Metlink bus fleet emissions 2023/24

Environmental performance report

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1. Summary

Metlink is committed to delivering an environmentally friendly bus fleet across the region by reducing emissions of greenhouse gases and harmful air pollutants from buses whilst increasing patronage.

This report summarises trends in greenhouse gas (CO_2 equivalents) and harmful pollutant emissions from the bus fleet from August 2018 to June 2024. Emissions were calculated by the new Metlink data analytics platform.

Air quality trends along the bus corridor through Wellington's Golden Mile are also presented.

Key findings

- CO_2e from the bus network has trended down since September 2021 as the proportion of service km travelled by electric buses increased relative to diesel service km. In 2023/24 total network CO_2e increased slightly as km by diesel vehicles increased as well as electric vehicle km.

- Electric buses performed 27% of the total fleet km in 2023/24 continuing the trend of improving network carbon efficiency as CO_2e g per km reduces.

- Bus operators Kinetic (formerly NZ Bus) and Mana have improved their carbon efficiency by increasing electric buses services, resulting in lower CO_2e emissions per km.

- The increase in electric service km corresponded to a decrease in harmful emissions (NOx and particulate matter) but this trend was slightly reversed in 2023/24 as the km travelled by diesel buses also increased.

- Most of the social costs estimated for bus fleet emissions in 2022/23 were due to air pollutant emissions (NOx) from diesel buses.

- An increase in the proportion of electric buses travelling on Manners Street (Golden Mile) was associated with reductions in harmful pollutants. Diesel particulate air pollution reduced by 42% from the 2020/21 baseline. There was a slight increase in diesel particulate in 2023/24 as the number of diesel vehicles was higher than the previous year.

2. Introduction

Diesel buses emit both greenhouse gases (which impact globally) and harmful air pollutants (which impact locally and regionally). Increasing the number of electric buses and the distance they travel relative to diesel buses is key to improving the environmental performance of the Metlink bus fleet.

Bus fleet emissions are tracked to report on two high level performance measures in Greater Wellington's Long-Term Plan (2024-34 LTP):

Metlink:

- All core service bus routes are decarbonised by 2030.

Greater Wellington organisation:

- Gross emissions from Metlink's public transport fleet will be minimised, reducing offsets required to reach net carbon neutrality.

This report presents a range of performance indicators that show progress towards bus fleet decarbonisation, trends in greenhouse gas emissions and harmful emissions, and local air quality impacts.

Bus fleet emissions were modelled using a detailed bottom-up approach that estimates emissions for greenhouse gases and harmful pollutants. The overall method is consistent with a Tier 3 assessment method as described in IPCC[1] and EEA[2] guidance. The model uses COPERT[3] emissions factors which are the best available as they are intended to represent real-world performance as opposed to regulatory emission limits.

Since the last emissions performance report (Mitchell & Clark 2022)[4], covering the period January 2017 to June 2022, the Bus Emissions Model has been updated and migrated to a new data warehouse and analytics platform designed for public transport by netBI[5]. As some of the inputs to the updated model are different from the previous emissions model, the emissions trend has been re-calculated back to 1 August 2018 (the start date of the updated model). Therefore, emissions trends reported here supersede those previously reported. Note the model update does not affect the direction of emissions trends or conclusions in the 2021/22 Metlink bus fleet emissions report.

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[1] IPCC 2019. 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Calvo Buendia, E., Tanabe, K., Kranjc, A., Baasansuren, J., Fukuda, M., Ngarize, S., Osako, A., Pyrozhenko, Y., Shermanau, P. and Federici, S. (eds). Published: IPCC, Switzerland

[2] EEA 2023. Air pollutant emission inventory guidebook 2023 1.A.3.bi-iv Road Transport

[3] European Computer Model to Calculate Emissions from Road Transport

[4] Mitchell T. & Clark, H. 2022. Metlink bus fleet emissions: Environment impacts annual summary. Greater Wellington Regional Council, Publication No. GW/ESCI-T-22/14, Wellington.

[5] https://netbi.com.au/

3. Greenhouse gas emission performance indicators

Greenhouse gases (GHG) from bus emissions are:

- Carbon dioxide (CO_2). The primary contributor to global climate change produced by burning of diesel and petrol.

- Methane (CH_4) and nitrous oxide (N_2O). Although emitted in smaller quantities and shorter-lived than CO_2, they are potent GHG which trap more heat than CO_2.

Bus fleet GHG emissions are reported as CO_2 equivalents (CO_2e) which include methane and nitrous oxide. Methane and nitrous oxide emissions are converted to CO_2e by multiplying by their Global Warming Potential (GWP) as follows: $CO_2e = CO_2 + (N_2O \times 298) + (CH_4 \times 25)$.

The CO_2e emissions performance indicator does not include GHG emissions from upstream electricity generation used to charge electric bus batteries.

3.1 Fleet decarbonisation CO_2e emissions

This high-level indicator shows the trend in total CO_2e emissions per month from the bus fleet (Figure 3.1). The main driver of CO_2e emissions is distance travelled by diesel buses. The diesel bus fleet (excluding rail replacements) was 37% of GW's organisational carbon footprint in 2022/23[6].Electrification of the bus fleet is key to GW becoming carbon neutral with the co-benefit of reducing levels of harmful emissions.

CO_2e emissions fell in 2020 (2019/20) due to reduced services during the COVID-19 travel restrictions. From September 2021 CO_2e emissions trended downwards as the proportion of total in-service km by electric buses increased. There was further dip in CO_2e from January to February 2023 as bus driver shortages necessitated reducing services resulting in fewer km travelled.

Network CO_2e emissions were slightly higher in 2023/24 than in 2022/23 as service km by both diesel and electric buses increased (Figure 3.2).

[6] https://www.gw.govt.nz/assets/Documents/2024/05/GWRC-Emissions-Management-and-Reduction-Plan-2024.pdf

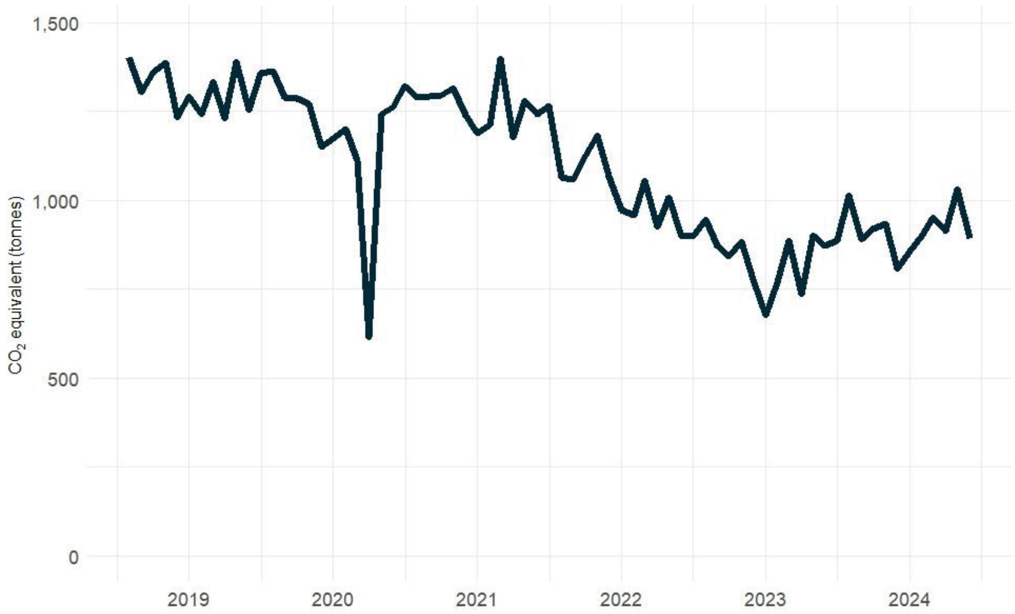

Figure 3.1: Bus fleet CO_2e emissions (tonnes) per month (August 2018 to June 2024)

