SciencesPo
URBAN SCHOOL

# PUBLIC TRANSPORT AS A LEVER FOR THE ECOLOGICAL TRANSITION

# Contributors

This project is financed by Transdev Group, in the pedagogical context of the first year of Master Governing the Ecological Transition in European Cities at the Urban School of Sciences Po Paris.

# Thanks

We thank Transdev Group for opening their doors and giving us the opportunity to work on this report. Their support has been precious to complete the work. A very special thanks for Rafael Alatriste-Gamba, who guided us from the beginning, and all of his colleagues that we had the pleasure to meet throughout the year. We also thank the Urban School of Sciences Po for the pedagogical tools, and our tutor, Loic Delhuvenne for the technical support.

# Abstract

The transport sector should become a key driver of the environmental transition, from a problematic source of emissions to a solution to face climate change. Green mobility is a multifaceted concept in hardly consensual terms but most of the actors from the sector agree on one thing: we must reduce transport emissions. And, what a better lever than Public Transportation to achieve the Paris Agreement targets? Yet, financial gaps and institutional obstacles prevent a range of local actors from accessing eco-friendly public modes of transport. Therefore, our report aims to empower local authorities and generate discussion across different actors by providing them with a few keys that foster public transport as a real lever for the ecological transition.

SciencesPo
URBAN SCHOOL

transdev
the mobility company

AUTHORS :
GIUSTI Daniele
GOMEZ Mateo
MARTINEAU Eva
STEBACH Adèle

# TABLE OF CONTENT

# APPROACH AND METHODOLOGY

## Introduction

Meeting the Paris Agreement's (PA) goal of limiting global warming to 1.5°C above pre-industrial levels requires rapid decarbonization across all sectors, including transportation. Transport sector currently accounts for 15% of the total GHG emissions, 23% of the global energy-related $CO_2$ emissions (IEA, 2020). In 2019, it emitted approximately 8.9 GTons (Gt) of $CO_2$ equivalent ($CO_2$-eq), which represents double the levels of 1990 (IPCC, 2022). To be on track with PA targets, transportation sector growth should fall by 3% per year until 2030 (IEA, 2023), it is now growing at 1.8% per year (IPCC, 2022). North America and Europe are the largest emitters due to the high connection between economic growth and mobility, but in other parts of the world, emissions' annual growth is up to 6 times the average. Additionally, in 40% of the countries, transport represents the most energy consuming sector. Freight and passenger road transport accounted for 70% of the transport sector emissions in 2019 (6.1 $GtCO_2$-eq), remaining the largest source of emissions. Without any political intervention, the IPCC foresees that it could keep growing from 16% to 50% by 2050 (2022).

Cities play an ambivalent role as significant contributors to emissions and frontline bearers of the consequences of climate change. On the one hand, the urgency of climate action in cities is underscored by the increasing impacts of climate change, with 70% of cities globally already affected and more expected to face drastic changes by 2050. On the other hand, cities contribute significantly to global emissions, resource consumption, and waste production, with rapid urbanization exacerbating these trends (UN HABITAT, 2011; UN DESA, 2019). Urban mobility is responsible for 40% of the transport-related emissions and 8% of the global $CO_2$ emissions (IPCC, 2022). It is consequently urgent to integrate the transportation sector into broader climate actions.

Different transport strategies are being implemented to answer the climate crisis but overall, they face important challenges. Local authorities imperatively need to foster inclusive, safe, resilient, and sustainable cities; especially by accelerating the provision of adapted infrastructure and services while reducing emissions. Overall, achieving sustainable urban mobility requires increased coordination, integrated planning and investment in public transport infrastructure, operating subsidies, and the development of efficient, multi-modal transport systems.

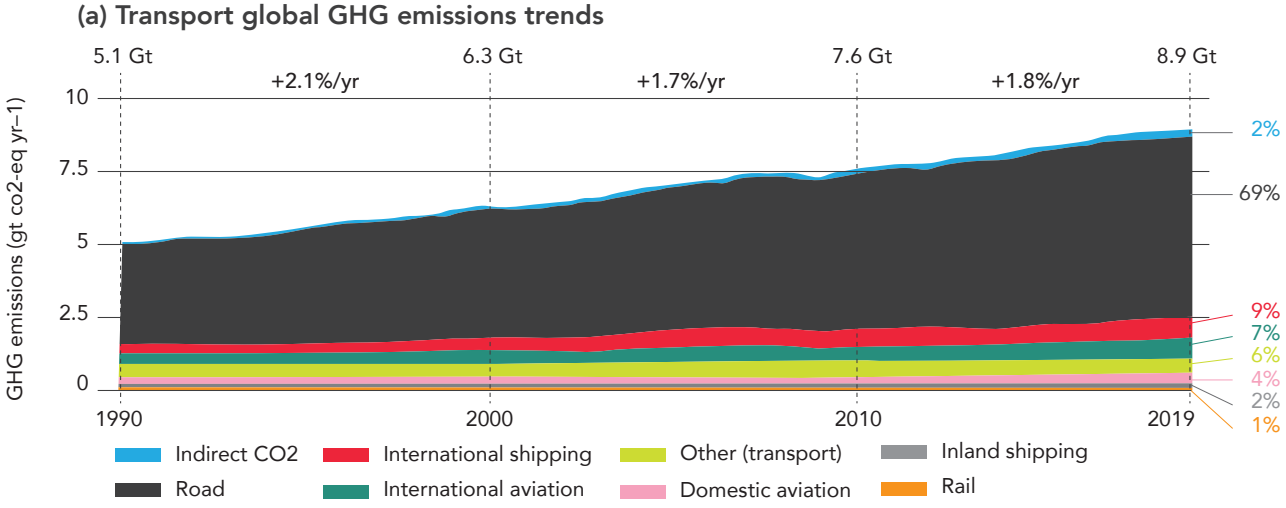



*Figure 1: Global and regional transport greenhouse gas emissions trends | Source: IPCC AR6 WGIII (2022)*

## Governance

Public transport governance is complex and involves a long list of different stakeholders. At the European level, we can already identify citizens, local and national authorities, operators, European Commission and Parliament, but also civil associations and industrial lobbies. Additionally, from a political perspective, the transport sector both pertains to mitigation policies - reducing GHG emissions is key for avoiding any further negative effects of rising temperatures - and adaptation, as new transport systems will be resilient and help face the consequences of climate change. To ensure coordinated planning and implementation of public transport services, many countries have established metropolitan or public transport authorities (MTAs, PTAs etc.) and mechanisms for cooperation between local and regional governments. However, challenges remain, particularly regarding cross-boundary operations and service integration.

## Urban planning

Addressing future challenges is an arduous task for local governments. Even though current emission reduction commitments are insufficient to meet the targets, some EU countries – like France – have already set ambitious targets for increasing the share of public transports and public investments. Additionally, successful modal shifts have already been observed in countries like Sweden and Norway through increased funding and improved services (ITF, 2024a). Yet, urban planning is too often considered separately from transportation networks, leading to an increased risk of lock-in (i.e. European city's infrastructures are already built and adapting them to new challenges increases the costs). This underlines the importance of integrating transport systems to urban planning, to avoid inefficient investments and improve services. In that sense, integrated services, transit-oriented and multi-modality developments could help foster sustainable mobility patterns and deal with expected doubling of passengers and freight transport activity by 2050.

## Finance

Moving to a greener transportation system is extremely costly for local authorities as it requires additional investments for new technologies and infrastructure. In the European Union, meeting climate objectives from 2021 to 2030 is expected to necessitate an annual investment increase of €130 billion for vehicles and alternative fuel infrastructure, surpassing the previous decade. Additionally, approximately €100 billion per year will be needed for additional investment in green transport infrastructure.

Local-scale actions offer opportunities for targeted solutions and community engagement, although decision-making autonomy varies, especially in "developing" countries. Despite challenges, cities have great potential to reduce carbon footprints through efficient service delivery and renewable energy adoption (REN21, 2019).

There seems to be a window of opportunity for public transport to be taken into account in climate policies. The European Commission adopted a Green New Deal strategy in 2020, with a net zero emission target in 2050. To achieve this objective, the transport sector becomes central. It represents 5% of the European GDP and emitted 25% of the GHG emissions in the EU becoming a crucial target in the ecological transition. Following the Green New Deal goals, emissions must be reduced by 55% by 2030 and 90% by 2050 compared to 1990 levels. Accordingly, the European Commission aims to consider transport in an integrated approach with the energy transition to sustainable energy production; this translates into a strategy of decarbonisation of transport as the main target to get out of fossil fuels. Their green mobility strategy is not entirely focused on public transport, as their roadmap aims to transition to sustainable, smart and resilient transport. Yet, the 2020 Sustainable and Smart Mobility Strategy very much focuses on public transport, aiming to increase the number of passengers. Additionally, the EU Urban Mobility Framework highlights public transport, accompanied by shared mobility solutions as a priority. This would effectively provide low-emission, affordable and inclusive mobility options, enabling social cohesion and local economic development.

Even though the European Commission defined a roadmap for transitioning and achieving goals, there is no consensus on whether public transportation should be a primary concern. Climate policies encompass many domains where transport is overlooked. There is no consensus on what should be considered as a "green" mobility. While some argue that fossil fuelled public transportation is already greener than private cars, others consider it is not sufficient and should be completely decarbonised. There is no consensus either regarding the decarbonisation paths: e-mobility or alternative fossil fuels, different options are put forwards by the industrials. With that in mind:

**HOW TO MAKE GREENER TRANSPORTATION ACCESSIBLE TO CITIES ?**

# Methodology

Our research methods are articulated around three qualitative pillars. First we conducted an academic and scientific literature review in order to understand how mobility was accounted for as a transition lever by the international actors and get a sense of the main challenges for the different stakeholders. Starting from the keyword "mobility", we explored scientific reports on climate change and environmental challenges, academic literature on sustainable urban planning and green finance. We went across several disciplines: economics, political sciences, sociology and finance.

