

Beyond best practice in selected cities

Closing transport gaps in Hungary, Lithuania,
Poland and Romania

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Summary

Cities are a significant contributor to global greenhouse gas emissions. With urban areas expected to accommodate 70% of the world's population by 2050, cities' contribution to emissions is projected to increase five-fold. Urban transport, particularly road vehicles, accounts for one-third of total urban greenhouse gas emissions and 60% of passenger vehicle emissions.

Reducing emissions from the transport sector is crucial for achieving climate neutrality in the EU. While overall emissions in the EU decreased by almost 26% from 2000 to 2020, emissions from the transport sector only fell by 10%. Increased activity in road transport and aviation has been the primary cause of emissions, making it challenging to fully decarbonise the EU's transport sector in the next three decades.

Urgent policy changes are necessary to mitigate the impact of urban transport on climate change, considering growing concern over the environmental impacts of urbanisation. To decarbonise mobility, the fastest and most cost-efficient approach is to support a modal shift towards public and active transport. Public transport, particularly stronger links between cities and their peripheral areas, can be instrumental in reducing emissions.

Collaboration with energy providers and local stakeholders, as well as promoting public participation in transport urban planning activities, can enhance the effectiveness of public transport. Additionally, investing in active modes of transport, such as walking and cycling, can significantly contribute to emissions reduction in cities, offering environmental benefits and promoting healthier lifestyles.

Introducing schemes like congestion charging, enhancing public transport and active mobility infrastructure, and employing traffic calming measures can help reduce passenger transport-related emissions and promote sustainable development in urban areas.

This report presents case studies on 10 Central and Eastern European cities, analysing key drivers of emissions and presenting best case policy recommendations based on each city's unique circumstances and regulatory landscape.

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Closing the gaps in transport policies in selected cities

Reducing emissions from the transport sector is crucial in achieving EU's goals of reducing emissions by at least 55% by 2030 and reaching climate neutrality by 2050 (Council of the European Union, 2023). While the overall emissions in the EU decreased by almost 26% from 2000 to 2020, emissions from the transport sector only fell by 10% in the same period. Increased activity in road transport and aviation is the primary cause of emissions, highlighting the difficulty of fully decarbonising the EU's transport sector in the next three decades (European Environment Agency, 2022). However, there is hope for the widespread adoption of electric vehicles and the development of railways. Still, this is hindered by the high costs of electric vehicles and governments' counteractive actions, such as significant investments in new motorways and subsidies for fossil fuels.

Cities have a major role in global greenhouse gas emissions, with transport being a significant contributor. Urban areas are expected to accommodate 70% of the world's population by 2050, resulting in a projected five-fold increase in cities' contribution to emissions (UN DESA, 2018). Meanwhile, transport in cities generates one-third of total urban greenhouse gas emissions, with road vehicles being the main contributor, accounting for three quarters of transport-related global CO₂ emissions. Passenger vehicles are responsible for 60% of these emissions. In the EU, 60% of citizens live in urban areas, with over 10 thousand inhabitants, and 40% of all emitted CO₂ is associated with urban mobility (European Commission, 2023a). Thus, urgent policy changes are necessary to mitigate the impact of urban transport on climate change, given the growing concern over the impact of urbanisation on the environment.

Accordingly, the fastest and most cost-efficient way to achieve decarbonised mobility is by decarbonising public transport and increasing its role in the modal share. Public transport is an essential solution to reduce emissions from the transport sector, particularly within urban areas. Urban public transport can play a crucial role in achieving a modal shift, particularly by strengthening links between cities and their peripheral areas which are responsible for most of the emissions in urban areas. With energy costs accounting for a significant proportion of the total public transport budget, transitioning to sustainable energy supplies or collaborating with energy providers and local stakeholders can save a lot of money.

Furthermore, public transport is already a major lever to meet the challenges of equity and social inclusion. Encouraging participation in transport urban planning activities with feedback activities on public transport utilisation and satisfaction can further enhance the effectiveness of public transport in reducing emissions. Encouraging participation in transport urban planning activities and linking public transport with active travel modes can further enhance the effectiveness of public transport in reducing emissions.

Active modes of transport such as walking and cycling can significantly contribute to reducing passenger transport-related emissions in cities. In the EU, walking and cycling account for 20-40% of all journeys made, resulting in a direct reduction in travel demand and a displacement effect of reducing the modal share of passenger cars (European Commission, 2023b). This not only benefits the environment but also promotes a healthier and more active lifestyle. Investing in active travel and promoting it as an alternative to motorised modes that rely on fossil energy sources can significantly reduce transport carbon dioxide emissions, particularly in urban areas. This can be a more promising approach than relying solely on technological measures.

Implementing schemes such as congestion charging, enhancing public transport and active mobility infrastructure, and utilising traffic calming measures to discourage private car usage are some ways in which urban documents and strategies can reduce passenger transport-related emissions. Policymakers at the city level are well placed to utilise various tools to mitigate GHG emissions from urban transport, promoting efficient and effective urban transport, which can significantly contribute to achieving objectives across multiple policy domains, including sustainable development and growth in the EU areas.

This report applies a comprehensive approach to emissions reduction to a total of ten cities from the four selected countries and lists some recommendations that could reduce emissions from passenger transport in a more comprehensive manner.

Warsaw

Warsaw is the largest city in Poland and the most significant engine of the country's economic growth. The city itself was responsible for nearly 14% of national GDP, recording the highest level of GDP per capita, nearing triple the national average. The Warsaw Metropolitan Area consists of 70 communes and towns, with an official population of 3.1 million inhabitants (City of Warsaw, 2023). Warsaw is an attractive and dynamic labour market resulting in a high migration balance, only partially recorded in official statistics. This applies also to hundreds of thousands of migrants from Ukraine, and to a smaller extent from Belarus who arrived even before the Russian invasion of Ukraine in February 2022.

The steady growth of Warsaw's population is accompanied by the rapid growth of neighbouring communes, which is increasing pressure on the transport system. The process of suburbanisation is accelerated by the lack of coordination in the spatial policy of municipalities, rising prices on the real estate market, less attractive (in comparison to Warsaw) supply of public transport at regional and county levels, as well as changes in inhabitants' habits.

Map of central Warsaw

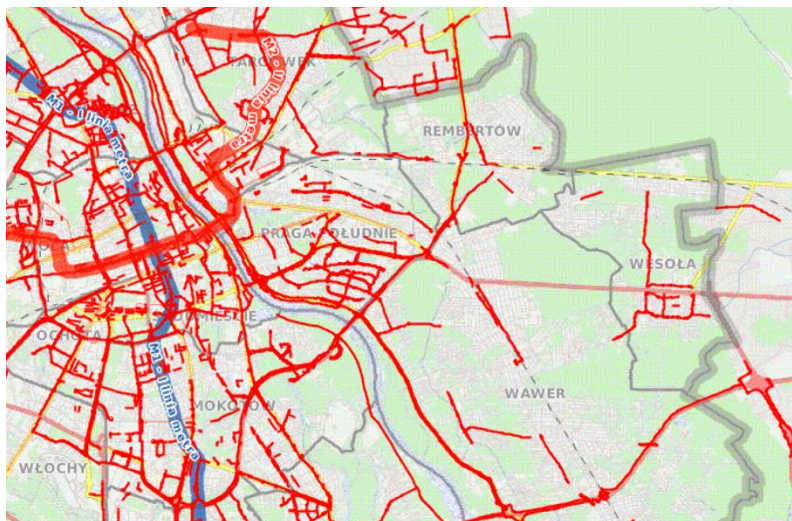


Figure 1 Map of central Warsaw

Cycle infrastructure in red, metro in blue and red, via [City of Warsaw](https://www.warsaw.pl/en)

Steady growth of individual motorisation in the capital city is a typical phenomenon for all cities in Poland. Warsaw, however, has always been characterised by a higher number of vehicles. While the national average is 682 cars per 1000 inhabitants, in Warsaw this number was 784. However, the dynamic of this growth is slightly slower: whereas the car density increased by 45% on average in Poland, in Warsaw this growth was 39%, though from a higher basis (Poland Statistical Office, 2022).

Public transport and modal split

The supply of public transport in Warsaw is very complex and consists of the metro, urban railway, trams, and buses. The role of the metro gained importance in recent years, carrying 240 million passengers in 2019. There are several municipal operators, generally split by transport type, including Metro Warszawskie sp. z o.o., SKM Warszawa sp. z o.o., Tramwaje Warszawskie sp. z o.o. and MZA Warszawa sp. z o.o. Part of the bus market is serviced by private bus companies on a gross contract scheme. The bus fleet is powered mostly by diesel, with some gas-powered buses. The share of battery buses is increasing – in 2017, electric vehicles consisted of 1% of the total bus fleet, whereas in 2021 their share was 9% (**Figure 2**).

In 2021, Warsaw's public transport carried more than 809 million passengers, a decrease of a third compared to 2019 but an increase of 7% compared to 2020 (City of Warsaw, 2022c). Since joining the European Union, Warsaw has been actively investing in the public transport sector, including developing its subway system (a second line opened in 2008). Buses, trams, and the metro account for the largest share of service. However, it should be noted that rail plays a crucial role in metropolitan and regional transport. For example, around 3,300 people travel by rail from the distant city of Radom (approx. 200 thousand inhabitants) per day (City of Warsaw, 2022a). Revenues from ticket sales also did not return to pre-pandemic levels and, for the first half of 2022, amounted to PLN 376 million (15% less than in the first half of 2019)¹.

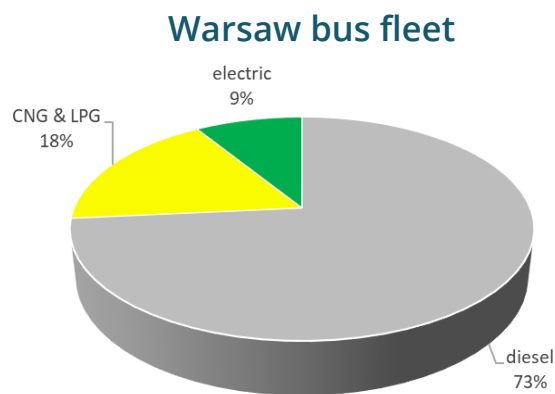


Figure 2 Warsaw bus fleet by fuel type, 2021

Source: own elaboration based on data obtained from the City of Warsaw (2023)

In research conducted for the newly developed mobility plan (2022), 43% of all respondents reported using a car for essential trips within the Capital Region, whereas 42% used public transport. A deeper analysis, however, reveals significant differences between the city of Warsaw and the surrounding metropolitan area. While just one in

¹ Own budgetary analysis including first half of budgetary years for 2019, 2020, and 2021, data retrieved from Statistical Office in Warsaw (2023).

three respondents living in the city travel by car, the share is higher among those living in the surrounding suburbs where 57% of people travel by car on a daily basis. The reverse is true for public transport, used by 55% of Warsaw residents and 24% of people living outside the capital (City of Warsaw, 2022b).

In areas outside Warsaw, obligatory journeys are twice as often made on foot (11% vs 6%). Commuting to work or school by bicycle was reported by about 3% of respondents. The share of this group is very similar in each of the analysed areas. However, it should be noted that the low share of journeys by foot is a result of the methodology used. The Warsaw Traffic Survey conducted in 2015 indicated that 18% of journeys in Warsaw were made by pedestrians, 47% by public transport, 32% in passenger cars and 3% using bicycles (PBS Sp. z o.o et al., 2016).

Warsaw's cycling infrastructure has been further developed in recent years (**Figure 3**), including the introduction of the bike-sharing system Veturilo. It includes 349 bike stations with nearly 5,000 bikes (including 100 e-bikes and 59 children's bikes).

The results of cycling traffic surveys carried out in Warsaw in 2020 indicate an increase in cycling traffic compared to the previous year by about 17.4%, accompanied by a substantial decline in the morning peak hours (Dudek & Ostaszewski, 2020). The lockdown can explain this higher share: the results of the 2021 survey showed a decrease in the number of cycling trips by 8.9% compared to 2020.

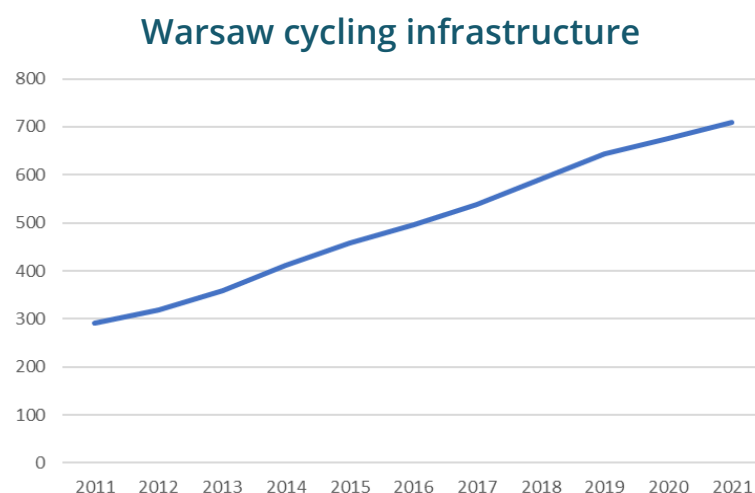


Figure 3 Development of cycling infrastructure in Warsaw between 2011 and 2021 (km)
(Poland Statistical Office, 2022)

Data collected from the TomTom Traffic Index suggests that average travel time increased by 3 minutes per day in 2021. Congestion levels amounted to 37%, which means that on average, travel times were 37% longer compared to non-congested conditions. For example, a half hour trip in free-flow conditions would take 11 minutes longer (TomTom Traffic Index, 2022c).

Emissions

In Warsaw, road traffic is the dominant source of transport noise, which covers a significant part of the city and exceeds 75 dB on its main arteries. In 2021, an emissions assessment was completed, specifically taking into account health impacts of tailpipe emissions and noise pollution in the Warsaw agglomeration, which consists of the city of Warsaw and the neighbouring communes (Lemitor, 2022). The assessment found exceedances above the permissible level for the Warsaw agglomeration for particulate matter PM10 (per day), PM2.5 particulate matter (per year) phase II and NO₂ (per year).

High concentrations of NO₂ resulting from intensive transport remain a significant problem in the Warsaw agglomeration, and road transport in Warsaw is the dominant source of emissions. Approximately 60-80% of pollution comes from road transport (Urbanowicz, 2017). The primary source of nitrogen oxide (NO_x) emissions in the Warsaw agglomeration is transport – as confirmed by data compiled for the 2021 air quality assessment for the Warsaw agglomeration (**Table 1**).

Table 1 Types of emissions in the Warsaw agglomeration area in 2021

Emission type	Emissions from road transport [kg]	Share in total emissions [%]
PM10	358,386	18.31%
PM2.5	271,142	15.8%
NO _x	5,616,423	48.77%
SO _x	12,223	0.8%
Benzo(a)pyrene ²	6.5	0.002%

(Główny Inspektorat Ochrony Środowiska, 2022)

The analyses and estimates indicate that 0.7% of Warsaw's inhabitants live in areas exceeding the NO_x emissions standard. As these standards are exceeded in the vicinity of roads in the city centre, on which many pedestrians travel, the number of individuals exposed may be higher (Główny Inspektorat Ochrony Środowiska, 2022).

In autumn 2020, the TRUE (The Real Urban Emissions) initiative carried out emission studies in Warsaw. They aimed to provide detailed information on the actual emission performance of vehicles and to support the city authorities' efforts to combat poor air quality (Lee et al., 2022). More than 220 thousand measurements from around 148 thousand cars were analysed using remote sensing technology. The average NO_x emissions for diesel passenger cars that are not subject to type-approval requirements under real-world driving conditions (i.e. meeting Euro 2 to Euro 6c standards) were between 1.6 and 4.3 times the regulatory limits (Lee et al., 2022).

² A carcinogenic benzopyrene commonly found in coal tar and vehicle exhaust (particularly diesel exhaust; Umweltbundesamt 2023)

Diesel cars complying with Euro 5 and lower standards were responsible for 45% of total NO_x emissions, although they accounted for less than 20% of the passenger car fleet in Warsaw. Diesel cars meeting Euro 3 and Euro 4 standards were also responsible for over 50% of total PM emissions, accounting for 10% of all measured emissions (Lee et al., 2022).

Key documents and strategies influencing emissions from passenger transport in Warsaw

The Strategy of Development (2018)

The Strategy of Development (2018) seeks to address challenges including frequent exceedances of air pollution standards (urban smog), low use of renewable energy sources, incomplete spatial planning, traffic congestion in the city and increasing needs for accessibility and quality of the urban transport network, as well as cycling and pedestrian routes. It includes the goals of shaping the functional and spatial structure by the principles of polycentricity and hierarchy and counteracting urban sprawl. It states that to ensure efficient, comfortable and safe movement it will be necessary to appropriately shape the transport system, public spaces and the natural environment (*Strategia Rozwoju Warszawy Warszawa 2030*, 2018).

The Climate Change Adaptation Plan for the City of Warsaw until 2050 (2019)

Critical challenges addressed in the document include tackling increased human mortality during hot weather and reducing the urban heat island effect. It points out that to mitigate climate change in Warsaw, investments in green spaces, water storage reservoirs and renewable energy sources are needed. Spatial planning documents and the city budget are to be developed with the Strategy in mind. Transport is indicated as one of many areas that are highly vulnerable to potential flooding (City of Warsaw, 2019).

The Sustainable Urban Mobility Plan for the Warsaw Metropolitan Area

The first Sustainable Urban Mobility Plan for the Warsaw Functional Area (WOF) was developed in 2016 and covered Warsaw and 39 neighbouring municipalities. The document pointed to the high share of alternative forms of travel compared to the private car. However, it identified the uncoordinated spatial development as a significant challenge exacerbating car usage. The consequence of the high demand for transport is the poor air quality in urban areas, particularly acute in selected municipalities neighbouring Warsaw (City of Warsaw, 2016). The SUMP is currently being adapted and covers wider geographical area by covering not only Warsaw but also 69 neighbouring municipalities.

Initiatives in place

In order to monitor emissions, the city of Warsaw is developing a dense network of air quality sensors. Out of 100 largest cities and capital cities, Warsaw ranked 30th in assessment of the quality of the natural environment in the Arcadis Sustainable Cities Index 2022 (Moore, 2022). Emissions from transport are limited through numerous actions, including modernisation of road infrastructure, development of the public transport system, as well as support for the development of electric and bicycle transport. Development of electric public transport (including development of the 2nd subway line, tram system and bus fleet electrification) is an important measure already underway to make public transport more attractive and environmentally friendly.

On the other hand, city policy continues to support private vehicles, which continue to be a significant challenge. Parking zones continue to expand, increasing by 14,300 spaces in 2021. Warsaw is preparing scenarios for the implementation of Clean Transport Zones, and the project aims to improve air quality by reducing emissions from the most poisonous vehicles. The city is preparing a plan to implement such zones and aims to pilot the programme by the end of 2023. The project will be phased and subject to extensive public consultation at each stage (City of Warsaw, 2022d). Additionally, planning street cleanings plays a vital role in limiting linear emissions.

Challenges

Many of the challenges facing Warsaw are threats common to all cities in Poland but they are multiplied by the size, importance and gravity of the capital city. Adverse changes in the public finance system undermine the financial stability of local budgets and may limit the possibility of making ambitious investments in the future. The energy crisis and Poland's unfavourable energy mix put a question mark on the possibility of maintaining the dynamic development of electric public transport in Warsaw as it reduced the competitiveness of electric buses in comparison to the diesel alternatives. Suburbanisation and its adverse effects are a massive challenge for Poland's cities, which are metropolitan areas' central hubs. Actions within the administrative borders of the city are not enough. Warsaw, therefore, undertakes systemic cooperation with neighbouring municipalities within the Warsaw Metropolitan Area, which consists of Warsaw and 69 communes. This cooperation will result from the Sustainable Urban Mobility Plan to be adopted in 2023 which should address the most critical challenges for mobility in the very complex and diversified urban functional area.

Recommendations

Recommendations for further emission reductions in the Warsaw area focus on policy changes and implementation at three levels: national, metropolitan and urban, and are briefly described below.

National level

National government should implement policy framework that create a long-term, predictable perspective for local government finances. This perspective should be based on a high degree of income autonomy, enabling an active, long-term investment policy at the local and metropolitan levels. As Warsaw is among the wealthiest self-governments in Poland, its challenges are of appropriate size.

It should also facilitate development of electromobility in public transport not only at the investment stage but also during further operation. This is particularly important in the current situation, in which the radical increase in electricity prices calls into question the economic competitiveness of further development of electric transport.

It should also create a legal framework for the development of metropolitan areas to facilitate better integration and coordination between local authorities in the city and the suburbs. These areas should be equipped with tools and resources for transport integration and development to integrate all forms of transport and create a real alternative to the uncontrolled use of the private car. The gravity area of the Warsaw Metropolitan Area is pervasive, including communes of different potential and abilities to co-finance complex transport systems.

Metropolitan level

The Warsaw Metropolitan Area needs to coordinate the spatial policy activities of the municipalities within the area to facilitate consistent and comprehensive urban planning.

Additionally, the Metropolitan Area should be striving for system and functional integration of the existing transport subsystems, including cycling which must be treated as an important feeder for railway transport.

Urban level

The urban core should be subject to further development of active mobility, including bicycle transport with strict link to the urban regeneration activities. This should include increasing the density and mix of functions in the vicinity of railway and subway stations.

The city should continue the development of public transport and infrastructure for renewable energy sources powering electric vehicles. The contracting of green energy and the construction of local renewable energy generation centres (on a small scale, solar electricity is already generated by the municipal operator MZA) could be the first stage in the 'greening' of electric public transport.

Lublin

Lublin is the largest city in the eastern part of Poland, and in terms of population (336 thousand inhabitants) is the 9th largest city in the country. It is one of the most important transportation hubs and a major academic centre in Poland. The city is the central part of the Lublin Metropolitan Area (LMA), and together with the much smaller city of Świdnik, it forms the core of the LMA in which metropolitan functions are concentrated. The city's distinguishing feature is its varied topography with a clear, but unique, historically shaped spatial structure. It includes a central urban zone with an area of downtown development, areas of residential districts developed over time and industrial manufacturing areas (City of Lublin, 2023).

Lublin's population has slightly decreased over the last years due to people moving to suburbs, many of whom are still commuting to the city. The process of decomposition of suburban space is fuelled by the lack of coordination in the spatial policy, rising prices on the real estate market in the city, unattractive supply of public transport at regional and county levels as well as changes in city inhabitants' habits. This suburbanisation leads to longer travel distances. In this way, space generating high demand for transport is being developed, and the demand is satisfied by the growing number of private cars, which creates secondary demand for road infrastructure and increases car-dependent suburbs (Wołek, 2018).