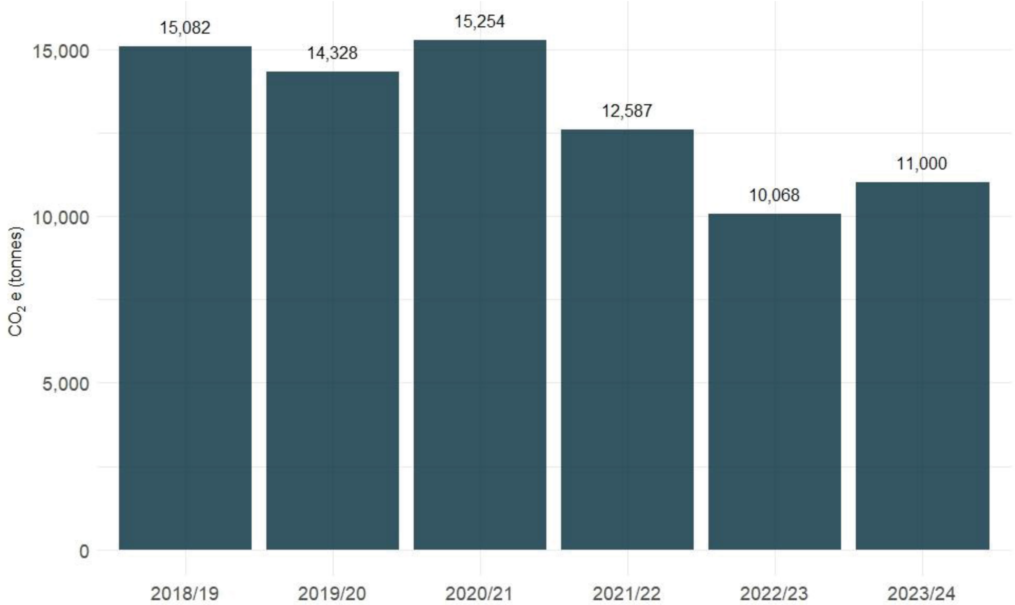

Figure 3.2: Bus fleet CO_2e emissions (tonnes) by financial year

3.2 Distance travelled by electric and diesel buses

This indicator shows the proportion of in-service km travelled by diesel and electric buses (Figure 3.3). The quantity of CO_2e and harmful emissions produced by the network is determined by how far the buses travel and the proportion of the distance travelled that is electric. The proportion total service km by electric buses has increased across the network (Figure 3.4). In 2023/24 the total in-service km across the network increased by almost 1.9 million km from 2022/23. The 2023/24 increase in km was made up of 980,162 electric km and 907,846 diesel km.

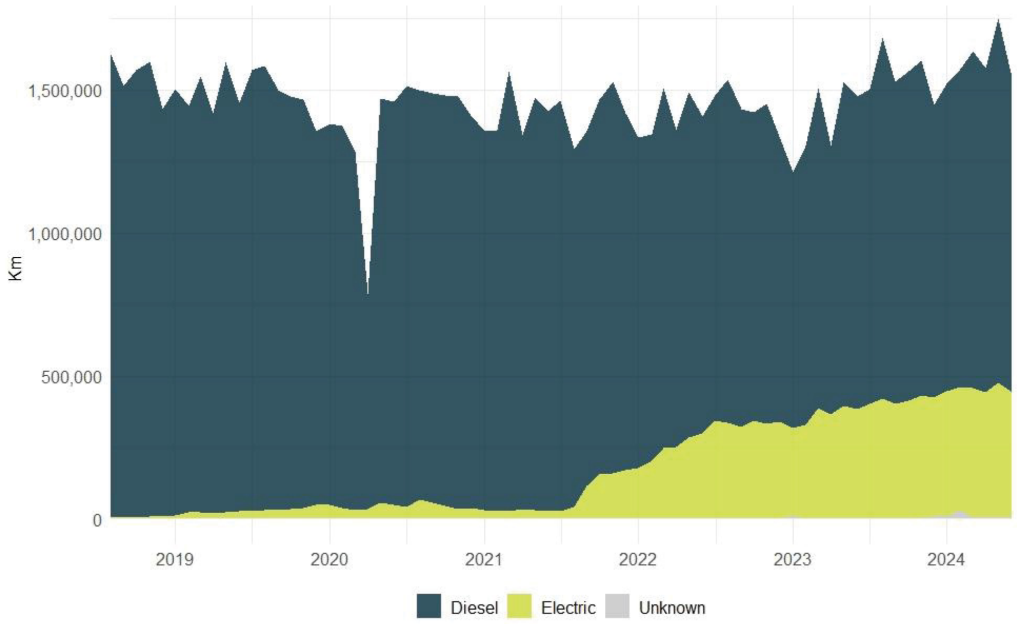

Figure 3.3: Bus fleet km per month by fuel type (August 2018 to June 2024)

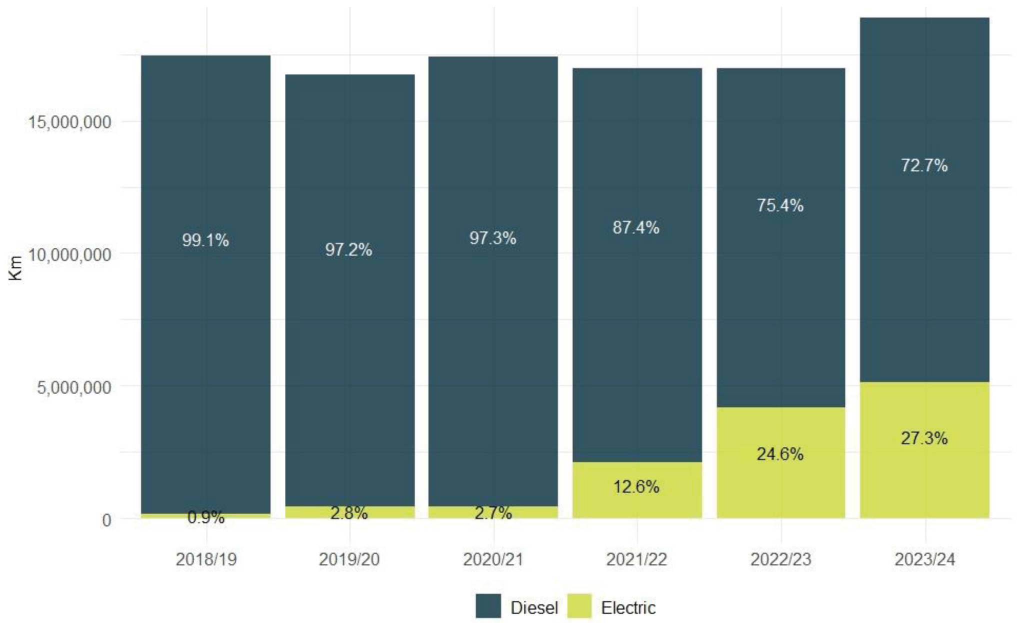

Figure 3.4: Bus fleet total km by fuel type by financial year

3.3 Organisational carbon footprint reporting

Estimated diesel fuel use across the network by financial year (Figure 3.5) is used to calculate the annual CO_2e contribution from Metlink diesel buses to GW's organisational carbon footprint[7]. Organisational reporting is based on the *GHG Protocol Corporate Accounting and Reporting Standard* in alliance with ISO 14064-1:2018 standards which calculates CO_2e kg for GW's GHG inventory as follows:

CO_2e (kg) = diesel fuel (l) x transport fuel emission factor 2.715 (MfE 2023)[8]

There is good agreement between CO_2e estimated by applying the MfE factor to the modelled diesel use and CO_2e calculated by the model for bus exhaust emissions (Figure 3.2). Annual CO_2e calculated from modelled diesel use was approximately 1% higher than when calculated from modelled exhaust emissions.

Diesel fuel use back calculated by the updated emissions model (2022) was lower than that calculated by the previous emissions model (eg, 18% lower in 2022/23) - although the trend was similar for both models. The difference in diesel fuel use calculated by the two models is attributed to the change in the method for tracking vehicle km which was previously based on PTBIS (Public Transport Business Information System). The current model uses the Real Time Information system (provided by Vix Technology) or Snapper trips to determine if a trip was run for in-service fixed-route services.

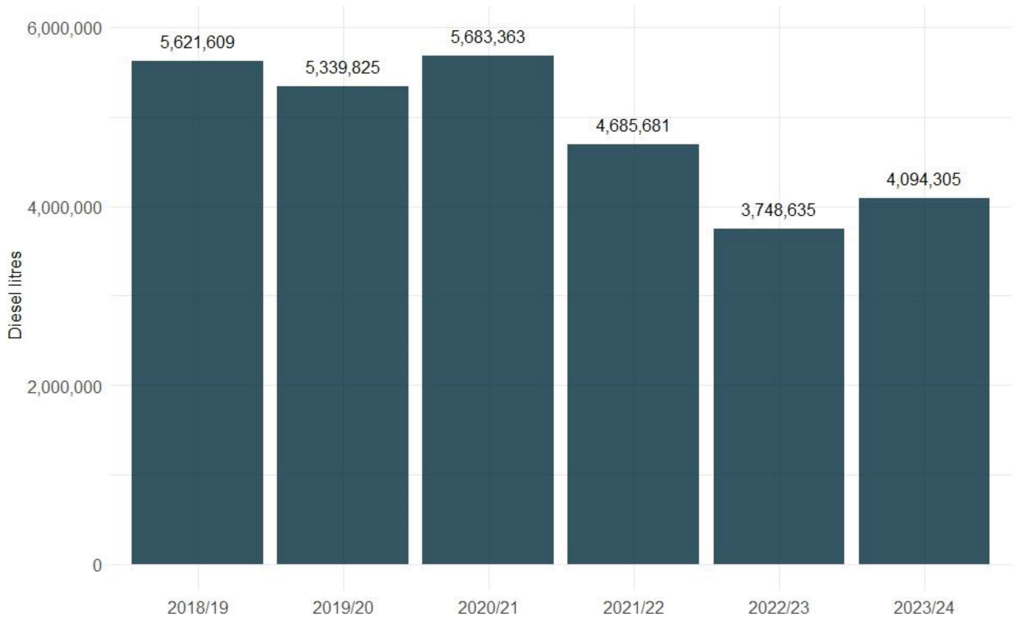

Figure 3.5: Bus fleet diesel fuel consumption (litres) by financial year

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[7] Ceelen, M. 2024. Greenhouse gas emissions inventory and management report. Greater Wellington Regional Council. https://www.gw.govt.nz/assets/Documents/2024/03/IMR_2223_Greater-Wellington-Regional-Council.pdf

[8] The national transport fuel emission factor is from the Ministry for the Environment's Emission Factor Workbook https://environment.govt.nz/publications/measuring-emissions-a-guide-for-organisations-2023-detailed-guide/

The GW organisation footprint includes CO_2e from electricity generation used to charge electric bus batteries. CO_2e emissions for electric buses are post calculated by:

- Estimating annual kilowatt-hours (kWh) by multiplying km travelled by electric buses by a conversion factor of 1.075 supplied by MfE (Table 3.1).
- Converting kWh to CO_2e by the location-based method, ie, an emission factor calculated from all electricity delivered to the national grid in a year or quarter published by MfE (2024)[9].

Table 3.1: Metlink bus fleet electric km (excluding rail replacement) and kWh by financial year

Financial year	Electric km	kWh
2018/19	162,231	174,398
2019/20	472,091	507,498
2020/21	463,908	498,701
2021/22	2,137,424	2,297,731
2022/23	4,173,703	4,486,731
2023/24	5,153,865	5,540,405

3.4 CO_2e emissions per km

3.4.1 Network-wide

This indicator tracks CO_2e g per km emitted in service each month as a measure of carbon use efficiency (Figure 3.6). CO_2e emissions per km reduced across the network from September 2021 as more distance was travelled by electric buses relative to diesel buses. In 2023/24 network CO_2e intensity was 580 g/km which is lower than the peak of 878 g/km in 2020/21. In 2023/24 CO_2e emissions per km declined slightly as distance travelled by electric buses increased marginally relative to the increase in distance travelled by diesel buses.

[9] : Ministry for the Environment. 2024. Measuring emissions: A guide for organisations: 2024 detailed guide. Wellington: Ministry for the Environment. https://environment.govt.nz/assets/publications/Measuring-Emissions-2024/Measuring-emissions_Detailed-guide_2024_ME1829.pdf

Figure 3.6: Bus fleet CO_2e emissions (g per service km per month) (August 2018 to June 2024)

A common measure for evaluating the carbon footprint of different travel options is CO_2e per passenger km. This indicator will be reported in future when more granular data on bus passenger occupancy is included in the bus emissions model.

3.4.2 Operators

This indicator shows CO_2e g per km emitted in service each month by bus fleet operator (Figure 3.7).

Services provided by Kenetic (formerly NZ Bus) became more carbon efficient from September 2021 when they added 51 electric buses to their fleet, replacing diesel service km with electric. Mana has improved carbon efficiency from July 2022 when they introduced the airport service which uses 10 electric buses.

Figure 3.7: Bus fleet CO_2e emissions (kg per service km per month) by operator (August 2018 to June 2024)

3.5 CO_2e emissions by bus route

The Metlink target is for all core services to be electric by 2030. Core services are provided by routes 1, 2, 3, 7, 110, 120, 130, 220 and AX (Airport Express). The long-term trend in monthly total CO_2e emissions by core route (except for AX which is fully electric) is shown in Figure 3.8.

In 2023/24 core routes produced 31% of the total network CO_2e emissions. The top 10 emitting routes (which include six of the core routes) produced 44% of the total network CO_2e emissions (Table 3.2).