Second, we attended the European Connecting Days conference (Apr. 2nd-5th, 2024). The event consists of a variety of conferences, discussions and debates about the general topic of mobility in the European Union and its neighboring countries. Brussels was not a case study, but some of the conferences were nonetheless highly informative and useful. Not all of them though: a large part of the conference was related to mobility topics outside the field of public transport (for example intercity mobility and freight transport). But even when the discussions were focused strictly on public transportation, the scope remained very much European, revolving around what the EU (particularly the commission) could and couldn't do. Guests were mostly ministers, politicians such as local mayors or transportation ministers, representatives of financial institutions (chiefly development banks), industry representatives, and of course an important number of European Commission officials.

Finally, we conducted fifteen 1h interviews with different professionals from the sector. We started with Transdev professionals issued from the Strategic and Finance departments. We then met with public transport experts: the DG from DG Move, UITP representatives and academics. Finally, we discussed with operators representatives from Morocco, Budapest, Madrid and Italy which allowed us to build our case studies.

We aim to develop knowledge on public transportation funding to support decision makers in their transitioning efforts. Our first chapter draws a state-of-the-art on current environmental policies and finance around public transportation. Chapter two presents the ASI ("avoid-shift-improve") framework and focuses on green mobility opportunities to reduce emissions. Finally, chapter three revolves around case studies, and highlights existing best practices for different mobility contexts.

### OUR MAIN TAKEAWAYS FROM THE EUROPE CONNECTING DAYS 2024

We discovered at that event two key concepts of EU regulation regarding mobility: TEN-T regulation, and SUMPs. TEN-T regulation is the commission's framework to fund, green and integrate continent-wide transportation networks, organized in corridors. SUMPs, or sustainable urban mobility plans, are directly related to urban public transportation networks, and basically have the same objectives as TEN-T, albeit at the local urban level. Most conferences seemed to tackle one or more of three topics: carbon emissions, integration, and digitalisation. Integration particularly seemed to be of the utmost importance for a lot of the speakers, who pointed out that it would bring about better economic flows and would facilitate the choice of transport for users. This usually led to broader discussions on modal shift, which were linked with digitalisation. Overall, we concluded at the end of the event that the EU's two pillars for modal shift were integration and digitalisation.

# How to shift to decarbonised modes of transport?

**Decarbonisation of the transport sector requires a shift to sustainable modes – this should not be entirely focused on shifting to electro-mobility which is limited, but rather on public transport to foster the transition. In most of the city centers, public transport systems are already efficient and have high modal share. Hence, the challenge awaits in less-dense areas. This chapter will explore how politics account for transportation, review urban planning challenges and will make a state of the art on the current funding environment.**

## RECOMMENDATIONS

1. Achieving a modal shift requires the recognition of transportation as a priority topic in the urban political agenda and coordinated action at all scales.

2. Planning urban transportation systems requires an integrated approach, taking into account the location of jobs and the density of population, to avoid maladaptation and inefficient networks.

3. The decarbonisation of the transport sector is costly and requires more investment at the global scale, and a better government funding basis at the local scale.

*Picture: Shipping station (Norway) | Credits: Transdev*

# 1. A MULTI-LAYERED GOVERNANCE

**"In order to adapt and prepare for climate change risks, EU norms and regulations like the Green Deal are crucial. The Union sets pivotal objectives on decarbonisation to pave the way for new sustainable and smart mobility across the continent."**

Herald Ruijters.
Directorate-General Mobility and Transport (DG MOVE),
European Commission

The ecological transition process involves a range of different actors at different levels, out of which politicians play a key role. The environmental crisis impacts all domains: health, buildings, agriculture, transport, etc. If we understand politics as the exercise of power within a social institution to shape the future development and the well-being of its inhabitants, current frameworks are insufficient for managing the transition. Hence, there is a need for new levers of actions, as for instance greener transport networks. This involves rethinking politics at all scales to create sustainable and resilient environments: global, national, and local governance. Multiple challenges complexify public transport politics. First, how public transport is globally framed as a potential lever for emissions reduction goals and adaptation to future climate risks. Then, how the European debate around sustainability shapes public transport future with increasing incentives for efficiency and electrification. Finally, multi-governance versus local governance where there are many intertwined layers of responsibility, and different actors involved which embroil even more the picture.

## The progressive consideration for transport as a key solution at the international level

The international scientific community agrees on considering transport as a key sector to target for emission reduction. Transport entered the international debate as a mitigation issue (i.e. set of strategies to reduce the impacts of climate change) but remained in the shadows as a secondary topic in the Conference of the Parties (COP) debates. The Paris Agreement (2015) accelerated the need to reduce emissions with the historical target of limiting climate change to 1.5°C.

Interestingly, around those years, transport came out as a major lever to reduce emissions. Indeed, from 2014, the International Panel on Climate Change (IPCC) is dedicating a full chapter only on transport (IPCC, 2014), showing its importance in future trends. Nowadays, the debate revolves around energy supply and production, and finance for the future of decarbonisation – directly connected to transport issues. The last COP in Dubai (COP28, 2023) showed the contentious issues around decarbonisation at the international stage – especially regarding the future of fossil fuels. However, transport was referenced in the COP28 outcome for the first time with the call on parties to foster and accelerate the reduction of emissions (ITF, 2023). COP28 was crucial in outlining how transportation questions intersect with multiple policy sectors and governments pledged to update their Nationally Determined Contributions (NDC) by 2025 ahead of COP30 hosted in Belem, Brazil.

As of June 2023, 98% of NDCs mention transport, 84% include transport measures, and 33% set $CO_2$ reduction targets (ITF, 2024b). Finally, transport resilience to climate risks remains overlooked in adaptation frameworks (i.e. set of strategies to reduce the vulnerability to climate change). The transport sector already experienced the impacts of a world pandemic and is also facing major threats at the local level.

## The push for electrification from the European level

Since 2013, the EU pushed local governments to implement Sustainable Urban Mobility Plans – introducing the concept of SUMP – in the Urban Mobility Package, which was updated in 2019. The same year, the European Member States approved the most ambitious environment agreement – the Green Deal – aiming to reach net zero emissions by 2050. This has major implications on national and local governments, as all states are required to implement effective strategies where transport is considered as a major lever of action. In order to cut emissions, the European strategy consists in decarbonizing light-medium-heavy duty vehicles by shifting to electric power. In fact, a central measure of the Green Deal is to stop the production of gas vehicles by 2035, presented as a double solution to the energy rising prices and environmental crisis. Nevertheless, whether electrification is the best pathway to decarbonisation remains questionable. It seems that the EU approach prioritizes the protection of industries in Europe - bringing financial support for private investments in green tech – rather than focusing on social and environmental justice. Recently, the revised TEN-T regulation (2024) set new targets for the transport sector to cut emissions by 90% by 2050, and plans for 431 urban nodes to have a SUMP by 2027. These are strategic plans and processes to meet the needs of urban inhabitants and workers and adopt an integrated planning approach. It is the first time that local governments are directly addressed and required to implement such strategies.

## Navigating the multiple layers of decision making from a local perspective

In most of the countries, transport governance is organized at the regional or municipal level, with PTAs, which are often decentralized arms to apply nationally framed transport policies. Most of them have a high degree of political and financial competences - such as the French PTAs (Autorités Organisatrices de Mobilité). On the contrary, some have really little autonomy due to high centralization and dependence on the national government, which is also an issue in terms of public transport development - as the Budapest PTA, BKK, facing major financial issues (see p. 32).

From a local perspective, there are two main challenges: first, the question of responsibility in a multilayer governance framework, and second, the capacity of local authorities to implement efficient and effective solutions. Indeed, implementing environmental policies requires capacity to deal with existing issues and rebound effects. If all the stakeholders cannot adopt a coordinated approach, there is a risk of increasing the vulnerability to climate hazards, known as maladaptation: increase in Green House Gases (GHG) emissions, burden put on the most vulnerable and reduce the flexibility to answer unforeseen changes, etc.

### Horizontal multi-governance: urban sprawling in Italy

In Italy, unregulated forms of urban sprawling took place during the 20th century, resulting in the emergence of informal neighborhoods known as «borgate» in the 1960s. These areas, detached from the city center yet integrated into it, symbolize the unplanned peri-urbanization that characterizes Italian cities, described as «città diffusa.» Indeed, the local governments boundaries were blurred and the administrative limits were challenged by the functional urban area or by the political influence, resulting in the lack of public services and transportation and explaining the high reliance on private mobility (Romano et al., 2017).

### Vertical multi-governance: the Spanish "millefeuille"

In Spain, public transport agencies (PTAs) and local governments are embedded in regional, national and international institutions with different objectives and attributions. Following the end of the Spanish civil war, in the 1960s, the country experienced an impressive economic growth with 8% of annual average growth. The government then adopted a policy of development at "all costs" ("desarrollismo"). Spanish cities doubled their populations in 20 years, principally due to rural migrations: their centers and closer peripheries became more dense and saturated. The absence of democracy until 1977 was translated into the lack of public basic infrastructures, public transport and the encouragement of private appropriation of land. At the end of the dictatorship, two parallel movements were at stake, democratization and vertical decentralization. However, these newly created seven Autonomous Communities and decentralized local governments are not necessarily favorable to each other and thus decision making can be highly fragmented (Cardesin Dias & Mirás, 2017).

## Navigating the multiple layers of decision making from a local perspective

When coordinated, local authorities (including PTAs) have the agency to foster the transition from the urban scale in a multi-governance framework. They can plan efficient public transit systems that can stimulate economic growth by improving access to jobs, reducing traffic congestion, and enhancing the overall attractiveness of the city.

1. Urban areas are economic and cultural hubs with significant political and financial influence. Most of the global population will live in cities by the end of the century - and already 80% of the European population is urban - which confort cities key position in pursuing sustainable development, as it was already stated by the 1987 World Commission on Environment and Development. Continuing on this path, the 1992 United Nations Conference on Sustainable Development in Rio de Janeiro strongly requested much needed and desirable cooperation between local authorities and stakeholders to design local agendas.