Map of Lublin

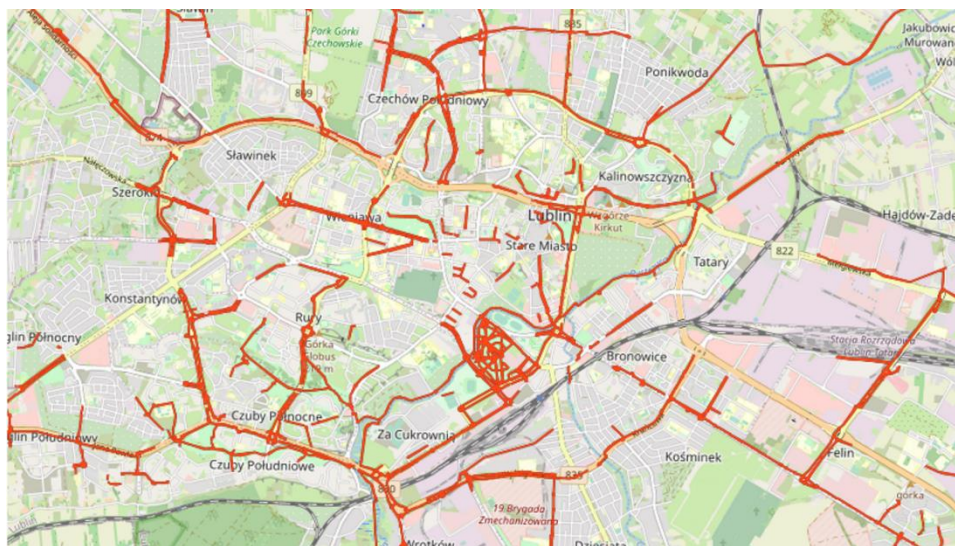


Figure 4 Map of Lublin

Cycle infrastructure in red, via [City of Lublin](#)

The intensive urban development of the neighbouring municipalities is the reason for the increasing importance of private cars. Also, steady growth of individual motorization in Lublin is a typical phenomenon for all cities in Poland. The number of cars per 1000 inhabitants in Lublin amounted to 630 in 2021 and it has increased by 40% since 2000 (682 cars was the Polish national average). For Lubelskie county, surrounding the city of

Lublin, the motorization index was even higher – 712 cars per 1000 inhabitants (Poland Statistical Office, 2022).

Public transport and modal split

The supply of public transport in Lublin consists of buses (diesel and battery) and trolleybuses. The only operator is municipally owned MPK Lublin. Since the accession to the EU in 2004, the city has been actively investing in the public transport sector, including the development of trolleybus transport. In 2021 around 52 million passengers carried by the MPK Lublin, far lower than before the COVID-19 pandemic (76 million in 2019) (MPK Lublin, 2023). Revenue from ticket sales also did not return to pre-pandemic levels and, for the first half of 2022, amounted to PLN 27 million – almost a quarter less than in the first half of 2019; Ibid.).

On the basis of surveys carried out for the new mobility plan, the inhabitants of Lublin travel most often by public transport (29%), car (21%), and on foot (17%). Only 8% of Lublin citizens travel by bicycle, although development of cycling infrastructure was seen in recent years (**Figure 5**) (Lublin City Council, 2022b).

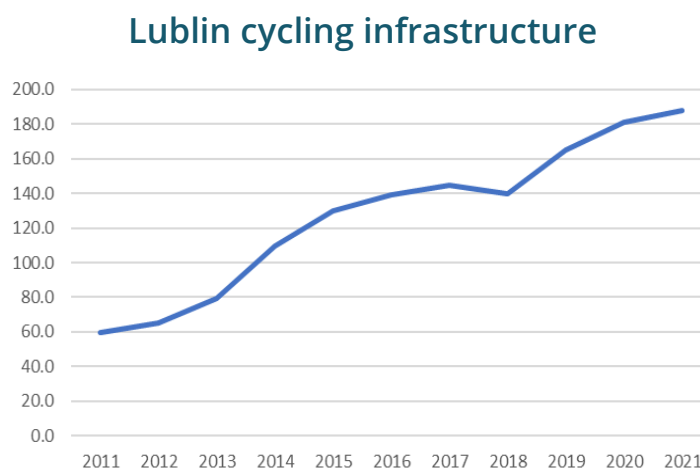


Figure 5 Development of cycling infrastructure in Lublin between 2011 and 2021 (km)

Own elaboration based on Polish Statistical Office data

Modal split of the residents living in the suburban area is completely different and residents are strongly dependent on individual cars (Lublin City Council, 2022b). In 2021, an increase in congestion levels was seen in Lublin. The data collected from TomTom Traffic Index suggests the average travel time increased by one minute per day. Congestion level amounted to 29%, which means that on average, travel times were 29% longer than during the baseline non-congested conditions. This means that a 30-minute trip in free-flow conditions will take 9 minutes longer (TomTom Traffic Index, 2022b).

Emissions

The emission analysis covers the area of the Lublin agglomeration, which consists of the city of Lublin and the neighbouring communes. The Lublin agglomeration zone was classified as Class A with respect to human health protection for sulphur dioxide SO₂, nitrogen dioxide NO₂, carbon monoxide CO, benzene C₆H₆, dust PM2.5, and PM10, and pollution by arsenic, cadmium, nickel and lead contained in dust. However, due to benzo(a)pyrene pollution, the Lublin agglomeration zone was classified as Class C. The target levels were exceeded at all measurement points (Lublin City Council, 2021a).

Transport has the most significant share in emissions of NO_xs, whereas its share in the PM2.5 and PM10 is spectacular (**Table 2**). The most important source of emissions is the municipal and utility sector. On the other hand, the negative impact of transport concentrates along major road routes and focuses on high traffic density areas through linear emissions and traffic noise.

Table 2 Types of emissions in the Lublin agglomeration area in 2019

	emissions from road transport (kg)	share in total emissions (%)
PM10	49,920	12.74%
PM2.5	36,775	10.74%
NO _x	723,669	43.42%
SO _x	1454	0.27%
Benzo(a)pyrene	0.8	0.50%

Based on the Strategy of the electromobility development in Lublin 2021(Lublin City Council, 2021b)

The total greenhouse gas emissions from all modes of transport, passenger and freight, in the Lublin Metropolitan Area amounted to almost 3 MtCO₂e. The Sustainable Urban Mobility Plan (SUMP) for the Lublin Metropolitan Area plans to reduce these emissions by about 0.3 MtCO₂ or around 10% by 2030 (Lublin City Council, 2022b).

Key documents and strategies affecting passenger transport

The Climate Change Adaptation Plan for the City of Lublin until 2030

Adopted in 2018, the Climate Change Adaptation Plan defines the adaptation actions necessary to adapt the city to climate change by increasing its resilience to extreme weather phenomena and their effects. On that basis the document aims to increase the city's capacity to cope with climate change's impacts. Public health, water management, biodiversity, spatial management, and planning are considered the most vulnerable to climate change. The latter guides the development of Lublin and the distribution of investment and core functional areas. Actions at the interface between climate and

transport include support for the development of electromobility in public transport and Construction and modernisation of a network of cycle paths and pedestrian routes as an alternative to car transport' (Lublin City Council, 2018).

The strategy of development for the city of Lublin (2022)

Lublin's new development strategy was adopted in early 2022. As such, it already addresses the impact of the pandemic on the functioning of the local community. Among other things, the document points out that the concept of the 15-minute city is beneficial in times of pandemic by fostering the shaping of the city in a sustainable manner. Reducing greenhouse gas emissions and fossil fuel combustion will be achieved, among other things, through the development of urban transport, electromobility and cycling infrastructure. Developing a sustainable mobility system has been identified as one of Lublin's most significant urban-environmental challenges (Lublin City Council, 2022a).

The Sustainable Urban Mobility Plan for the Lublin Metropolitan

The SUMP for the Lublin Metropolitan Area that should be adopted in 2023, includes two horizontal goals: (1) decreasing the transport's impact on the environment, and (2) improving traffic safety. In addition, the draft SUMP also includes seven operating goals:

1. Spatial planning focused on public transport and active mobility
 2. Promoting Active mobility
 3. Development of coherent public transport
 4. Optimal use of the car
 5. Development of urban logistics
 6. Increasing the social acceptance for the implementation of sustainable mobility
- Development of the structures supporting sustainable mobility (Lublin City Council, 2022b).

Initiatives in place

In the area of transport, the Development Strategy of the City of Lublin aims to facilitate reduction of greenhouse gas emissions and fossil fuel combustion through the development of public transport, electromobility, and cycling routes (Lublin City Council, 2022a). The plans for the development of cycling include not only the city itself but also the development and integration of the cycling network in the metropolitan dimension.

The city of Lublin focuses on the improvement of its strengths, which mainly means supporting and developing public transport. Supply of public transport, consisting of buses and trolleybuses, is managed by the municipal company MPK Lublin and increased by 15% between 2012 and 2021 (Chamber of Commerce for Urban Transport, 2022).

Trolleybus – the backbone of the electromobility in Lublin

As the city has operated trolleybuses since 1953, its way to increase electric public transport was obvious. In recent years the trolleybus infrastructure was upgraded, and new rolling stock was introduced. Moreover, the diversification of the electric fleet has been made, as 28 battery electric buses were put into operation in 2021. Electric vehicles used in Lublin's public transport (138 units, including 110 trolleybuses and 28 battery electric buses) constituted 35% of all vehicles used in public transport in 2021. Despite an increasing share of battery-charged buses, trolleybuses still lead the way as modern technological solutions due to their advantage of in-motion charging. The share of trolleybuses with traction batteries increased to nearly 55% in 2019. The supply of trolleybus transport reached almost 4.5 million vehicle-km in 2021, an increase of 69% compared to 2012.

Challenges

Many of the challenges facing Lublin are similar to those facing many other cities in Poland. Especially challenging are the changes in the public finance system that undermine the financial stability of local budgets and may limit the possibility of making ambitious investments in the future. The energy crisis and Poland's energy mix, which is heavily reliant on coal and fossil gas, threatens the dynamic development of electric public transport in Lublin due to decreasing competitiveness of electric vehicles when compared to diesel buses.

Suburbanisation and its adverse effects are also a massive challenge for Lublin. Actions within the administrative borders of the city are not enough to adequately address the issue. Lublin, therefore, undertakes systemic cooperation with neighbouring municipalities within the Lublin Metropolitan Area, which consists of Lublin, 21 towns and five districts. This cooperation resulted from the Sustainable Urban Mobility Plan (SUMP) developed in 2022. The SUMP addresses the most critical challenges for mobility in the functional area of the largest city in eastern Poland.

Important endogenous factors in reducing emissions from transport at the city level are the lack of social acceptance for introducing restrictions on car transport, including parking policy.

Recommendations

Recommendations for further emissions reductions in the Lublin area are on three levels: national, metropolitan, and urban.

National level

The national government should create framework that would ensure a long-term, predictable perspective for local government finances is essential to the state's public

finance system. This perspective should be based on a high degree of income autonomy, enabling an active investment policy at the local and metropolitan levels.

This should also include creating and implementing solutions to promote the development of electromobility in public transport not only at the investment stage but also during further operation. This is particularly important in the current situation, in which the energy crisis and high electricity prices have shifted the economic calculus of further development of electric transport.

In addition, this must be supported by the creation of a legal framework for the development of metropolitan areas (currently, there is only one metropolitan area in Poland) with tools and resources for transport integration and development to integrate all forms of transport and create a real alternative to the uncontrolled use of private cars.

Metropolitan level

Metropolitan level recommendations focus on developing municipalities and systems which are fully integrated and function effectively and efficiently. In order to achieve this, the Lublin metropolitan area must coordinate the spatial policy activities of the municipalities in the area. Policy development should strive for system-wide and functional integration of the existing transport subsystems in order to most fully and efficiently meet the population's needs.

Urban level

On the urban level, cities and districts should focus on the minutiae of citizens' transport needs – are sidewalks developed to support walking? Which intersections are unsafe for cyclists? Are public transit stops well-lit and clean?

Cities should focus on developing active mobility through both social and infrastructural interventions to support intermodality and the shift to active transport. In addition, cities should continue the development of public transport and infrastructure for renewable energy sources for powering electric vehicles.

Gdańsk

Gdańsk is the biggest and most important urban area in Northern Poland and one of the strategic economic centres of the country. In June 2022 the city's population exceeded 470 thousand, however this does not reflect immigration levels from Ukraine. The population density is 1787 people per km², which is lower than for other large Polish cities such as Kraków (2456 people per km²), Poznań (2081 people per km²) or Wrocław (2303 people per km²) (Poland Statistical Office, 2022).

Due to its location in the Central European region and by the Baltic Sea coast, Gdańsk is an important element of the European transportation system and a huge logistic hub in the region. The Gdańsk Seaport is a strategic transshipment point not only for the Polish economy, but also from the perspective of Czech Republic, Slovakia, Ukraine, Lithuania and other neighbouring countries. It is the second biggest Baltic seaport in terms of transshipment volume, and with 2 million TEUs the seaport had a share of 66% in the Polish container market. In recent years, the Port of Gdańsk has been the fastest-growing port in Europe. In 2021, 53.2 million tonnes of goods were handled at the port (Port Gdańsk, 2022).

Map of central Gdańsk



Figure 6 Map of central Gdańsk cycle infrastructure

Source: City of Gdańsk

Gdańsk, together with neighbouring Gdynia and Sopot forms the core of the metropolitan area. The Gdańsk-Gdynia-Sopot Metropolitan Area consists of 59 communes and towns, with an official population of 1.6 million (City of Gdańsk, 2022b). Its core area, the Tri-city (cities of Gdańsk, Gdynia, and Sopot) is an attractive and diversified labour market, but also, together with other seaside communes and towns, one of the most important summer tourist destinations in Poland.

The metropolitan area forms a complex mosaic of cities with county (*powiat*) rights and urban and rural municipalities. There is a competition for residents between the latter two, with some authorities earmarking a significant space for housing development in the spatial development conditions and directions studies and local plans. As a result, the rural and suburban areas acquire new residents quickly, a significant proportion of whom move from the metropolitan core area. However, this development of suburban areas is not accompanied by proper planning of the transport sector. The low supply of public transport services strengthens the role of the private car in commuting from such a municipality to the main cities of the metropolis.

At the same time, according to the official statistics, Gdańsk is one of the few medium and large cities to record an official increase in population in recent years (Poland Statistical Office, 2022). This is due to the dynamic development of the southern residential districts. Providing these districts with proper public transport is now a significant challenge and requires investment in the tram (ongoing) and rail (planned) infrastructure.

The steady growth of individual motorization in Gdańsk is a typical phenomenon for all cities in Poland. The number of cars per 1000 inhabitants in Gdańsk amounted to 664 in 2021 and it has increased by 34% since 2011. However, with 682 cars on average in Poland, the level of car ownership in Gdańsk was slightly below the national average (Poland Statistical Office, 2022).

Public transport and modal split

The supply of public transport in Gdańsk is quite complex and consists of rapid urban railway, trams, and buses. The rapid urban railway is operated by Rapid Urban Railway (*Szybka Kolej Miejska* - SKM), a subsidiary of the Polish National Railways (PKP). The SKM is a system that includes rolling stock and railway infrastructure of its most intensively serviced section between Gdańsk and the city of Rumia. Gdańsk and other public authorities are minor shareholders of the company, which makes further integration difficult with municipal transport.

The trams and buses are operated by the municipal operator GAIT. In addition, some buses are serviced by private bus companies on the gross contract scheme. The GAIT owns 141 tram trainsets, and the total number of buses owned by the municipal operator and private companies amounted to 286. Since Poland's EU accession, the city of Gdańsk and its municipal transport company have been actively investing in the public transport sector, including the significant expansion of the tram system. The Gdańsk Project for the Development of Urban Transport (GPKM) is a multi-year comprehensive programme, implemented in 2003, for the expansion of tramway infrastructure, modernisation, and purchase of tramway and bus rolling stock. It is being implemented in stages. In recent years, the municipal operator GAIT has invested around PLN 441 million as part of the GPKM. These included purchasing 50 modern tram sets and the modernisation of the tram depot. In addition, the city is implementing new sections of tram lines to shorten the travel time to the city centre from the

southwestern districts of Gdańsk. As in other Polish cities, majority of public transport investments were co-financed from EU sources.

While most of the buses are diesel buses, 18 electric buses are to be deployed in second half of 2023 (City of Gdansk, 2022c). The mileage of public transport vehicles in 2021 was 33.1 million vehicle-kilometres. As in other cities in Poland, public transport in Gdańsk is heavily subsidised. In 2021, ticket revenues in Gdańsk covered only 27.4% of public transport expenditure. This was driven to a large degree by the lower than usual utilisation rate due to the COVID-19 pandemic and free travel for children, young people (up to the age of 24), families with at least three children and senior citizens over the age of 70 (City of Gdansk, 2022c).

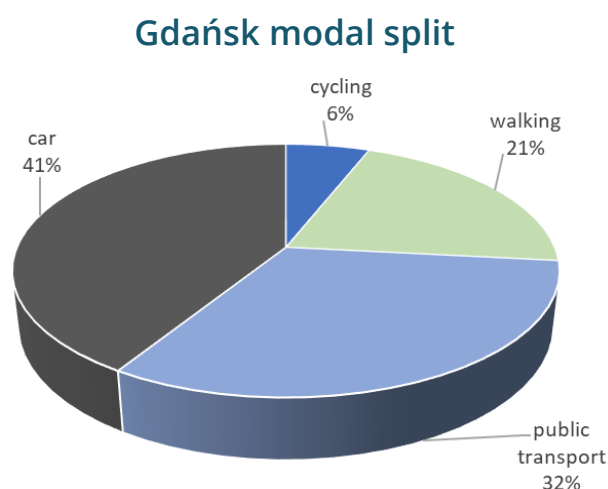


Figure 7 Modal split of Gdańsk in 2016

Own elaboration based on data obtained from the Complex Traffic Research conducted in 2016

Older data on modal split shows slight dominance of car over public transport. A 6% share of cycling should be evaluated positively, being one of the best scores among mid- and large-sized cities in Poland. It is a result of the consequent development of a cycling network supported by regular and massive educational campaigns among citizens. The length of cycling infrastructure in Gdańsk increased by 37% between 2011 and 2021, exceeding 200 kilometres. But taking into account all sections of roads with calmed traffic (nearly two-thirds of the total length of roads in Gdańsk), also dedicated for cycling, the length amounted to 851 km (City of Gdansk, 2022b).

The data collected from TomTom Traffic Index for the Gdańsk, Gdynia, and Sopot together suggests the average travel time increased by 3 minutes per day in 2021. Congestion level amounted to 34%, which means that on average, travel times were 34% longer than during the baseline non-congested conditions. This means that a 30-minute trip driven in free-flow condition will take 10 minutes longer (TomTom Traffic Index, 2022a).

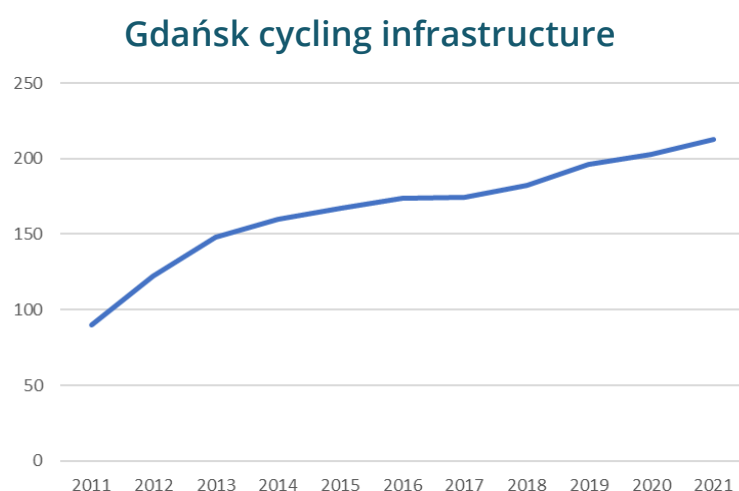


Figure 8 Development of cycling infrastructure in Gdańsk, 2011-2021 (km)

Own elaboration based on Polish Statistical Office data

Emissions

The primary source of air pollution in the Pomeranian Region is the municipal and household sector (surface emissions); a smaller share is constituted by emissions from transport (linear emission) and industrial activity (point source emission; Główny Inspektorat Ochrony Środowiska, 2022). A closer look at the core of the Metropolitan Area (cities of Gdańsk, Gdynia, and Sopot) reveals the increased importance of transport-related emissions. The primary source of nitrogen oxide (NO_x) emissions in the Gdańsk-Gdynia area is transport, as confirmed by data compiled for the 2021 air quality assessment.

Table 3 Types of emissions in the Gdańsk-Gdynia-Sopot region in 2021

	emissions from road transport [kg]	share in total emissions [%]
PM10	129 612	10.36%
PM2.5	100 465	8.88%
NO_x	2 134 863	41.63%
SO_x	4 583	0.16%
Benzo(a)piren	2.3	0.38%

Source: own compilation based on data provided by "Roczna ocena jakości powietrza w województwie pomorskim. Raport wojewódzki za 2021". Regionalny Wydział Monitoringu Środowiska w Gdańsku, Główny Inspektorat Ochrony Środowiska, Gdańsk 2022

It should be noted that the Tri-city is characterised by the cleanest air among cities with more than 100 thousand inhabitants in Poland. For more than a decade, the Tri-city

agglomeration has been recording low values of PM2.5, which is particularly dangerous for the human organism. However, this is the result of policy targeting coal heating in Gdańsk, Gdynia and Sopot than transport policy (City of Gdansk, 2022c).

Key documents and strategies

Gdańsk 2030 Plus City Development Strategy (updated in 2022)

Gdańsk 2030 Plus City Development Strategy is the most important document setting directions of city development over the next few years. The revised Strategy has gained a spatial dimension and among the biggest changes in the document is a new strategic objective - Green City and expansion of the Accessible City strategic objective, both of great relevance to the topic of urban mobility.

The most important action lines under the Accessible City objective include improving conditions for everyday mobility by prioritising and developing sustainable and integrated pedestrian, cycling, and public transport systems. It also aims to implement the concept of intensifying the development of already built areas and the compact city of short distances.

The revised Strategy contains ambitious, measurable indicators for achieving the strategic objectives. The most important ones for passenger transport concerns increasing the share of journeys by foot, bicycle, scooter, and public transport in the total number of trips in the city from 59% to 65%. In addition, public transport should become much more attractive in comparison to travel by car: on average travel time by public transport in relation to travel by car should decrease from 174% to 150% (City of Gdansk, 2022c).