Route 2 (Miramar/Seatoun to Karori) has reduced CO_2e emissions from September 2021 when 51 new electric vehicles were introduced. In 2023/24 99% of distance travelled on Route 2 was electric making it the most carbon efficient route producing 8 g of CO_2e per km.

Route 1 (Island Bay to Johnsonville West/Churton Park) has reduced CO_2e emissions from late 2022 due to the introduction of 21 additional electric vehicles. In 2023/24 60% of distance was travelled by electric buses. Despite the relatively high electric km, Route 1 produced 5% of the network CO_2e due to the high number of km travelled.

Route 110 (Emerald Hill to Upper Hutt) has the largest contribution (8.6%) to network CO_2e emissions as it is a high km route with no electric service.

Route 52 (Newlands to Johnsonville) and **Route 25** (Khandallah to Wellington Aro Valley) had the highest CO_2e g/km of the top 10 emitting routes. This is attributed to the steep road grade of the Ngauranga Gorge and Kaiwharawhara Gorge which increases diesel fuel consumption and associated emissions.

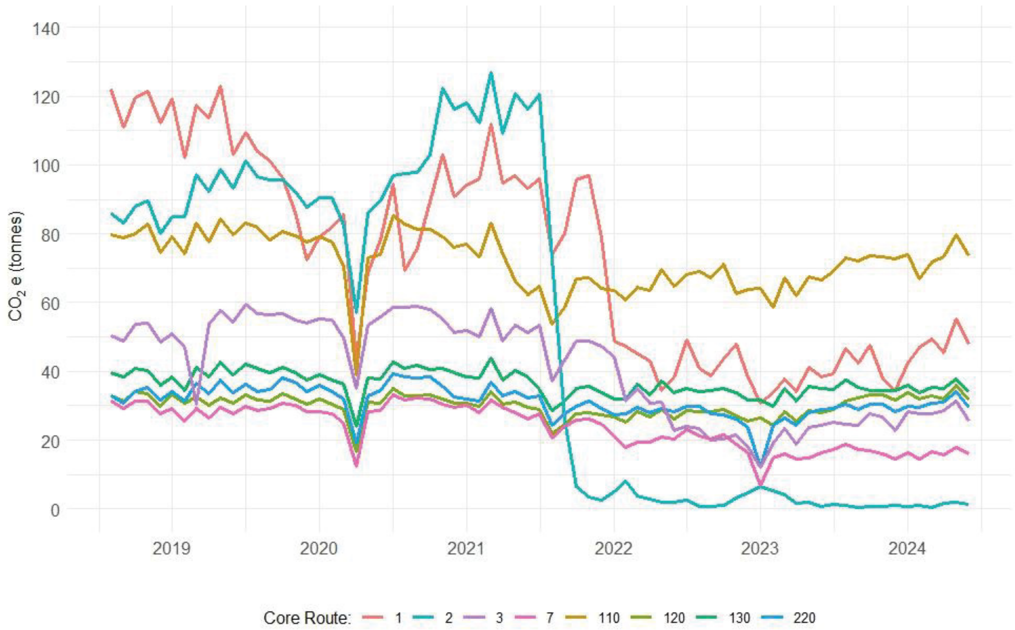

Figure 3.8: Core routes total CO_2e (tonnes) per month (August 2018 to June 2024)

Table 3.2: Contribution by route to total network CO_2e in 2023/24. Top highest emitting routes are shown by rank 1 to 10. Total km does not include the additional 15% estimated for repositioning.

Route	Rank	Percent total network CO_2e	Total km	% electric km
110*	1	8.6%	1,011,182	0%
1*	2	5.3%	1,222,435	59.2%
83	3	4.5%	703,210	24.8%
130*	4	4.2%	576,229	0%
52	5	3.9%	388,598	0%
120*	6	3.8%	475,293	0%
24	7	3.8%	570,801	29.9%
220*	8	3.6%	442,740	0%
25	9	3.3%	314,613	0.1%
3*	10	3.2%	501,623	45.0%
7*	17	2.0%	269,129	37.4%
2*	66	0.1%	1,383,742	99.0%
AX*	207	0%	406,855	100%

*core route

4. Harmful pollutant emissions indicators

Harmful emissions or air pollutants have adverse human health effects, these include:

- Particulate matter – both particles smaller than 10 micrometres (PM_{10}) and those smaller than 2.5 micrometres ($PM_{2.5}$) – which arises primarily from diesel fuel combustion, brake/tyre wear and road dust. Effects are mainly respiratory and cardiovascular, ranging from reduced lung function, more hospital admissions and reduced life expectancy.

- Nitrogen oxides (NOx), in particular nitrogen dioxide (NO_2) – which are emitted from diesel and petrol fuel combustion – increases susceptibility to infections and asthma, reduces lung development in children and has been associated with reduced life expectancy.

A significant factor influencing harmful emissions from diesel buses is the European emission standard (Euro) that the vehicle was manufactured to meet. Overtime Euro emission limits for heavy vehicles have become more stringent (Figure 4.1). On-road testing shows that heavy-duty vehicles built to Euro IV and Euro V frequently do not meet their specified emission limits. However, Euro VI vehicles have delivered a step change in reducing NOx emissions compared to previous standards (Metcalfe & Kuschel, 2022)[10].

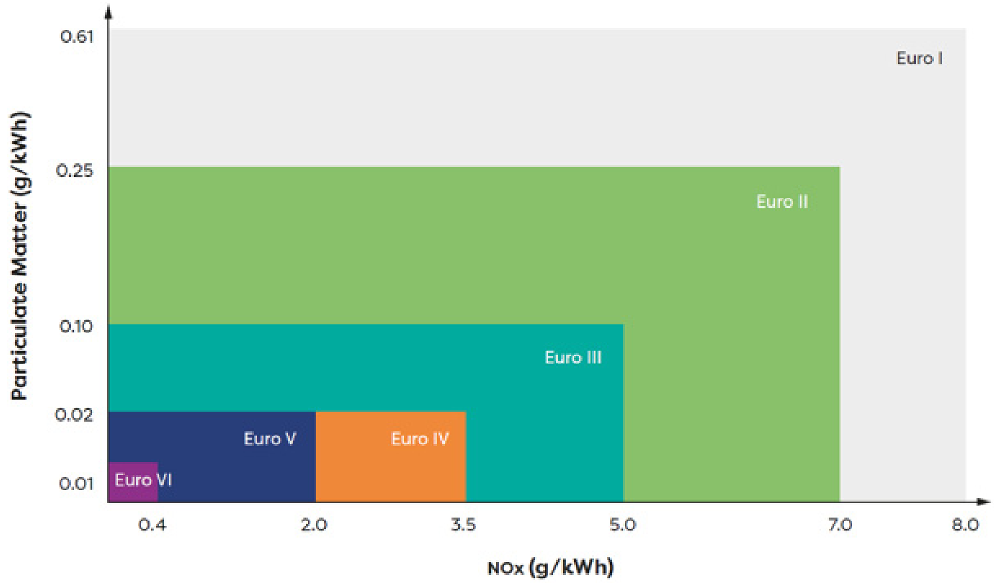

Figure 4.1: Development of European heavy-duty legislated emission limits.
Source: https://www.aecc.eu/legislation/heavy-duty-vehicles/

[10] Metcalfe J and Kuschel G (2022). Estimating the impacts of introducing Euro 6/VI vehicle emission standards for New Zealand. Report prepared by Emission Impossible Ltd for Te Manatū Waka Ministry of Transport, 4 July 2022. MoT-Euro-6-modelling-final-report-4-July.pdf (transport.govt.nz)

In mid-2018 Metlink rolled out major changes to bus routes and replaced the oldest and most polluting buses with newer models manufactured to meet more stringent Euro emission limits. This fleet change resulted in a downward step change in modelled harmful emissions across the network (Mitchell & Clark, 2022)[11].

