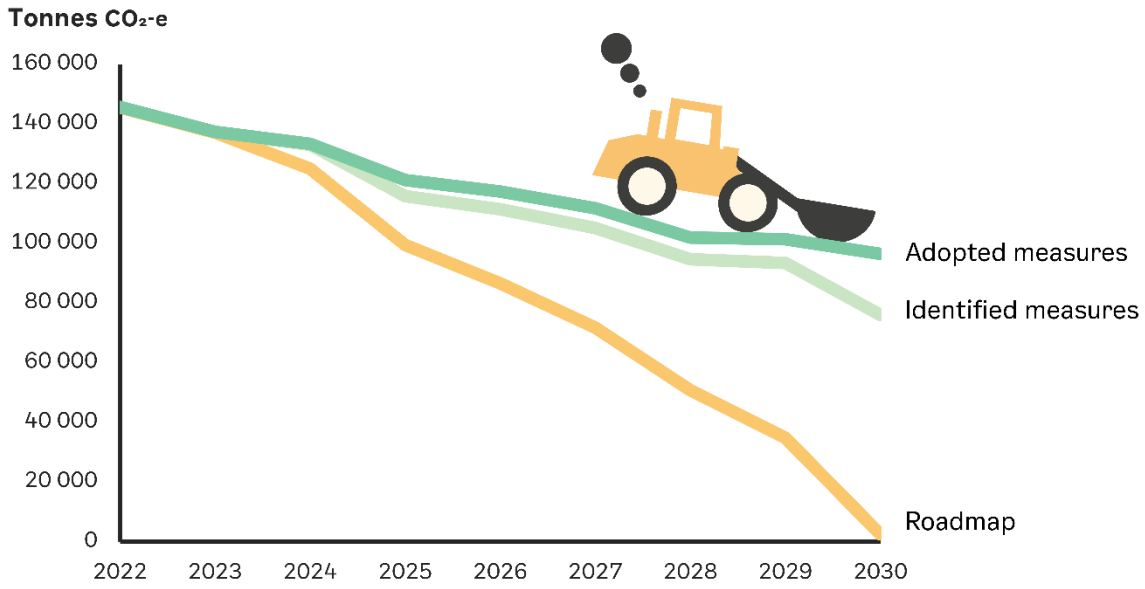

Figure 6: Roadmap for Other mobile combustion, 2022-2030

The identified measures included in the figure are as follows:

Requirement for all construction sites to be zero-emission by 2030
The requirement for all construction sites to be zero-emission by 2030 comes in addition to the effect of the adopted measure which is a requirement for construction sites to be fossil-free imposed via new zoning plans (around 50,000 tonnes CO_2eq.). This can be done through the further tightening of requirements in land-use plans covering all future developments, regardless of when the zoning plan was adopted.

At the same time, this means that, as the number of zoning plans that will be covered by the current requirements is expected to increase, the effect of requirements in land-use plans will diminish towards 2030 (from 20,000 tonnes CO_2eq in 2026 to 12,000 tonnes CO_2eq in 2030). A phased introduction of 50% in 2025, 70% in 2027 and 100% in 2030 has been assumed for this measure.

Carbon tax of NOK 2,000/tonne in 2030 for construction projects
As a basis for Report to the Storting No. 13 (2020-2021) Climate Plan for 2021 – 2030, the Norwegian Environment Agency (Norwegian Environment Agency, 2020b) submitted calculations of the impact of a carbon tax of NOK 2,000/tonne in 2030 on emissions from construction projects. The Norwegian Environment Agency estimates that emissions can be reduced by 10,000 tonnes CO_2eq in 2021 and up to 70,000 tonnes CO_2eq in 2030 nationally, as a result of the tax increase. The national calculation has been scaled down to the local level based on population. The effect is estimated at around 1,000 tonnes CO_2eq in 2030.