The Climate Change Adaptation Plan for the City of Gdańsk until 2030

The adaptation plan of the City of Gdańsk to climate change up to 2030, was created in response to one of the most important environmental problems, climate change and the need to adapt to the effects of these changes. Gdańsk's transport system (rail, road, air and sea) is exposed to the effects of climate change, particularly flooding and strong winds (City of Gdansk, 2018).

The Sustainable Urban Mobility Plan for Gdańsk

The objectives of the Sustainable Urban Mobility Plan (SUMP) adopted in 2018 included improving conditions for walking and cycling, improving the public transport system and its integration with active forms of mobility. Its content was influenced by the outputs of the CityMobilNet project from the URBACT III programme, implemented between 2016 and 2018 (*CityMobilNet*, 2022).

The SUMP contains an analysis of the current situation and actions that balance how people move around the city. The document sets out six primary objectives, which are to improve conditions for walking and cycling, to increase safety for all road users, to improve accessibility to alternative modes of transport to the individual car for all travellers in all areas of the city, to increase the share of journeys by public transport in total trips and to reduce the negative impact of transport on people, health and the environment (CityMobilNet, 2019) .

Initiatives in place

Consequent development of electric public transport, with the highest priority on expansion of existing tram systems, is an important measure to make public transport more attractive and environmentally friendly. Municipal operator GAI T is expecting its first delivery of electric buses in 2023. According to the Electromobility Strategy adopted in 2020, Gdańsk plans to purchase 60 electric buses and 24 hydrogen buses (City of Gdansk, 2020).

Another activity that could decrease emissions from the transport sector in the Gdańsk is the introduction of car parking restrictions and traffic calming by increasing the share of streets with a maximum speed of up to 30 km/h. It is noteworthy that already in mid-2018 such streets accounted for 62% of the length of all streets in Gdańsk (City of Gdansk, 2018). Regarding the more restrictive parking policy, which could be introduced through paid parking and residential zones, in Gdańsk, it has been carried out in a non-integrated manner and has so far been expressed primarily in the expansion of the paid parking zone.

Regarding tariff and ticket integration, a real breakthrough involving the full integration of municipal public transport systems (organised by municipalities) with the rail transport system (for which the provincial government is responsible) has been missing for many years. This limits the possibility of creating an attractive public transport system based on highly efficient rail transport, characterised in the Metropolitan Area by high spatial and temporal accessibility. In 2020, such an attempt was made in Gdańsk, offering a monthly ticket for municipal transport lines and for train journeys between stops and stations within the administrative boundaries of the city at an attractive price (Gołab, 2020). Although this offer seems beneficial from the passenger's point of view, there are still discrepancies in assessing the costs that the municipalities concerned will incur in the following years of operation of such a product. Hence, at a time of growing crisis in public finances (including those of local authorities), this solution is not implemented by other municipalities (Wołek, 2020).

One of the most spectacular activities promoting active mobility is the "Cycling May" campaign, which originated in Gdańsk and expanded to more than 80 cities in Poland. In 2021 approximately 78 thousand children and teachers in Poland were involved. In Gdańsk, 177 schools and kindergartens participated, translating into more than 31 thousand participants (City of Gdansk, 2022b). The campaign is strongly linked with the development of cycling infrastructure in Gdańsk.

Challenges

Many of the challenges facing Gdańsk are threats common to all cities in Poland. But in the case of Gdańsk, these threats are multiplied by the very complex nature of its metropolitan area, tourism attractiveness, and economic development. Adverse changes in the public finance system undermine the financial stability of local budgets and may limit the possibility of making ambitious investments in the future. The energy crisis and Poland's unfavourable energy-mix put a question mark on the possibility of maintaining the dynamic development of electric public transport in Gdańsk, which includes trams and electric buses. This is driven by the current reduced economic efficiency of electric vehicles in comparison to diesel buses.

The challenge of suburbanisation, which affects also other cities in Poland, also affects Gdansk and more broadly the Tri-city region. The impact of spatial expansion is multiplied by a deficit in the supply of public transport services, resulting in a strengthening of the role of the private car in commuting between the surroundings and the metropolitan core. This peculiar competition for residents results from the planning authority of individual municipalities, their diverse land resources, attractiveness and aspirations, and limited willingness to cooperate. This is a result of an inefficient allocation of public resources and long-term trends in the real estate market. Especially the growing housing costs have stimulated the migration of some of the residents of larger cities to the areas of neighbouring municipalities, which, although less well-equipped with technical and social infrastructure, had properties at a lower price. The resulting suburbanisation is expressed, among other things, in a chaotic land-use structure and the remoteness of sources and destinations. This, in turn, leads to over-investment in technical infrastructure, including roads, primarily serving the growing car traffic flows (Wołek, 2020).

Recommendations

Recommendations for development of passenger transport that could result in emission reductions from the sector in Gdańsk and the broader metropolitan area could be divided into three levels.

National level

At the national level, it is essential to adopt a framework that creates a long-term, predictable perspective for local government's finances. This framework should be based on a high degree of income autonomy, enabling an active investment policy at the local and metropolitan levels. As Gdańsk is among the wealthiest urban self-governments in Poland, its challenges are of appropriate size and need to be provided appropriate and predictable funding.

Another essential driver of decarbonization in Gdańsk that requires action at the national level is the development of electromobility in public transport not only at the

investment stage but also during further operation. This is particularly important in the current situation, in which the radical increase in electricity prices calls into question the economic advisability of further development of electric transport.

Finally, national authorities should adopt a legal framework for the development of metropolitan areas with tools and resources for transport integration and development to integrate all forms of transport and create a real alternative to the uncontrolled use of private cars. The gravity area of the Gdańsk-Gdynia-Sopot Metropolitan Area is very complex, including communes of different potential and abilities to co-finance complex transport systems.

Metropolitan level

At the metropolitan level, it is essential to coordinate the spatial policy activities of the municipalities forming the Gdańsk-Gdynia-Sopot Metropolitan Area. It is also essential to strive for systemic and functional integration of the existing transport subsystems, including cycling (treated as an important feeder for railway transport), walking, and potentially shared mobility systems as the next step towards Mobility-as-a-Service model.

Urban level

There are a significant number of policy opportunities at the urban level, such as further development of active mobility, including bicycle transport with a strict link to urban regeneration activities. To reduce vehicle traffic the city should rethink road system development, with a positive example of the reduction of one section of planned road from 2x2 to 2x1 lanes.

Cities should additionally continue the development of public transport and infrastructure for renewable energy sources to power electric vehicles. This can be done through contracting green energy and the construction of local renewable energy generation centres as the first stage in the 'greening' of electric public transport.

Public transportation interventions should be targeted to create a dense and efficient network. Intensification of complex bus and tram prioritisation, which includes bus lanes, signalling, and upgrade of technical infrastructure, can support network speed and reduce waiting times. Hydrogen buses should also be tested for eventual introduction as they offer a viable clean alternative to internal combustion engine buses.

Additionally, development of the Southern Pomeranian Metropolitan Railway (an urban railway line) and urban development around railway stops. More generally, the city should increase the density and mix of functions in the vicinity of existing railway stations.

Bucharest

Bucharest is the capital and largest city of Romania, situated in the south-eastern part of the country, in the middle of the plains. Two rivers flow across Bucharest – Dâmbovița, and Colentina – and the heavy deforestation from the past transformed the areas around Bucharest into rich agricultural fields.

According to the latest data from 2020, Bucharest has a population of a little over 2 million, growing from 1.9 million in 2008. This represents almost a tenth of the Romanian population. In line with European and global trends, people are moving towards the periphery of the capital in search of cheaper houses with small gardens and more quiet areas for families. The dynamic pushed for rapid development of the margins of Bucharest that triggered a rapid urbanisation of agricultural surroundings.

Bucharest is thus characterised by a “chaotic suburban development” (Floroiu & Coheci, 2019) determined by legislative and economic factors similar to the majority of post-communist countries in Central and Eastern Europe. Since the 1990s, city density declined, and the built area has grown in the last decade, especially triggered by large-scale real-estate developments.

Map of Bucharest

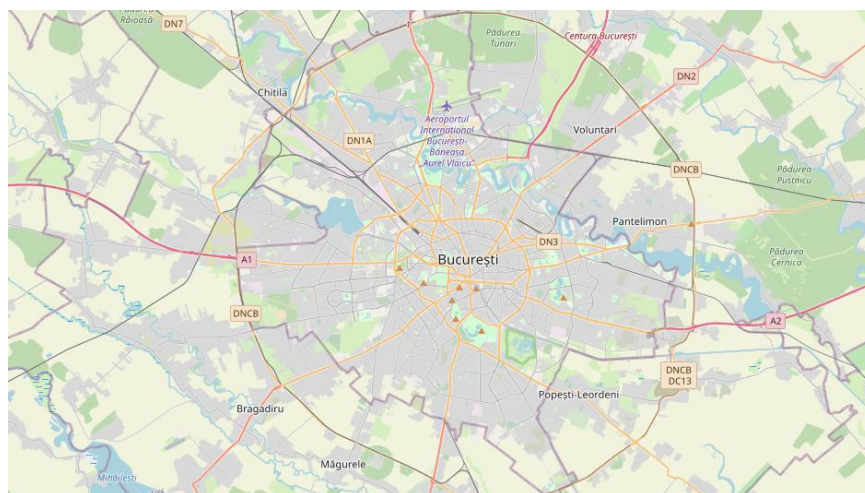


Figure 9 Map of Bucharest

via [OpenStreetMap and contributors](#)

Along with the population increase, there is a traffic increase. Of the total number of cars registered in Romania, over 20% are registered in Bucharest (Bugheanu, 2015). According to data from 2021, Bucharest was the eighth most congested city in the world, in a statistic covering 404 cities in 58 countries on six continents (TomTom Traffic Index, 2022d).

As a consequence of economic development and the increase in the number of private cars, the city's transport infrastructure needs to withstand frequent traffic jams and an insufficient number of parking lots, which are often supplemented at the expense of green spaces (Niță et al., 2018).

Public transport

As most studies show, one of the main pillars of sustainability in cities is urban transport. Bucharest's public transportation system mirrors the chaotic development of the city. Despite a fairly extensive public transport system (770 km of the bus network, 282 km of the tram network, and 142 km of trolleybus network, with a density of about 3.99 km/km²), there is a low efficiency of public transport, as well as timetable integration, which makes public transport in Bucharest to lack attractiveness (Andrei & Luca, 2021).

Societatea de Transport Bucureşti (STB, The Bucharest Transport Company) is the main public transport company in Bucharest, and it is under the authority of the Bucharest City Hall. At the end of 2021, STB had 175 lines (23 trams, 16 trolleys, 136 buses), and a fleet of 1,559 vehicles (280 trams, 181 trolleys, 1098 buses). In the 2021 annual report, STB announced that it had made steps towards acquiring 100 new trams and an undisclosed number of electric buses, but the acquisitions were not finalised (STB, 2021). At present, there are hybrid buses circulating in Bucharest, and there is an approved project of buying 100 electric buses in the next 12 to 48 months (latest 2023). The project including the buses and the infrastructure would cost 62 million EUR, money that will come from European funds (Sustainable Bus, 2022).

The main STB's activities and budget in 2021 were related to maintenance and making little progress in improving and modernising the transport system. The main updates in 2021 and 2022 are the single transport ticket valid for all means of public transport and the paid parking system in the centre of the city. Despite small improvements, the public transport system in Bucharest is still confronted with a series of long-standing issues. These issues include a lack of dedicated bus lanes, an old and polluting fleet, and limited policy promoting public transport. Furthermore, due to a lack of electronic information screens, there is no predictability at public transit stations. Lastly, public perception of the public transit is poor; concerns include a perceived lack of comfort and cleanliness. (STB, 2021).

Bucharest is notorious for a very underdeveloped bike lane network which is only 15 kilometres long. The City Hall announced a plan in the very early phase to extend the network with five new itineraries with a total length of 13 kilometres (Romania Insider, 2022).

Emissions

Air pollution may be considered a public health emergency in Romania. According to the European Environment Agency, more than 26 thousand premature deaths in Romania could be attributed to air pollution in 2016. Most of the air pollution is concentrated in the capital city, where the most economic activity is happening and where the traffic is highest (Maftei et al., 2022a).

The Court of Justice of the European Union condemned Romania in 2020 for not meeting its obligations to improve air quality, ruling that the country has systematically violated air quality norms in Bucharest (European Commission, 2021). In May 2020, the European Commission sent a letter of formal notice to Romania giving it four months to take necessary measures to address – amongst others - illegal levels of NO₂ in the agglomeration of Bucharest (Ibid.).

In Bucharest, the daily limit of particulate matter (PM10) has persistently been exceeded, ever since EU law became applicable in Romania. Illegal annual levels of nitrogen dioxide (NO₂) have also been recorded. According to EU law, local authorities in Bucharest are obliged to prepare and adopt an air quality plan for the capital region when its residents are exposed to harmful and illegal levels of air pollution (Ibid.).

Bucharest City Hall's Air Quality Plan was challenged in court at the end of 2020 by three Romanian NGOs – Centre for Sustainable Policies "Ecopolis", Optar, and 2Celsius, a co-author of this report, supported by ClientEarth (R. I. Popescu & Corbos, 2010). A court in Bucharest has annulled the city authorities' Air Quality Plan because it did not include measures that would achieve legal levels of air pollution in the "shortest time possible" as required by law. The plan also failed to include a detailed timetable for implementing the measures or to assess their expected impact. Furthermore, it did not include measures that would sufficiently address emissions from the transport sector – an important contributor to air pollution in the city (Ibid.).

In 2021 the Mayor of Bucharest announced that a new study for air pollution in Bucharest was being conducted by an international consortium (Mayors of Europe, 2022). The results are yet to be made public and they will be used in elaborating a new Integrated Plan for Air Quality in Bucharest. Currently, strategies and actions are based on data from 2013, which is highly contested in the public sphere. The study is expected to confirm that traffic is one of the main causes of air pollution in Bucharest, followed by waste management, economic activity, destruction of green space, and others.

Key documents and strategies

Sustainable Urban Mobility Plan 2016 – 2030 for Bucharest – Ilfov envisions a total budget of 3.6 million EUR for surface transport in Bucharest in the targeted period (Rom Engineering Ltd & AAENSA Consulting, 2016). According to it, the main three priorities concerning transport infrastructure are (1) the improvement of the existing infrastructure, with a focus on the subway that is acknowledged as the most important means of transport in Bucharest, (2) extension of pedestrian areas and the network of bike lanes, and (3) increasing traffic safety by putting in place more measures to control the speed in traffic. The local strategies and documents are in harmony and always refer to national strategies.

The last version of the National Strategy for Sustainable Transport that includes targets for 2020 and 2030 was elaborated in 2008 and is based on data as old as 2006. It notes that road transport increased by 1.58% between 2006 and 1995, whereas greenhouse

gas emissions have increased by a greater proportion. However, this data fails to capture the full scale of changes due to its time scale.

The Romanian General Master Plan for Transport was adopted in 2016 and comprises all national transport projects for the 2021-2030. On the road transport level, the plan refers to improvements and construction of highways and expressways, railways, and multimodal projects for main cities in Romania, Bucharest being the main priority (European Parliament. Directorate General for External Policies of the Union., 2015).

Initiatives in place

Despite a general vision that prioritises big infrastructure projects and encourages road and air transport to the detriment of railroad transport, there is an underlying concern for emission reduction in the national and local strategies. The level of ambition though is low, and the measures fail to trigger a meaningful change that could have a big impact on emissions. As a result, transport sector still is the sector that sees a continuous increase in emissions.

At the national level, but with a high impact for Bucharest, the government has been funding Rabla, a program that offers people incentives to scrap old cars and use the incentive to buy new cars (Radacini, 2023). This is also the longest-standing environmental program for the transport sector, which many environmental organisations criticise for an adverse impact on the environment. In practice, Rabla did not prove its mission of reducing emissions but managed to only put more cars on the streets, contributing to a congested Bucharest. A 2Celsius report shows that for every new car in Romania, five old cars are registered, which makes the Rabla program useless also in terms of the disposal of old cars (Loredana, 2022).

In Bucharest, some steps are being taken to increase the attractiveness of public and sustainable transport, such as plans to extend bike lanes, to acquire new trams, to move to electric buses, but the measures are still to be implemented. At the same time, many expected measures are still not being taken, including introduction of low emissions zones, dedicated bus lanes, and policies reducing car usage.

Challenges

An important challenge for a transition to green transport in Bucharest is the financial challenge of updating an overall old and inefficient system. Consequently, much of the budget is always drained in maintenance and support projects, while the transition is always postponed. Moreover, there is a lack of political will to tackle the most pressing issues. One example is the ever-increasing number of individual passenger cars in the streets, with no impactful measures being taken to reduce their number or restrict their usage.

At the infrastructure level, public transport in Bucharest is covering an important part of transportation needs, but it has an untapped potential of replacing individual passenger

cars. Local authorities are failing to rebuild the reputation of public transport and increase its attractiveness. Meanwhile, the perception of an old and dirty public transport system is being disseminated, although it is not entirely true.

Recommendations

Transport strategies should be integrated with other environmental strategies and urban development plans to create a comprehensive and long-term vision for the city. Strategies must be substantial with robust modelling and up-to-date research and data.

Transport development in Bucharest must focus on shifting journeys away from the road and private cars and towards public and active transport. At the highest level the city must change priorities from big infrastructure projects to sustainable transport objectives. The city should explicitly encourage public transport in Bucharest to the detriment of individual passenger cars, and the 'polluters pay' principle should be better reflected in the city's transport policies and programs aiming at infrastructure development.

Brasov

The heart of the Central Region of Romania and one of the eight Romanian development regions, Braşov is the sixth largest city in Romania. With a population of around 240 thousand people, the city's population is decreasing – down from roughly 280 thousand in 2002. The city and 17 other communities form the metropolitan area of Braşov with a population of over 400 thousand people (National Institute of Statistics Romania, 2023).

Situated in the centre of the country, Braşov is an important intersection of commercial roads that link the Balkans to the rest of the Europe, connecting north, south, east, and west Romania (R. Popescu & Corbos, 2010). Braşov is crossed by the main European motorways (E81, E68, E60) and by the IV European corridor, and has developed an extensive network of public roads. The road to Braşov from the capital of Bucharest contains one of the densest road segments in the country, the Prahova valley, famous for extreme congestion routinely making the trip between the two cities incredibly long.

Map of central Braşov



Figure 10 Map of central Braşov

via [OpenStreetMap and contributors](#)

Rail connections are often the faster option – the fastest connection from Bucharest takes 141 minutes and the slowest roughly 236 minutes (Barza, 2020). Currently, there are 29 trains connecting the two cities, 20 from the state-owned CFR Călători and 9 from private companies. The density of railway lines in the city (67.7 km/1000 km²) is above the Romanian average (Ibid.). The city will also have an airport starting from June 2023, which is the first new airport built in post-communist Romania despite being highly contested by environmental activists.

Braşov is one of the main poles of urban tourism in Romania, its geographical location close to the mountains offering the city a huge touristic potential. Over 1.4 million tourists visited Braşov in 2019, growing from 510 thousand in 2010 and 990 thousand in 2015 (Direcţia Judeţeană De Statistică Braşov, 2021). In a study regarding inhabitants' perceptions about tourism and the positive and negative impacts of the tourism in Braşov (Albu, 2020), infrastructure, development and upgrades to the types of services provided to the local community, the creation of new jobs and business opportunities and the increase of investments in number and volume in the local economy were found to be the most positive impacts. In contrast, tourism's negative impacts such as the rise of land and real estate prices, the rise of rates applied to certain services and the uncontrolled development of tourism leading to environmental degradation were seen as counter to the city's development.

Public transport

The public transport in Braşov is under the responsibility of the city hall through its autonomous direction RATBV. It consists of over 40 bus and tram lines that cover the city relatively well (Search Corporation & Sigma Mobility Engineering, 2021). The metropolitan area is covered by a further 19 lines. The fleet of public vehicles in the city of Braşov consists of 190 total buses and trams with roughly 72 buses and 51 trams, and a total of 123 electrified vehicles. The city hall of Braşov aims for a 100% electric

fleet in coming years, however there is no target date. As of May 2023, Braşov's electric bus fleet was the largest in the country.

Despite the relative comprehensiveness of the public transit network, passenger cars continue to be an important mode of transport. RATBV registered a 20% slower speed than network average for the top 10 lines because of congestion driven by passenger cars which then translates into non-compliance with the bus and trams timetables. The number of vehicles per every 1000 people in Braşov (the motorization index) is 6% higher than the national average (Search Corporation & Sigma Mobility Engineering, 2021). A survey among more than 5000 employees travelling to and from work in the city shows that 84% of them use the bus, with personal cars being the second option.

The Plan for Sustainable Urban mobility envisions a municipal network of bike lanes to reduce the passenger cars usage for distances shorter than 10 kilometres. The aim is to make the bike an efficient means of transport, not only recreational. Currently, the bike path network in the city is not well developed, consisting of lanes on the streets or on the sidewalk that have clear safety concerns. There is no subway in Braşov.

Emissions

Air quality in Braşov is monitored through a network of six fixed automated stations managed by the Agency for Environmental Protection Braşov. Two of them also monitor traffic in the city. The Agency publishes monthly reports regarding the state of the air quality, the most recent one (December 2022) showing that particulate matter (PM10) is higher than the stated limit due to vehicle traffic. This pattern holds over multiple environmental reports, and it is clear that PM10 levels consistently exceed the safety threshold.

According to European legislation, the number of daily averages above the standard limit for PM 10 must not exceed 35 days in a year. A study on air quality in Braşov for the time period of 2016-2020 showed that this limit was exceeded at two out of three stations measuring this pollutant with records of 43 and 72 days exceeding the limit (Maftei et al., 2022a).

The main sectors contributing to the emission of air pollutants in Braşov are commercial, institutional, households, transport (road and rail), industrial processes, and energy (Maftei et al., 2022b). Despite its geographical location at the foot of the mountains that offers a perception of a clean and natural city, Braşov is one of the most polluted cities in the country and in Europe, ranking 273rd out of 323 cities in Europe ranked according to air quality (Fodor, 2021).

Local documents and strategies

The Sustainable Development Strategy of Braşov 2030

The Sustainable Development Strategy is the overarching document that sets the priorities for the municipalities for 2030 in all important sectors, with an overarching commitment for sustainable development (WSP Parsons Brinckerhoff, 2015). For the transport sector, the strategy is briefly describing the situation and stating a few general objectives, first one being the rentability of the RATBV, followed by fulfilling companies' need for transporting their employees, developing ticketing system based on distance, a modal type of transport for the metropolitan area, and promoting car-sharing.