A breakdown of the fleet in-service kilometres (kms) by bus types in 2023/24 across the network shows a 27% of all kms were undertaken by electric buses (Figure 3.4). Although 5% of kms were travelled by Euro III buses, they produced 35% of the fleet modelled NOx emissions and 56% of $PM_{2.5}$ exhaust emissions.

4.1 Engine type emissions standards

A more detailed view of the trends in service km by engine type (Figure 4.2) shows fewer km by Euro III (red) and increased km by electric buses (green) since September 2021.

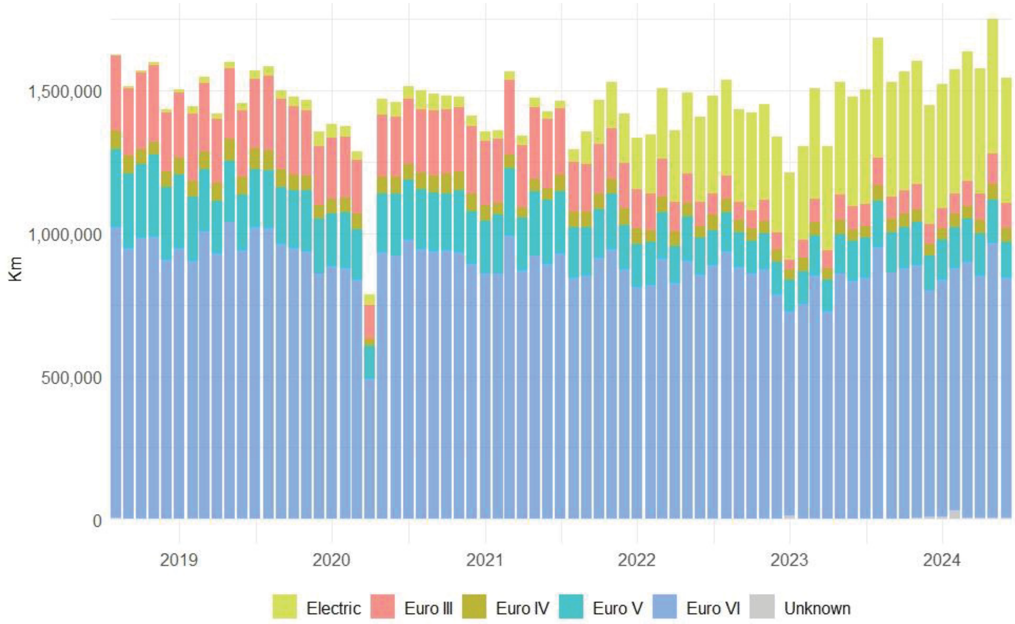

Figure 4.2: Bus fleet in-service km per month by engine type (August 2018 to June 2024)

[11] Mitchell TA and Clark H. 2024. *Metlink bus fleet decarbonisation impacts on air quality. Wellington City Golden Mile 2022/23 update.* Greater Wellington Regional Council, Publication No. GW/KI-T-23-22. https://www.gw.govt.nz/assets/Documents/2024/05/Bus-fleet-decarbonisation-and-Golden-Mile-air-quality.pdf

4.2 Harmful pollutant emissions

4.2.1 $PM_{2.5}$ emissions trend

Previously $PM_{2.5}$ emissions were only able to be reported for diesel exhaust. The updated bus emissions model (2022) now includes non-exhaust emission factors relating to brake and tyre wear which are produced by all vehicles including electric. Brake and tyre wear produce particles through mechanical abrasion. These particles contribute to road dust with the smaller sized particles being re-suspended in air due to turbulence of passing vehicles. Currently the brake and tyre wear emission factors are the same for both electric and diesel buses and do not consider different braking systems. Brake and tyre wear emission factors are an ongoing area of international research and emission factors in the bus emissions model will be updated as the evidence base develops.

Across the network exhaust $PM_{2.5}$ is reducing as the proportion of electric bus km increases relative to diesel buses (Figure 4.3). Brake and tyre wear emissions are produced by all vehicles and depend on total network km. These non-exhaust emissions will not reduce with decarbonisation.

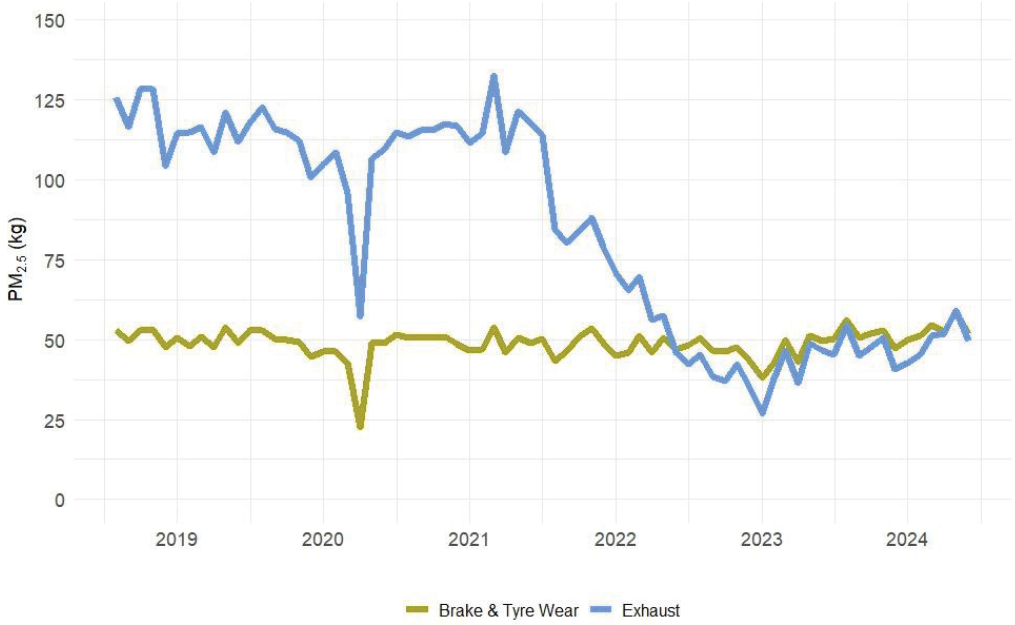

Figure 4.3: Bus fleet total $PM_{2.5}$ (kg) per month (August 2018 to June 2024)