2. Local authorities are closer to the daily lives of their residents, allowing them to implement and adjust policies more responsive than higher levels of government.

   The effects of these decisions are often most immediately felt at the local level. From a mitigation perspective, investing in public transportation reduces the reliance on private vehicles, significantly lowering greenhouse gas emissions and improving air quality. Public transportation systems are also essential for adaptation and social equity, providing affordable and accessible mobility options for all residents. This is particularly important in cities with significant socio-economic disparities. Decarbonizing societies can create new forms of integration between domestic energy and transport systems, which has implications for energy and transport poverty. Recognising vulnerable groups at risk of both types of poverty and highlighting the importance of interdisciplinary research and policy development to address these interconnected issues is therefore fundamental. As EU households devote almost 25% to 'housing, water, electricity, gas and other fuels' and 12.5% to 'transport' (Eurostat, 2022) climate mitigation measures, such as carbon taxes, often disproportionately impact certain communities and groups by increasing their expenditures. This highlights the need for alternative pricing designs and related policies to ensure fairness. Low-income individuals are especially affected, as energy and transport costs consume a large proportion of their incomes, and they typically lack the financial resources to invest in energy-efficient appliances or vehicles.

3. Local authorities can pioneer innovative solutions and set trends that other municipalities and regions may follow. Such approaches characterize European Union (EU) programmes, such as Eurocities, national government initiatives and the activities of transnational municipal networks like C40. The EU sets overarching goals and standards for its Member States, supports cross-border cooperation, and provides funding through programs like Horizon 2020 and the European Green Deal. International accords such as the Paris Agreement set global targets for climate action, guiding national and local policies towards shared objectives. This multilevel governance framework ensures that policies are coherent, resources are effectively utilized, and best practices are shared across different levels of governance.

Public transportation stands out as a backbone in urban environmental policies. By reducing emissions, promoting equity, and fostering economic growth, sustainable transportation systems are integral to the success of the ecological transition. The collaborative efforts across urban, regional, national, and international levels of governance ensure that public transportation systems not only meet local needs but also contribute to broader environmental and societal goals. As cities continue to navigate the complexities of the ecological transition, the lessons learned and innovations developed will serve as valuable models for other urban areas worldwide, driving global progress towards a more sustainable future. ■

**"As energy poverty has begun to receive significant policy attention in the EU, the next step for policy-makers is to recognize that transport poverty also exists and that it has an important energy dimension."**

(Martiskainen et al., 2021)

# 2. A STRATEGIC APPROACH TO PLANNING TRANSPORTATION

**"The usual analysis 'higher density will provide lower number of kilometers for people' is a question that is ill formulated. It is not only a question of density of people. It is more a question of where the density is connected to the density of jobs and how the two are connected."**

Xavier Timbeau,
Economist at OFCE

Urban strategic planning is essential for creating sustainable cities and making the distance between global and local visions smaller, thanks to the mediation of the nation-state. Strategic planning represents a management tool that determines the direction in which an organization is moving, and how it will get there. Urban strategic planning "determines the direction of development of a city or urban area, in the context of its current profile and Strengths, Weaknesses, Opportunities, Threats (SWOT) analysis. This approach helps the city to respond to fast-moving events, to manage change and to improve the quality of life" (UN-Habitat, 2014).

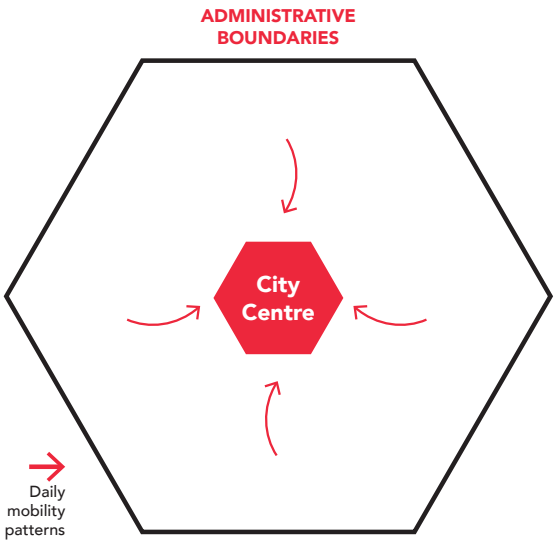
## Public transport planning faces the decrease in land availability

Most of the still growing cities face the issue of "sprawling" inducing an over-consumption of land by large cities. It is foreseen that the surface area of cities will double by 2030 on average, yet not proportionally to the population increase, leading to an overall decrease in density. This is particularly the case for booming metropolises in Asia and Africa. In Europe, most cities are middle-sized and their structure will probably stabilize over the next decade, increasing the risk of "lock-in". One must note that the extension of mass transit networks is often confronted with the lack of available land: apart from road infrastructure, public authorities generally do not have the land needed to develop subway, tramway, or LRT schemes. Developing new networks, therefore, requires paid expropriation mechanisms. They are often too costly to ensure the viability of such projects.

## The mobility patterns are influenced by the existing urban structure

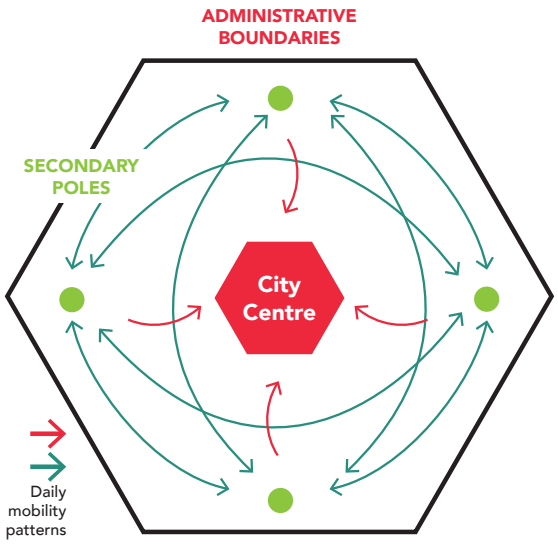
The way infrastructures and settlements evolved over time largely impacts the current share of transport emissions. De facto, according to Bertaud, "Urban spatial structures are shaped by market forces interacting with regulations, primary infrastructure investments and taxes" (2004). Emissions are a function of distance, and the overview of urban forms tells us that public transport is easier to plan in dense areas. The performance of urban forms can be assessed through the evaluation of the following aspects of urban structures: daily trip patterns, land use and density profiles. One key aspect to take into account for policy-makers is the location of jobs. Indeed, thinking the city implies adding a spatial and social dimension: trade-offs between price of land and cost of transportation for the choice of housing surface and location.

Strengthening urban space and enhancing planning are recognised as potential benefits not just environmentally-wise, but at the same time for their betterments in urban life enjoyment and citizens well being, thanks to facilitated access to services and economic prosperity. This includes integrating land use with transportation planning, promoting density, and preserving natural areas. Effective communication strategies and educational programs are also crucial for gaining public support and encouraging sustainable behaviors. Association between strategic planning and energy use is obvious as well as successive reduction in GHG emissions, for energy use is grounded on how urban spatiality, density and form are planned and accomplished (Owens, 1992; Capello et al., 1999).



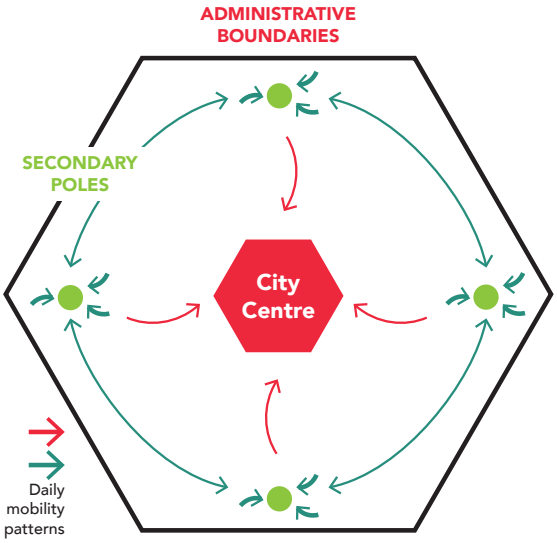

## Monocentric city

The traditional **monocentric model** is based on the assumption that a city will develop from a unified city center with high job density, surrounded by residential areas (Alonso, 1964; Muth, 1969). The daily commutes are straightforward to the CBD (central business district) and the value of land is market driven and decreases with distance. This model is not representative of reality, nevertheless, it is still relevant to understand some forms of commuting.



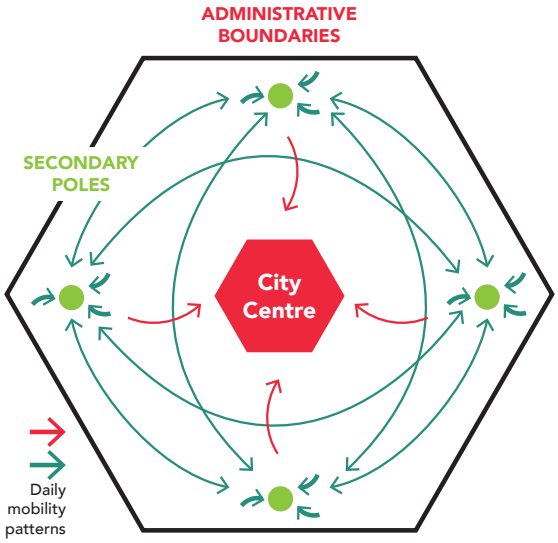

## Polycentric city - "random model"

Most of the fast-growing cities developed as randomly polycentric - as most of the US cities: their city center has no prevalence yet there are no organized "satellites" and self-sufficient neighborhoods. Jobs attract people from all over the city, resulting in random commuting trips. According to Bertaud, the value of land should be a function of connectivity. In that case, the aggregation of accessible destinations should increase the value of land.