Waste and wastewater
In 2020, emissions from landfill sites and waste water facilities accounted for 5% of total emissions in Oslo, equivalent to around 53,200 tonnes CO_2eq. With the adopted measures, emissions from the sector could be reduced by 45% in 2030 compared with 2009. This corresponds to residual emissions of 36,300 tonnes CO_2eq in 2030. The reduction stems from a natural reduction in methane gas emissions from closed landfill sites.

No measures have been identified that could bring about further cuts in emissions in the sector. Emissions from landfill gas must be significantly reduced in order for Oslo to achieve its emission reduction target. These emissions will be challenging to reduce, but the Agency for Climate is working to identify new measures to reduce emissions from the sector.

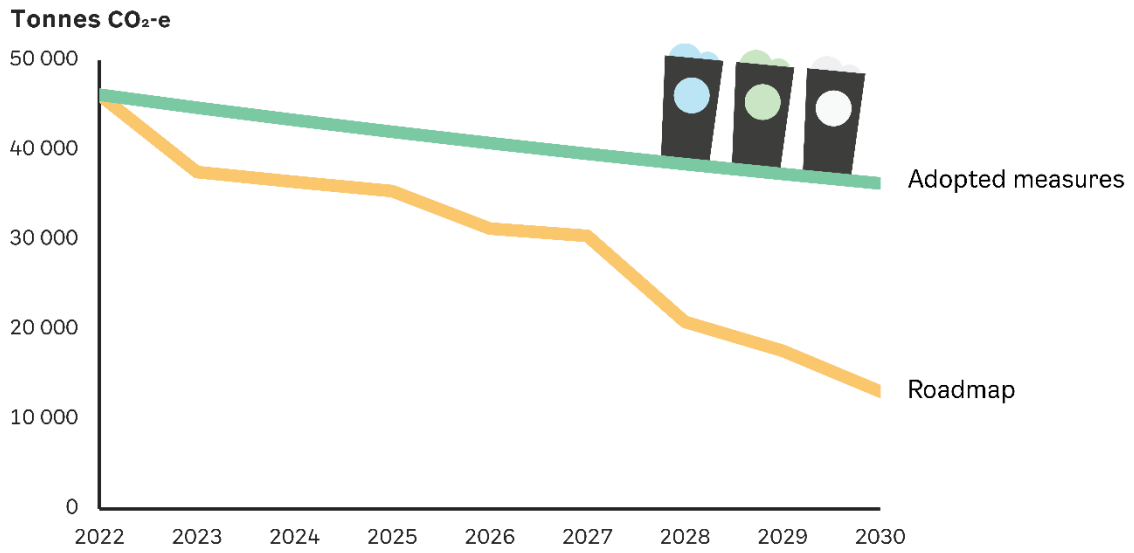

Figure 7: Roadmap for Waste and wastewater, 2022-2030

Waterborne navigation

In 2020, waterborne navigation accounted for around 4% of total emissions in Oslo. This corresponds to 40,300 tonnes CO_2eq. About a third of these emissions originate from arriving and departing ships, while the rest comes from heating, etc. for ships in port. Oslo City Council has adopted the Action Plan for the Port of Oslo as a zero-emission port, which estimates that the measures in the plan could reduce emissions from waterborne navigation within the municipal boundary by around 90% in 2030 compared with 2009 levels. The action plan is currently being revised and is due to be considered by the City Council in spring 2023.

Figure 8 shows that the estimated emission level in 2022 is around 27,800 tonnes CO_2eq. With the implementation of the identified measures, emissions in the sector could be reduced to below 3,000 CO_2eq by 2030, and the necessary reduction in emissions in the sector achieved. This corresponds to a 90% reduction in emissions in the sector from 2009. The residual emissions in 2030 primarily originate from inbound and outbound ships other than the international ferries.

A description of the identified measures is presented after the figure. Several of the measures overlap, as some measures will contribute to an increase in the use of shore power (reduced emission at port). The isolated effect indicates that there is potential for reductions in emission levels if the measures are implemented in isolation, but it will probably be necessary to implement many of the measures in order to reduce emissions from inbound and outbound sailings and moored ships. During the revision of the action plan, a more thorough assessment will be made of the phasing-in of measures and the projected climate effect.

