# ISTANBUL METROPOLITAN MUNICIPALITY ALLOCATION & IMPACT REPORT

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# CONTENT



ISTANBUL METROPOLITAN MUNICIPALITY

# GLOSSARY

| | |
|---|---|
| **Baseline Scenario** | Baseline scenarios are estimates of how GHG emissions and their primary influencing factors could develop in the future if no specific measures are implemented to curb emissions. |
| **C40** | The global network of nearly 100 mayors of the world's leading cities. |
| **$CH_4$** | Methane, the main component of natural gas, is a greenhouse gas that influences the climate system when released into the atmosphere. |
| **Climate Neutral** | Refers to balancing greenhouse gas emissions with their absorption or removal from the atmosphere. |
| **$CO_2$ Equivalent ($CO_2e$)** | The standard unit of measurement used to express the global warming potential of each greenhouse gas. |
| **Emission Reduction** | Reduction in GHG emissions relative to a base year or baseline scenario. |
| **Ex-ante** | Analysis conducted prior to implementing an intervention. |
| **Ex-post** | Analysis conducted following the implementation of an intervention. |
| **Greenhouse Gas (GHG)** | Gases that trap heat in the Earth's atmosphere, contributing to the greenhouse effect. Key examples include carbon dioxide ($CO_2$), methane ($CH_4$), nitrous oxide ($N_2O$), and fluorinated gases. |
| **Metrobus** | Bus rapid transit system in Istanbul. |
| **Mode of Transport** | Refers to the various means of transportation used within cities or metropolitan areas, including public transit (buses, subways, trams), private vehicles (cars, motorcycles), bicycles, walking, and shared mobility services (e-scooters, ride-hailing). |
| **$N_2O$** | A colorless, odorless gas that is a potent greenhouse gas and contributes to global warming. It is also known as laughing gas and is produced by natural processes in soil and water, as well as by human activities such as agriculture, industrial processes, and fossil fuel combustion. |
| **Vehicle Kilometers Travelled** | Distance travelled by a vehicle multiplied by number of vehicles. |

# ABBREVIATIONS

| | |
|---|---|
| **$CH_4$** | Methane |
| **$CO_2$** | Carbon Dioxide |
| **$CO_2e$** | Carbon Dioxide Equivalent |
| **GCAP** | Green City Action Plan |
| **GHG** | Greenhouse Gas |
| **ICMA** | The International Capital Market Association |
| **IMM** | Istanbul Metropolitan Municipality |
| **MWh** | Megawatt-Hour |
| **$N_2O$** | Nitrous Oxide |
| **SDG** | Sustainable Development Goal |
| **SECAP** | Sustainable Energy and Climate Action Plan |
| **SUMP** | Sustainable Urban Mobility Plan |
| **TURKSTAT** | Turkish Statistical Institute |
| **USD** | United States Dollar |

## SUSTAINABILITY AT THE HEART OF IMM'S VISION

With 50.9 million tones $CO_2e$[1] in 2023, Istanbul accounted for approximately 10% of the country's total emissions of 552.2 million $CO_2e$.[2] The largest share in the formation of greenhouse gas emissions in Istanbul is energy consumption with 65%, followed by the transport sector[3] with 31%.[4] Therefore, sustainability in Istanbul has been a primary vision of IMM.

With the raising the importance of sustainability all over the world, Istanbul Metropolitan Municipality (IMM) administration has also placed sustainability at the center of its management framework. For setting the target for Istanbul to become a carbon-neutral and resilient city by 2050, the Deadline 2020 commitment at the 2019 C40 Mayors Summit was adopted. In addition, IMM's 2022 application to the European Commission's 'Climate Neutral and Smart Cities Mission Call for Expressions of Intent' under the Horizon Europe Programme was approved and Istanbul was placed among the 112 cities supported to achieve climate neutrality by 2030 with this application. IMM has focused on the goal of creating a sustainable, carbon-neutral and resilient city across all its operational themes for achieving its sustainability targets by adopting critical strategy documents and action plans. Documents prepared on this aim are the Istanbul Vision 2050 Strategy Document, Sustainable Urban Mobility Plan (SUMP), Climate Change Action Plan, Green City Action Plan (GCAP), Sustainable Energy and Climate Action Plan (SECAP), Sustainable Development Goals Voluntary Local Review, and Local Equality Action Plan etc.