## Polycentric city - "urban village"

This model bears in its name its meaning: a city with multiple centers where the city center has no prevalence over other clusters of jobs. The ideal form is the "**urban village model**": small self-sufficient communities, where trips are short, decentralized and can be achieved with active mobility modes. However, this model was never observed at a large scale. It gave birth to the "15-minute" model, increasingly politically charged.




## Composite city

Finally, the composite or mixed model is closer to the reality and dominant model across the world: the city structure is a mix of the different models listed above. In fact, cities are never 100% one or another urban structure, yet the structure gives us interesting information to evaluate the needs for efficient public transportation.

# 3. AN INTRODUCTION TO PUBLIC TRANSPORT FINANCE

## 3.1 – State-of-the-art of global climate finance

After years of insufficient growth, the scope of climate finance has started experiencing a great increase in the past few years. The Climate Policy Initiative's 2023 Global Landscape of Climate Finance estimates the sum of all yearly climate-related flows almost doubled between the pre- and post-Covid era.

One must say that such an increase remains extremely insufficient to respect the 1.5°C targets set by the 2015 Paris Agreement. The median scenarios, indeed, estimated a required global investment of around 8 trillion euros per year by 2021/2022, with subsequent growth until approximately 11 trillion dollars starting in 2030.

As of 2022, approximately 90% of the global climate investments are directed towards mitigation - a constant for years now. Multiple factors explain this dominance, including the need to reduce emissions as early as possible while adaptation remains, for most countries on Earth, a rather long-term matter. One must also consider mitigation policies' almost exclusive potential for economic viability: more than half of all investments directed towards mitigation are managed by the private sector, while 97% of all adaptation funding, which is, for the most part, unprofitable as of today, is provided by public actors.

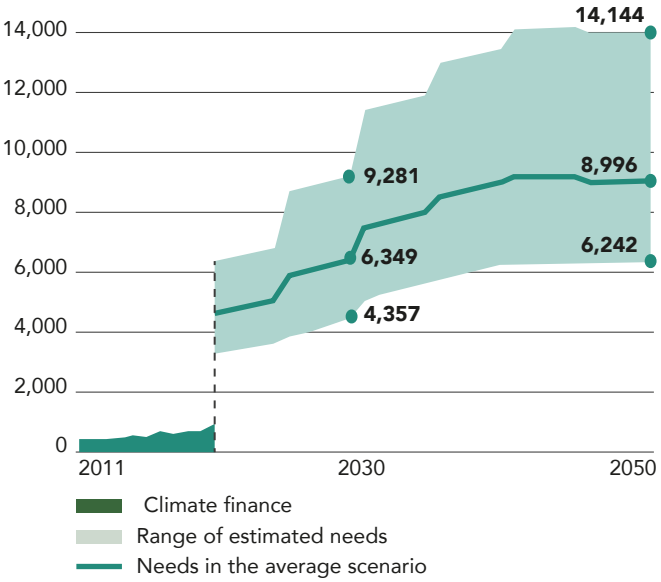



*Figure 2: Global tracked climate finance flows and the average estimated annual climate investment need through 2050 | Source: Climate Policy Initiative (2023)*

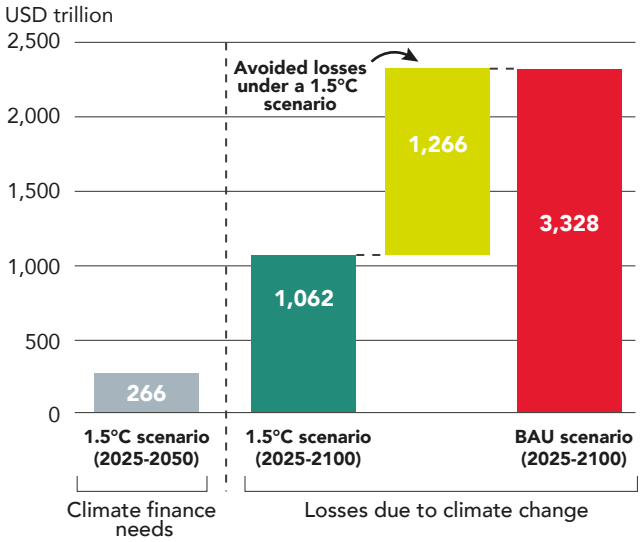



*Figure 3: Cumulative climate finance needs vs. losses under 1.5°C and BAU scenarios | Source: Climate Policy Initiative (2023)*

**The CPI Initiative estimates sufficient climate finance funding would be five times less costly than not acting, under a +1.5°C-by-2050 scenario.**

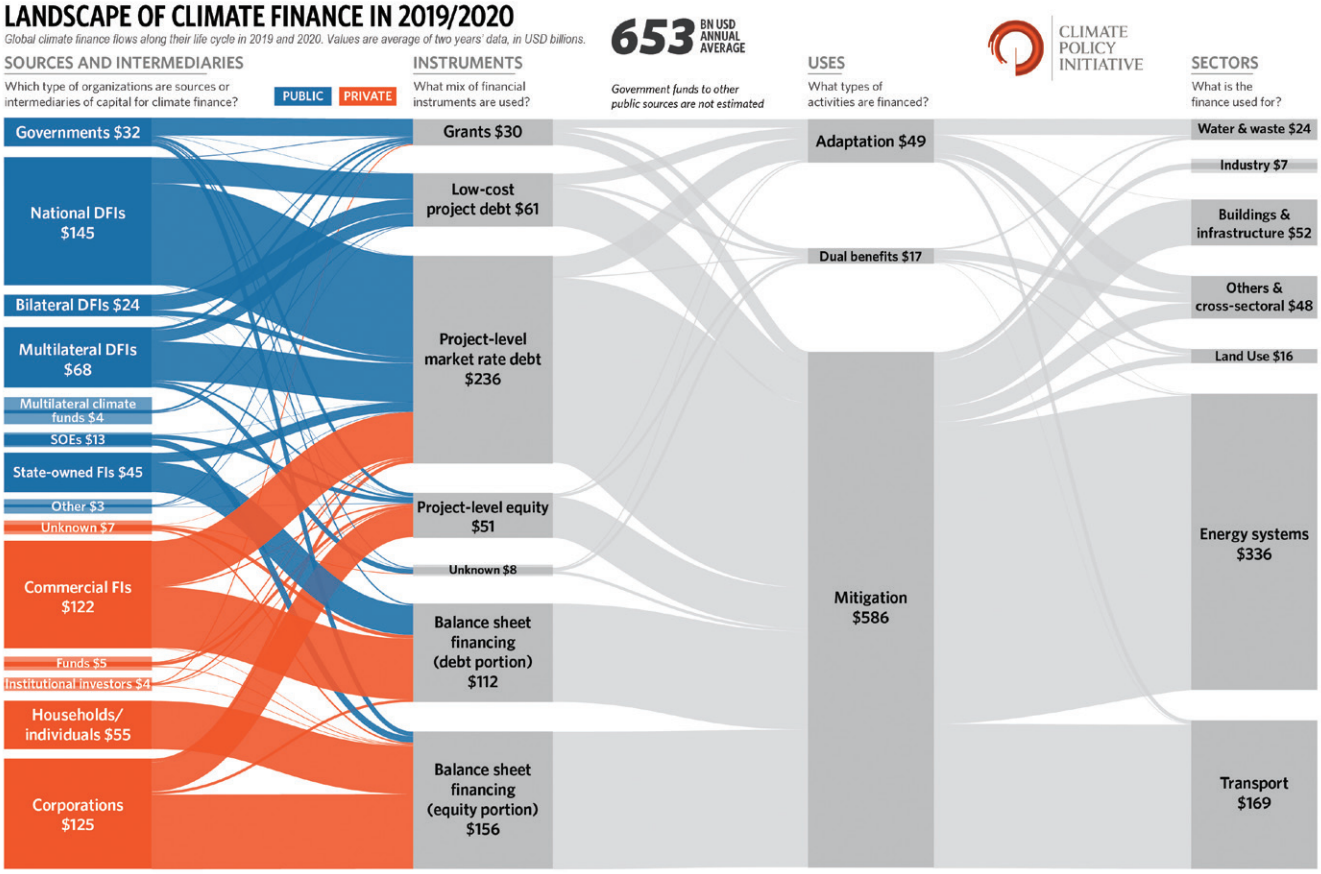



*Figure 4: Landscape of Climate finance in 2021/2022 | Source: Climate Policy Initiative (2023)*

**↑ Mitigation efforts are globally concentrated around three main poles.**

**Sustainable energy systems investments** concentrate the most investments - more than half a trillion dollars per year nowadays, an amount that exploded once new energy technologies reached profitability thresholds a few years ago. Those investments are aimed at expanding renewable energy sources such as wind, solar, and hydroelectric power, as well as improving energy storage and grid infrastructure to support the increased use of renewables. Additionally, there is significant funding for innovations in energy efficiency and clean energy technologies, which are essential for reducing reliance on fossil fuels and lowering greenhouse gas emissions.

**Building & Infrastructure** investments target the enhancement of energy efficiency and the reduction of emissions within the built environment. Funding is directed towards retrofitting existing buildings to improve insulation and energy use, constructing new buildings that meet stringent green standards, and upgrading infrastructure to be more resilient to climate impacts. These efforts accounted for an average of 240 billion dollars yearly in the 2021/2022 period.