The Urban Mobility Plan for Metropolitan Braşov

The Urban Mobility Plan for Metropolitan Braşov was elaborated in 2015 and is valid for 2016-2030. The vision refers to five strategic objectives: accessibility, safety, environment, economic efficiency, and urban environment (Municipality of Brasov, 2015). The optimal scenario envisioned in the plan is one with reduced travel time for passengers, a 6% reduction in emissions by 2030, streets prioritised for public transport, 40 kilometres of bike lanes by 2040, and increased space for people. This document is supported by an updated traffic study published in 2021 which offers more up to date data about transport in Braşov (Search Corporation & Sigma Mobility Engineering, 2021).

Air Quality Plan for Braşov

Air Quality Plan for Braşov expired in 2022, and there is not a new strategy in place yet (Municipality of Brasov, 2018). For the transport sector, the plan envisioned the building of bike lanes, park & ride facilities, cleaning the streets, metropolitan trains, and free public transport.

Activities focused on decreasing emissions from transport sector

The main activity that the municipality is employing to decrease the emissions from the transport sector is the transition to 100% electrical bus fleet in public transport. More than half of the buses in Braşov are already electric and more acquisitions are envisioned for the future. The plans for improving public transport also consist of increasing bus speed and frequency by prioritizing the streets for public transport, extending the bike paths network in the city, and encouraging car-sharing.

However, Braşov is struggling with high levels of air pollution and multiple transport challenges. In this context, the activities that are already happening are inadequate and the planned activities lack ambition and a concrete timeline. There are also several activities that were planned for 2022 and failed to be implemented, like building an efficient bike lanes network. Other plans – like the metropolitan train which would

reduce some of the traffic in the city – are taking very long to be implemented, with the metropolitan train feasibility plan extended for a further year and a half.

Challenges

The main challenge to implementing measures to improve public transport and to decrease emissions from transport in Braşov is financing. As it is shown in Braşov's public strategies, the business-as-usual scenario which only involves maintenance activities is obviously the cheapest at 7.8 million EUR, while the optimal scenario that involves sustainable development projects is the most expensive with a total budget for 2016-2030 of over 328 million EUR.

Moreover, the high motorization index of the city is proving very hard to reduce. The personal car is an important means of transportation due to cultural and economic reasons, but this is also a consequence of public transport shortcomings. The municipality has some plans for park & ride infrastructure and to promote car-sharing with limited results so far.

The tourism is another challenge for Braşov, in the context of a rapid and significant increase of tourist numbers. This is both an opportunity to develop sustainable practices in the city, and also a trap of ever-increasing cars in the city and more pressure on the city's infrastructure.

Recommendations

Key recommendations for Braşov focus primarily on encouraging the uptake of public transportation and making active transport measures like cycling more attractive to the public, in an effort to move away from personal vehicles. The city of Braşov should focus on implementing more ambitious measures for encouraging public transport in the city and in the metropolitan area.

Public transport can be supported by coupling the transition to electric buses with making public transport an efficient mode of transport for passengers, including through reliable timetables and dedicated bus lanes throughout the city. The city should accelerate development of the bike lanes network and development of park & ride infrastructure. Based on the overall improvement of public transport infrastructure, the city should implement a communications campaign to promote sustainable transport.

Cluj Napoca

The municipality of Cluj-Napoca is located in the central area of Transylvania and covers an area of almost 180 km². It is located in the connecting area between the Apuseni Mountains, the Someșan Plateau and the Transylvanian Plain. It stretches along the valleys of the rivers Someșul Mic and Nadăș and, through certain extensions, on the secondary valleys of Popești, Chintău, Borhanciu and Popia. To the southeast, it occupies the space of the upper terrace on the northern slope of the Feleac hill, being surrounded on three sides by hills. To the south, the city is guarded by Feleac Hill, with a maximum altitude of 825 m, at the top of Măgura Sălicei.

Map of Cluj-Napoca

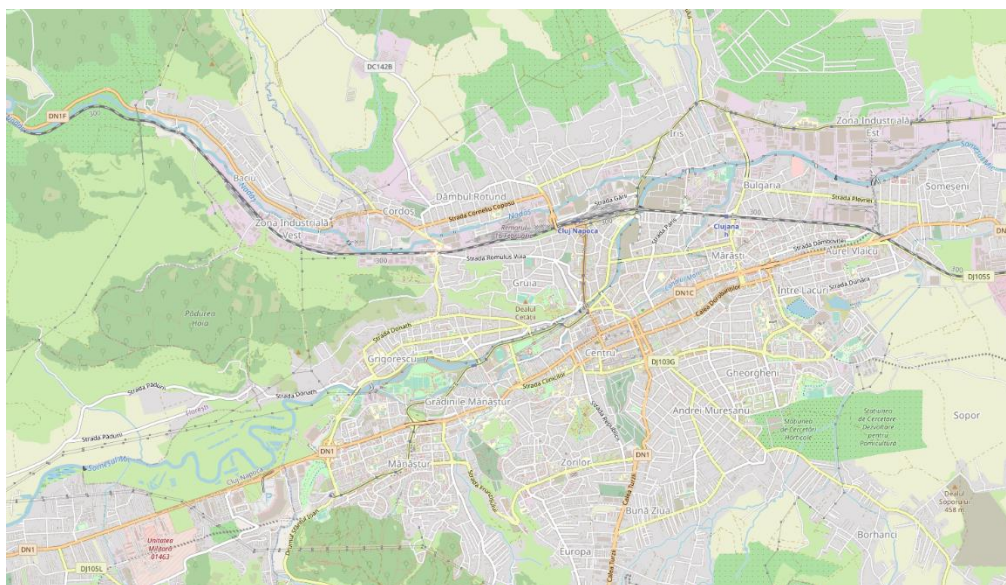


Figure 11 Map of central Cluj-Napoca

via [OpenStreetMap and contributors](#)

Despite decreasing population, Cluj Napoca with population of almost 290 thousand inhabitants, is the second largest municipality in Romania, after Bucharest (National Institute of Statistics Romania, 2023). This decrease in population is mostly the result of urban population moving to neighbouring localities. Currently, the whole metropolitan area of Cluj Napoca has roughly half a million inhabitants.

The economy of the Cluj metropolitan area (ZM Cluj) is dominated by the economic activity in the city of Cluj-Napoca, the main county, regional and national growth pole that concentrates, in 2018, over 80% of active companies, jobs and turnover generated in the functional area, just over 70% of the jobs in the county and more than a quarter of those available in the Northwest region. This fact translates into a value of GDP per inhabitant (PPS) at a level of 89% of the EU27 average for 2017, one of the best values in the country, after the capital (National Institute of Statistics Romania, 2023).

These values are determined by a permanent positive evolution in the post-recession period, especially after 2012, when the average annual growth rate of the number of enterprises was 6.6% per year at the level of ZM Cluj and 5.1% per year in the municipality of Cluj-Napoca (National Institute of Statistics Romania, 2023).

Overview of local documents and strategies

Sustainable Urban Mobility Plan

The Sustainable Urban Mobility Plan (SUMP) for the period 2021-2030 was approved in 2022. The development of the SUMP for the period 2021-2030 of the Cluj-Napoca Metropolitan Area took into account the existing strategic context at the global and European level, as well as the concerns regarding urban mobility and transport identified internationally.

The SUMP was developed through a transparent and participatory approach. In all stages of the development of the Plan, relevant actors, citizens and civil society representatives, public transport operators and economic operators from the studied territory were consulted, questionnaires and opinion polls were applied (Mitroi & Stadler, 2022).

The concept of functional areas "functioning as a unitary system from a political and/or social and/or economic point of view" appears, "where common characteristics and interdependence relationships are found that determine cohesiveness and distinguish them from other territories" (Mitroi & Stadler, 2022).

Electromobility

At the national level, a rapid increase in the number of electric vehicles is noted. In the Cluj-Napoca metropolitan area there are 40 EV charging stations, including in neighbouring towns (Apahida, Florești). They are primarily located in the city's parking lots, as well as in the premises of some gas stations or some hotels. The number of charging stations for EVs is high compared to other major urban centres in the region and at the national level.

However, there are also neighbourhoods that are not directly served by charging stations. Considering the fact that access to charging stations is very important for residents of collective housing districts, the need to expand charging stations for EVs is noted. This is supported on the one hand by national funding for economic operators, as well as by adapting the legal framework in the field of energy performance of buildings.

The expansion of the network of EV charging stations still requires support from local public authorities, especially in areas with high population density. At the same time, planners should also account for the projected sharp increase in the use of small

electric vehicles (e.g., scooters, bicycles), which also require charging stations, and which can be planned and grouped together with those intended for cars.

In addition, as of 2020 Cluj-Napoca City Hall started issuing taxi licenses exclusively for EVs. Any withdrawn taxi authorisation is to be converted to an EV taxi authorisation and reassigned in accordance with legal provisions.

Measures for reduction of road traffic emissions

Cluj-Napoca has a series of measures designed to reduce road traffic emissions, which include development of Cluj metro and other forms of public transport, as well as promotion of active modes of transport. These measures are supported by traffic restrictions, including a daily ban on access for vehicles greater than 3.5 tonnes during peak morning and evening hours, with the exception of public transport.

Development of Cluj metro

The first metro line in Cluj-Napoca-Floresti seeks to eliminate up to 40 thousand personal car trips per day by 2030 and 170 thousand by 2060, and is a flagship project of the Sustainable Urban Mobility Plan 2020-2030 (Mitroi & Stadler, 2022). Civil society representatives were active in the conceptualisation and implementation of this project, projecting that showing that the impact of the subway on the traffic in the municipality is high - the reduction of the traffic in Cluj-Napoca is projected to decrease from 82% share of trips taken in individual cars to 42%.

The Cluj metro is planned to have a single line, with a length of 20 km in the first phase, on which there will be 19 stations. Unlike the capital, where it runs exclusively underground, part of the Cluj taxiway will be on the surface, especially in the western part of the city (Floresti and Gilău communes), where space still allows for this. The maximum transport capacity will be 15,200 passengers per hour and per direction at maximum frequency.

The trains will be much shorter than those in Bucharest: three wagons, compared to six in Bucharest. The length of a train from Cluj will be 51 m, compared to 112 m in Bucharest, and the maximum capacity (number of passengers) will be less per train in Cluj than in Bucharest. However, planners anticipate a higher frequency in Cluj.

City Hall will take over the administration of the metro line, as delegated by the partner town and communes in the metropolitan area of Cluj. Construction is expected to be highly disruptive, with several boulevards closed to car traffic for at least a year (Alstom, 2023). This project will not open to the public for several years, but key excavation work is expected to finish by 2026.

Prioritization and expansion of public transport

Recent investments in the modernization of the fleet have significantly increased the comfort of trips and public access to information regarding the availability of services is much better. At the same time, the city of Cluj-Napoca is among the few cases where public transport can compete with private cars on certain routes in terms of travel time, especially where there are dedicated lanes. This is largely due to the fact that cars are stuck in traffic, rather than public transport being quick –the commercial speed of public transport is still well below 20 km/h.

In order to achieve the desired modal share of 37% for public transport, the public administration must first invest in prioritizing public transport by ensuring an increase in commercial speeds above 20 km/h. This objective can be achieved by implementing the metro line, but until the project is finalized, surface transport must be optimized. Therefore, at the level of public transport, it will be essential to prioritize transport in the east-west direction (the main development corridor) and in connection with the train station. Developing dedicated lanes, when coupled with traffic light prioritization will be able to transform public transport into a viable alternative to traveling by personal car in terms of both time and money.

At the metropolitan level, the strategy for the coming years aims to expand and make public transport routes more efficient. On the one hand, it is about extending the lines to the suburbs further away from the city centre. On the other hand, to be able to economically support this expansion, an optimization of the lines is needed. In this sense, intermodal nodes coupled with transfer parking will be used to connect the metropolitan public transport lines with local ones. However, the most important project in this regard is the metropolitan train, as it has the capacity to serve the entire metropolitan development corridor with minimal investment (as long as only frames and minimal interventions are included in the modernization and equipment of the stations).

Taking into account the planning of the metro implementation stages, it will be essential that the Florești commune also benefits from an express connection with the areas of interest in Cluj-Napoca. That is why, for Florești, the mobility corridor with the dedicated public transport line from the south, to Bucium/Vivo, remains a priority.

Active mobility

The municipality of Cluj-Napoca is among the cities with a greater number of bicycle lanes, but as is the case in most other cities, they don't constitute a coherent framework. The last few years have brought a gradual improvement in cycleway projects and there is a better understanding of this type of infrastructure at the level of local public administration.

Priority must be given to investments in the completion of the network of cycle paths in the coming years. Each housing district must benefit from an efficient and safe bicycle

connection with the central area. This approach requires the completion of the network, and the revision of the existing tracks that have a precarious level of service. From a strategic point of view, it is important that the investments in the expansion of the velo infrastructure are carried out in an integrated way, at the corridor level, avoiding specific interventions or distinct projects for tracks, dedicated lanes and sidewalks. In this sense, the cycle path network will be completed following the concept of "complete streets," which aims to reconfigure a street emphasizing the balance between public transport, cycling, pedestrian travel and cars.

With minimal investment, the municipality's bike network can be extended to the metropolitan area, especially to localities with a high flow of tourists, through a network of non-motorized travel corridors. The flagship project remains the Someșului project, which would serve the communes with the greatest development dynamics. Apart from the flagship project on the Someșului corridor, the expansion of the network can be done with minimal costs through the use of re-striping and temporary bollards before further funding is allocated.

Vilnius

Vilnius is the capital city of Lithuania, located in the south-eastern part of the country and in terms of population (at the beginning of 2022 there were 592 thousand inhabitants) — the largest city in Lithuania (Statistics Lithuania State Data Agency, 2022). The number of inhabitants continues to grow, as does urban sprawl. The population of Vilnius' functional urban area, which includes suburban territories, differs from 718 thousand to 732 thousand inhabitants (according to the 2020 data). In comparison to 2020 data for the city area (580 thousand inhabitants), this shows that about 19–21% of the population of Vilnius' functional urban area lives outside the city and generates significant need for commuting from suburban territories to the city.

The area of Vilnius is 402 km². A distinctive feature of the city is a diverse topography with a unique, historically formed spatial structure. This includes urban zones, with an area of downtown development, areas of residential districts developed at various time periods, and industrial manufacturing areas. The central zone is located in the lowland surrounded by hills, shaping favourable conditions for emissions' concentration in the most densely populated area with the majority of workplaces. Vilnius' topography features also create obstacles for active mobility – river Neris, which divides the city in the middle, reduces the possibility of the shortest route for pedestrians and cyclists, and daily commuting up to 5 km usually would mean the hilly route.

Map of Vilnius with public transit and bike lane infrastructure

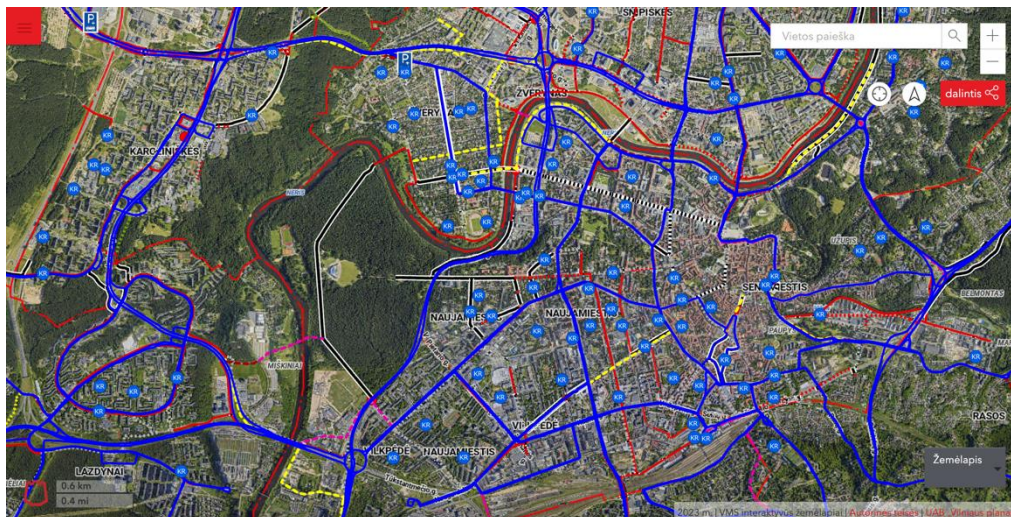


Figure 12 Map of Vilnius

Public transit routes (blue) and bike lanes (red) and planned bike lane expansions (other), [via UAB Vilnius Maps and the City of Vilnius](#)

The circumstances described above lead to a constantly increasing number of cars and car ownership rates. Between 2017 and 2021 about 34,600 cars were registered in Vilnius city and about 12,600 more in Vilnius district (REGITRA, 2023). The number of cars per 1000 inhabitants during the same period rose almost 15% in Vilnius city and

almost 30% in Vilnius district, with only 1% of the car fleet powered by eco-friendly fuels. At the end of 2021 in Vilnius city, this indicator was 403 cars per 1000 inhabitants, and in Vilnius district - 539 cars per 1000 inhabitants (Ibid).

Public transport and modal split

Municipal Enterprise “Susisiekimo paslaugos” and its brand “JUDU” (trans. “I AM MOVING”) is responsible for all mobility-related sectors in Vilnius, such as parking, cycling infrastructure, pedestrian infrastructure, shared bikes, traffic organisation, public transport, etc (JUDU, 2023).

Public transport carriage services are provided by three operators. The public transport fleet consists of buses (diesel, gas, hybrid, and electric buses) and trolleybuses. Vilnius has confirmed a strategy for the renewal of public transport, so by 2030 composition of the public fleet of buses should be improved.

Vilnius public transport fleet

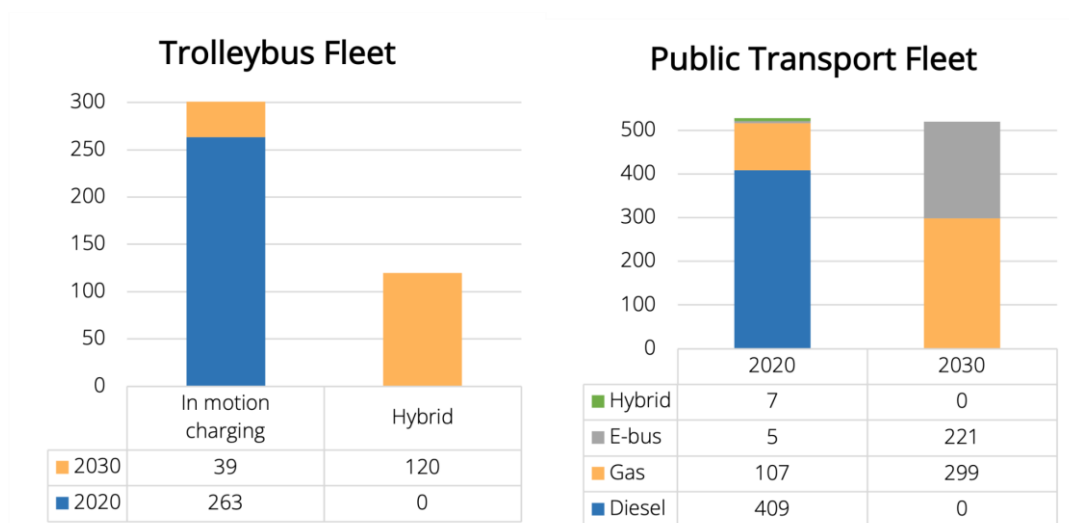


Figure 13 Vilnius public transport bus fleet by bus type and trolleybus fleet by type

(Susisiekimo paslaugos, 2020)

The COVID-19 pandemic strongly affected public transport in Vilnius. Until 2020 revenues from ticket sales were rising, however, later numbers dropped (**Figure 14**, below). In 2021 over 121 million trips were made by public transport, almost 11% less than in 2020.

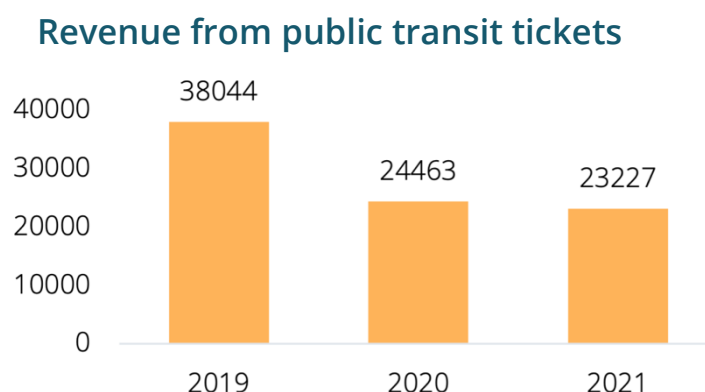


Figure 14 Revenue from ticket sales, thousands EUR

(Susisiekimo paslaugos, 2021)

A representative survey to identify the modal split in Vilnius was conducted in 2017 during the development of the Vilnius Sustainable Mobility Plan (Vilnius City Municipality & Susisiekimo paslaugos, 2018). Based on the results of this survey the inhabitants of Vilnius most often travelled by car (48.6%), public transport (25.4%), and on foot (24.5%). Only 1.5% of the inhabitants choose bicycles. Many sustainable mobility-related measures from Vilnius' SUMP were implemented in recent years, so another representative survey is scheduled for the beginning of 2023 to identify the impact of these measures on the modal split in Vilnius (Vilnius City Municipality & Susisiekimo paslaugos, 2018).

Emissions

According to the analysis conducted for Vilnius SUMP, about 60 – 80% of the emissions in Vilnius city are caused by road transport. The analysis revealed that PM10 and nitrogen dioxide (NO₂) levels exceeded concentration limit values along the streets with the busiest traffic. In the scheme below (**Figure 15**) educational facilities located in the areas with exceeded NO₂ levels are indicated.