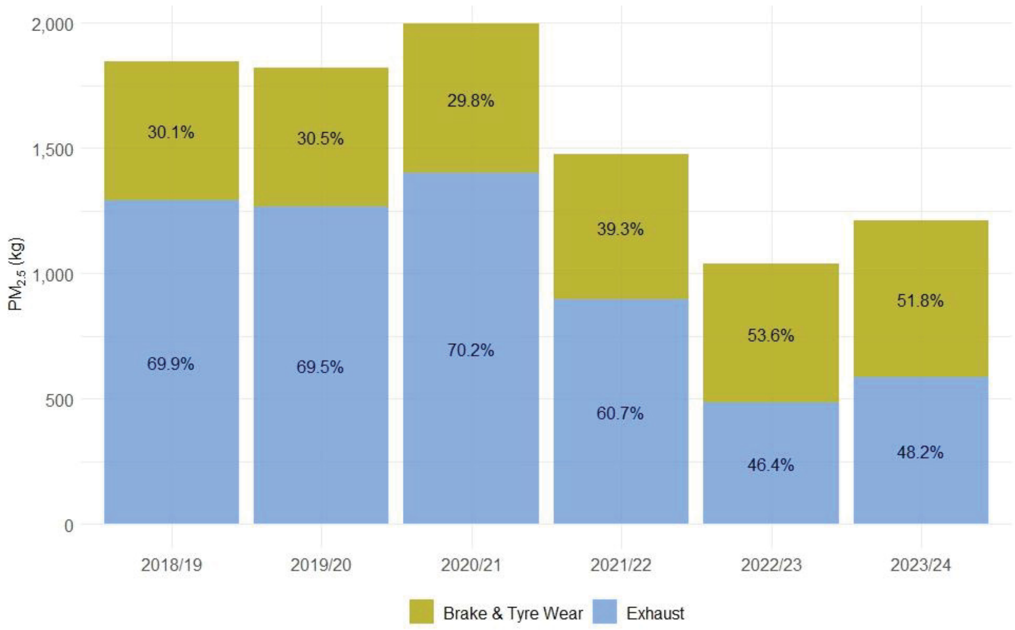

Figure 4.4: Bus fleet total $PM_{2.5}$ (kg) emissions by financial year

4.2.2 NOx emissions trend

The trend in NOx emissions (Figure 4.5) is the same as the trend in $PM_{2.5}$ exhaust emissions and diesel fuel usage. Total NOx emissions by financial year are shown in Figure 4.6.

Figure 4.5: Bus fleet total NOx emissions (tonnes) per month (August 2018 to June 2024)

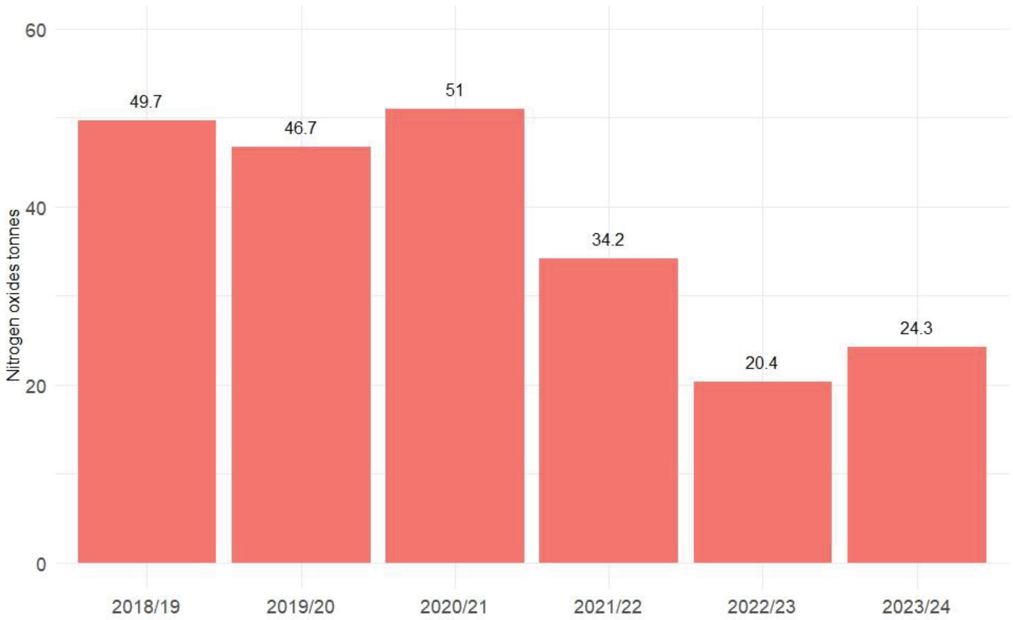

Figure 4.6: Bus fleet total NOx emissions (tonnes) by financial year

5. Social costs of bus fleet emissions and noise

Transport emissions, either GHG or air pollutants, impact society though increased medications use, lost productivity through illness, increased hospitalisation, premature death and climate extremes.

The value to society of reducing GHG, harmful emissions and noise impacts from the bus fleet through decarbonisation was calculated for Metlink by Emission Impossible Ltd (EIL). GHG emissions were valued using the shadow price of carbon published by Treasury in their CBAx Tool[12]. Air quality costs were calculated using 2021 damage costs published by NZTA Waka Kotahi Monetised Benefits and Costs Manual (MBCM)[13] derived from the national Health and Air Pollution Study (Kuschel, 2022[14]). Noise was costed using values reported by the Victorian Transport Policy Institute (VTP 2020)[15].

The total social cost of bus emissions in 2022/23 was estimated as $26.1 million (in 2024 dollars). Most of these social costs are due to NOx emissions from diesel buses (Figure 5.1). For comparison the estimated social costs for NOx emissions from all land transport in our region in 2016 was estimated as $755 million (Kuschel, 2022)[16].Therefore, Metlink bus emissions are responsible for approximately 3% of the damage caused by NOx emissions from all vehicles in our region.

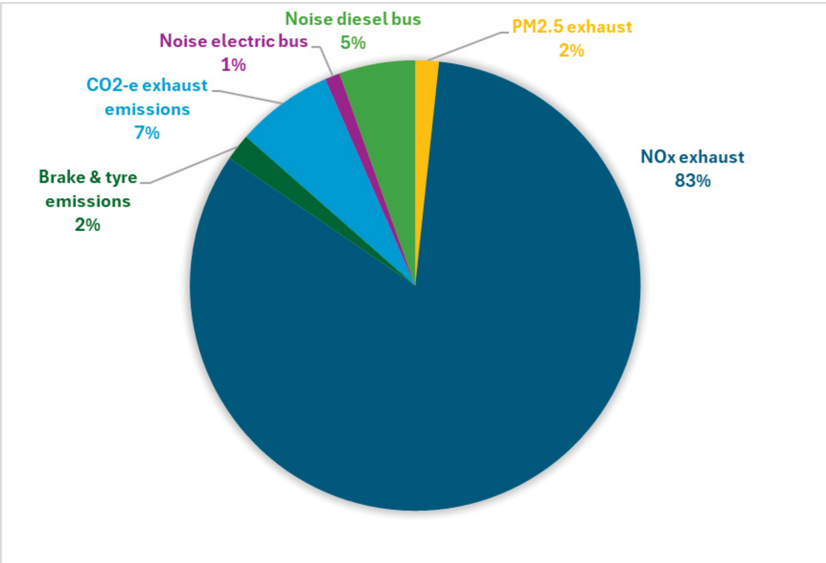

Figure 5.1: Relative contribution of bus fleet sources of emission and noise to total social costs estimated based on 2022/23 bus fleet data

[12] Treasury (2023) CBAx Spreadsheet Model | The Treasury New Zealand
[13] https://www.nzta.govt.nz/assets/resources/monetised-benefits-and-costs-manual/Monetised-benefits-and-costs-manual.pdf
[14] Health and air pollution in New Zealand 2016 (HAPINZ 3.0): Findings and implications | Ministry for the Environment
[15] VTPI (2020). Transportation Cost and Benefit Analysis II – Noise Costs, Victorian Transport Policy Institute, Australia, 20 March 2020. Transportation Cost and Benefit Analysis - Noise Costs (vtpi.org)
[16] Health and air pollution in New Zealand 2016 (HAPINZ 3.0): Findings and implications | Ministry for the Environment

6. Local air quality indicators

Levels of two harmful pollutants, black carbon (fine diesel soot particles) and NO_2 (nitrogen dioxide), were monitored beside a bus-only lane on Manners Street in Wellington city to track impacts of bus fleet electrification on air quality along the Golden Mile.