**Transport** accounted for $169 billion in climate finance. Transport is a critical sector for achieving global climate goals, accounting for approximately 24% of direct $CO_2$ emissions from fuel combustion.

| TRANSPORT SUB-SECTOR | 2019 | 2020 | 2021 | 2022 |
|---|---|---|---|---|
| Aviation | | 1 | 0.2 | 0.05 |
| Other / Unspecified | 92 | 64 | 6 | 17 |
| Policy & National Budget Support & Capacity Building | 2 | 2 | 2 | 3 |
| Private Road Transport | 62 | 84 | 184 | 295 |
| Rail & Public Transport | 17 | 11 | 68 | 8 |
| Transport-oriented Urban Development and Infrastructure | 1 | | | 0.0004 |
| Waterway | | | 2 | 6 |
| **Total** | **174** | **163** | **263** | **410** |

*Figure 5: Breakdown of transport sector climate finance by sub-sector |Source: Climate Policy Initiative (2023)*

As of today, investments in this area focus mainly on the electrification of transportation, including the production and deployment of electric vehicles (EVs) and the necessary charging infrastructure. The development and expansion of public transportation systems, such as metro, light rail, and bus rapid transit (BRT) networks, only gathers less than 20% of all transport-related climate finance.

This distribution of transportation investment mostly results from (a) public transportation's unprofitability and (b) the incapacity of public actors to fund the necessary initial investments for such systems to be implemented.

In most of the world, local and regional authorities' expenditures are much greater than the sum of all taxes they collect – making them dependent on other bodies to finance their day-to-day activities. Similarly, the Cities Climate Finance Leadership Alliance has underlined that only 4% of public development bank funds are specifically mandated to finance local governments' projects.

Local authorities, in this context, are greatly dependent on external financial mechanisms to fund costly infrastructural projects – such as the development of collective transportation schemes.


*Figure 6: Subnational government expenditures and revenues as percentages of general government expenditures and revenues, 2016 (OECD/UCLG, 2019)*

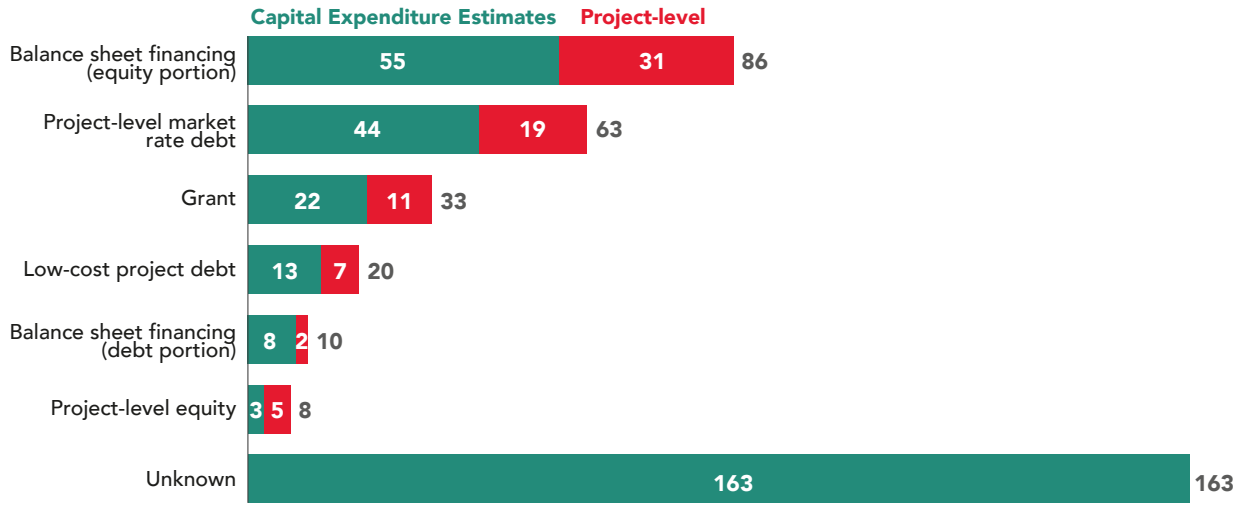



*Figure 7: Urban climate finance by financial instrument (2017-2018) | Source: Climate Policy Initiative (2023)*

Local bodies' fiscal and market capacities, however, are highly variable depending on their national legal and political contexts. A C40 study has shown that only 32% of major OECD countries were fully able to borrow from regional and national governments, and 39% could issue municipal bonds by themselves.

These issues on access to funding can be witnessed on the cartography of local public transportation networks, with the number of local public transportation networks by inhabitants being greater in federal countries than in centralized countries with few financial capacities fully devolved to subnational bodies (all other things equalized). ■

# 3.2 – Outlook at public transport financing and funding

The funding of greener public transportation is determined by two factors: the ability to generate enough revenues to cover the initial investment, operations and maintenance costs, and the infrastructure financing (ITF, 2024). Thus, one of the biggest challenges is to identify the sustainable sources of finance and funding to cover the costs of CAPEX and OPEX.

## The finance gap for transportation infrastructure financing (CAPEX): insufficient public support vs. limited private investments

### European project-based funds

The EU has established several financial mechanisms aimed at facilitating the ecological transition. The Green Deal plan includes a significant focus on sustainable and smart mobility, with substantial investments earmarked for modernizing public transportation infrastructure. It encompasses a variety of funding programs, which prioritize projects that contribute to greener and more efficient transportation networks:

- **Connecting Europe Facility (CEF)**
  Key funding instrument that supports the development of high-performing, sustainable, and efficiently interconnected trans-European networks. Under the CEF, the EU allocates funds to projects that enhance the sustainability and integration of public transport systems.

- **InvestEU Program**
  Provides crucial financial support to sustainable infrastructure projects through the mobilization of public and private investments. InvestEU aims to generate significant private investment in sustainable transport, leveraging EU guarantees to reduce risks and attract additional funding. It includes a dedicated sustainability window that supports green mobility initiatives, encouraging the adoption of innovative and eco-friendly public transport solutions.

- **Horizon Europe**
  As the EU's research and innovation framework program, Horizon Europe allocates substantial resources to projects that foster innovation in sustainable transport technologies.

- **Cohesion Fund and European Regional Development Fund (ERDF)**
  These funds target regions with economic and infrastructural disparities, aiming to reduce these gaps by promoting sustainable development. They are the budgets set by the European Cohesion Policy. Both funds allocate resources to improve public transport infrastructure, focusing on green and inclusive mobility solutions.

| POSITIVE | LIMITATIONS |
|---|---|
| Provide grants for technical assistance, project planning and implementation etc. | Project based: a discontinuous source of funding |
| Key support for green transition in Eastern and Southern Europe | Bureaucracy: difficult to access, complex submitting and approval process, lack of transparency |

### European Investment Bank & European Regional Development Bank

The EIB and ERDB count as the EU's financial arm. They provide loans and financing for large-scale sustainable transport projects. The EIB has become one of the biggest transport lenders and prioritized green investment, with €11 billion per year on average for the period 2012-21. The EIB will also be involved in the Green Deal framework in securing European company investments. These banks support is often crucial for enabling cities and regions to undertake significant infrastructure upgrades that align with the EU's climate goals.

| POSITIVE | LIMITATIONS |
|---|---|
| Useful source of capital for infrastructure investments where national and private finance are less available | Often goes through central governments and not cities directly |
| Provide low rates loans and take more risks than traditional banks. | Only for CAPEX investments |

## Private investments: a remote money well

Traditional private financial tools such as PPPs seem outdated and do not fill up the ideal of accessible and green finance. They are criticized because they are too costly in the long run for public authorities and not primarily focused on serving the common good. Hence, there is an urgent need to find good alternatives: green bonds, low interest loans, etc.

| POSITIVE | LIMITATIONS |
|---|---|
| Loans: common and simple finance instruments<br><br>(Green) Bonds: tax-free interest with a predefined cost of financing | Regulatory frameworks: no direct access to private finance (56% of the countries forbid local governments to borrow)<br><br>Lack of revenue: constraint for attracting private capital<br><br>Project size conditioning the private investment |

## Alternative sources: potential for infrastructure investment

- **Land Value Capture instruments**
  It is defined as a policy instrument for governments to capture the increase of land value after development projects (OECD, 2022). Nevertheless, LVC instruments raise important questions:

| POSITIVE | LIMITATIONS |
|---|---|
| Capture the value of increased accessibility to services (the indirect beneficiaries).<br><br>Potential to become a non-neglectable source of infrastructure finance (e.g. Hong-Kong, Dublin) | Practical challenges: It remains unclear how and when to start implementing LVC, and there is a limited local government capacity and lack of political will.<br><br>Discontinuous financial tool: its nature makes it difficult to collect ongoing revenue.<br><br>Equity concerns: goes against two equity principles. It applies regardless of the between income and level and uniformly across the territory which may cause social justice issues. |

- **Carbon credits**
  Carbon credits are tradable certificates or permits representing the right to emit one metric ton of $CO_2$. These credits are part of market-based mechanisms aimed at reducing global greenhouse gas emissions, and are generated by emissions reductions. They can be traded on compliance markets (where governments enforce emissions regulations) or in voluntary markets open to all.

| POSITIVE | LIMITATIONS |
|---|---|
| At face value, they can be an easy source of money: if an operator electrifies its fleet and lowers its emissions, it can generate carbon credits to sell.<br><br>Public transportation is overall prone to lowering emissions quite easily, and can thus generate a lot of carbon credits. | Public transportation is not in the compliance market, it therefore has to rely on the less active voluntary market.<br><br>Since carbon credits only take into account scope emissions, a great push towards modal shift (which lowers emissions) would not be rewarded in carbon credits.<br><br>Things like electrification mean that the money would only roll in after the financial effort has been carried out, maintaining the question of the initial funding for a project, since emissions have to go down first for credits to be generated |

# A decreasing funding base: the need for better fare policies and tax allocation (OPEX)

The ratio of revenues/operating cost has been decreasing for the last decade, which puts operator companies in a difficult position. Yet, the progressive increase in public transport demand coupled with better transport policies and tax allocation could increase the public transport funding basis.

## Users funding

Users' direct funding usually represents an important but declining part of the transport authorities' and operators' revenues - with some notable variations among countries - but ranges between 25-35% in Europe as a result of EU Policy (Ruijters; D'Amico). This is mainly due to deficient fare-setting policies, often influenced by politics in two ways: national targets for fare-setting policies and political interferences with fare-setting policies. This is illustrated by variations in ticket pricing following electoral cycles, free public transport services, or heavily subsidized periodical tickets. The last ITF report recommended focusing on efficiency for the financial sustainability of public transport and equity principles with concessional fares (2024).