In 2024, IMM allocated approximately 776.4 million USD[5] for initiatives under the 'Environmentally Sensitive Istanbul' theme, including waste management, recycling, renewable energy, energy efficiency, green spaces and tackling climate crises. Additionally, approximately 1.8 billion USD[6] was invested under the theme of 'Accessible Istanbul' to enhance sustainability in public transportation systems, especially rail systems, seaways, intelligent transport systems, and highways. Since 2019, sustainable project investments have been prioritized, and significant projects such as railway systems, waste incineration facilities, renewable energy facilities, decarbonization of public transport, and bicycle paths have been implemented in line with strategic plans and investment service programmes.

One of the most important steps taken by IMM to promote sustainable transportation is to improve public transportation network especially by giving priority to rail systems. Istanbul possesses a unique characteristic, with its 380.7 km rail systems lines and 10 lines simultaneously under construction, and is the only city in the world to have achieved this on a global scale. 2050 target is to enhance the rail network in Istanbul to approximately 717 km together with the lines operated and constructed by the Ministry of Transport and Infrastructure, and thereby connecting numerous neighborhoods and Istanbulites with rail systems.

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[1] IMM. (2025). Climate Change Monitoring Report 2024.
[2] TURKSTAT. (2025). Greenhouse Gas Emission Statistics, 1990-2023.
[3] Greenhouse gas emissions from transport include road, rail and maritime, and it is a fact that this ratio will be even higher if the aviation sector is included.
[4] IMM. (2024). Climate Change Monitoring Report 2024.
[5] These figures are target-based expenditure amounts and include personnel expenditures and investment and service expenditures associated with the activities, but exclude general government expenditures and transfer expenditures to other administrations (Source: IMM. (2025). Annual Report 2024. https://finansman.ibb.istanbul/wp-content/uploads/2025/04/2024-FAALIYET-RAPORU.pdf
[6] ibid.

# IMM SUSTAINABLE FINANCE FRAMEWORK

In 2023, IMM introduced a Sustainable Finance Framework[7]—the first document of its kind prepared by a local government in Türkiye—setting out the principles governing the use of sustainable finance instruments. A Second Party Opinion[8] confirming the framework's reliability, effectiveness, and alignment with the criteria established by the International Capital Markets Association (ICMA) was obtained from Sustainalytics, a leading environmental and sustainability assessment organization.

The Framework addresses the four core components:

### Use of Proceeds

- **Green Use**
  - Clean Transportation
  - Renewable Energy
  - Climate Change Adaptation
  - Pollution Prevention and Control
- **Social Use**
  - Affordable Basic Infrastructure
  - Access to Essential Services
  - Food Security and Sustainable Food Systems
  - Socioeconomic Advancement and Empowerment

### Project Selection and Evaluation

- IMM's Sustainable Working Committee (SWC) will be responsible for reviewing and overseeing the project evaluation and selection process in accordance with the Framework's eligibility criteria.

### Management of Proceeds

- The Eligible Sustainable Projects Portfolio relating to a Sustainable Finance Instrument will constitute expenditures that occurred no earlier than three budget years prior to the year of issuance, the budget year of issuance, and two budget years following the year of issuance.

### Reporting

- IMM will annually publish allocation and impact report on its website until full allocation. IMM may on a best efforts basis report on impact metrics where relevant.

[7] https://finansman.ibb.istanbul/wp-content/uploads/2023/12/Sustainable-Finance-Framework.pdf
[8] https://finansman.ibb.istanbul/wp-content/uploads/2023/12/Second-Party-Opinion.pdf

## USE OF PROCEEDS

On 6 December 2023, the Municipality issued its first green bonds, and this transaction marks IMM's largest-ever bond offering as well as the first green bond issued by a Municipality in the CEEMEA region.

*Table 1: Green Bond allocations by project*

| ISIN | Project Category | Project Name | Project Status | Allocated Amount | Share |
|---|---|---|---|---|---|
| XS2730249997<br>US46522TAC27 | Clean Transportation | Çekmeköy-Sancaktepe-Sultanbeyli Metro Line | Under construction | $ 133,395,522 | 19% |
| | | Mahmutbey-Bahçeşehir-Esenyurt Metro Line | Under construction | $ 325,485,075 | 45% |
| | | Procurement of Metro Vehicles | Procurement in progress | $ 256,119,403 | 36% |
| TOTAL | | | | $ 715,000,000 | 100% |

All projects financed by this green bond are still in the construction/procurement phase and not yet operational as of 31 December 2025. More detailed information about allocation and impact of green bond proceeds can be found in Allocation & Impact Report 2024[9].