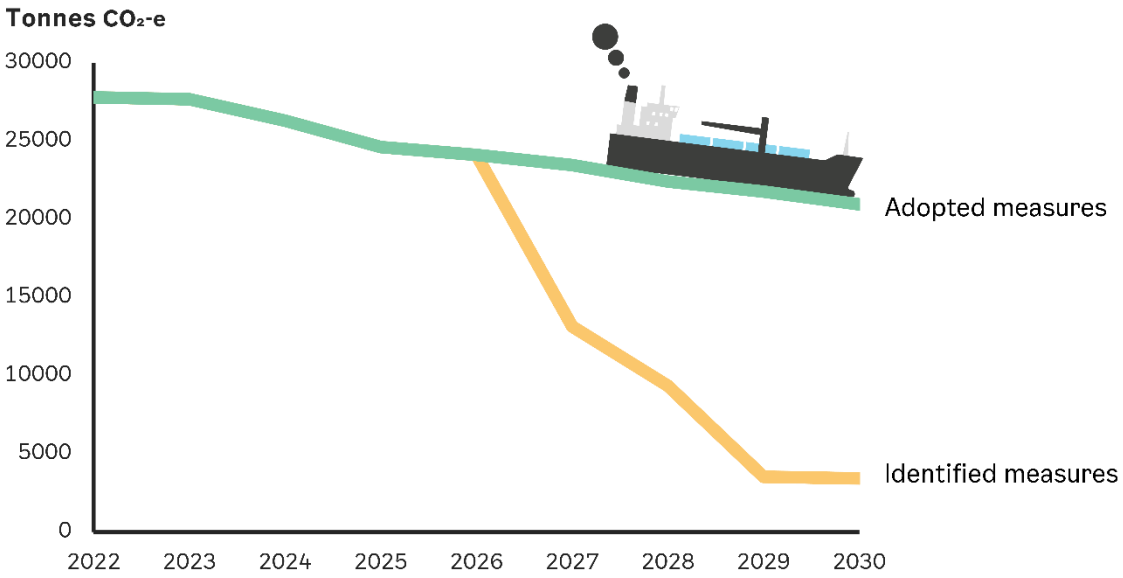

Figure 8: Roadmap for Waterborne navigation, 2022-2030

Requirement for zero-emission solutions for international ferries (inbound and outbound sailings)
This measure entails the introduction of a requirement for international ferries to use zero-emission solutions during inbound and outbound sailings. The Action Plan for the Port of Oslo states that this must be done if new routes are established, if existing routes are exposed to competition, in connection with contract renewals, or if the situation permits. However, it is rare for new routes to be opened, and the contracts signed with international ferry companies are long-term in nature. When the effect of such a requirement can be achieved is uncertain and the requirement has therefore been viewed as an identified measure, rather than an adopted measure, in the Climate Budget.

If the requirement were to cover all inbound and outbound international ferry sailings, the isolated effect would be around 10,000 tonnes CO_2eq. The requirement will also cut emissions in port, as the ships will be zero-emission while in port. This effect is included in the roadmap from 2027 onwards, but with a correction with regard to double-counting for the other measures that will reduce emissions in port. This is a very uncertain estimate, as it is, for example, likely that the effect will take effect more gradually because contracts are replaced at different times.

Differentiated port fees
Cruise ships arriving at the Port of Oslo are currently charged lower port fees if they cut emissions of CO_2, NO_X and SO_X while they are moored. The identified measure is based on further developing this environmental differentiation and extending it to cover other segments. The climate effect in the roadmap is taken directly from the Action Plan for the Port of Oslo and is stated as amounting to 900 tonnes CO_2eq.

Requirement for zero-emission solutions at port
The measure entails using the Ports and Fairways Act to require all ships to use shore power while moored at a pier. As it is not possible to require all consumption of heating and electricity to come from shore power, the effect that has been included is set to 65% of emissions while in port, corrected for the other adopted measures relating to shore power. This is considered to be an optimistic estimate. If all ships were to be required to use shore power for 65% of their consumption, this would correspond to an effect of around 7,000 tonnes CO_2eq.