## Taxpayers and government funding

The ITF recommended to provide a better stability to government funding basis through legislatively established dedicated taxes and cross-subsidies (ITF, 2024).

- **Beneficiary-pays tax: capture the external benefits of public transport from certain groups**
  A particularly illustrative case is the «Versement mobilité», a French specificity relying on the idea that public transport increases the efficiency of the labor market. It replaced in 2019, the Versement Transport [Transport payment, VT] that was in force since 1971. In France the Public Transport Authorities are in most cases organized at the communal or metropolitan level by the Autorités Organisatrice de Mobilité (AOM), and they are financed through 3 main streams.

*Credit: Transdev.*

*Credit: Transdev.*

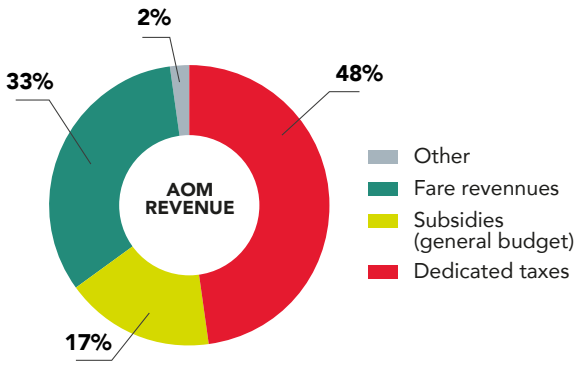



*Figure 8: Figure 8: Revenu des AOM en France en 2018 | Source: Rapport Duron*

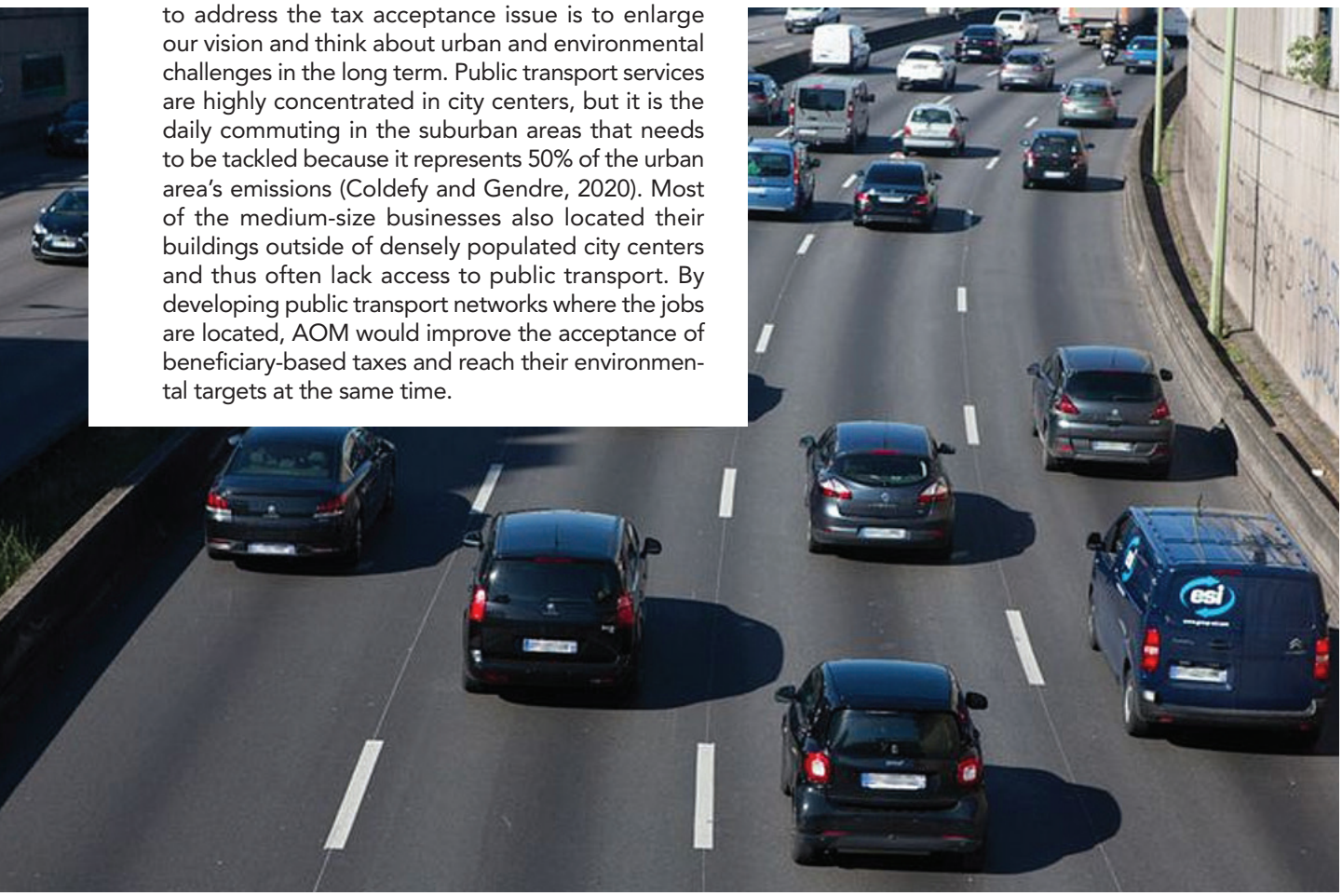
The VM is a tax paid by companies of 11+ employees in communes with over 10,000 inhabitants since the last reform in 2020. The maximum rates range from 0.55% to 2.95% depending on the size of the population and legislation. It is the most significant dedicated tax for the funding and expansion of public transportation in France as it allows operation funding - as well as other mobility services since 2019 - and infrastructure investment depending on the AOM. Yet, it is regularly criticized by the representatives of the business (MEDEF) and industrial (UIMM) federations, concerned about the fairness of this tax. Indeed, medium-sized businesses are often located at the city peripheries less connected to transport services (43% of the workers around Paris commute by public transport vs. 8% in the other regions). Additionally, we observe a continuous drop in fare rates, and increasing reliance on VM - according to last estimates, it contributes up to 60% of the financing of some AOM.

The VM remains a fundamental source of funding for French transport authorities. In the short term, it seems that better legislation on fare-setting policies could answer some disputes: Duron et al. suggested freezing VM funding for AOM with free-transportation systems (2021). Another way to address the tax acceptance issue is to enlarge our vision and think about urban and environmental challenges in the long term. Public transport services are highly concentrated in city centers, but it is the daily commuting in the suburban areas that needs to be tackled because it represents 50% of the urban area's emissions (Coldefy and Gendre, 2020). Most of the medium-size businesses also located their buildings outside of densely populated city centers and thus often lack access to public transport. By developing public transport networks where the jobs are located, AOM would improve the acceptance of beneficiary-based taxes and reach their environmental targets at the same time.

- **Polluters-pay tax: capture the external cost of private vehicles on the environment and finance sustainable investments in response to the climate crisis**

Congestion charges are in most cases a dedicated revenue for transport (including road transport). Nevertheless, London and Milan are the only European examples of cities spending most of their congestion charges on public transport. In fact, congestion charges should be conceived as part of a broader shift towards public transport as in Norway, an incentive charge to change people's behavior; otherwise, it causes equity challenges. There, urban tolls contribute at 40% of the capital financing for new infrastructure projects and are backed by a good acceptance rate (55% in 2022).

There are other examples of road-user charges to internalize the external costs of fossil fuel vehicles: carbon tax, fuel tax, parking tax, etc. Remarkably, fuel taxes represented an important source of revenue for local authorities, 4.4% of all taxation revenues in Europe in 2020 (ITF, 2023). As congestion charges, these can help public authorities to motivate a shift towards public transport, if thought together with sustainable mobility plans. ■




*Credits: Jean Baptiste Gurliat | Ville de Paris*

# CHAPTER 2: DECARBONIZING MOBILITY

**With the intention of decarbonizing, we can give new meaning to local public transport [...] change its perception. Offering a service that works, giving it social prestige, convincing users that polluting less is a good thing. It is not about banning, but about making those who engage in certain practices feel ashamed.**