NO₂ exceedances (left) and school zones (right)

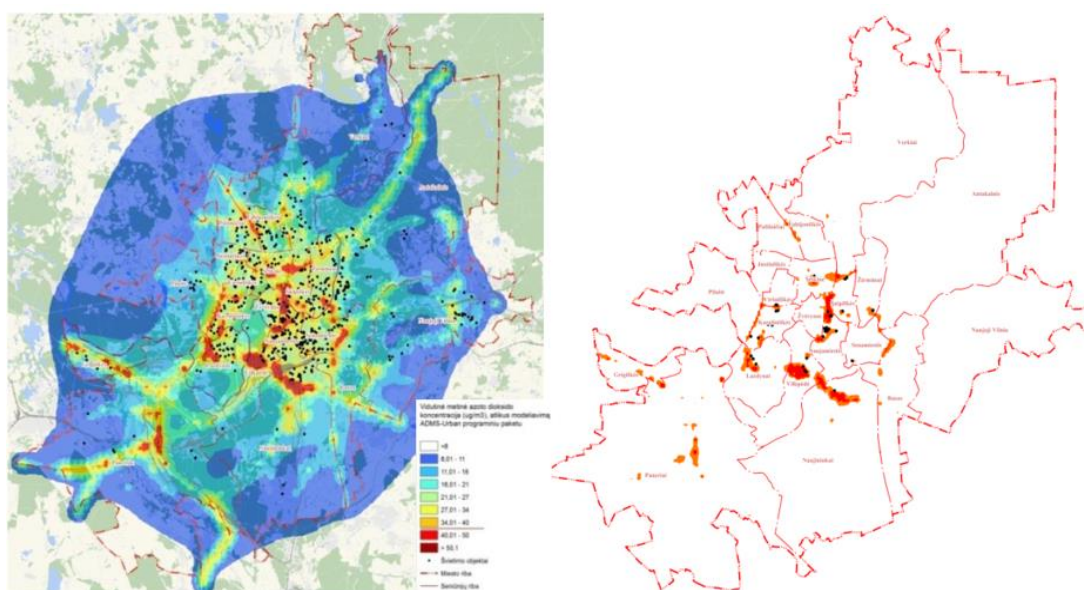


Figure 15 Areas with NO₂ values over the limit and educational facilities in those areas (Vilnius City Municipality & Susisiekimo paslaugos, 2018)

The role of transport as the main source of air pollution has been confirmed by other reports. The report from 2022 by that included the results of air quality measurements, taken in 2019 indicated that correlation of air pollution with transport intensity (Bekesiene & Meidute-Kavaliauskiene, 2022). Measurements of NO₂ concentration revealed exceedances in three measuring points, all of which were located near main transport arteries – Geležinio Vilko str., Molėtų highway, and Western bypass (Vilnius City Municipality, 2023b).

The secondary aim was to assess the effect of street cleaning measures since these measurements were carried out in eight city streets with intensive traffic to assess pollution before and after street cleaning. The figure below (**Figure 16**) shows the changes in emissions (left column – before the cleaning, right column – after cleaning) and the overall situation on these streets. The results show emissions close to or exceeding the limits in almost all observation points. The biggest emissions were observed on Šeimyniškių and Tūkstantmečio streets in April (Vilnius City Municipality, 2023b).

NO₂ (left) and PM₁₀ (right) values before and after street cleanings

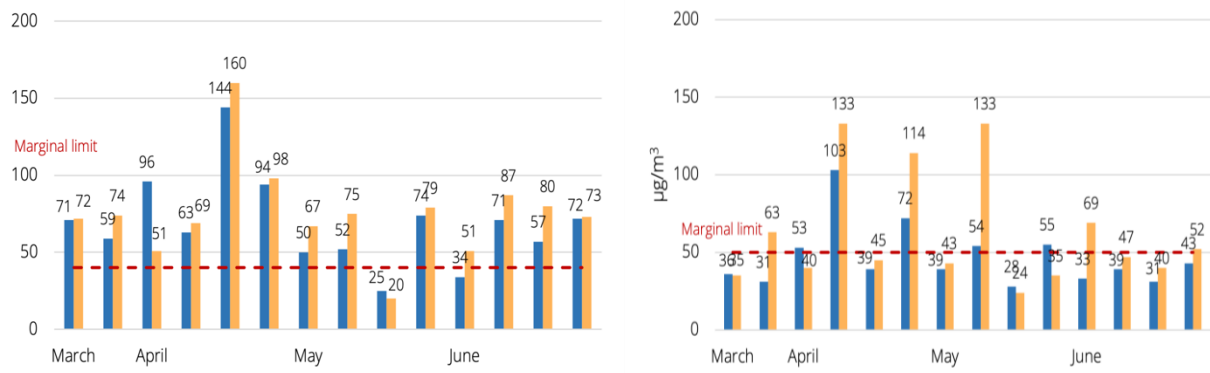


Figure 16 PM₁₀ and NO₂ pollution on Vilnius streets before and after cleaning

(Vilnius City Municipality, 2023b)

Currently, the overall situation is being monitored by four national air quality research stations and 34 sensors installed by Vilnius city municipality. The latter is mostly located near educational institutions. All the information is provided on the dedicated page with real-time data and retrospective trends available. This tool enables the city and other stakeholders to monitor air quality in Vilnius, indicate sources of pollution, make assumptions about the causes for a change in one or more indicators, and make decisions on organising abatement and prevention works.

Vilnius air pollution dispersion

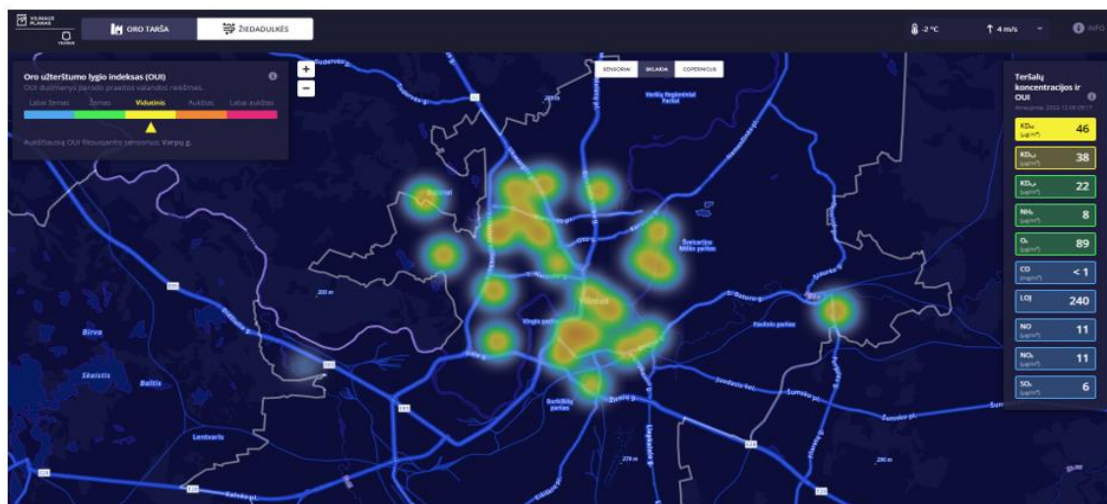


Figure 17 Real-time dispersion of air pollution, Vilnius

(Vilnius City Municipality, 2023)

Key documents and strategies

Vilnius Sustainable Urban Mobility Plan

The vision of the city of Vilnius is “it’s fun, safe, and convenient to travel in Vilnius!”. The following three objectives should be achieved by implementing Vilnius Sustainable Urban Mobility Plan (hereinafter- Vilnius SUMP):

- By 2030, to improve the quality of travel, shorten travel time, and make a trip a pleasant experience.
- By 2030, to reduce the negative impact of travel on the environment.
- By 2030, to reduce car congestion in urban areas (Vilnius City Municipality & Susisiekimo paslaugos, 2018).

These are to be achieved through measures divided into thematic groups:

- Environment humanization, safety, and walking promotion
- Development and improvement of non-motorised transport (active mobility)
- Development and promotion of public transport
- Greening of auto-transport and improvement of traffic system
- Improvement of mobility management, and training of rational mobility habits (Vilnius City Municipality and Susisiekimo paslaugos, 2018).

Vilnius SUMP Action Plan 2020 implementation started at the end of 2018 after the SUMP approval by the Vilnius City Council. In 2021 Vilnius SUMP implementation monitoring revealed that only 7% of all Vilnius SUMP measures were implemented in two years. Analysis revealed that in all thematic measure groups, measures with the highest priority (set in the Action Plan until 2020) and measures which are necessary for the implementation of other measures (base measures) were successfully implemented. Measures related to infrastructure development, fleet renewal, or major traffic management changes were not implemented due to the lack of time, financing, or political will.

SUMP’s implementation and overall institutional operation were evaluated using the EU project “Fact-finding study on the status and future needs regarding low- and zero-emission urban mobility” tool. The tool - sustainable urban mobility indicators (SUMI) - is dedicated to cities and urban areas to identify the strengths and weaknesses of their mobility systems and to focus on areas for improvement. Vilnius evaluation was reached based on the survey results, SUMP evaluation tool results, and 8 SUMI indicators results, provided by Vilnius representatives. After the evaluation, the project’s staff provided insights on future SUMP implementation and overall institutional operation for Vilnius city (Directorate General for Mobility and Transport. et al., 2021).

Vilnius SUMI evaluation results

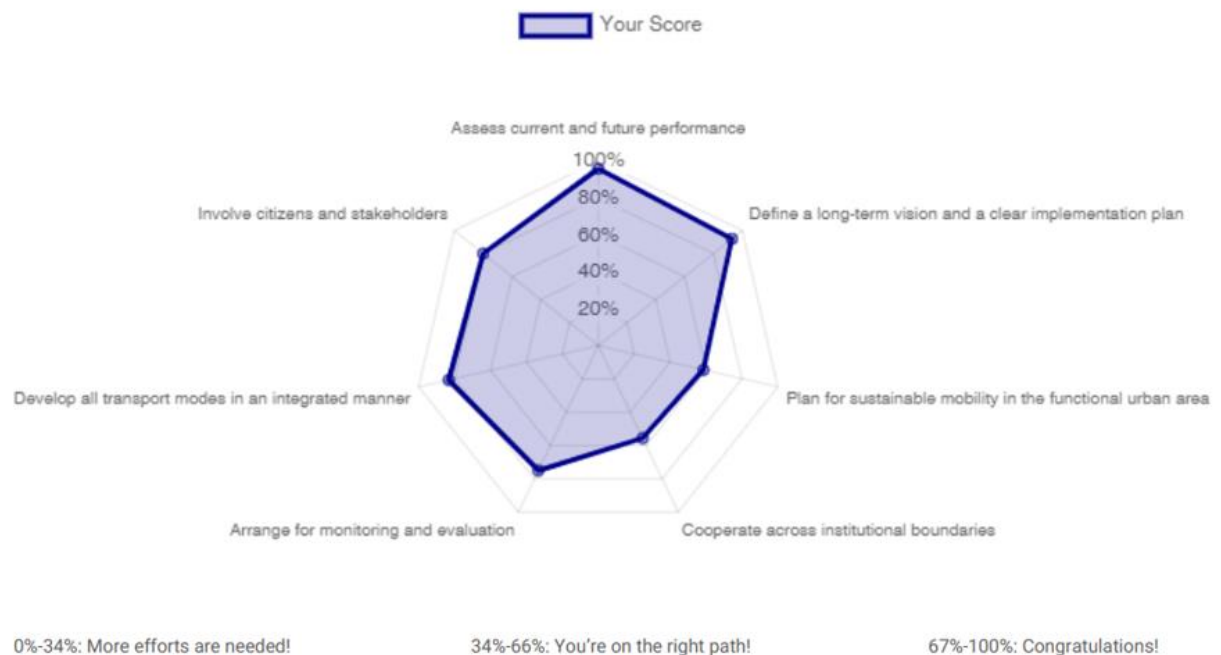


Figure 18 Vilnius evaluation results

(Directorate General for Mobility and Transport. et al., 2021)

Recently ME “Susisiekimo paslaugos” updated SUMP Action Plan 2024, which contains 51 measures with an overall 506 million EUR budget. The measures are divided into five groups. Three of them are oriented to develop, improve and promote travel by public transport (15 new routes, 9 km of dedicated lanes, integrated ticket), on foot (180 km of new or renewed pedestrian infrastructure, 50 street intersections with priority for pedestrians, accessible and comfortable Old Town, 30 km of humanised streets, low-speed zones) or by bicycle and other micro-mobility means (190 km of cycling paths, new bike-sharing operator). These measures can contribute to emission reduction through a modal split shift towards more sustainable mobility. The fourth group is targets cars and traffic management – reducing emissions by installing 300 public charging points and 270 points on street lighting poles, introducing a Low Emission Zone, further encouraging the sharing economy, ensuring smooth traffic flow by eliminating 46 traffic lights, ensuring priority for public transport on intersections with traffic lights, coordinated traffic lights for cars, loop traffic in Užupis. These measures together with public transport fleet renewal (55% of the fleet - electric; the fleet is less than 5 years old) are directed to reduce emissions. The last group of measures is oriented on sustainable mobility habits development through communication with society and communities, pupils' education, travel planning tools, and forms a base for all the other measures to work.

Air Quality Management Programme 2020-2025

The objective of the Programme and Action Plan is to maintain air quality that is favourable to human health and the environment and to reduce air pollution by

particulate matter, nitrogen dioxide, and benzo(a)pyrene in Vilnius city, in order to ensure that concentrations in the ambient air remain within the permissible levels of ambient air pollution (Vilnius City Municipality, 2020b).

This objective is to be reached through urban, technical, and technological measures, which include reducing emissions from mobile sources of air pollution, promoting non-polluting or less polluting modes of mobility, shaping the urban environment to reduce the spread of air pollution from mobile sources, and measures to reduce emissions from stationary sources. This is additionally supported by communication, education, and other legal and/or organisational measures, which include communication and education activities, monitoring, actions to be included/included in strategic, territorial planning, and other documents. The plan also includes a contingency plan in the event of an increase in contamination.

The plan includes mobility measures, included in the Vilnius SUMP, Vilnius City Municipality Strategic Plan 2010-2020 and Strategic Plan for 2020-2030, ME "Susisiekimo paslaugos" strategic plans and several other Vilnius city strategies and action plans.

Vilnius City Municipality Strategic Plan 2020-2030 and Action Plan 2022-2024

Vilnius City Municipality Strategic Plan 2020-2030 developed a vision for 2030 – an effortless city for living, visiting, and business. This vision is elaborated in three areas: the city as a service without interruptions, making it easy to do what's important to residents, businesses, and visitors and developing a progressive and sustainable city (Vilnius City Municipality, 2021a).

In the Action Plan for 2022-2024, two programmes related to the problem of emissions were developed: Mobility and Environment and Urban Development (Vilnius City Municipality, 2020a). The mobility programme has multiple actions related to the infrastructure development – carriageway repairs, pedestrian infrastructure repairs, new underground passages, new pedestrian and cycling infrastructure, dedicated public transport lanes in Vilnius, Narbuto streets, renewal of public transport fleet with environmentally friendly vehicles and measures incorporated from Vilnius SUMP Action Plan (Vilnius City Municipality, 2020a).

The Environment and Urban development programmes are more focused on waste management, cultural heritage preservation, green spaces and connections, and engineering infrastructure maintenance. The programmes most related to passenger transport include development and implementation of an environmental education programmes, reduction of PM10 air pollution (e.g. through street cleaning), and the development and implementation of an environmental monitoring programme.

Vilnius City Municipality Green Transport Enhancement Strategy

The goals of the Strategy are to enhance a positive percentage change in the fleet of environmentally friendly vehicles in Vilnius City in order to have 5% green vehicles from

all new cars registered in the city per year by 2020, and 10% green vehicles from all new cars registered in the city per year, by 2025 (Dermantė, 2023). To support this the plan aims to ensure the availability of electric vehicles charging throughout the city. This is projected to reduce the noise level of motor vehicles in urbanised areas by 5% and greenhouse gas emissions in urbanised areas by 10% (Ibid.). Goals are to be reached through the implementation of Vilnius SUMP measures (Vilnius City Municipality and Susisiekimo paslaugos, 2018).

Vilnius City Renewable Energy use in Vilnius Municipality Action Plan

Vilnius City Renewable Energy use in the Vilnius Municipality Action Plan was introduced in 2015. The main goal of the plan was to achieve 36.4% of final energy consumption to be from renewable energy sources by 2020, more than twice the level in 2013, when the share of renewable energy was only 16.2%. According to the Implementation Report, the share of renewable energy in 2018 was almost 26% (Susisiekimo paslaugos, 2020). Based on the Implementation Report results, 3 recommendations were developed. Firstly, it is crucial to accelerate the deployment of energy efficiency measures, including retrofitting of multi-apartment buildings and public buildings, and reducing electricity consumption. Second, Vilnius must accelerate the implementation of measures to reduce fuel consumption in the transport sector, with an additional focus on improving efficiency, attractiveness, and fleet renewal in the public transport sector. And third, Vilnius must also develop rooftop solar power plants (Susisiekimo paslaugos, 2020).

Vilnius City Municipality Programme for Improvements of Energy Efficiency in Selected Neighbourhoods 2023

Vilnius City Municipality Programme for Improvements of Energy Efficiency in Selected Neighbourhoods 2023 is based on a feasibility study on the possibilities for increasing the energy efficiency of the neighbourhoods developed in 2019 (Vilnius City Municipality, 2023a). The study listed six measures to be implemented:

- Complex renovation of multi-apartment buildings (expected outcome – to reduce thermal energy by at least 156 MWh/year).
- Upgrade of district heating networks (expected outcome – to reduce thermal energy heat losses by at least 2,6 MWh/year).
- Street lighting network renewal and modernisation (expected outcome – to reduce electricity consumption by at least 1002 MWh/year).
- Repair of internal roads within neighbourhoods (expected outcome – to meet the standards for internal roads).
- Repair of pedestrian paths within neighbourhoods (expected outcome – to meet the standards for pedestrian paths).
- Cycle path network renewal and/or extension (expected outcome – improved cycling conditions).
-

Neighbourhoods can apply to participate in the Programme. Selected neighbourhoods have an opportunity to develop a unique neighbourhood renewal plan with the

measures included in the Programme (and other related programmes), selected according to the specific neighbourhood needs (Vilnius City Municipality, 2023a).

Vilnius Master Plan

This Plan is focusing on urban goals and spatial measures, however shaping the urban environment to reduce the spread of air pollution from mobile sources is discussed in lower-level documents – detailed plans, design proposals, etc (Vilnius City Municipality, 2021b).

Initiatives in place

All main activities focused on decreasing emissions from the transport sector are included in the Vilnius SUMP Action Plan until 2024. The goal for public transport is to increase the share of electric public transport in the total public transport fleet to 55% (Vilnius City Municipality, 2021a). In 2023 -2024 procurements for new public transport operators and fleet renewal are planned, with the plan to purchase 200 new electric buses and 159 trolleybuses. One of the goals regarding private car management is the reduction of their negative environmental impacts. This goal is to be reached through the expansion of charging stations for electric cars (300 public points and 270 points on street lighting poles) and the introduction of a low-emission zone (hereinafter – LEZ). The first stage of LEZ implementation is planned for 2023-2024, the second stage until 2030, and the third stage after 2030. It is estimated to reduce car flow by 10% and particulate matter emissions by 31% with this measure (Vilnius City Municipality, 2021a).

Vilnius low emission zone stage I and II

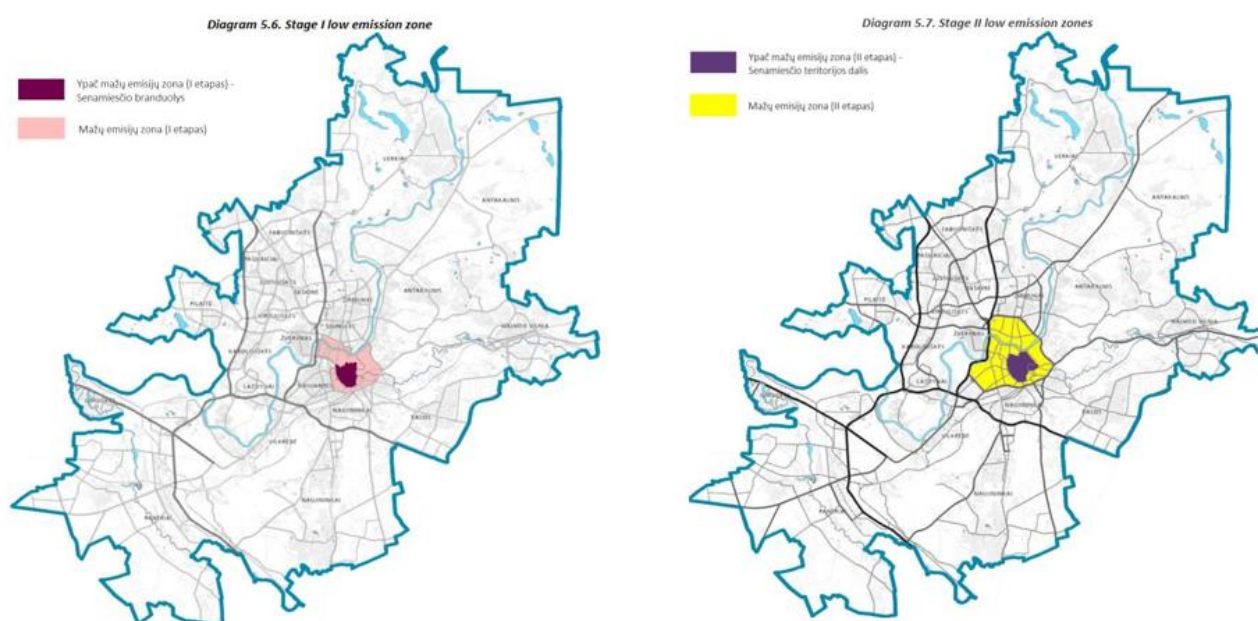


Figure 19 Low emission zone in Vilnius

Stage one, left; stage 2, right (Vilnius City Municipality & Susisiekimo paslaugos, 2018)

Additional measures are planned to increase the share of active mobility trips. This will be implemented through improving conditions of 51 km of pedestrian walkways (renewal of infrastructure, applying universal design principles), ensuring lightning, priority on traffic light-controlled junctions, and building a network of 190 km of bicycle paths (with the aim to ensure bicycle path within 250m radius for 90% of the population), and improvement of traffic safety, etc.

The measures described above are still to be implemented, however, Vilnius has already implemented many activities directly and indirectly focused on decreasing emissions from the transport sector. In 2017, four Park and Ride facilities were opened in Vilnius. The sites are located adjacent to rapid transit network bus stops. Drivers can leave their car and continue the journey by public transport for just 50 Eurocents. In June 2020, traffic loops, a measure to curb transit traffic in the Old Town, were implemented. The goal is to reduce car transit in the Old Town and thus to improve conditions for sustainable modes users and lower air and noise pollution.