Cooperation with other cruise ports on common requirements regarding shore power
Upgrading cruise ships to allow for shore power is expensive. To get more ships to switch to shore power, more ports than just Oslo need to offer shore power. Oslo is in the process of establishing shore power for cruise ships (measure 27 in the Climate Budget). However, in order to bring about reductions in emissions, the facilities will actually have to be used. Cooperation with other ports on common requirements regarding shore power will therefore be conducive to the realisation of measure 27. In the baseline trajectory, emissions from cruise ships in port are estimated to amount to almost 3,000 tonnes CO_2eq. If these emissions are to be eliminated, cruise ships must use shore power for all their needs while in port, including heating (see measure below).

Replace the use of heating oil on ships in port with renewable alternatives
Even if ships use shore power, this will only replace around half of the emissions that are generated in port. This is because the ships need power for heating and other purposes on the ship, for which fossil fuel-fired boilers are used. This measure involves replacing these boilers with renewable alternatives. The emission-reducing effect of the measure is calculated by assuming that emissions from ships at port in the baseline trajectory are eliminated, but is corrected for overlap with the existing transition to shore power. The roadmap also includes a correction for overlap with shore power for cruise ships (see above). The isolated effect of the mitigation measure is estimated to be up to 4,000 tonnes CO_2eq if all ships were to use zero-emission solutions while in port instead of heating with fossil fuels. This has been estimated by assuming that 45% of emissions from ships in port originate from heating. However, this is an uncertain estimate, as the actual figure will vary between ships. If a requirement for zero-emission solutions is introduced for inbound and outbound international ferry sailings, much of the effect will already be achieved as the ships will then be zero-emission in any case.

Heating
In 2020, heating accounted for just 2% of total emissions in Oslo. Emissions from this sector have been cut by 92% since 2009, primarily due to a ban on the use of mineral oil (oil-fired boilers). In order for the emission reduction target to be achieved, all fossil emissions from the sector should be cut by 2030.

This year's Climate Budget contains no adopted measures in the heating sector. Therefore, the green line with adopted measures in Figure 9 shows merely the expected development in the baseline trajectory. Implementing the identified measure which reduces the use of gas for heating purposes could result in an overall reduction in emissions in the sector of 98% in 2030, compared with the 2009 level.

The gap between identified measures and the required reductions stems from emissions from the combustion of paraffin wax. Although these emissions should be reduced, no measures have so far been identified to reduce these emissions.