- Black carbon is released from incomplete fuel combustion and makes up most of the $PM_{2.5}$ in diesel exhaust. Black carbon is a strong marker for diesel particulate. Euro III buses are higher emitters of black carbon than Euro IV and newer models that are required to be fitted with diesel particulate exhaust filters. However, the emissions performance of buses on the road varies depending on vehicle maintenance and driving conditions.

- Nitrogen dioxide (NO_2) – is formed when NOx exhaust emissions emitted from diesel and petrol fuel combustion are oxidised in air. Although regulated Euro emission limits for NOx have been reducing, they have not achieved the world reductions expected. The exception is Euro VI in which real-world test cycles show the stringent NOx emission limit is largely met (Metcalfe and Kuschel 2022)[17].

More information on the air quality monitoring project is available in a separate report (Mitchell & Clark, 2024)[11].

6.1 Changes in Manners Street bus fleet emissions profile

Since the introduction of new fleets and routes in July 2018 the bus fleet profile traversing Manners Street on Wellington's Golden Mile has improved (Figure 6.1) as diesel buses are replaced by electric. From 2021/22 the progressive electrification of routes 1, 2, 3, 83 and Airport Express (AX) has reduced the number of diesel buses that travel through Golden Mile.

[17] Metcalfe J and Kuschel G (2022). Estimating the impacts of introducing Euro 6/VI vehicle emission standards for New Zealand. Report prepared by Emission Impossible Ltd for Te Manatū Waka Ministry of Transport, 4 July 2022. MoT-Euro-6-modelling-final-report-4-July.pdf (transport.govt.nz)

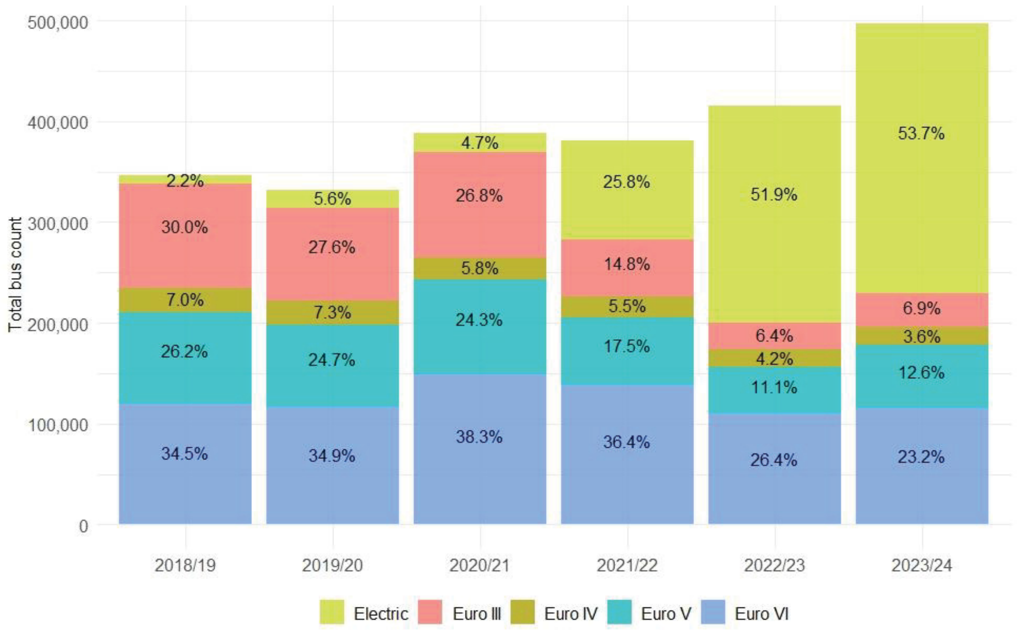

Figure 6.1: Total bus count by engine type and financial year sighted for stop 5006 on Manners Street (northbound) and Willis Street stop 5510

6.2 Diesel particulate (black carbon) trend

Black carbon has been monitored at the Manners Street bus stop since July 2020 (Figure 6.2). Since monitoring began, diesel particulate levels on Manners Street have declined sharply (Figure 6.3). In contrast, levels of diesel particulate from general traffic measured near the Urban Motorway have decreased at a much lower rate (Figure 6.3).

Annual average black carbon was 42% lower in 2023/24 than in 2021/22 when the fleet profile was 95% diesel.

Black carbon levels were slightly higher in 2023/24 than in 2022/23 reflecting the increase in the number of diesel buses (Figure 6.1).

Figure 6.2: Monitoring site at bus stop 5006 on Manners Street northbound lane (Lat -41.28967, Lon 174.7750)

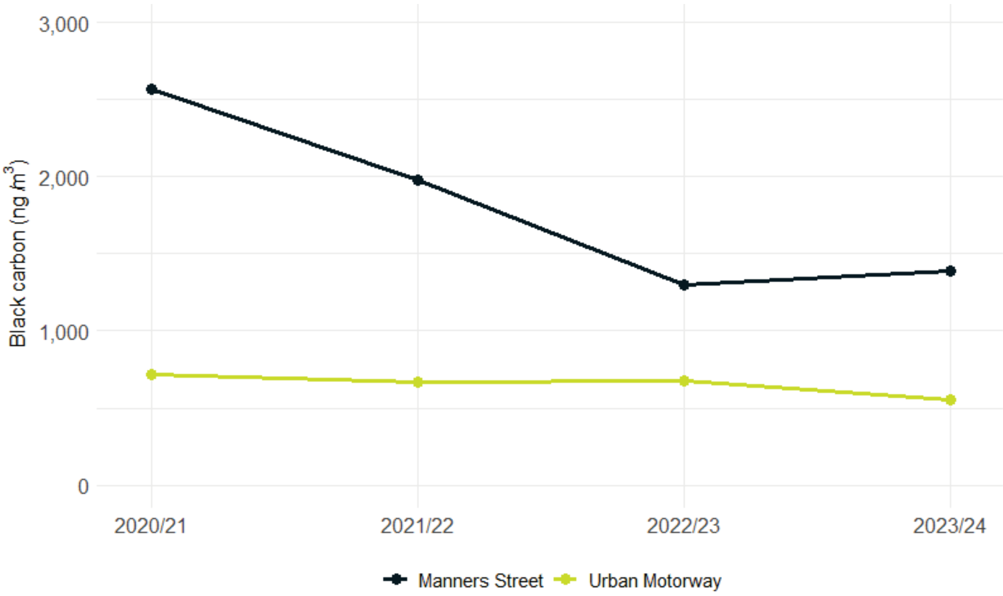

Figure 6.3: Average black carbon (ng/m³) by financial year monitored on Manners Street bus only lane and near the Urban Motorway

6.3 Nitrogen dioxide (NO_2) trend

Nitrogen dioxide has been measured in Manners Street since July 2016 and at the Manners Street bus stop next to the black carbon monitor since July 2020 using passive diffusion tubes (Figure 6.4).