Luciano D'Amico, former TUA president

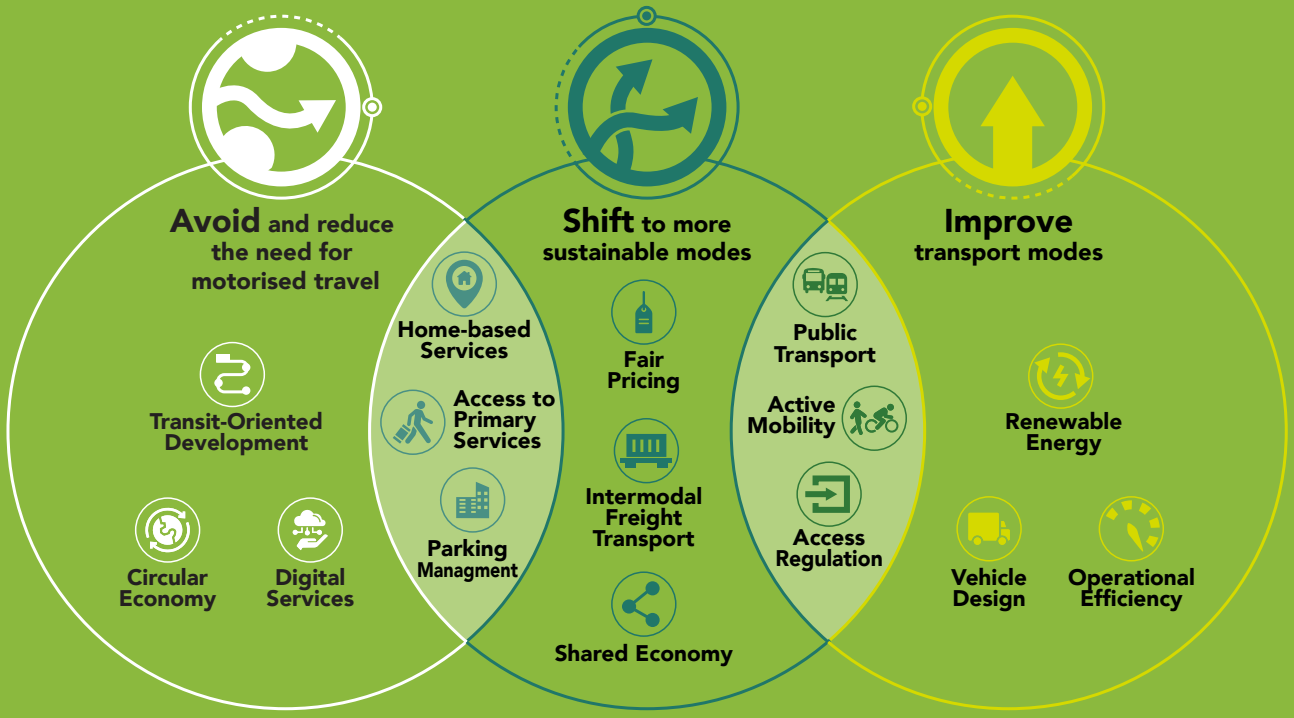



*Figure 9: Avoid-Shift-Improve Framework | Source: SLOCAT (UNFCCC)*

**How to reduce transport emissions? This chapter aims to give a state of the art in terms of research and political opportunities to reduce infra-urban emissions. We decided to base our reasoning on the avoid-shift-improve (ASI) framework (IPCC, 2022), a model that seeks to change behaviors by improving efficiency, and that can be applied to the transport sector in order to reduce emissions. Therefore, we will see that a reduction of activity per kilometer is needed (*avoid*), as well as a shift to low-carbon transport modes (*shift*) and an improvement of vehicles efficiency and fueling (*improve*).**

## RECOMMENDATIONS

1. Local authorities should adopt a long-term transport strategy answering urban and ecological challenges through the planning of efficient networks where people and jobs are located.

2. A modal shift in favor of public transportation is required in order to meet the targets.

3. Global authorities' pledges for the development of new technologies and the phasing out of fossil fuels are fundamental to lower transportation environmental impacts.

# 1. "AVOID" - REDUCING ACTIVITY

The first lever of action to reduce transport emissions is to reduce unnecessary motorized trips. Indeed, the limitation of mobility, whether it is absolute or just car-related, indirectly pushes for the development of public transport, among other forms of mobility. The COVID crisis showed that reducing activity through imposed constraints has long-term consequences. The promotion of alternative services coupled with effective urban planning are necessary tools to achieve efficient transportation networks.

## New mobility patterns and rebound effect: learnings from the pandemic

The reduction in passenger traffic was one of the major direct and immediate impacts of the COVID crisis, mostly due to mobility constraints imposed by governments and the fear of contagion in mass-transit networks. This had two major implications: a short-term positive effect on global GHG emissions, and a long-term negative effect for public transportation use and finance.

- **Short-term positive effect on emissions**
  The worldwide pandemic crisis affected all transportation systems. One of the striking consequences of the lockdowns was the significant decrease in passenger transport-related emissions - up to 95% in some cities (IEA, 2020b). This is probably due to the (hard) constraints on daily commutes. For the transport sector only, research estimates that emissions declined by 11.6% compared to 2019 (IPCC, 2022).

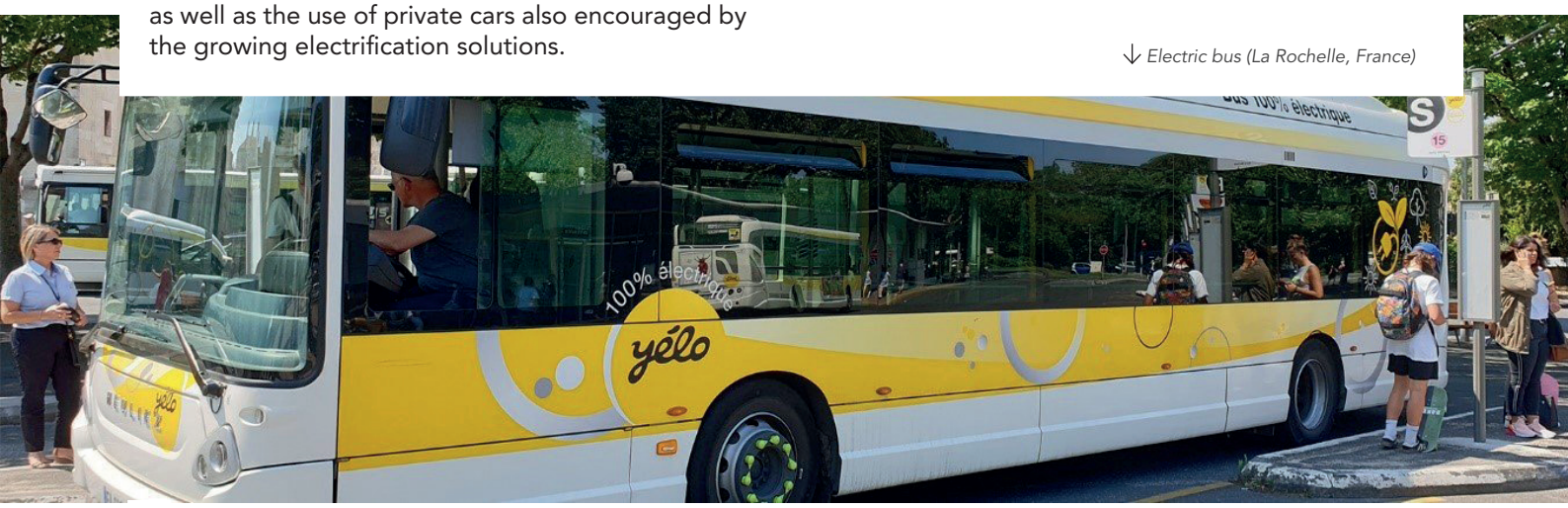
  Long-term negative impact on public transport structures. The lockdown fostered micro-mobility solutions as well as the use of private cars also encouraged by the growing electrification solutions.

Nevertheless, public transportation and railways still suffer from reduced demand with some major implications. First, some European cities lost a significant part of the public transport modal share to private cars. In the long term, these changes in travel patterns encouraged by environmentally friendly private cars could affect commuter traffic demand and people might relocate further to the outskirts of cities. Second, it fragilized the public transport authorities: they were particularly affected by the lost revenues during the lockdown and post-crisis eroded attractivity.

In 2022, a rebound effect was observed on emission trends after the pandemic: the constrained mobility reduction did not influence positive long-term behavior changes, and even encouraged a part of the population to relocate further and rely on the electric private vehicles boom for their needs. An increase in passenger traffic and cargo activities led to a 3% increase in transport emissions (IEA, 2023).

## The importance of long-term integrated urban planning

The development of infrastructure and settlement highly impacts the share of transport emissions and the use of public transport. In most cases, the wide difference between urban shapes results from market incentives, favoring high-density urban centers and low-density suburbs. In Europe, the challenge for public transportation and urban planning is to link the city to the living area as suburban mobility represents 1/3 of the emissions at the urban scale (Coldefy and Le Gendre, 2020). Efficient and integrated services can help address territorial inequalities of access to efficient mobility services.




↓ *Electric bus (La Rochelle, France)*

## Modèle Ergodique à Absorption et Saturation"[MEAPS model] (Parodi and Timbeau, 2023)

MEAPS is an economic model developed to analyze patterns of mobility, with a focus on work mobility as it represents 40% of the overall daily travels. Individuals mainly choose where to live in relation to their workplace, but there are some constraints as the price of living close by can be expensive. The modelisation tool allows to grasp all the mobility levers for the transition to greener networks: modal shift, reduction of the overall traveled kilometers, etc. MEAPS aims to do a cost-benefit analysis by dealing with the polycentric urban structure and encompassing all of these factors. The model is designed to be a replicable tool, using public data, for dialogue with the local population and authorities. Until now, it has been only applied to La Rochelle but is in the process of scaling up to Marseille, a city forty times bigger.

## Application to La Rochelle (France)

> **"When we produced the map, they [La Rochelle authorities] decided to re-discuss the SCOT [Urban Plans]. They had a way to show what they were doing was going to deteriorate the level of emission and would imply further cost to reduce emissions."**
>
> X. Timbeau, Economist at OFCE

The model was revealed to be impactful. Researchers worked in hand with municipal officers. In 2019, the municipality was working on a 30% carbon emission reduction part of the "La Rochelle Zero Carbone" by 2030 compared to 2019 levels. MEAPS in that case became a political tool to meet environmental targets. La Rochelle is an attractive seaside territory, with a high quality of life. The model concluded that for daily mobility on an annual basis, the inhabitants emit on average 1.56t $CO_2$-eq. Nevertheless, the shorter the distance to the city center, the less individuals emit. Therefore, the main challenge for public authorities is the steady-flow incoming population. The long-term urban planning strategy was to keep the same density across the territory, but it increased reliance on private mobility and urban sprawl. MEAPS reintroduced trust between urban and rural authorities and encouraged a long-term vision taking into account population and job density for transport planning.