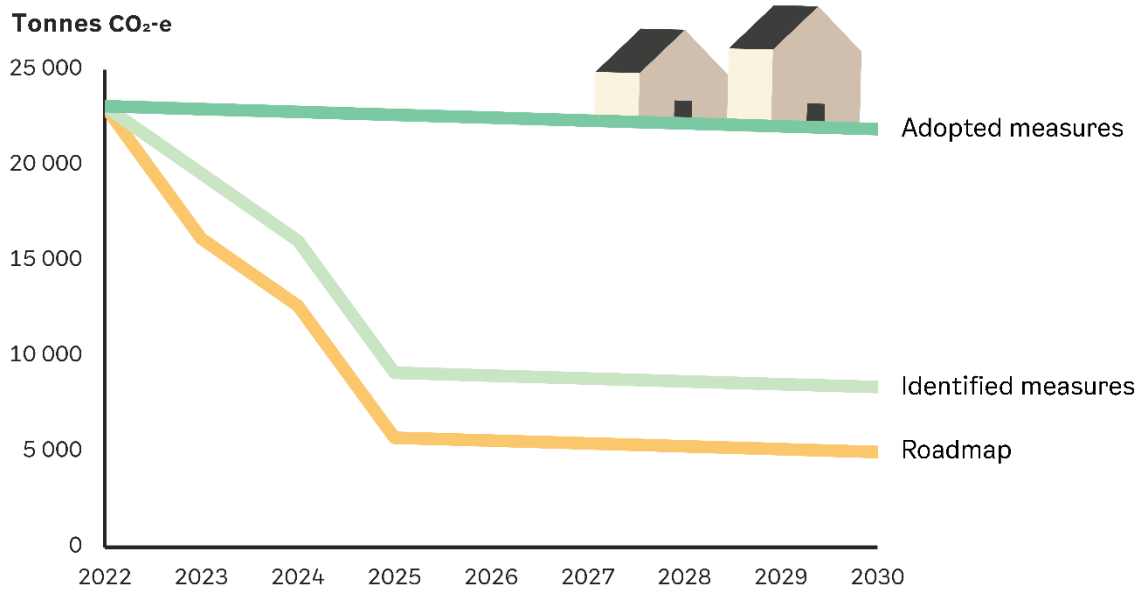

Figure 9: Roadmap for Heating, 2022-2030

The identified measures included in the figure is as follows:

National ban on the use of gas for heating purposes from 1 January 2025
The Agency for Climate has assessed measures that could reduce emissions from the use of gas for heating buildings and believes that a national ban would be the best approach. A ban would eliminate emissions from this source, equivalent to 13,500 tonnes CO_2eq. The estimated climate effect is only the effect that will be reflected in the emission inventory. The actual effect of the measure may be greater, as the emission figures in the emission inventory do not include tanks with a storage volume of less than 0.4m^3 or tanks used for temporary storage.

6 Other effects of measures in the Climate Budget

6.1 Other cost-benefit effects

Many of the measures in the Climate Budget have other beneficial or cost-related effects besides reductions in GHG emissions. One example is improved air quality and lower noise levels as a result of measures which reduce vehicle use or increase the use of zero-emission technologies in road transport and construction projects. Measures that promote cycling and walking also offer health benefits, while measures which reduce discharges from waste water contribute to better water quality in the Oslo Fjord.

The measures in the climate budget may have economic consequences beyond what is covered by the city treasury, e.g. where the business sector is required to use zero-emission solutions that are more expensive than fossil-fuel based solutions. Some measures will lead to an increase in sales of biofuels, which could potentially have negative effects for GHG emissions or biodiversity elsewhere in the world. The City of Oslo is therefore imposing requirements regarding sustainable biofuels in its procurements in order to avoid this.

6.2 Distributional effects

The City Council wishes to ensure that climate measures do not lead to greater social inequality. It is assumed that climate measures relating to construction projects and transport in the Climate Budget are the sectors within which the measures will have the greatest impact on the population and the business

sector. At a general level, the Agency for Climate has assessed the distributional effects of climate measures within transport. This is discussed in more detail below. Requirements for zero-emission construction sites are discussed at the end of the chapter.

Anticipated distributional effects of transport projects

A third of Oslo's population lives in a household which does not have access to a personal vehicle, and two in every three journeys are made on foot, by bicycle or on public transport. Investment in public transport, road toll payments and the use of space for walking and cycling instead of car parking all contribute to the redistribution of resources from those who have access to a car to those who do not. Women and low-income groups walk and travel by public transport more often. Overall, these population groups will benefit from the redistribution.

Mitigation measures aimed at the business sector, such as environmental requirements for taxi permits and measures relating to goods and service transport vehicles, will have different consequences for different stakeholders. The requirements may entail an economic risk during the transitional phase to zero-emission solutions, and could have different consequences for large and small enterprises. In order to avoid inequal consequences of the measures, the municipality is working to establish charging infrastructure and offering grant schemes to both reduce the costs associated with transition and boost innovation capacity.

The road toll ring

On 1 June 2019, new road toll stations and a new road toll system were introduced, with more road toll sections in Oslo and the former Akershus. As a result, residents across the whole of Oslo now pay more to travel by car than they did previously. Urbanet analyse (2017) has looked at the distributional effects of the new road toll sections. The analyses show that men tend to pay road tolls more often than women, because they tend to travel by car more. Households with multiple members are affected more than single persons, and those with medium or high incomes are affected to a greater extent than those with low incomes. This is because those with higher incomes tend to travel by car more to get to and from work. Travel to and from work is also affected more than other types of travel.