*Table 2: Green Loan allocations by project*

| Lender | Project Category | Project Name | Project Status | Amount |
|---|---|---|---|---|
| ING Bank A.Ş. | Clean Transportation | Eyüpsultan-Bayrampaşa Tram Line | Under construction | ₺ 1,500,000,000 |
| JP Morgan, BNP Paribas, ING Bank, Societe Generale | Clean Transportation | Ümraniye-Ataşehir-Göztepe Metro Line | Under construction | € 150,000,000 |

Although the green loan agreement signed for the financing of the Ümraniye-Ataşehir-Göztepe Metro Line (M12) project qualifies as a green loan, and the project is included in the eligible projects portfolio under the Sustainable Finance Framework, the impact details of this project are not included in either this report or the previous report, as the agreement was signed in 2023, prior to the publication of our Sustainable Finance Framework, and is subject to separate reporting mechanisms to the Lenders.

Accordingly, this report focuses on the Eyüpsultan-Bayrampaşa (T7) Tram Line project, for which a green loan agreement was signed with ING Bank A.Ş. in January 2025.

[9] https://finansman.ibb.istanbul/wp-content/uploads/2025/01/IMM-ALLOCATIONIMPACT-REPORT-2024.pdf

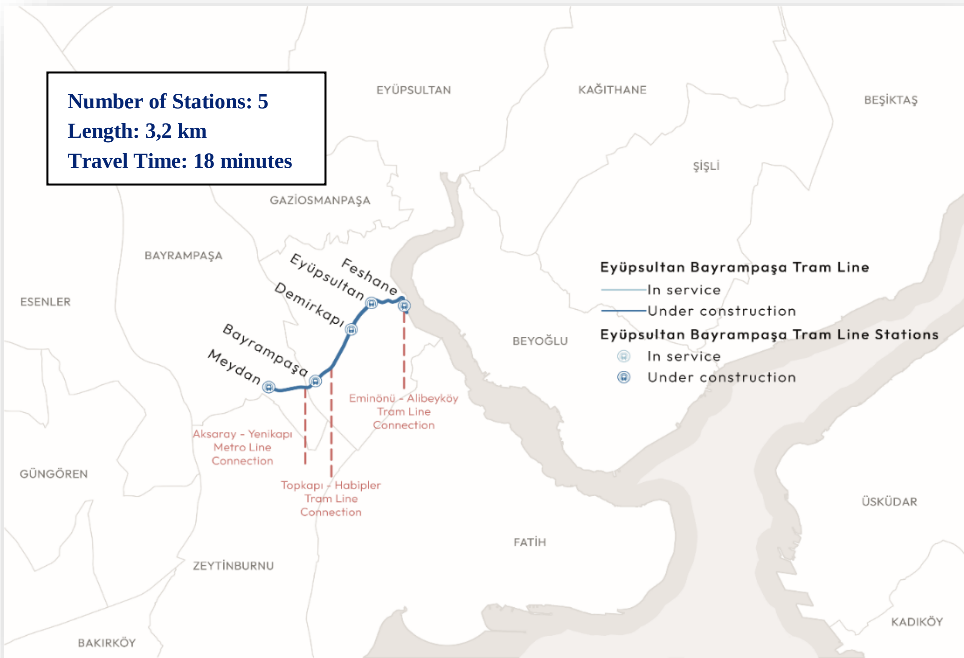
# EYÜPSULTAN-BAYRAMPAŞA TRAM LINE

Eyüpsultan-Bayrampaşa Tram Line project is one of the important lines in the Municipality's rail systems network. The tram line project has been planned within the boundaries of the Eyüpsultan and Bayrampaşa districts which are distinguished by dense residential zones, major commercial centers, and significant historical and cultural assets.

Consisting of 5 stations, Meydan, Bayrampaşa, Demirkapı, Eyüpsultan, and Feshane, the tram line has a total length of 3.2 km starting from Bayrampaşa Square, following Eyüpsultan Boulevard, and reaching Feshane on the Eyüp waterfront. Between Feshane and Demirkapı stations, 1.8 km of the total 3.2 km line are planned underground while the remaining part is planned at ground level.

The line is planned to be in service in 2027 and it will take 18 minutes to travel full circle between Feshane and Meydan stations in an uninterrupted and comfortable way with the completion of the line. The line will have several connections to the existing transport network; it will be connected to the Eminönü-Alibeyköy Tram Line (T5) at Feshane Station, Topkapı-Habipler Tram Line (T4) and Aksaray-Yenikapı Metro Line (M1) at Bayrampaşa Station. With this line, the population living in the settlements located in European Side will have direct and indirect access to many historical, cultural and industrial districts of Istanbul such as Feshane, Eyüpsultan, Bayrampaşa.