Data is not yet available for the 2023/24 financial year as the monitoring tubes are analysed in the United Kingdom resulting in a 3–4-month delay before results are received.

NO_2 levels on Manners have reduced significantly over the seven-year monitoring period (2016/17 to 2022/23) following the introduction of the new bus fleet and routes in July 2018 (Figure 6.5).

There was a small NO_2 reduction in 2019/20 due to the impact of COVID-19 travel restrictions followed by a larger reduction between 2020/21 and 2022/23 as electric buses replaced diesel buses along Manners Street.

From 2017/18 to 2020/21 NO_2 concentrations on Manners Street were approximately double the concentrations measured by the Urban Motorway monitoring site. However, in 2022/23 NO_2 concentrations at Manners Street had reduced to 1.4 times higher than the Urban Motorway monitoring site.

In 2022/23 all Golden Mile tube sites (Manners Street, Courtney Place and Lambton Quay) recorded similar NO_2 concentrations, indicating the diminishing impact of bus emissions on air quality relative to other traffic, as the fleet is electrified.

Figure 6.4: Location of air monitoring sites

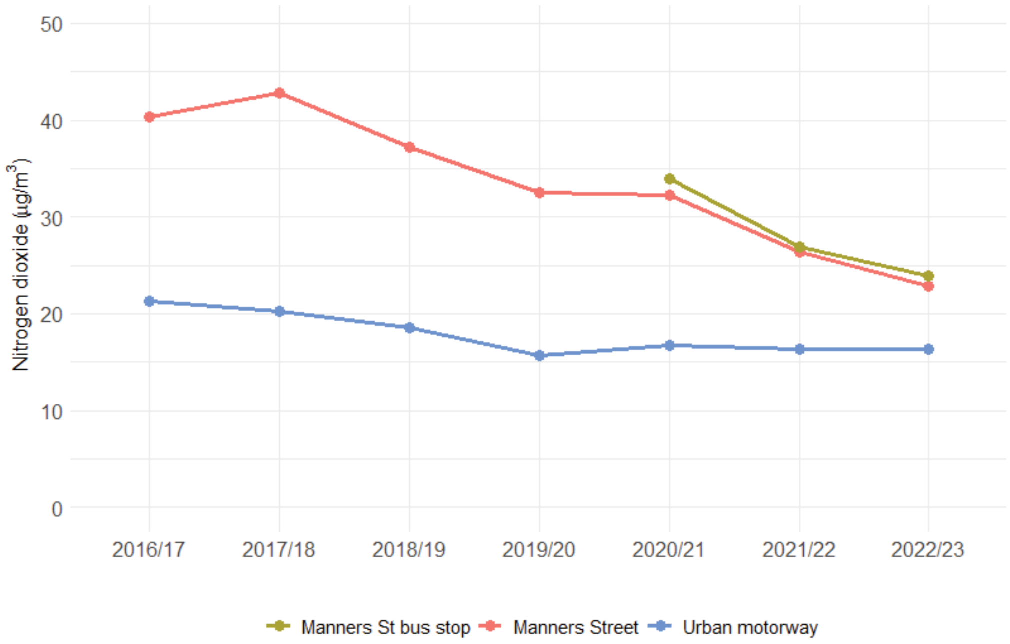

Figure 6.5: Average NO_2 (µg/m³) by financial year monitored on Manners Street bus only lane and near the Urban Motorway

7. Emissions calculation method

Emissions modelling

Bus fleet emissions are modelled using a detailed bottom-up approach that estimates emissions for greenhouse gases and harmful pollutants. The overall method is consistent with a Tier 3 assessment method as described in IPCC[18] and EEA[19] guidance. The GW Bus Emissions Model was developed by Emission Impossible Ltd (EIL) and uses COPERT[3] emissions factors which are the best available as they are intended to represent real-world performance as opposed to regulatory emission limits.

Briefly, the following assumptions have been used in this report:

- Km for unsighted trips that ran have been included based on scheduled km for all non-cancelled trips.
- To account for fuel used during bus repositioning (dead running) whilst not in service, 15% was added to the calculated emissions totals.
- Vehicle loading is fixed at 50% of maximum passenger loading.
- CO_2e emissions for electricity used to charge bus electric batteries are not calculated in the model.

Model development and reporting

The GW Bus Emissions Model was developed in 2016 by EIL to evaluate the emissions associated with tenders for new bus fleet and routes. This model was updated in 2019 and used in-house for corporate GHG reporting from 2018/19 to 2022/23 and for bus emissions environmental reporting for the period 4/1/2017 to 30/6/2022 (Mitchell & Clark, 2022)[4]. This model version was called EMMA (Emissions Modelling, Monitoring and Analysis)

The Bus Emissions Model (underpinning EMMA) was updated in 2022 by EIL to be consistent with the methodology and assumptions for calculating emission factors in the national Vehicle Emission Prediction Model (VEPM)[20]. The 2022 model version was implemented on Metlink's new cloud-based business data analytics and reporting system (netBI). This model version is called the Bus Emissions Cube.

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[18] IPCC 2019. 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Calvo Buendia, E., Tanabe, K., Kranjc, A., Baasansuren, J., Fukuda, M., Ngarize, S., Osako, A., Pyrozhenko, Y., Shermanau, P. and Federici, S. (eds). Published: IPCC, Switzerland

[19] EEA 2023. Air pollutant emission inventory guidebook 2023 1.A.3.bi-iv Road Transport

This report is based on the Bus Emissions Cube with emissions data back cast to 1 August 2018. There are some differences in emissions calculated by EMMA compared to the Bus Emissions Cube, although the trends are generally consistent. The differences between these two models are attributed to updated emission factors, new parameters in the Bus Emissions Cube (eg, road gradient) and differences in the way bus trips are tracked. The method for tracking vehicle km was previously based on PTBIS (Public Transport Business Information System) which was retired in May 2023. The Bus Emissions Cube uses the Real Time Information system (provided by Vix Technology) or Snapper trips to determine if a trip was run for in-service fixed-route services.

Future changes to the Bus Emissions Cube

Like EMMA the Bus Emissions Cube only tracks mileage and calculates emissions for buses at the start and end of an in-service trip. Therefore, for consistency with previous reporting 15% has been added to emissions totals to account for emissions produced while buses move between depots and reposition at the end or start of a trip (dead running).

From mid-2024 buses will be fitted with new telematics which will improve the accuracy of calculating distances and speeds as well as allowing more buses to be sighted. This will also allow out-of-service kms to be tracked so that more accurate estimates of emissions from dead running can be reported and allow real-world fuel use validation. This will improve the accuracy of of bus km tracking for future reporting.

A further improvement to the model will be to have more granular parameters for passenger occupancy which can be matched to patronage data so that emissions per passenger km can be calculated.