Revenues generated via the road toll ring are used to improve accessibility for all road user groups and fund road and public transport improvements. No studies are available which have analysed the overall effects of this for Oslo. The road toll payment system also reduces car use and GHG emissions and improves the urban environment (Norwegian Public Roads Administration, 2019).

Improved public transport

Good public transport services bring people from different parts of a region together and reduce inequality by giving everyone the practical and financial opportunity to participate in working life and lead an active life outside work (Ruter, 2020a). In Oslo, 34% of the population live in a household which has no access to a car. In the inner-city area, this applies to more than half of the population. Attractive public transport services help to make this possible. More than half of the city's population live less than 500 metres from a public transport stop which is convenient for them. Approximately 80% of the population live in an area with public transport services with at least four departures per hour (Urbanet Analyse, 2021). However, a study from the Oslo region shows that less affluent residential areas on the periphery of the region have poorer access to competitive public transport. The study also shows that areas of Oslo with a high proportion of non-Western immigrants tend to have better access to public transport. These differences are also linked to different housing preferences (Lunke, 2022).

Public transport is funded through ticket revenues, road tolls and public appropriations. Funding through the road toll payment system results in a transfer from those travelling by car to those travelling by public transport. At the same time, both public transport and road tolls help to reduce traffic levels and thus improve accessibility on the roads for commercial traffic and those who have no option but to travel by car.

Incentives to promote cycling

The bicycle is a readily accessible and affordable means of transport. Improvements to cycling infrastructure create more opportunities for residents who either cannot afford or are unable to use a car or who live in an area with poor public transport services.

A cohesive and safe cycle path network makes the bicycle a more attractive means of transport for many groups in the population (children, women, the elderly, etc.), as road safety is improved and it feels safer to cycle on cycle paths rather than public roads. Safe cycling infrastructure offers particular benefits in areas with low public transport provision and areas with a heavily loaded public transport system and/or road network. Increasing the number of cyclists on the streets can also help to improve safety in vulnerable areas, as there are more people moving around in the cityscape (Spacescape, Markör, 2016).

There are major health benefits associated with switching from passive to active forms of travel like cycling (Journal of the Norwegian Medical Association, 2020). Where an increase in cycling results in less car use, this will also reduce air and noise pollution, which will be especially beneficial for those living in areas with heavy traffic.

The reduction in the number of on-street parking spaces in favour of cycling infrastructure could disadvantage some groups, such as people with disabilities and businesses that depend on goods and service transport. In connection with the planning of new cycle paths, consideration is given to whether mitigation measures are appropriate in order to maintain accessibility for these groups as far as possible. Mitigation measures could for example include reserved parking for disabled persons and goods deliveries at suitable locations in areas close to where parking spaces have been removed.

Changes to parking provision

In recent years, the City of Oslo has redeployed many parking spaces in favour of cyclists, public transport and urban life. Emphasis has been placed on ensuring access to parking for disabled permit holders, and provision for goods deliveries.

In 2015, the Institute of Transport Economics studied the distributional effects of parking facilities with regard to housing and employment (Institute of Transport Economics, 2015). The study showed that, although single people and those on low incomes do not tend to have their own parking space, they do tend to have good public transport services close to their home. There are minor differences in access to parking at workplaces depending on income and household structure.

The resident parking scheme (City of Oslo, City Council, 2012) is a scheme where residents are given better access to and discounted prices for parking in their area, while visitors have to pay a higher fee. The evaluation scheme was evaluated in 2009 (Urbanet Analyse, 2009) and consisted of a pre- and post-trial survey which involved the registration of cars and questionnaire surveys. The evaluation showed that the scheme has given residents easier access to parking where they live and led to a significant reduction in the proportion of parked cars from non-residents, especially in the case of Frogner and St. Hanshaugen. Nine out of every ten residents found it easier to find a parking space. More than half agreed with the statement “the resident parking scheme makes it easier for me to live in central Oslo”. However, the business sector gave more mixed feedback, which led to changes being made to the scheme. For example, the rule concerning maximum parking time was abolished.