*Figure 1: Eyüpsultan-Bayrampaşa Tram Line*



## SDG MAPPING OF FINANCED ASSETS

Within the scope of the sustainable efforts, IMM has taken decisive steps to support and localise each of the 17 Sustainable Development Goals (SDGs). This tram line project will directly contribute to Goal 11 “Make cities and human settlements inclusive, safe, resilient and sustainable” and Goal 13 “Take urgent action to combat climate change and its impacts” through the construction of the line for which the green loan is allocated.

In addition to direct contribution of the two of the SDG goals, the tram line project indirectly support several other goals. The widening of the rail system network along with the increased travel capacity by the rail system and the decrease in road motor vehicle traffic will also relate to the objectives under Goal 3, “Ensure healthy lives and promote well-being for all at all ages” specifically in reducing road traffic accidents and reducing deaths caused by pollution. On the other hand, new technologies planned to be used in rail systems will also contribute to the targets of improvement in energy efficiency under Goal 7 “Ensure access to affordable, reliable, sustainable and modern energy for all”. Public transportation systems are a basic services in cities, and the implementation of rail systems that provide faster and more comfortable transportation will increase the proportion of the population living in households with access to these fundamental services.

# IMPACT REPORT ON ALLOCATED PROCEEDS

## Estimated Impact Figures

The following estimated impact figures are provided to measure the Eyüpsultan-Bayrampaşa Tram Line project and the savings foreseen for this line:

*Table 3: Estimated Impact Figures*

| | Indicator[10] | Eyüpsultan-Bayrampaşa Tram Line |
|---|---|---|
| Project Information | Expected Project Completion Date (Year) | 2027 |
| | Allocated Amount (₺) | 1,500,000,000 |
| | Approximate length of infrastructure to be built by proceeds (km)[11] | 1.35 km |
| Impact Data-Reduced/ Avoided Emissions | Annual $tCO_2$ | 1,162.6 |
| | Annual $tCH_4$ | 2.96 |
| | Annual $tN_2O$ | 18.2 |
| | Annual $tCO_2e$ | 1,183.8 |
| Other Impact Data | Total annual energy saved (MWh) | 2,690.6 |
| | Annual estimated reduction in vehicle usage (vehicle-km in million) | 9.8 km |
| | Annual estimated reduction in fuel consumption (ton) | 12,765 |

[10] The indicators illustrate the expected approximate impacts are based on anticipated annual results for a representative year (2028) once a project is completed and operating at normal capacity.
[11] Since rail projects are complex projects with many components such as excavation, electromechanical works, tunnel construction, rail laying, etc., the approximate length of infrastructure to be built by proceeds indicator is a representative figure calculated by the green loan proceeds share in the total cost of the project and corresponding portion in the total rail length, and it should be taken into consideration that it may differ in the actual progress of the project.

# EXPECTED SOCIAL CO-BENEFITS

## Increasing Accessibility

In cities with high mobility, the transportation becomes a crucial issue for citizens and fast, modern and high-capacity public transportation systems become a necessity. The Eyüpsultan-Bayrampaşa Tram Line is planned to provide a fast, comfortable and reliable public transport option to all residents of the city by providing services to the spiritual/historical districts where there are dense residential zones and major commercial centers. This line will facilitate access to bus terminals in Esenler and Alibeyköy districts and an important historical/touristic area called Fatih Historical Peninsula through the connections with Eminönü-Alibeyköy Tram Line, Topkapı-Habipler Tram Line and Aksaray-Yenikapı Metro Line.

## Contribution to Employment and Economic Activities

Both the construction phase and operation phase will provide employment opportunities for many individuals. Currently, a total of 211 blue-collar and white-collar workers have been employed for the construction of the line. After the completion of construction phase, it is planned to create job opportunities for 150 blue-collar and white-collar workers during the operation periods. In addition, providing access to the commercial areas will not only positively impact on individuals who are working/living in this area and will also contribute to Country's economy.

## Reduction of Time Lost in Traffic

Especially in densely populated cities, rail system transportation positively affects working population by significantly reducing the travelling time. Rail systems minimize time loss in traffic by providing an alternative and rapid mode of transportation especially during peak hours. Due to this mode of transportation, commuting times and traffic-related stress will reduce and productivity will increase. Furthermore, shorter travel times allow employees to use their leisure time more efficiently and spend more time on their personal activities and self-development. In the long term, rail lines improve the quality of life for the working population, fostering social and economic dynamism in urban areas.