Vilnius old town traffic loops

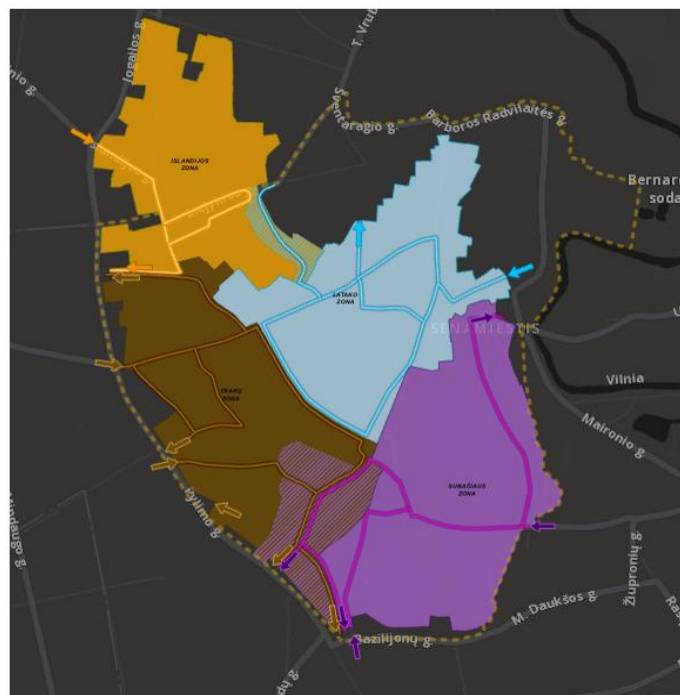


Figure 20 Traffic loops in the old town

(Vilnius City Municipality, 2022)

In 2021, the Standard for Vilnius City Municipality streets' infrastructure was developed. The document consists of 12 urban street principles and five thematic chapters elaborating on these principles (Vilnius City Municipality, 2023c). The principles are oriented on a vision for Vilnius streets: the street is the main public area of the city, where life and movement go together. Streets must be safe and comfortable for people first, not vehicles. Themes presented in the Standard are: geometry, street greenery, materials, outdoor equipment and lighting (Ibid.).

In 2021, Vilnius announced the Vilnius Green Wave project (Vilnius City Municipality, 2023d). The goal of the project is over a two-year period to plant 10 million bushes, 300 thousand climbing plants and 100 thousand trees. Vilnius City Municipality's ambition is for every one of the 2,000 kilometres of Vilnius streets to be green, with green spaces adorning both the horizontal and vertical surfaces of the city.

Conclusions and challenges

The central zone of Vilnius city is in the lowland surrounded by the hills. This results in emissions concentrating in the most densely populated area with most workplaces. About 60-80% of the emissions in Vilnius city are caused by road transport. PM10 and NO₂ values in many observation points near main transport arteries are exceeding the limits. Pollution levels after street cleaning are higher than before, indicating the need for more effective cleaning methods.

Avoiding emissions should be done at the tailpipe. Despite the vision and goals set in Vilnius' SUMP, currently there is a clear lack of measures for car traffic reduction in the city centre. Together with service deficiencies in public transport (the main alternative for car travel) there is a major challenge created for shifting modal split towards more sustainably balanced values in the areas most affected by pollution. Despite all the incentives and actions on both national and municipal levels, only 1% of the car fleet is powered by eco-friendly fuels in Vilnius city. Around 37% of the public transport fleet is powered by eco-friendly fuels and the city should seek to implement a fully zero emissions public transport fleet.

On the policy level, Vilnius city has a wide and intersecting framework of legal documents regarding mobility and air quality improvement. This creates both the opportunity of integrated processes between different municipality divisions and challenge of some measures left without a clear responsibility for its implementation. The major challenge regarding mobility-related policies on a higher level is the lack of cooperation between the Vilnius city municipality and Vilnius district municipality, which creates significant barriers to policy development and must be addressed.

Vilnius SUMP monitoring and the updated Action Plan together with real time data and trends on air pollution available online form a favourable environment for effective and timely implementation of mobility measures with proper ex-post evaluation.

Kaunas

With over 300 thousand inhabitants, Kaunas is the second-largest city in Lithuania after Vilnius. Kaunas is showing the same tendencies as Vilnius – a slightly growing number of inhabitants and strong suburban sprawl due to the residents moving to live in suburban areas. As a result, the number of inhabitants in the central part of the city and apartment buildings districts with buildings dating back to Soviet times, mostly decreasing. The population of Kaunas' functional urban area is estimated between 380-440 thousand inhabitants (Statistics Lithuania State Data Agency, 2022). This shows that about 20–30% of the population of Kaunas' functional urban area lives outside the city and generates significant pendulum migration from these territories.

Map of central Kaunas

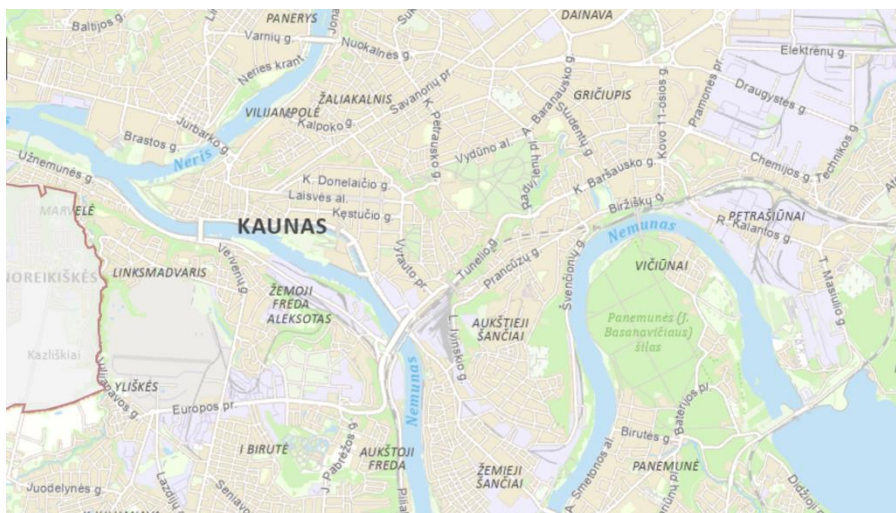


Figure 21 Map of central Kaunas

Via geoportal.lt, City of Kaunas

The city is located in the central part of the country and plays a number of significant roles including serving as a transnational communication hub due to its excellent air (Kaunas airport), rail (prospective Rail Baltica line), road network as well as potential inner water communication, connections with other countries, and Lithuanian cities and towns, leading to very intense freight traffic and heavy transit flows.

Kaunas' area is 157 km². The central part of the city is located between the Nemunas and Neris rivers, in a low-lying area, at an altitude of 30-35 m above sea level, surrounded by three hills. Dozens of staircases have been built on the slopes surrounding the city centre, necessitated by the terrain. The biggest share of inhabitants, workplaces, and education facilities is located in the area between these two rivers, thus the need for active mobility is not as necessary for short distances between city parts on different sides of the rivers. However, the hills are a very strong obstacle.

As in the Vilnius case, because of the situation described above, the number of cars and car ownership rates in Kaunas and Kaunas functional urban areas are growing. Between 2017 and 2021 about 17,900 more cars were registered in Kaunas city and roughly 11,900 more in Kaunas district (REGITRA, 2023). The number of cars per 1000 inhabitants during the same period rose almost 12% in Kaunas city and 23% in Kaunas district, with only about 0.5% of the car fleet powered by eco-friendly fuels. At the end of 2021 in Kaunas city, this indicator was 457 cars per 1000 inhabitants, and in Kaunas district - 580 cars per 1000 inhabitants (REGITRA, 2023). These numbers are the highest among Vilnius, Kaunas, and Klaipėda.

Public transport and modal split

The supply of public transport in Kaunas consists of buses (diesel, gas, hybrid buses) and trolleybuses. The only operator is JSC “Kauno autobusai”. In 2021, JSC “Kauno autobusai” applied for and received EUR 10 million in funding from the Climate Change Programme for the purchase of 78 new hybrid CNG buses. New buses are expected to arrive in 2023 (Adampolis, 2020).

In 2021, there were 28 million passengers carried by the public transport in Kaunas. Despite a slight rise in numbers (0.3% more than in 2020), it was far lower than before COVID-19 pandemic – in 2019 there were 47 millions of passengers carried by the public transport in Kaunas (a roughly 40% drop) (Kauno Autobusai, 2023). Revenues from ticket sales changed accordingly – in 2021 it was only 11 million EUR, 35% lower than in 2019 when these revenues amounted to 17 million EUR.

According to a survey conducted in 2018, the inhabitants of Kaunas travel often by car (57.3%), public transport (28.7%), and on foot (10%) (Kaunas City Municipality, 2018). Around 4% of the inhabitants choose bicycles. The modal split of the residents living in the suburban area strongly depends on the individual car. This is an important topic, as the city is spreading, more and more residents choose to live outside the city.

Emissions

According to Kaunas SUMP analysis, in 2017, 77% of pollutants released from mobile sources were carbon monoxide (CO), accounting for 88% of all emissions (Kaunas City Municipality, 2020a). Per capita emissions are estimated at 0.3 kg per year per capita.

Analysis of the 2010-2016 situation carried out for the Air Quality Management Programme 2020-2025 revealed that pollution by PM10 in Kaunas (in three observation points) is mainly influenced by emissions from thermal energy production, transport, and elevated pollution (Kaunas City Municipality, 2020b). While the *average* annual concentration of PM10 did not exceed the limits at any observation points, however, there were individual days when these limits were exceeded. Looking at the trends in PM10 concentrations for the period 2010-2015, a slight decrease can be observed at all observation points.

Further, the average annual concentration of NO₂ in four observation points in the 2010-2016 period did not exceed the level set for the protection of human health (Ibid.). In terms of maximum one-hour NO₂ concentrations, for the period 2010-2016, the limit was exceeded only once in 2011 presumably because of the increased emissions from energy companies and individual homes due to cold weather, and meteorological conditions unfavourable to air mixing.

The maximum daily average of eight hours limit of CO for the same period was additionally not exceeded. However, the heatmap prepared for Kaunas' SUMP (which uses 2017 data) shows that the biggest CO concentration areas are located alongside the busiest traffic arteries and CO₂ emissions from private cars are 8.5 times bigger than from all public transport (Kaunas City Municipality, 2020a).

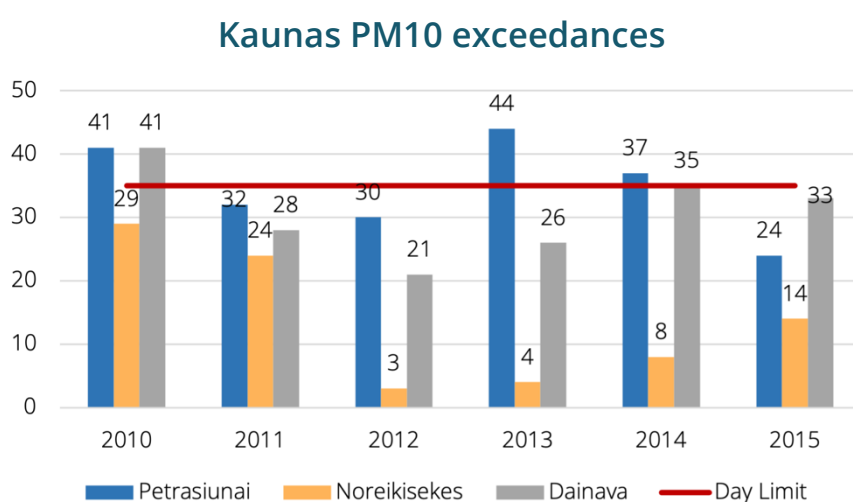


Figure 22 Number of days with PM10 exceedances between 2010 and 2015

(Kaunas City Municipality, 2020)

As of 2023, there are two national air quality research stations and 20 additional sensors in the Kaunas city municipality. Data from the sensors is available on the dedicated website (Kaunas City Municipality, 2023b). An interactive map shows concentrations of key pollutants - particulate matter, carbon monoxide, ground-level ozone, nitrogen, and sulphur dioxides - and the Air Pollution Index (API), which can be used to assess potential health risks.

Currently, measurements are continuously carried out in 20 different locations in all 11 districts. The website shows simplified data for interested parties, and more complex and precise data is provided for the experts (Kaunas City Municipality, 2023b).

Kaunas air pollution dispersion

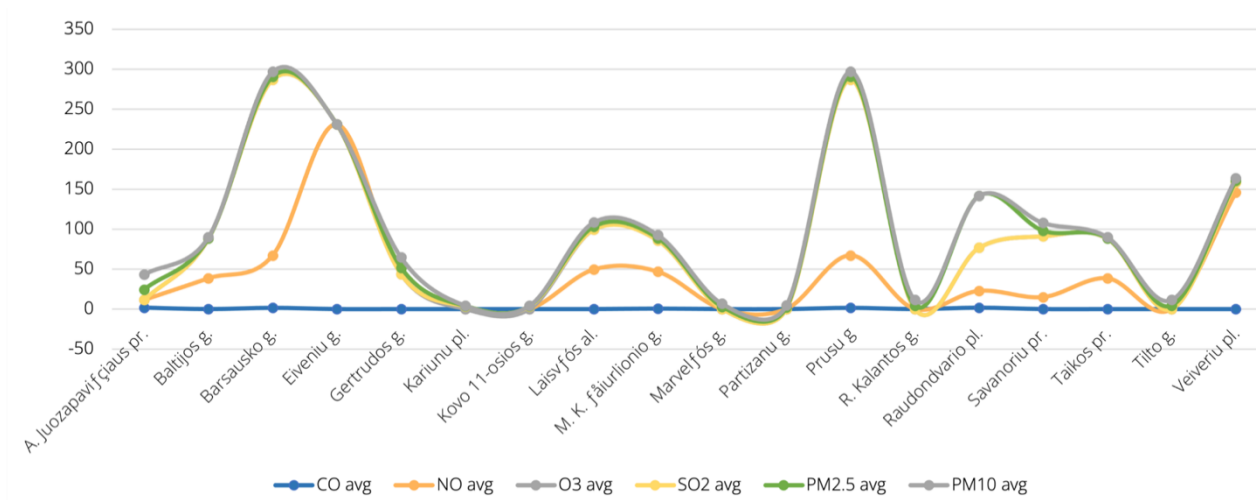


Figure 23 Dispersion of air pollution in Kaunas, $\mu\text{g}/\text{m}^3$

(Kaunas City Municipality, 2023)

Key documents and strategies

Kaunas Sustainable Urban Mobility Plan

Kaunas Sustainable Urban Mobility Plan (hereinafter – Kaunas SUMP) 2030 aims to reduce congestion and improve accessibility in Kaunas, increasing the attractiveness of public transport and ensuring safe and convenient door-to-door (last mile) mobility (Kaunas City Municipality, 2020a). The goal is to reduce trips made by car by 10%.

Accordingly, the Action Plan until 2020 was divided into three parts:

- Deploying and expanding intelligent transport systems in cities.
- Public transport development and promotion.
- Non-motorized transport promotion and safety improvement.

Air Quality Management Programme 2020-2022

Most of the measures included in the Programme are related to mobility and include public transport promotion, fleet improvement, service area expansion, the introduction of mobility as a service concept. Cycling and walking infrastructure development, and maintenance as well as other street infrastructure maintenance are included.

Kaunas City Municipality Strategic Plan until 2030

Kaunas City Municipality Strategic Plan's vision is that Kaunas - a smart, dynamic city of sustainable change, a centre of attraction (Kaunas City Municipality, 2023a). Strategic Plan has four relevant themes:

- smart city management and public services,
- transport and sustainable mobility,
- sustainable development of territories and environment, and
- a Green Deal.

All these themes are incorporated in the third priority - A smart city managed on the principles of sustainability and the Green Deal. For this priority four strategic goals are set:

- A sustainable, continuously improving organisation for a comfortable life for citizens.
- Safe mobility for all, increasing the share of sustainable journeys, and reducing transport pollution.
- Sustainable and inclusive spatial development, focusing on everyone's daily needs and qualitative urban environment.
- A modern, resource-efficient, climate-smart, and competitive city based on the Green Deal principles.

Implementation of this priority will be monitored through sustainable energy development index (2020 value – 45.5 points, targeted 2030 value – 80 points) as well as a new indicator – savings in CO₂ emissions. In transport and sustainable mobility theme multiple sustainable mobility and emissions-related measures are provided:

- To encourage less polluting travel modes.
- Improve accessibility and quality of public transport.
- Increase the compatibility of public transport systems in Kaunas region.
- Limit the flow of motorised transport coming to Kaunas city.
- Develop low emission zones and electric vehicle infrastructure.
- Deploy technological solutions for efficient mobility management.

Initiatives in place

Kaunas is focusing on public transport improvement, promotion of electric cars and transport air pollution control system in the central part of the city by setting up a low emission zone.

In the public transport sector main measures that can help decrease emissions from the transport sector are creating a public transport lane network by installing 39.5 km of A lanes, prioritisation of 30 non-main intersections for public transport, renovation of the public vehicle fleet by maintaining their average age of no more than 5 years, development of public transport system standards and monitoring indicators.

A low-emissions zone (LEZ) was created to encourage residents to use alternative methods of travel in the central part of the city. This zone will be implemented in two phases. The first phase will be a pilot one and will include traffic restrictions in the Old Town and will be implemented by 2023. The second stage will be implemented by 2030 and will cover the entire central part of the city of Kaunas. LEZ tool with smart cameras is to be connected to the smart city mobility management platform. Desired effects

include reduced air and noise pollution, reduced traffic jams, and residents choosing alternative ways of travelling in the central part of the city.

Kaunas low emission zone stage I and II



Figure 24 Low emission zone in Kaunas

Stage one, left; stage two, right (Kaunas City Municipality, 2023)

Additionally, planned projects include development of a smart city mobility management platform, a parking space management system, increased use of electric cars, and development of a traffic speed control plan and installation of sectoral speed metres.

Conclusions and challenges

High car transit levels in the central part of the city and in suburban territories are a big challenge in terms of pollution (both air and noise). While public transport is well developed in the central area, where people can travel with other active means as well, the situation in farther territories is more complicated – transit levels are still high, but many streets are not suitable for public transport, public stops are farther away, infrastructure for active mobility modes is in poor condition or absent.

An important point to look at in the future is strengthening the cooperation between Kaunas city municipality and Kaunas district municipality, as these territories have a strong connection, high level of commuting that cannot be effectively managed by the current public transport service. Furthermore, no infrastructure for all means of active mobility (walking, cycling) is provided.

Klaipėda

Klaipėda is the third largest Lithuanian city in terms of population, with almost 166 thousand inhabitants, and an area of 110 km². The number of inhabitants is slightly growing. Suburban sprawl is also present as in Vilnius and Kaunas. According to the data from the Department of Statistics, there are about 212 thousand permanent inhabitants (as of 2020) in Klaipėda city and Klaipėda district municipalities combined and the majority of inhabitants of the suburbs work in Klaipėda (Statistics Lithuania State Data Agency, 2022). This means about 20% additional commuters from suburban territories. However, these suburbs are well integrated with the city through city bus lines and city water public transport.

The city is located in Western Lithuania. It is the metropolitan seaside centre at the confluence of the Curonian Lagoon and the Baltic Sea. The city centre is the most densely populated area, workplaces and other targets are also mainly located in the central part thus the distance of the typical journey is short. Due to the topography, location of the population, and target points accessibility, Klaipėda is very suitable for active mobility promotion and development.

Map of Klaipėda

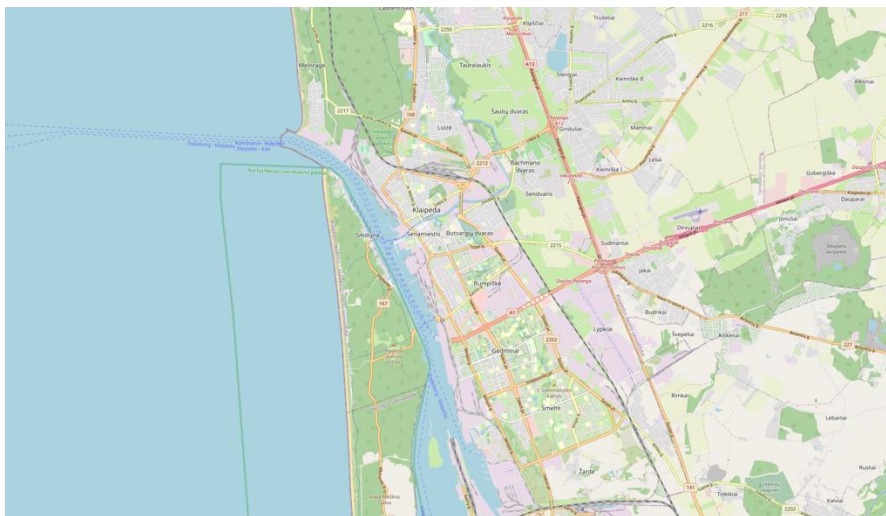


Figure 25 Map of Klaipėda and surrounding regions

Via [OpenStreetMap and contributors](#)

Despite the situation described above, the number of cars and car ownership rates in Klaipėda and Klaipėda functional urban areas are growing. Between 2017 and 2021 roughly 8,200 more cars were registered in Klaipėda city and 8,900 more in Klaipėda district (REGITRA, 2023). The number of cars per 1000 inhabitants during the same period rose almost 13% in Klaipėda city and 35% in Klaipėda district, with only about 0.5% of the car fleet powered by eco-friendly fuels. At the end of 2021 in Klaipėda city, this indicator was 410 cars per 1000 inhabitants, and in Klaipėda district - 571 cars per 1000 inhabitants (Ibid.).

Additionally, Klaipėda is the important industrial centre of Western Lithuania for its road, railway and sea transport hub. The Port of Klaipėda is the principal ice-free port on the eastern coast of the Baltic Sea. As a deep-water, multipurpose port with universal applications, it serves as the most significant transportation hub in Lithuania (Port of Klaipėda, 2023). Nineteen big stevedoring companies, ship-repair, and shipbuilding yards operate within the port, and all marine business and cargo handling services are rendered.

Public transport and modal split

Public transport in Klaipėda is managed by the public entity “Klaipėdos keleivinis transportas” and served by six different operators, the biggest of which, JSC “Klaipėdos autobusų parkas”, provides 43% of the city’s public transport (KKT, 2023). The supply of public transport in Klaipėda consists of 224 vehicles – small (M2) and big (M3) buses, 59 of which are fuelled by gas or electric (Ibid.). In 2021, there were almost 28 million trips made by public transport in Klaipėda, which is a 25% decrease from the year 2019. In 2021, operators were facing financial struggles not only because of lower numbers of passengers, but also rising prices of fuel and electricity.

According to the survey conducted in 2017 for Klaipėda SUMP, the modal split is quite balanced - the inhabitants of Klaipėda travel mostly by public transport (29%) and on foot (29%), while 4% choose bicycles, 1% - other modes (taxies, etc.), and cars make up the remaining percentage (Klaipėda City Municipality, 2020a). In the suburban area, the percentage of trips taken by car is significantly higher (45%), part of public transport is almost the same (28%), and part of trips made on foot is significantly lower (19.5%; Ibid.).

Emissions

Klaipėda’s air pollution is mainly caused by road transport and from large industrial enterprises. The main pollutants are nitrogen dioxide (NO₂), sulphur dioxide (SO₂), carbon monoxide (CO), and VOCs (Klaipėda City Municipality, 2022a). The highest concentrations of PM₁₀ in Klaipėda are observed in the industrial, energy companies’ areas and in the seaport area.