Measures for zero-emission taxis

Oslo has introduced environmental requirements for taxis. Taxi vehicles tend to be replaced at a faster rate than private cars, and a range of zero-emission cars is now available on the market with comparable costs to those of ICE vehicles. It is assumed that the environmental requirement will not adversely affect the incomes of taxi drivers if the necessary charging and refuelling infrastructure is in place before the environmental requirement enters into force (City of Oslo, Department of Urban Environment, 2017). Changes in travel patterns as a result of the COVID-19 pandemic and the new national permit regulations are probably of greater importance to the industry, and future developments in profitability and industry

structure are uncertain. This is discussed in a report from the Institute of Transport Economics and the Fafo Research Foundation on taxis in Norway through to 2020 (Institute of Transport Economics, 2020).

Measures to promote zero-emission vans and heavy transport in Oslo

Climate requirements will affect the transport sector, but it is uncertain how they will affect the industry and what they will mean for different businesses. In 2020, a questionnaire survey was conducted in industry, which was followed up by a number of in-depth interviews (Hafslund, 2021; Zero, 2021) concerning barriers to the transition to zero-emission heavy transport. The most important barrier highlighted by the industry is financial risk. This applies to both small and large players. It can be assumed that businesses which operate with low margins will be worst-placed to adapt and make substantial investments in new zero-emission vehicles. Predictability concerning measures is important for businesses if they are to plan purchases and see the overall cost of their investments.

Facilitating the more efficient transport of goods and services will result in a reduction in the number of vehicle-kilometres per product. Both a reduction in traffic levels and electrification will make a general contribution to lower NOx emissions, lower noise levels, and a better urban environment for those living or staying in the area in which the transport takes place.

Fossil-free construction site regulation in zoning plans

In autumn 2020, the City Council for Urban Development pursued a dialogue with the major industry players regarding requirements for fossil-free construction sites. During these meetings, it was stated that the industry can meet the requirement, but at an additional cost. Requirements regarding fossil-free construction sites mean that biofuel must be used, which is more expensive than fossil fuels. Biofuels cost around 50 to 100% more than traditional fuels. In addition, there are administrative costs associated with obtaining biofuels. These costs impact equally on all actors, but they can be more challenging to meet for smaller businesses. The municipality may therefore grant dispensations in individual cases in order to avoid imposing requirements that are either impossible or disproportionately demanding to meet, provided that the applicant can implement other mitigation measures to compensate for the lack of emission reductions.

7 Reference list

Bymiljøetaten, Oslo kommune, 2021b. Data for fornybarandel i kjøretøyparken til drosjesentralene i Oslo i 2018, 2019 og 2020, received by e-mail, spring 2021

CICERO, 2020. Lokale datakilder på klimagassutslipp

CICERO, 2022. Referansebane for klimagassutslipp i Oslo fram til 2030

Entreprenørforeningen for bygg og anlegg, 2019. "Markedsrapport 2019, EBA Oslo, Akershus og Østfold"

Hafslund, 2021. Rapport Kartlegging av klimagassutslipp fra tungtransport i Oslo

IPCC, 2007. Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.). Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 996 pp., retrieved 02.09.20. Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change

Lunke, Erik Bjørnson. 2022. 'Modal Accessibility Disparities and Transport Poverty in the Oslo Region'. *Transportation Research Part D: Transport and Environment* 103: 103171. 15 January 2022

Miljødirektoratet, 2020. Klimakur 2030

Miljødirektoratet, 2020b. Dokumentasjon effektutregninger i Klimaplan for 2021-2030. Not published. Received from the Norwegian Environment Agency 13.4.2021

Miljødirektoratet, 2022a. Utslipp av klimagasser i kommuner, Oslo, retrieved 06.09.22

Miljødirektoratet, 2022b. Informasjon om de kommunefordelte utslippstallene, received by e-mail spring 2022

Miljødirektoratet, 2022c. Nye krav til kildesortering av avfall, retrieved 29.07.22

Miljødirektoratet, 2022d. Forslag til omsetningskrav for avansert biodrivstoff til ikke-veigående maskiner og økt omsetningskrav til veitrafikk. Retrieved 08.09

Norconsult, 2020. Trafikantbetaling som virkemiddel. Redusert klimagassutslipp og trafikk i Oslo.