*Table 4: Comparison of travel times by modes of transport*

| | Direction[12] | By car | By rubber-wheeled PT | By metro |
|---|---|---|---|---|
| Morning Peak (6 a.m. – 9 a.m.) | Feshane to Bayrampaşa | ~ 30 minutes | ~ 43 minutes | ~ 9 minutes |
| | Bayrampaşa to Feshane | ~ 27 minutes | ~ 45 minutes | ~ 9 minutes |
| Evening Peak (5 a.m. - 8 a.m.) | Feshane to Bayrampaşa | ~ 25 minutes | ~ 44 minutes | ~ 9 minutes |
| | Bayrampaşa to Feshane | ~ 20 minutes | ~ 46 minutes | ~ 9 minutes |

[12] The indicators illustrate the expected approximate impacts are based on anticipated annual results for a representative year (2028) once a project is completed and operating at normal capacity.

# METHODOLOGY OVERVIEW

## Methodology Overview

In this report, Eyüpsultan-Bayrampaşa Tram Line project will be covered and the analyses have been carried out on a project basis.

The approach followed to derive the impact indicators for Eyüpsultan-Bayrampaşa Tram Line project are based on the comparison between:

- The GHG emissions and energy consumption of the green projects and
- The GHG emissions and energy consumption of the alternative modes of transportation (i.e., those passengers that would continue to use road transportation alternatives, in case the metro lines were not financed).

The "baseline scenario" for the impact assessment is the "alternative modes of transportation" (in the case of projects studied within this report, this refers to road transportation alternatives considering the project implementation area).

## Main Approach and Assumptions

The estimated impact is based on the following key approaches:

- The reported impact refers to the anticipated (i.e., ex-ante) environmental impact rather than the actual (i.e., ex-post) impact;

- The reported impact is defined as 'Avoided/Reduced' (i.e., a reduction/ avoidance compared to the scenario where the project is not financed);

- Calculations assume that the tram line vehicle operates under stable conditions, following a regular and planned schedule, and that in the absence of financing, all passengers would shift to alternative modes of transportation (i.e., road transportation);

- The data used in the calculation of impact indicators in this report are available official data obtained from the relevant departments of the IMM. These indicators have been calculated based on the models and assumptions made with this data, and it should be noted that there may be a difference between the actual measurements after the implementation of the projects. In addition, the right to revise the model is reserved to increase the accuracy of the estimates in future reporting periods.

## The Baseline

The baseline considered to derive the environmental impact assumed that all passengers would continue using the road transportation alternatives as the alternative modes of transportation, in the case that the project had not been financed.

The baseline is assumed according to the estimation of future travel demand by Istanbul Transportation Model (IUM) within the scope of the Sustainable Urban Mobility Plan (SUMP) of Istanbul. In addition to the approved Transportation Master Plan, transportation demand forecasts are made using the IETT Transportation Model for the entire public transportation system (bus, metrobus, sea routes, minibus) and studies and data from the Istanbul SUMP.

Within the scope of the model:

• OD (broken down by 24 hours): It was created using the Istanbul Card transaction data from actual journeys. It reflects passengers' daily travel patterns based on specified algorithms,

• Roads: All roads in Istanbul are categorized into 99 types based on the number of lanes and free-flow speed. Updates on the relevant areas remain in progress.

• Public Transportation System: All stops and lines have been integrated into the model, with stops assigned into zones. Daily OD stop-zone matches are provided,

• Timetables (ORER): All lines in the public transportation system are defined in the model with departure times. Timetables are used instead of frequency in public transportation assignments,

• Model Working Principle: The model can be operate using 4 different assignment models. The parameter chosen for Istanbul is the Khirchoff principle,

• Impedances: The factors affecting durations that determine travel time

are used as data. IMM considers this model to be appropriate for impact reporting purposes.

## Baseline Values

1. The baseline values, the total passenger demand for the tram line construction is sourced from the feasibility report for Eyüpsultan-Bayrampaşa tram line.

2. The impact assessment calculations were advanced using the total passenger demand from the feasibility report.

3. It is assumed that all passengers would switch to alternative modes of transportation with the following distribution: 65% of them travel by bus-truck, 30% of them by minibus-panel van and 5% of them by car[13]. Even if the actual modal mix may be a more complex mix of the three modes, it is deemed that a more detailed estimation at project level would not yield a material and significant increase of reliability of the final estimates. The data is summarized in Table 5.