The current situation assessment for Air Quality Management Programme 2022-2026 revealed that in 2020 the annual average PM₁₀ concentrations did not exceed the limit value in any observation points (Klaipėda City Municipality, 2022b). The annual average PM₁₀ concentration was 18-24 µg/m³. In a longer period (2003-2020), the rise of PM₁₀ concentration has been recorded. Although the annual average PM₁₀ concentration did not exceed the limit value, on individual days or for particular periods the air quality monitoring stations recorded high levels of PM₁₀ concentrations. The highest daily mean values at the Klaipėda Šilutės highway station reached 146 µg/m³ (Ibid.).

Furthermore, the annual average NO₂ concentration exceeded the limits set for the protection of human health (RV1) and vegetation protection (RV2) in numerous

observation points between 2018 and 2020 (Klaipėda City Municipality, 2022b). Points with the highest NO₂ concentration values are located in the central part of the city, near busy transport arteries. Data from 2018 to 2020 shows that NO₂ concentrations were generally declining at almost all of the observation points. In 2018, the annual average NO₂ concentration in 12 points exceeded the limits established for the protection of human health; in 2020 there were only five points with excessive NO₂ concentration left. However, some of this decrease could have been caused by the reduced traffic due to the COVID-19 pandemic.

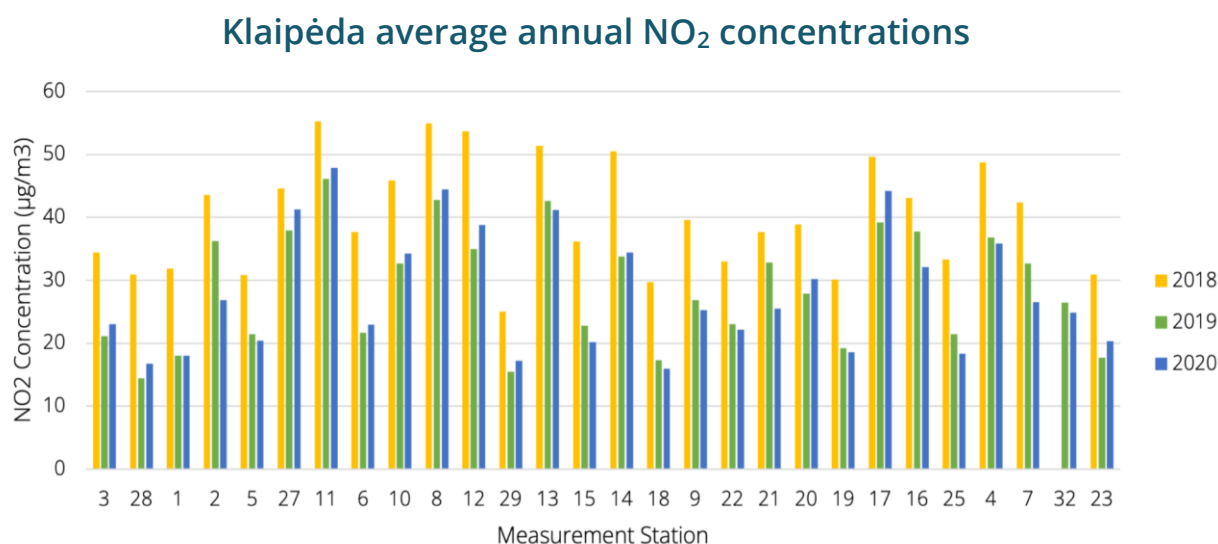


Figure 26 Average annual NO₂ concentration at the observation points

(Klaipėda City Municipality, 2022b)

Data demonstrates a considerable drop in CO content in 2019 in comparison to 2018. However, CO concentration values remained either unchanged in 2020 when compared to 2019 (Klaipėda City Municipality, 2022b). Increases are assessed in the areas near the railroad and logistic transit points. In order to maximise the objective assessment of road transport's impact on air quality in the Air Quality Management Programme 2022-2026, it is recommended that further monitoring of this pollutant be undertaken.

Klaipėda average annual CO concentrations

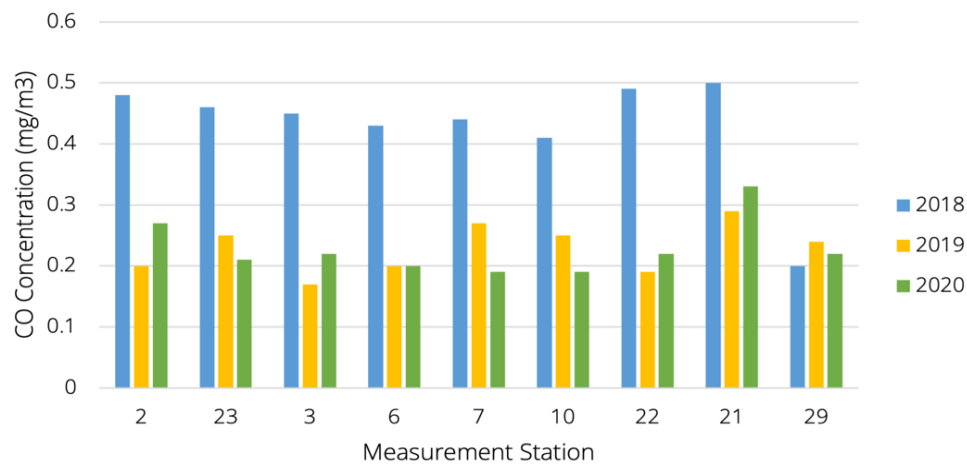


Figure 27 CO concentration Average 2018-2020

(Klaipėda City Municipality, 2022b)

According to the 2022-2026 environmental monitoring programme, 35 monitoring points are to be established for more complex monitoring, 24 of which are set to measure the emissions from road transport.

Key documents and strategies

Klaipėda Sustainable Urban Mobility Plan

Klaipėda Sustainable Urban Mobility Plan (SUMP) set a vision for 2030: *Klaipėda - healthy and environmentally friendly, a fast and convenient city*. Klaipėda's vision for sustainable mobility defines two strands of objectives (Klaipėda City Municipality, 2020a). The first goal is to create a healthy and environmentally friendly city: to promote healthy lifestyles, encourage citizens to be active on foot or by bike, be outdoors, and create a clean, safe, and attractive urban environment. The second goal is to create a fast and convenient city of Klaipėda, where travelling by sustainable transport is less time-consuming than travelling by private car. This should be achieved by ensuring the attractiveness and speed of public transport, creating a modern image, ensuring convenient door-to-door movement without owning a car, providing comfortable access for people with mobility challenges. As the main measures to achieve these goals were stated:

- Fast public transport line in the north-south direction, Taikos blv. - Herkus Mantas str. axis.
- Public transport priority, "A" lanes on other main streets.
- Improving the attractiveness, convenience, information, image of public transport, and renewing the fleet.
- Aligning city and regional public transport.
- Development of cycling infrastructure in the main axes of the city and in local centres (cycle lanes, bike sharing system, bike racks, storage, parking).

- Improving conditions for pedestrians in local centres.
- Development of pedestrian zones,
- Improving mobility for people with special needs, and traffic restrictions in the Old Town.
- Re-organisation of traffic in the New Town to improve conditions for driverless transport.
- Improving traffic safety.
- Multimodality points on the public rapid transit line, convenient transport modes, and comfortable interchange at bus stops.
- Promotion of electric cars, development of charging stations.

As of mid-2023, no Klaipėda SUMP monitoring evaluation have been completed. However, according to the annual reports of public entity “Klaipėdos kelevinis transportas”, alignment of city and regional public transport is implemented with one jointed ticket system, ITS measures were introduced in four parking lots for parking management and in two streets for car flow management, and pilot bicycle.

Air Quality Management Programme 2020-2023

The objective of the Programme and Action Plan is the air quality favourable to human health and the environment (Klaipėda City Municipality, 2020b). The goal is a reduction of air pollution by particulate matter and nitrogen dioxide to ensure that their concentrations do not exceed the limits. The Action plan is divided into five areas:

1. Reducing emissions from mobile air pollution sources
2. Reducing pollution from stationary sources
3. Reducing pollution from households
4. Short-term measures for elevated particulate matter concentrations
5. Monitoring air quality and raising public awareness.

Mobility-related measures are included in the first part and are focused on road infrastructure improvement and maintenance, promotion of cleaner/alternative mobility modes, and reducing pollution from shipping.

Klaipėda City Municipality Strategic Plan 2021-2030

The vision set for Klaipėda City Municipality Strategic Plan is International Sea City through becoming smart and creative, progressive, inclusive, vibrant, and sustainable (Klaipėda City Municipality, 2021). The third priority set in this Strategic plan is sustainable urban development. Relevant goals set for this priority are as follows:

- To implement a targeted sustainable mobility policy. This is to be achieved through encouraging people to choose alternative ways of travelling, development of infrastructure for electric cars, development of cycling infrastructure networks, restrictions and fees for cars, and education about sustainable mobility.

- To improve public transport services, through the renewal of the fleet with environmentally friendly fuelled vehicles, and public transport network expansion.
- To enhance sustainable development of the urban area by conversion of sites and buildings and targeted use of other larger disused, underused and/or inappropriately used sites and areas.

Action plan to reduce particulate matter air pollution in Klaipėda City Municipality 2019-2021

This Action Plan incorporated:

- Klaipėda city municipality environment programme 2019-2021,
- Klaipėda city municipality transport system maintenance and development programme 2019-2021,
- Klaipėda city municipality maintenance and modernisation programmes for urban infrastructure 2019-2021,
- Klaipėda city municipality health programmes 2019-2021, and
- Klaipėda city municipality urban planning programme 2019-2021 (Klaipėda City Municipality, 2019).

Relevant measures in the plan include an action plan for the renewal of the public transport fleet and development of Park & Ride sites in the northern part of the city. Further sanitation, cleaning, and landscaping of parks, squares, green spaces, and green areas belonging to the municipality is included in addition to development of pedestrian and cycling infrastructure (Klaipėda City Municipality, 2019).

Initiatives in place

Like other Lithuanian cities, Klaipėda places a strong emphasis on public transport, active mobility, and sustainable car traffic. Klaipėda SUMP Action Plan presents measures for public transport services and fleet improvement and promotion of multimodality for the 2018 – 2025 period. The goal of the strategy of Municipal Enterprise “Klaipėdos keleivinis transportas” for 2022 – 2024 is to expand the mileage of clean public transport from 32% in 2021 to 45% in 2024 through increasing the number of gas/hybrid fuelled buses by 11 vehicles and electric buses by 24 vehicles (KKT, 2023).

Promoting different active mobility measures in the Old Town, New Town, and local centres are planned for 2018 – 2024 including pilot projects of closed streets, infrastructure renewal, and applying the principles of universal design, traffic safety improvement, etc. Furthermore, measures are elaborated for cycling including the development of a consistent cycling network, main cycling axis formation, and installation of other cycling infrastructure, including bicycle racks, storages, and repair stops.

More sustainable car traffic is to be enforced through the introduction of a emissions free zone in the Old Town until 2025 and around Smiltynė until 2028, expansion of charging stations for electric cars, ITS measures (traffic management), and educational activities.

The measures described above are perceived as an indirect continuation of already implemented activities focused on decreasing emissions from the transport sector in Klaipėda:

- ME “Klaipėdos keleivinis transportas” has replaced fossil gas in its buses with biomethane (KKT, 2023).
- Public transport in the city’s suburban area is an integral part of the Klaipėda public transport system. Since 2014, ME “Klaipėdos keleivinis transportas” have separated urban and suburban travel statistics for ease of analysis and planning.
- The first bicycle street was introduced in Klaipėda in 2022. Bicycle streets where cyclists are able to ride freely, not necessarily on the right-hand edge of the road, while cars will have to adapt to their speed is a sure step in promoting sustainable mobility in cities.

Conclusions and challenges

Klaipėda is the metropolitan seaside centre at the confluence of the Curonian Lagoon and the Baltic Sea. The analysis revealed Klaipėda city’s urban and functional situation to be very suitable for sustainable mobility measures’ implementation.

The Klaipėda’s air pollution is mainly caused by road transport and emissions from large industrial enterprises. The highest concentrations of PM₁₀ in Klaipėda are observed in the industrial, energy companies’ areas and in the seaport area. In a longer period of 2003-2020, an increase in PM₁₀ concentration is observed. Annual average of NO₂ concentration exceeded the limits set for protection of human health, but 2018 – 2020 data shows a decrease in NO₂ concentration in addition to CO concentration.

Klaipėda is intensively renewing the public transport fleet. Strong partnership in the mobility-related sector between Klaipėda city municipality and Klaipėda district municipality is a solid base for wider, more complex actions.

Challenges identified in Lithuanian cities (Vilnius, Kaunas, Klaipėda)

Most of the challenges are common for all previously described cities and many other smaller cities in Lithuania as well as in other European countries facing them. The energy crisis and post-COVID-19 public transport popularity drop are the main two barriers in achieving significant changes, decreasing emissions from the transport sector.

While the barriers mentioned above may be temporary and do not fully depend on the country or city actions, Lithuanian cities face other challenges that can and should be eliminated – the lack of political will to introduce unpopular measures, particularly those that are worsening conditions for cars, tendency to favour measures that are suitable for making flashy news, lack of cooperation between adjacent municipalities.

Additional challenge is the update and implementation of the developed documents – very often strategies, plans, or guidelines are put aside, and development is carried out as usual but not according to drafted plans.

Recommendations for Lithuanian cities (Vilnius, Kaunas, Klaipėda)

Recommendations for further emission reductions in the presented Lithuanian cities centred around three levels:

National

The Concept of Comprehensive Spatial Plan of the Republic of Lithuania (CSPRL) 2050 creates a framework for spatial, territorial, and specific topics' development in the whole country (**Figure 28**, below). Based on the partnership-based concept and development strategy in Lithuania, using the combined transport and other efforts from the various partners, it is suggested to organise 3 levels of mobility services:

- high-efficiency public transport zones,
- moderate efficiency public transport zones, and
- zones with mobility as a right.

Lithuania mobility organisation levels

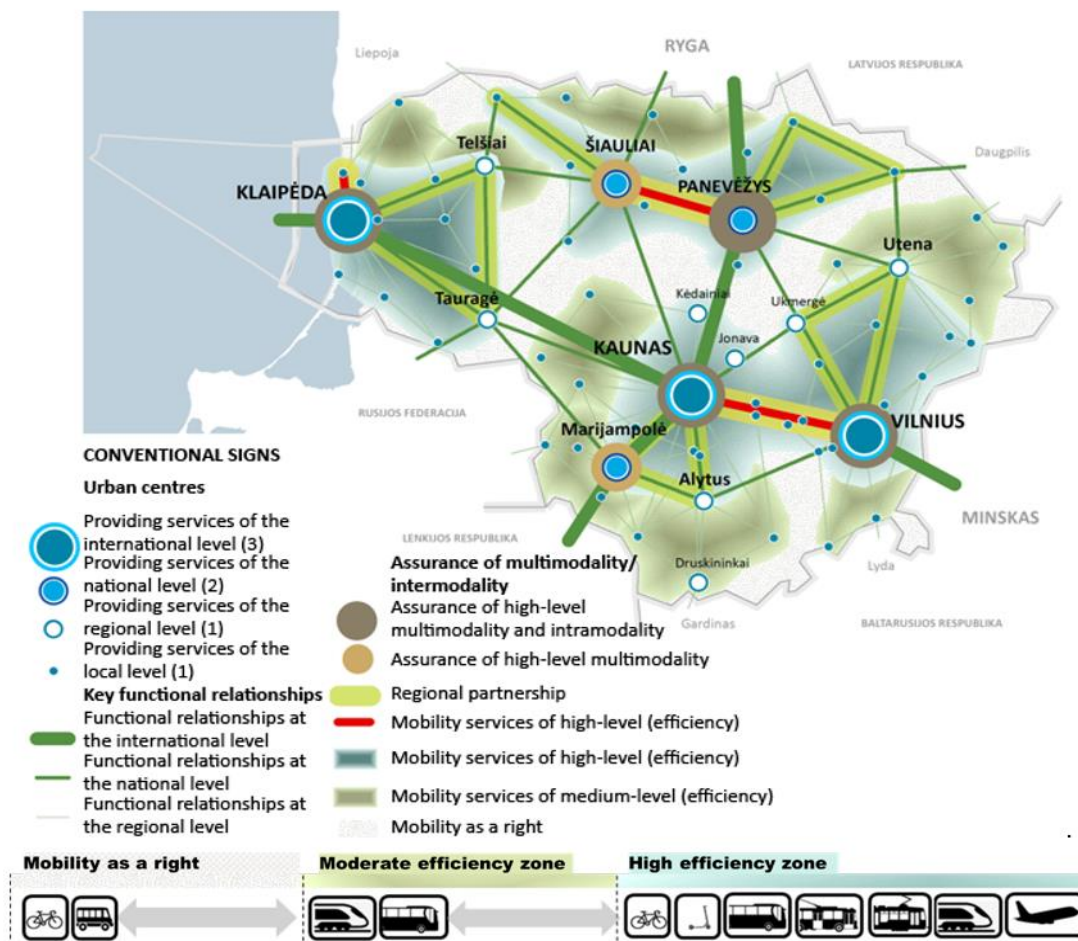


Figure 28 Diagram of mobility organisation levels

(Republic of Lithuania, 2019)

Clear guidelines for partnerships and integrated public transport systems are needed for the concept to be implemented nation-wide. The Ministry of Environment of the Republic of Lithuania currently is carrying out the procurement of Sustainable Cities Guidelines development services, so in the near future, the tool for the implementation of principles drafted in the CSPRL will be available for the cities.

The tool described above will be useful for urban planning. However, additional relevant national documents are provided for mobility planning, including guidelines for the preparation of sustainable mobility plans. Currently this document is being updated – previous versions focused only on the cities and particular type of towns. New version aims to regulate sustainable mobility plans for different types of territories - cities, municipalities, regions or other functional urban zones.

Metropolitan

On the metropolitan level, it is important to implement measures in partnerships with adjacent municipalities and introduce integrated systems between main urban centres (both national and regional levels). For example, connected public transport in Klaipėda city and Klaipėda district, a public entity “Green Region”, joined the project of Jurbarkas, Šilalė, Tauragė and Pagėgiai municipalities. The main objective of the project is to implement the development strategy of the functional zone Tauragė+ in order to promote business development and increase investment attractiveness, improve conditions for tourism development and organise public transport services in Tauragė region.

Urban

At the local level, it is important to thoroughly implement developed and approved strategies and plans, carry out consistent monitoring and adjust documents if desired effects are not reached or the situation/conditions changed, and planned measures are no longer relevant. Additionally, public transport and active mobility should remain a priority.

Budapest

The capital of Hungary is situated along the Danube, in the heart of the Carpathian basin. Hilly Buda, which comprises one-third of the city's area of 525 km² is located along the right bank of the Danube surrounded by low mountains. János Hill, with its 529 metres, is the highest summit of Buda. Across the river sprawls flat Pest (Budapest, 2022). Budapest, which is both a city and county, forms the centre of the Budapest metropolitan area, which has an area of 7,626 square kilometres and a population of over 3,3 million inhabitants, constituting 33% of the population of Hungary.

Budapest is a significant economic hub. On the national level, Budapest is the primate city of Hungary regarding business and economy, accounting for 39% of the national income, the city has a gross metropolitan product of more than \$100 billion in 2015, making it one of the largest regional economies in the European Union.

The city now consists of 23 districts, six in Buda, 16 in Pest and one on Csepel Island. Each district is a separate municipality, but the common Budapest municipality is responsible for certain matters. In Budapest, there are 23 district city councils and a capital city council. There are 23 district mayors and a Mayor of Budapest. The road network is also shared: The main roads are owned by the city council, and the smaller ones by the district councils.

Transport

Budapest is a centre of the Hungarian transport system; it is a hub of the railways and road TEN-T network in Hungary. The Liszt Ferenc International Airport is also located in the Budapest region. There is a ring road outside the city, bypassing international traffic.

Passenger transport, both within the city and in relation to the region, is fundamentally determined by the significant outflow of population from Budapest to the suburbs in the last decades. The situation is similar to that in other cities described in the report. The dispersal of people has been accompanied by an increase in the number of cars and their travel performance. It is a twofold process: The spread of individual travel has allowed people to move out into the agglomeration, and the move out to communities underserved by public transport has fuelled the demand for private cars. As a result, several hundred thousand people are commuting to Budapest day by day sometimes even from outside the agglomeration, and a great many of them by car. The situation is made even more complicated by the fact that many pupils commute. In recent decades, a number of shopping centres have been built in the agglomeration, and there is also considerable car traffic to them. Finally, tens of thousands of people commute from Budapest to one of the agglomeration cities.

Passenger transport within Budapest

The transport of Budapest can be characterised by several viewpoints. In **Table 8**, passenger transport performance in passenger km/year is shown. These data indicate the huge weight of non-Budapest residents' trips to Budapest, in 2018 (Becsák, 2022)

Table 4 Passenger transport in million passenger km/year in Budapest 2018

Transport mode	Budapest total	Local residents within Budapest	Local residents in and outside of Budapest	Non-residents within Budapest
Cars	5,997	2,470	557	2,969
Buses	2,102	1,624	127	350
Metro	1,292	1,009	38	243
Commuter rail	333	182	27	124
Trams	850	654	28	167
Rails*	807	20	65	722
Total	12,366			

*Rail data includes emissions from both freight and passenger trains (Budapest Development Centre, manuscript).

Mobility in Budapest is heavily reliant on cars, making up a majority of the modal split.

Budapest modal split

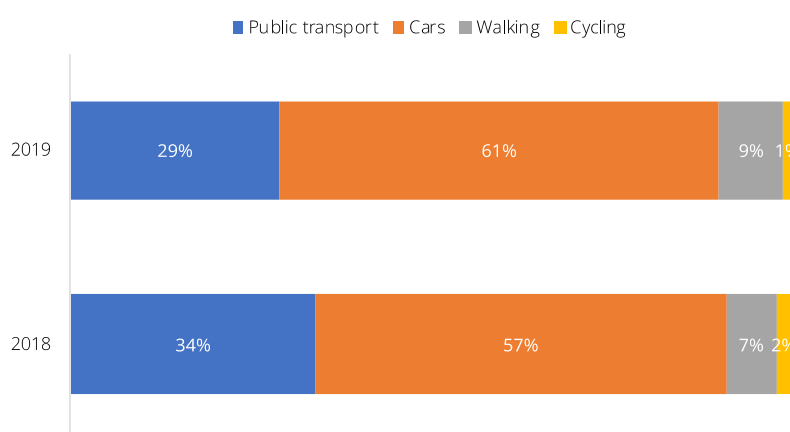


Figure 29 Budapest modal split 2018-19

(Municipality of Budapest, 2021)

Public transport in Budapest is the responsibility of the city council, while intercity transport is the responsibility of the state. In the agglomeration, local public transport is varied. Urban mobility is served mainly by the interurban buses passing through the cities. Only a few municipalities do provide local bus services. One or two towns are linked to the Budapest public transport system by bus services.