Norconsult, 2021. Utslippseffekter av nullutslippssoner i Oslo

Oslo Havn, 2018. Handlingsplan for nullutslippshavn, retrieved 24.06.21

Oslo kommune, Bystyret, 2012. Sak 191/2012. Forskrift om beboerparkering i Oslo - Byrådssak 57 av 26.04.2012

Oslotaxi, 2022. Data for fornybarandel i kjøretøyparken til Oslotaxi i 2022, received by e-mail spring 2022

Renovasjons- og gjenvinningsetaten, 2022. Utredning med tiltak for utslippsfri og ressurseffektiv avfallshåndtering i Oslo. Retrieved 29.07.22

Ruter, 2020a. Målbilde for bærekraftig bevegelsesfrihet

Ruter, 2020b. Innrapporterte drivstofftall for Nesoddfergene og Øybåtene. Received by e-mail, spring 2020

Ruter, 2021. Information on electric buses and activity data in future Oslo contracts, received by e-mail spring 2021

Spacescape, Markör, 2016. Underlagsrapport sykkelstrategien: Kartlegging av dagens og morgendagens syklister

SSB, 2022c. Table 11271, retrieved 22.07.22

Statens vegvesen, 2019. Bompengesystemet i Oslo, retrieved 24.06.21

Statens vegvesen, 2022. Null og lavutslippsone, retrieved 08.08.22

Tidsskriftet den norske legeforening, 2020. Andersen, L. B., Bere, E., Helsegevinst ved sykling til jobb, retrieved 24.06.21

Transportøkonomisk institutt, 2015. Parkeringstilbud ved bolig og arbeidsplass. Rapport 1439/2015. Christiansen, P., Engebregsten, Ø., & Usterud Hanssen, J., 2015

Transportøkonomisk institutt, 2020. Aarhaug, J., Oppegaard, S. M. N., Gundersen, F. H., Hartveit, K. J. L., Skollerud, K. H., & Dapi, B., TØI rapport Nr. 1802/2020; p. 142. Drosjer i Norge fram mot 2020

Transportøkonomisk institutt, 2020. Hulleberg, N, Ukkonen, A. TØI rapport nr. 1746/2020. Klimakur 2030 - transportmodellberegninger

Urbanet Analyse, 2009. Kjørstad, K. N., & Opheim Ellis, I., UA-rapport 14/2009. Evaluering av prøveordning med beboerparkering i indre OsloUrbanet Analyse, 2017. Ellis, I. O., & Amundsen, M. Revidert Oslopakke 3. Fordelingsvirkninger av forslag til nye bomsnitt i Oslo (Notat UA-notat 121/2017), retrieved 24.06.21

Urbanet Analyse, 2020. Raustøl, J., Høyem, H., Strætkvern A., Alstad, S. Notat 153/2020. Vurdering av RTM23+ mot RTM region øst

Urbanet Analyse, 2021. Ellis, I. O., Kjørstad, K. N., Strætkvern, A. B., & Berglund, G. Reisevaner i Oslo og Viken. En analyse av nasjonal reisevaneundersøkelse 2018/19 (Prosam rapport Nr. 242; p. 196), on behalf of Prosam and Ruter. http://prosam.org/index.php?page=report&nr=242, retrieved 24.06.21

Utviklings- og kompetanseetaten, 2022. Datagrunnlag for kommunal kjøretøypark og aktivitetsdata for gjennomsnittlige kjørelengder for Oslos kjøretøy, received by e-mail, spring 2022

Zero, 2021. Virkemiddelanalyse for utslippsfri og biogass tungtransport i Oslo innen 2030