*Table 5: Distribution of Alternative Travelling Modes*

| Distribution % of Alternative Travelling Modes | |
|---|---|
| Bus - Truck | 65 % |
| Minibus - Panel Van | 30 % |
| Car | 5 % |

To enhance clarity, an example calculation has been added, using the year 2030 Eyüpsultan-Bayrampaşa hourly total passenger demand, vehicle-km calculations are shown.

| | |
|---|---|
| TPD_h | : Hourly total passenger demand |
| s_bus | : Share of alternative modes of travel for buses |
| s_minibus | : Share of alternative modes of travel for minibuses |
| s_car | : Share of alternative modes of travel for cars |
| TP_b_h | : Hourly total passenger for bus alternative |
| TP_m_h | : Hourly total passenger for minibus alternative |

[13] Distribution of alternative travelling modes is obtained from IMM Department of Rail Systems.

TP_c_h : Hourly total passenger for car alternative

TP_b_h = TPD_h × s_bus
TP_b_h = 3,800 × 0.65 = 2,470 passenger/hours
TP_m_h = TPD_h × s_minibus
TP_m_h = 3,800 × 0.30 = 1,140 passenger/hours
TP_c_h = TPD_h × s_car
TP_c_h = 3,800 × 0.05 = 190 passenger/hours

4. The number of alternative modes of travelling is calculated using the number of passengers per vehicle class and the average number of passengers carried by vehicle class. For this report, the assumption for the average number of passengers carried by vehicle class is shown in Table 6.

*Table 6: The Average Number of Passengers Carried by Vehicle Class*

| The Average Number of Passengers Carried by Vehicle Class | |
|---|---|
| Bus | 91.48 passengers |
| Minibus | 19 passengers |
| Car | 1.56 passengers |

AP_bus : The average number of passengers carried per bus
AP_minibus : The average number of passengers carried per minibus
AP_car : The average number of passengers carried per car
N_bus : Number of buses
N_minibus : Number of minibuses
N_car : Number of cars

N_bus = TP_b_h / AP_bus
N_bus = 2,470 / 91.48 = 27 bus
N_minibus = TP_m_h / AP_minibus
N_minibus = 1,140 / 19 = 60 minibus
N_car = TP_c_h / AP_car
N_car = 190 / 1.56 = 122 car

5. Under normal conditions, a bus is assumed to travel 225 km, a minibus 200 km and a car 40 km per day. In addition, serviceability coefficients are assumed to be 0.85 for bus, 0.90 for minibus and 0.90 for car. Related parameters for each vehicle class are shown in Table 7.

*Table 7: Average Travel (km) Per Day and Serviceability Coefficient for the Road Transportation Alternatives[14]*

| Alternative modes travelling | Bus | Minibus | Car |
|---|---|---|---|
| Average travel (km) per day for the road transportation alternatives | 225 km | 200 km | 40 km |
| Serviceability coefficient for the road transportation alternatives | 0.85 | 0.90 | 0.90 |

Annual Vehicle-Km for each vehicle class is calculated by average travel (km) per day (a year is assumed to be 365 days).

V_km_bus : Annual vehicle-km of buses
V_km_minibus : Annual Vehicle-Km of Minibuses
V_km_car : Annual Vehicle-Km of Cars
D_AT_bus : Average travel (km) per day for a bus
D_AT_minibus : Average travel (km) per day for a minibus
D_AT_car : Average travel (km) per day for a car
SC_bus : Serviceability coefficients for buses
SC_minibus : Serviceability coefficients for minibuses
SC_car : Serviceability coefficients for cars

V_km_bus = D_AT_bus × SC_bus × 365 × N_bus
V_km_bus = 225 × 0.85 × 365 × 27 = 1,884,769 km
V_km_minibus = D_AT_minibus × SC_minibus × 365 × N_minibus
V_km_minibus = 200 × 0.9 × 365 x 60 = 3,942,000 km
V_km_car = D_AT_car × SC_car × 365 × N_car
V_km_car = 40 × 0.9 × 365 × 122 = 1,603,080 km

## Environmental Impact Analysis[15]

When we consider the transportation sector in Istanbul, it is evident that road transportation is the primary source of transportation emissions. Gasoline and diesel fuels, in particular, are the most significant contributors of these emissions. Therefore, in this calculation approach, the emissions from road transportation-identified as having the highest impact on Istanbul's overall transportation emissions-are calculated and presented for the specific pilot regions.