The intercity public transport is served by the state-owned Hungarian State Railways Company. It operates a good suburban railway network, a very old and scuffed commuter railway network, and a rather appropriate bus network. Experts have long been advocating the integration of agglomeration and local public transport in Budapest, but somehow the policy is unable to cope with the task. There is no coordinated tariff system and the schedules are poorly coordinated. The Budapest public transport is coordinated by the Budapest Transport Centre (BKK), the Municipality's transport organising authority.

Budapest transport overview

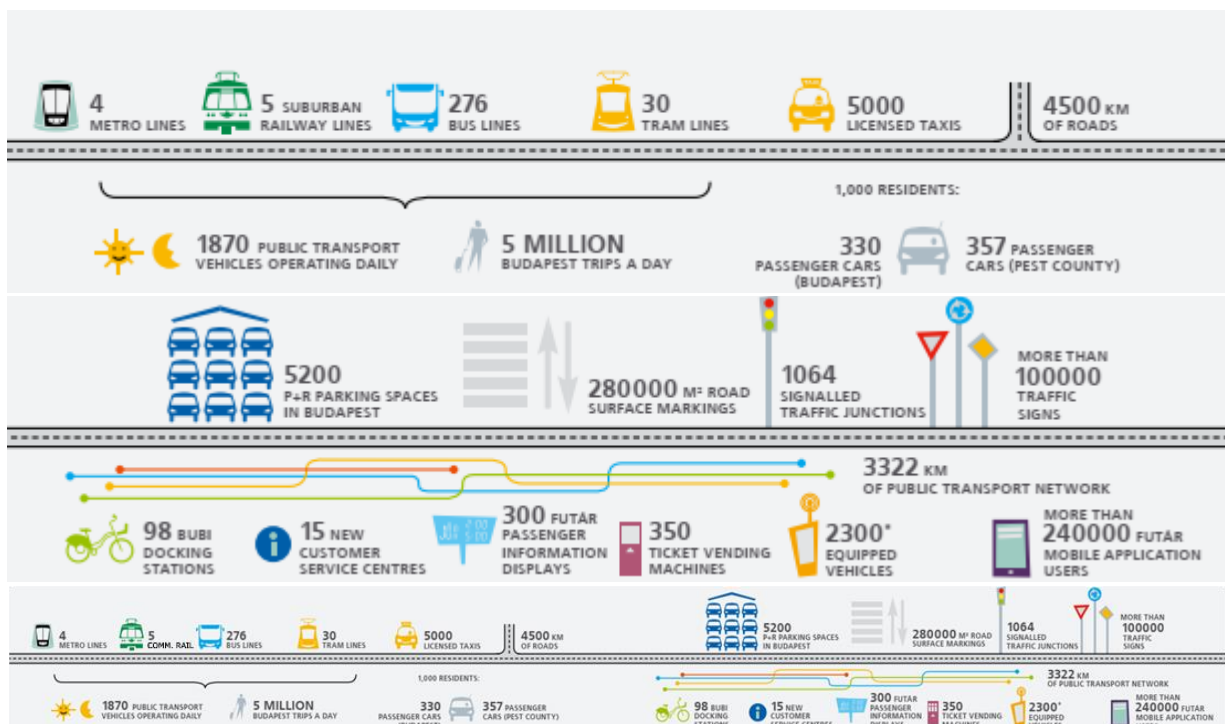


Figure 30 Budapest transport overview

(BKK 2015)

The public transport network is well developed. According to the Budapest Environmental Status Valuation 2019-2020, the approximately 4.3 million daily trips are made by public transport in the metropolitan area, an average of about 37.4% are made by bus, 27.0% by tram, 25.6% by metro, 5.8% by trolleybus and 4.2% by commuting railway (Municipality of Budapest, 2021).

Several years ago, a decision was taken to improve accessibility by low-floor vehicles. The first low-floor Combino trams entered service on 1 July 2007, and there were 488 high-floor and 113 low-floor tramways on 1 January 2022 (Németh, 2007, 2022b). There are ambitious plans to improve the accessibility of the tram network, but getting access to the necessary financing is difficult because of the anti-municipal policies of the government and the parliamentary majority.

The renewal of the bus fleet is also slow. The oldest diesel buses often are being replaced not by new ones but by younger ones bought second-hand. The number of buses was 1430 in 2020, and their average age was 11.3 years. The ageing of the bus fleet is also reflected in the air pollution resulting from the bus transport. The renewal of the bus fleet is partly due to the fact that the service is only partly provided by the incumbent Budapest Transport Company, there are also external service providers. The largest is Arrivabusz, owned by Deutsche Bahn, which operates 500 buses. Usually, they are buying the newest Euro 6 buses.

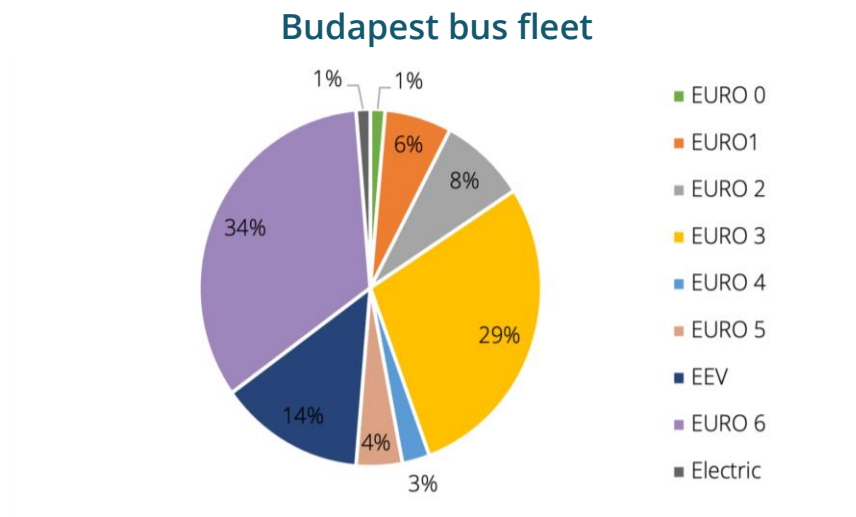


Figure 31 Budapest bus fleet distribution by EURO standard

(Municipality of Budapest 2021)

There are four metro lines. The rolling stock of three of them is new but the first line's wagons are more than 50 years old. The trolleybus fleet consists of 140 vehicles almost half of which have batteries so they can drive on streets where there is no overhead line (Németh, 2022a). According to a presentation in the Balázs Mór Club, in the bus, trolleybus and tram fleet 80% of vehicles will be air-conditioned and have low floors by 2040. There will be a maximum age limit from 2025. Only around two thirds of buses should be electric by 2040.

In Budapest, many people cycle to work. Some employers, which includes the Clean Air Action Group has also earned the title of "cyclist-friendly workplace". Commissioned by the Cycling Club, the market researcher Medián surveys cycling habits every two years. In 2018, 51% of respondents biked every week and 16% cycle regularly. The pandemic has significantly increased the proportion of regular cyclists according to the 2022 survey.

Budapest cycling habits survey results

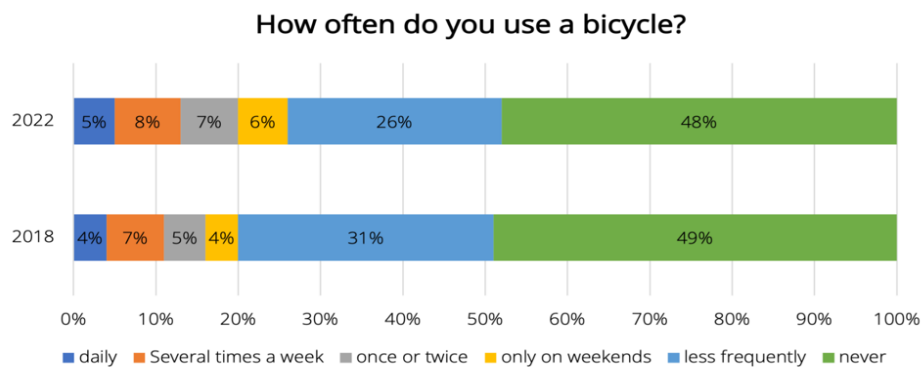


Figure 32 Survey: "How often do you use a bicycle?"

(Medián, 2022)

In 2010, the length of the main cycling network in Budapest was 209 km. By the end of 2020 it grew by over 60% and reached 337 km (Becsák, 2022). However, this is still less than a third of the total length of the road network at almost 1200 km (Magyar Közút, 2022). There is a cycling-friendly secondary road network. During the pandemic, when there was a surge in cycling to work, some main road lanes were designated as cycle lanes. These lanes are still designated as cycling routes, after the lifting of the pandemic restrictions. The city council believes that reducing car traffic is a good way of relieving the city of the burden of car pollution and its consequences. So they plan to dedicate additional lanes to bicycle traffic.

Key documents and strategies

Several programs, strategies and concepts are speaking about the transition of Budapest transport. They have a common vision about smaller traffic in the city in 2030, but schedules, milestones, and indicators have not been defined.

Budapest 2030 Long-Term Urban Development Concept

The Budapest Long-Term Urban Development Concept describes intelligent mobility (Finta (Ed.), 2014). Among others it aims to increase the appeal of public transport to make it an increasingly realistic alternative for drivers. However, the Development Concept points out that individual mobility will always remain an important factor in the city's transport. For this purpose, the inadequacies of the road network must be eliminated by constructing new bridges over the Danube, developing radial links around the city, and creating spaces for off-street parking. The Development Concept aims to give priority to walking and cycling as a way of improving air quality in the city.

Budapest 2027 Integrated Urban Development Strategy

This document puts the transport concepts in the „Green Budapest” chapter. One can find some common ideas, such as „sustainable transport” or „city of small distances”, and it names a flagship, the interlaced tramway of the Pest side of the Danube. At last, the document lists some projects too.

The Strategy talks about the need for cooperation with the government on the transport and other infrastructure burdens on Budapest. The main aim of cooperation could prevent further urban sprawl by facilitating the provision of employment, and social and educational infrastructure in the agglomeration, and shifting as much as possible of the modal shift to public transport by strengthening the infrastructural and organisational basis of transport services at the regional level.

Budapest Environmental Program

This document calculates the mitigation potential of local passenger mobility. The number of inhabitants and the number of passenger cars per thousand inhabitants is the basis for the calculation. The calculation assumes that the current car use is eliminated and that in the future it will be 90% public transport and 10% cycling. According to the calculations, the personal transport mitigation potential is 367.4 kg CO₂/capita. This carbon sequestration potential is 24% of the total mitigation potential of Budapest.

Sustainable Energy- and Climate Action Plan (SECAP)

The Budapest SECAP writes that transport is responsible for 24% of energy use and 28% of CO₂ emissions at the metropolitan level. The energy use of public transport in Budapest is only 2% of the total energy use in the city, which means that the change of modal split is a good tool to decrease the GHG emissions in Budapest.

Budapest Mobility Plan – the Budapest SUMP

The 2019 version of the Budapest Mobility Plan (BMP) has two volumes. The strategy is in the first volume and the second volume gives a transport development and investment program, which contains evaluations of the proposed interventions designed to fulfil the strategy (BKK, 2022).

According to the first volume, urban transport development over the past three decades has not been able to follow the development of the urban area with the needed flexibility for many reasons. This phenomenon is occurring in the Budapest metropolitan region as well and transport in Budapest suffers several problems, as described in the BMP problem tree (**Figure 33**).

From the perspective of emissions reduction, Budapest has pledged to achieve a 40% reduction by 2030, however, the BMP lacks comprehensive targets or a target tree. In

the absence of a target tree, we are forced to consider the alignment of strategic objectives to the comprehensive target. BMP key objectives are well aligned with the problems identified within the BMP, however only the first strategic objective of the tree can be linked to zero emissions as an overarching goal. The 'liveable urban environment' objective aims to influence transport needs and mode choice, together with a reduction of the environmental impact and strengthening of equal opportunities. There is significant room for increasing the ambition of this document to achieve Budapest's climate goals and decarbonise passenger transport.

The second volume uses a cost-benefit analysis (CBA) as the base of the evaluation of the planned interventions, but the details are unclear. However, this calculation method cannot give carbon emission reductions the credit they deserve in the project appraisal, and projects focussing on emissions reductions are at a systemic disadvantage using this method. It is likely this is why the evaluation additionally includes the ranking of the achievement of the environmental objectives as a metric. Overall, the climate assessment of the second volume projects is good, and no project has come forward that would not reduce carbon emissions in Budapest.

Challenges

Many of the challenges facing Budapest are threats common to other cities described in the report. Adverse changes in the public finance system undermine the financial stability of local budgets and may limit the possibility of making ambitious investments in the future. The problems of suburbanisation are similar too. Suburbanisation and its adverse effects are a massive challenge for Budapest. Actions within the administrative borders of the city are not fully effective, and cooperation with the cities in the agglomeration is formal and unstable. The recently established Budapest Agglomeration Development Council may be a platform to address the dysfunction between cities in the neighbouring regions and may be able to implement comprehensive transport and development policy more successfully.

In principle, development and transport management decisions are based on the BMP, the SUMP of Budapest, and serve its objectives. But this is not always true even for the major projects discussed in the current version of the BMP, and there are smaller renovation projects which run directly counter to the objectives of the SUMP. There is a lack of annual targets and their annual evaluation and monitoring of the achievement of the BMP targets remains unclear in this context.

For a long time, Budapest's plans and projects were determined by transport planners who were stuck in the paradigms of the second half of the 20th century. As Fleischer (2014) wrote in the ex-ante evaluation of the first version of Budapest SUMP, the strategies are often obsolete even as new strategies are being drawn up. Politics and misallocation of resources lead to the development of sub-optimal solutions.

The BMP gives a great opportunity to overcome this phenomenon, but there is strong resistance. Transport planners who prioritise car transport in every instance have

strong intuitional support and often close working relationships with key decisionmakers. Even as the city tries to reduce the role of private transport in line with the BMP, those who put car transport above all other modes continue to find institutional and governmental support.

Budapest mobility plan problem tree

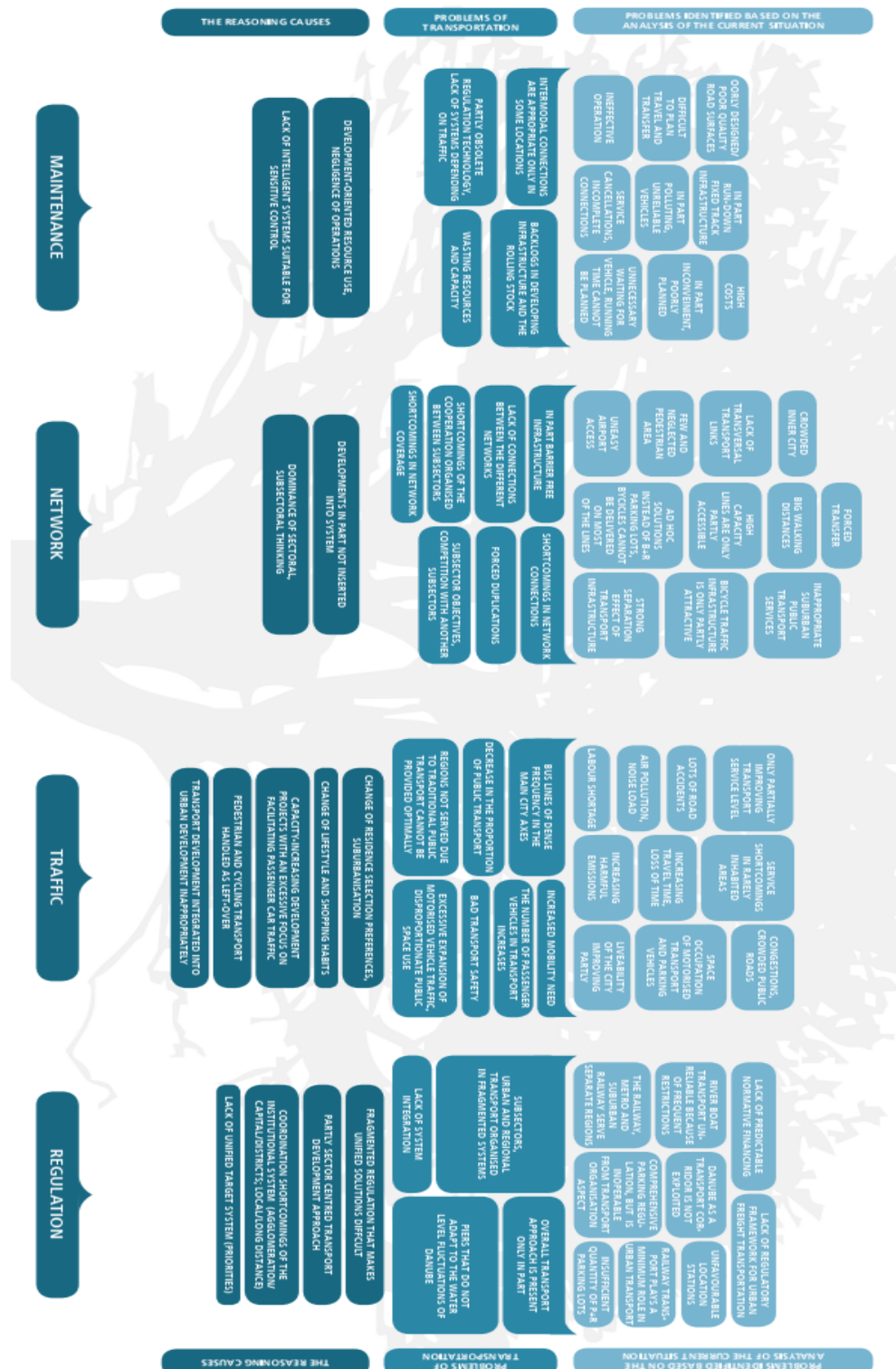


Figure 33 Budapest Mobility Plan problem tree

Summary and conclusions

As discussed, transport holds a high share of emissions in Eastern Europe, mainly originating from road transport and aviation. To achieve the goal of decarbonising the transport sector in the following three decades, this section provides a comprehensive approach and several recommendations for reducing emissions from passenger transport in ten selected cities from four studied countries.

The issues which the ten identified cities deal with are often similar. While some cities are experiencing population growth and others face population decreases, in both cases suburbanisation is on the rise. Bucharest has seen significant growth and expansion leading to the capture of agricultural land. Lublin has seen a decrease in population growth as citizens migrate towards suburban areas. In the case of Polish cities, suburbanisation is particularly influenced by the unorganised coordination in the spatial policy of municipalities, rising prices on the real estate market, less attractive supply of public transport at regional and county levels, as well as changes in inhabitants' habits. However, this phenomenon eventually increases the pressure on the transport system, causing an increase in emissions.

Another issue identified in the ten studied cities and caused by population growth and suburbanisation is the increase in individual motorization and car ownership which consequently amounted to an increase in the congestion rate and time travelling. The described situation highlights the dominant role of road transport in the share of emissions. For example, road transport holds 60 to 80% of the emissions in Vilnius or in Kaunas, where mobile sources are ranked first in the share of CO₂ emissions. This problem is made worse by the aged fleet and poor quality of automobiles. Among the selected cities, only in Gdańsk and Klaipėda other sectors are the primary sources of emissions, households and industry respectively.

The modal split of the residents living in the suburban area of the introduced cities is completely different and typically strongly depends on private cars, but in the case of Klaipėda, the modal split is balanced. Furthermore, the positive development of cycling infrastructures, active investment in public transport, as well as the crucial role of rail transport in serving metropolitan and even regional connections, are also noticeable in these cities. Nonetheless, the hierarchy of using different transport modes starts with cars, continued by public transport, foot, and cycling. The chaotic and unintegrated public transport in the cities of Budapest and Bucharest should be pointed out, in particular, Budapest suffers from the slow renewal of its bus fleet.

The challenges hindering the endeavours in reducing emissions from the transport sector are also common and interconnected in the ten selected cities. The benefits of employing renewable energy sources in transport fleets are underestimated, and the resulting energy crises affect electromobility in a negative way. Using more fossil fuels to compensate for the demand has caused the exceedance of air pollution standards in

different cities like Warsaw. Further, the energy crisis and the recent pandemic resulted in a noticeable drop in using public transport.

Lacking coordination between different local authorities accounts for the traffic congestion in the city, difficulty in accessibility, and suboptimal quality of the urban transport network, cycling, and pedestrian routes. In some instances, these problems are caused by the old national strategies such as in Bucharest. These national strategies and the included measures are not sufficient for reducing transport-related emissions. For instance, Bucharest and Vilnius are lacking dedicated measures for car traffic reduction or designated LEZs. Another issue, as in the case of Lithuanian cities, is non-adherence to the documents and lacklustre enforcement.

In Budapest, the major challenge is the prioritising of cars in the decision-making process. This might be the result of the lack of cooperation at different levels. Lack of political will and limited incentives for using eco-friendly car fleets, as well as the lack of actions on administrative issues, exacerbate the situation. In the city of Lublin, poor social acceptance of limiting the use of cars for transportation hinders political will. Another obstacle in reaching green transport in these cities is the lacking long-term predictability of the size of the local budget which constitute a challenge in funding long-term investment in the infrastructure needed for low carbon modes of transport. The security of local budgets' finances is threatened by negative changes to the public finance system. This negativity affects the cost of fuel and electricity and eventually discourages the electrification of the buses fleet.

The need to submit Sustainable Urban Mobility Plans (SUMP) as a precondition for some EU funding has improved uncoordinated spatial development and cooperation and typically aims to reduce emissions from transport by 2030. Its goals will be reached through a series of efficient recommendations in order to promote electromobility, the public transport system, and integration with active forms of mobility such as cycling, and pedestrian infrastructures. Additionally, restricting car parking, calming traffic, and designating LEZs are planned in many cities. Following these measures, the modal split will shift towards more sustainable mobility and will improve safety. The SUMP facilitates regular monitoring and data updates for the Action Plan of each city to achieve a convenient, healthy, and environmentally friendly city as in the city of Klaipėda.

In addition to the indicators and recommendations introduced in the cities' SUMP, there are several recommendations to pave the way toward decarbonizing the transport sector. These measures have been identified for the ten selected cities but may be applied to other cities as well. In the case of Polish and Lithuanian cities, these recommendations start with strategies that should be employed at the national level including a legal framework for integrated management of all transportation modes, governing long-term local financial issues, and advancing electric public transport development. The coordination of policy activities and the integration of transport subsystems is left to the administrators of the metropolitan areas. At the city level, implementing and monitoring strategies is advised.

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