The "Greenhouse Gas Emission Inventory Compilation from Road Transportation" calculated for the pilot region was calculated by taking the following steps into account.

Calculations[16] for all GHG emissions from different modes of transportation are expressed in terms of carbon dioxide equivalent ($CO_2e$). In this calculation approach, all GHGs were calculated by the experts

[14] Average travel (km) per day and serviceability coefficient for the road transportation alternatives are obtained from IMM Department of Rail Systems.
[15] Environmental impact calculations are made by IMM Directorate of Climate Change Experts.
[16] The calculation of greenhouse gas emissions by the IMM Climate Change Directorate experts assists the Department of Rail Systems in the following areas:
- Determination of the emission source of activities taking place in road transportation,
- Identifying which transportation modes need the most improvement,
- Monitoring progress in reducing emissions from road transport in the coming years,
- Calculating the reductions that can be made in the coming years according to the emission result by setting specific indicators, actions and targets.

at the IMM Directorate of Climate Change according to the Global Protocol for Community Scale Greenhouse Gas Emissions Inventory (GPC) 'BASIC' standard.

Activity data has been calculated according to the GPC 'BASIC' standard in a manner consistent with IPCC guidelines and presented in a way that facilitates consistency and comparability of emissions data.

Since the GPC requires GHG emissions to be reported by scope and sector, it has divided them into three categories: Scope 1, Scope 2 and Scope 3. GHG emissions from sources located within city boundaries fall under Scope 1. Accordingly, road transportation emissions from transportation are[17] calculated under Scope 1.

The coefficients that quantify the emission per unit of activity are called "Emission Factor". Emissions from highways in the transportation sector are calculated by multiplying the emission factor by the relevant activity data.

Three greenhouse gases are included in the calculation: $CO_2$, $CH_4$ and $N_2O$. The global warming potentials (GWP) of the GHG emissions included in the calculation are taken from the IPCC 5$^{th}$ Assessment Report (AR5)[18]. Emission factors used are from the IPCC Emission Factors. The calculation was made using the formula shown below, adapted from the Intergovernmental Panel on Climate Change (IPCC) "Scope-1" methodology. Vehicle-based values were combined on a project basis, and total consumption was calculated by year[19].

$$Emission\ GHG,\ FUEL\ (tons\ GHG) = Fuel\ Consumption\ (TJ) \times EF\ (tons\ GHG/TJ)$$

| | |
|---|---|
| Emissions | : Mass of $CO_2$, $CH_4$ and $N_2O$ emitted (in $tCO_2e$) |
| Fuel | : Mass or volume of burning fuel |
| EF | : $CO_2$, $CH_4$ and $N_2O$ emission factor per unit of mass or volume |

To provide more clarity, the environmental impact results shown for 2030 with this methodology are given in Table 8. The slight discrepancy between this example and the table is attributed to rounding.

*Table 8: Emission Calculation Table for 2030 by IMM Directorate of Climate Change*

| 2030 | Vehicle-km (km/year) | $CO_2$ | $CH_4$ | $N_2O$ | $tCO_2e$/year Total Emission | (kg/year) Fuel Consumption | MWh Energy Equivalent of Total Consumption |
|---|---|---|---|---|---|---|---|
| Bus-Truck | 1,884,769 | 1,496 | 2 | 21 | 1,519 | 469,434 | 5,607 |
| Minibus-Panel Van | 3,942,000 | 1,140 | 2 | 16 | 1,158 | 357,922 | 4,275 |
| Car | 1,603,080 | 312 | 3 | 10 | 325 | 101,788 | 1,253 |
| **Total** | **7,429,849** | **2,948** | **7** | **47** | **3,002** | **929,144** | **11,135** |

[17] Annual kilometer values of Road Vehicles for Rail Line Systems are obtained from the Financial and Economic Feasibility Reports prepared by the IMM Department of Rail Systems.
[18] IPCC 5th Assessment Report (AR5) - https://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch1ref5.pdf
[19] Average fuel consumption in liters/100 km: gasoline for cars, diesel for buses, minibuses and trucks taken from IPCC guidelines.

## $CO_2$, $CH_4$ and $N_2O$ Emission Savings

Electric rail transports are considered as a zero-direct emission modes of transport by the IMM Department of Rail System.

| | |
|---|---|
| T_$CO_2$ | : Annual $CO_2$ emission |
| T_$CH_4$ | : Annual $CH_4$ emission |
| T_$N_2O$ | : Annual $N_2O$ emission |
| C_$CO_2$ | : Rail transports $CO_2$ emission |
| C_$CH_4$ | : Rail transports $CH_4$ emission |
| C_$N_2O$ | : Rail transports $N_2O$ emission |
| S_$CO_2$ | : Annual $CO_2$ emission savings |
| S_$CH_4$ | : Annual $CH_4$ emission savings |
| S_$N_2O$ | : Annual $N_2O$ emission savings |

S_$CO_2$ = T_$CO_2$ - C_$CO_2$
S_$CO_2$ = 2,948 - 0 = 2,948 t$CO_2$/year
S_$CH_4$ = T_$CH_4$ - C_$CH_4$
S_$CH_4$ = 7 - 0 = 7 t$CH_4$/year
S_$N_2O$ = T_$N_2O$ - C_$N_2O$
S_$N_2$ = 47 - 0 = 47 t$N_2O$/year

## Estimated Reduction in Fuel Consumption and Energy Consumption Savings

For the energy consumption calculations of the Eyüpsultan-Bayrampaşa Tram Line project, Kabataş-Bağcılar Tram Line (T1) is used as a reference. According to the feasibility study of Eyüpsultan-Bayrampaşa Tram Line, since the station typologies of the tram line are similar with T1 line, it is assumed that the energy consumption will be the same. The annual electrical energy consumption (kWh) of T1 tram line for 2024 is shown in below Table 9.

*Table 9: T1 Line Annual Electrical Energy Consumption (kWh) in 2024*

| T1 Line Annual Electrical Energy Consumption (kWh) in 2024 | |
|---|---|
| January | 2,069,309.04 |
| February | 1,781,355.74 |
| March | 1,895,984.49 |
| April | 1,797,132.19 |
| May | 1,829,567.23 |
| June | 2,345,017.45 |
| July | 2,491,018.88 |
| August | 2,438,179.21 |
| September | 2,124,889.46 |
| October | 1,840,483.77 |
| November | 1,689,034.72 |
| December | 1,933,574.96 |
| **Total:** | **24,235.547.14** |

The estimated amount of electrical energy consumed on the Eyüpsultan-Bayrampaşa Tram Line for the year 2024 was calculated by proportioning the length of the T1 line (19.3 km) and the length of the Eyüpsultan-Bayrampaşa Tram Line (3.2 km).

T1_EC : T1 tram line energy consumption
C_EC : Coefficient to be used in energy consumption calculation
EB_EC : Eyüpsultan-Bayrampaşa tram line electricity energy consumption forecast

EB_EC = T1_EC x C_EC
EB_EC = 24,235,547.14 x (16.58 / 100) = **4,018,329.06 kWh/year**

Eyüpsultan-Bayrampaşa Tram Line Electricity Energy Consumption Forecast table is shown in Table 10.

*Table 10: Eyüpsultan-Bayrampaşa Tram Line Electricity Energy Consumption Forecast for 2024*

| Electrical Energy Consumption Forecast | |
|---|---|
| (T1) Kabataş-Bağcılar Tram Line length (A) | 19.3 km |
| Eyüpsultan-Bayrampaşa Tram Line length (B) | 3.2 km |
| Coefficient to be used in energy consumption calculation (C=B/A) | 16.58 % |
| (T1) Kabataş-Bağcılar Tram Line Energy Consumption (D) | 24,235,547.14 kWh/year |
| **Eyüpsultan-Bayrampaşa Tram Line Electricity Energy Consumption Forecast (E=CxD)** | **4,018,329.06 kWh/year** |

According to the feasibility study, an increase of 10.76% in 2030 foreseen in the vehicle-km values and it is assumed that there will be an increase in electrical energy consumption at the same rate.

EB_EC_2030 : Eyüpsultan-Bayrampaşa tram line energy consumption forecast in 2030
CI_2030 : An increase coefficient for electrical energy consumption

EB_EC_2030 = EB_EC x CI_2030
EB_EC_2030 = 4,018,329.06 x (110.76 / 100) = 4,450,701.27 kWh/year

Actual annual energy consumption savings are estimated to be equal to the difference between Energy Equivalent of Total Fuel Consumption and Tram Line Energy Consumption.

AAECS : Actual annual energy consumption saving
EETFC : Energy Equivalent of Total Fuel Consumption (Table 8)

AAECS = EETFC - EB_EC_2030
EETFC = 11,135.00 – 4,450.70 = 6,684.30 MWh