> **"If you welcome new people in places that are not really dense today, but you increase the density, you will be able to expand public transportation networks there. You need to increase density: try to design a pleasant medium size neighborhood with decent quality of life. And by doing so you may reduce the number of kilometers and enter a positive dynamic. That is something that is probably more sustainable."**
>
> X. Timbeau, Economist at OFCE

Transit-oriented developments (TOD) are long-term urban strategies mixing land use and transport planning in order to reduce emissions and enhance the quality of life. Curitiba (Brazil) is one of the historical examples of TOD, with a program launched 50 years ago (ICLEI, 2016). In 1972, the city adopted an ambitious strategy to guide growth around infrastructure. They developed main transport corridors and implemented zoning and land-use regulations to increase the density of the mixed-use neighborhoods along the main axis. Downtown, the city created car-free zones and pedestrian areas. Overall Curitiba is a successful example of TOD, that paved the way for other cities such as Hamburg (Germany), or Vancouver (Canada) to create a low-carbon environments. TOD remains limited in European cities as most of the urban structures are stabilized. Finally, urban planning policies must consider equally land use and transport planning as the case of La Rochelle illustrated.

# 2. "SHIFT" - MODAL SHIFT TO LOW-CARBON TRANSPORT MODES

## The benefits of modal shift

What good is improved public transport if nobody uses it? The question of modal shift is one of the most widely discussed today, particularly at European level, where local governments have a certain capacity to weigh in on the issue. It is a very discussed topic because it has many implications. First, an ecological one: getting people to take public transport instead of driving their cars significantly lowers emissions, even if the means of public transport are not themselves electric. 20 people in an old, inefficient bus is still better for the environment than 20 people in as many individual electric vehicles. It also lowers air pollution. Linked to these reasons there is also a cost factor: a modal shift to public transport is the most cost-effective way to reduce individual transportation emissions, particularly compared to the cost of acquisition of electric vehicles, but also for all sorts of operators, who see higher fare revenues if more and more people pack up in a bus, also driving down the average cost of operations. It is also far cheaper for individuals to pay for public transport than for all the costs associated with a car. The modal shift also has a long-term effect on infrastructure costs for cities, which go down. Particularly, with less wear and tear on roads, maintenance costs go down significantly, since there are so many of them. There are also social benefits to modal shift, as it improves mobility for those who cannot afford cars, and reduces inequalities. Moreover, linked to both cost and emissions, modal shift is the most practical way to reduce emissions, since it is easier to do than completely redesigning our cities, or attempting a complete EV overhaul of private transportation (C40, 2021). Finally, modal shift can be a great step taken in decoupling carbon emissions from growth, by "lowering the diagonal" which puts emissions in direct relation with traveled kilometers (Gao & Newman, 2018). In consequence, many cities today include modal shift in their plans to achieve net zero emissions.

Overall we may say that we can modally shift to two types of low-carbon forms of mobility: active mobility and public transport. Active mobility, while an important part of urban carbon neutrality objectives, is harder to shift to, because of the makeup of cities today - they are too large for cyclists and pedestrians to regularly commute to work this way.

For example, despite Paris' best efforts, today only 11,2% of users commute to work on a bike, versus 5% in 2010 (Gonzalez, 2024). Doubling up the figure is impressive, and car use has gone down, but the fact remains that most Parisians today use public transit. To achieve a modal shift towards active mobility, cities need to be transformed, a long-term and gargantuan task. Public transportation, on the other hand, is a much more feasible and short-term alternative. This is not news, and it is why, even though a modal shift away from cars does not necessarily mean putting more people into public transport, this is the stated aim of many cities around the world. For example, Granada's action plan for the 21st century - the so-called *Agenda 21* - specifically mentions modal shift and lower reliance on cars, and intends to put in place more public transport (Ayuntamiento de Granada, 2003: 43). Another benefit of public transportation specifically compared to active mobility is that since it is easier to foment a modal shift towards it, it is more likely to indirectly lead to the transformation of cities. For example, in the Greater Paris metropolitan area, denser housing patterns are found around public transport stations.

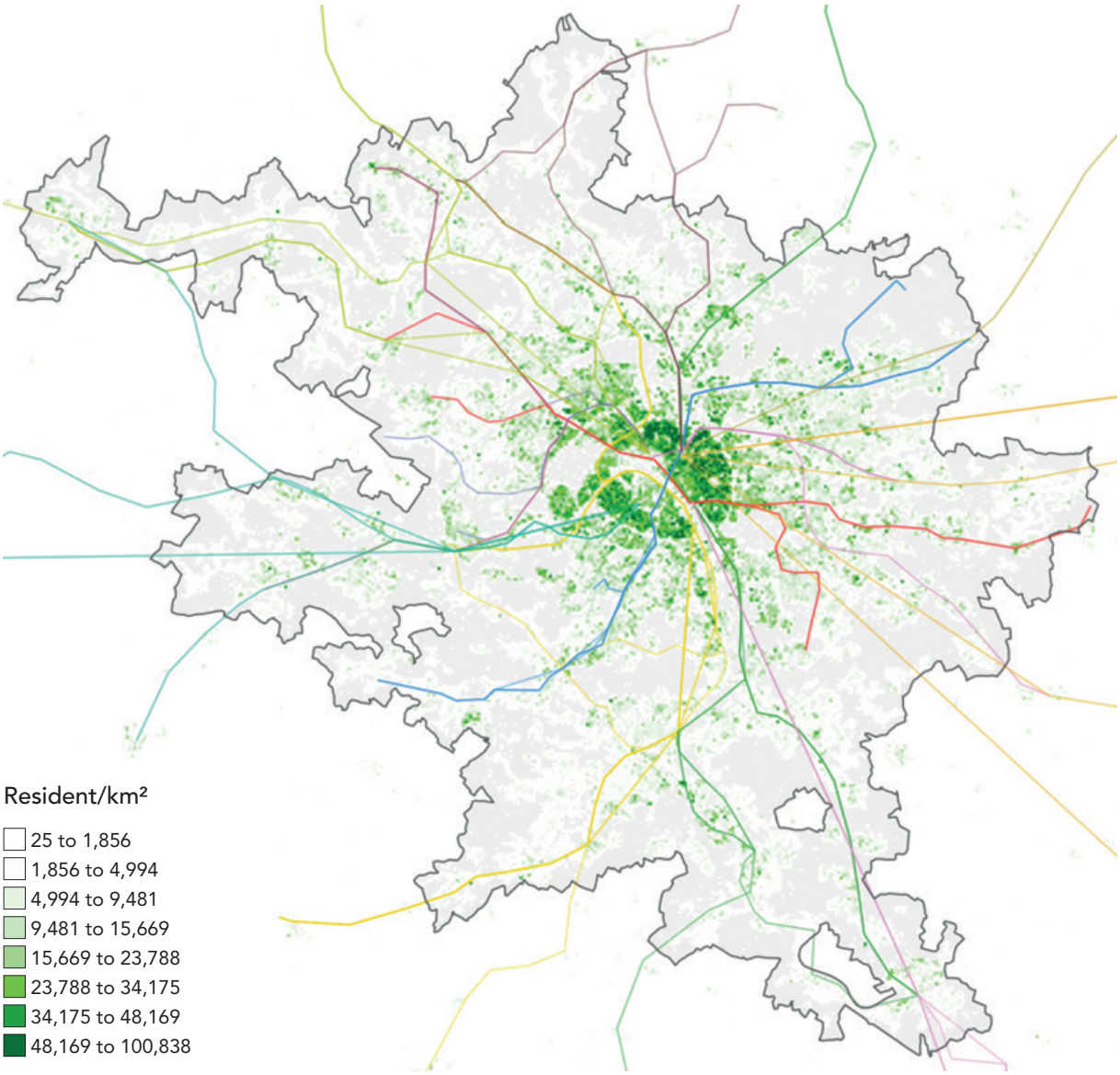



*Figure 10: Population density and public transport (metro) services | Sources : INSEE, Données carroyées (carreau 200m), population 2015 fidéli ; IRIS (Aire Urbaine) ; IDFM, GTFS open source, 2020*

Here, the chicken and the egg dilemma has a clear solution: nowadays density consistently comes after public transportation, and not the other way around. As further evidence of this, numerous North American cities have implemented or proposed future plans to purposefully densify cities along public transport corridors (the in-vogue transit-oriented development). Los Angeles and Toronto are good examples of this (Zhu et. al 2021). This phenomenon is a virtuous circle for all benefits of modal shift: as transportation drives densification, more and more people are keen on using the nearby public transport infrastructure, and this demand leads to increased capacity from operators, leading to even more urban transformations, and so on.

In Europe, most Sustainable Urban Mobility Plans (SUMPs) as well as other urban development plans include modal shift. This insistence at the local level partly originates from a lack of it at the European level, which recently has seemed to prioritize electrification (for example, all new buses will have to be carbon-neutral by 2035 according to the EU commission), even for public transport infrastructure, over modal shift, despite the fact that the former is far less effective in reducing emissions than the latter. But this local approach has allowed for policy innovation to flourish as cities attempt to figure out how specifically they could move people from cars to public transit.

International research shows that the main factor that plays into everyone's choice of transport is convenience (Dunedin City Council, 2023: 36). Several factors play into what "convenience" means, but there are two obvious main ones: cost and time. Overall, people want to commute in the least possible time for the cheapest possible price. This creates a two-pronged framework for modal shift, that all cities and operators play into: convenience and inconvenience, in a way the carrot and the stick.

## The "inconvenience" approach: making cars less attractive for commuters

The first multi-purpose "inconvenience" (meaning reducing the convenience of car transportation) approach in large cities is low emission zones or LEZ. This has been implemented in cities like London, Paris, Stockholm and Milan. The London LEZ has been a good example of a success story for modal shift. One of the fears of LEZs is precisely that while it might mean fewer combustion engine cars (a main reason for their implementation is reducing traffic congestion), it might not necessarily mean more people on public transport. Yet research has shown that in London, the lack of alternatives for users pushed the city to invest in new bus lines in order to accommodate the increased demand for transport alternatives that EVs could not realistically fulfill due to their cost (Litman, 2005). This is a prime example of inconvenience pushing people into buses. Similar "inconvenience" approaches can be seen with for example restrictive parking policies. This cost-based approach can also translate itself into more convenience-oriented policies, such as simply expanding public transport by either bringing it to further places, or by making it more regular and accessible. Here, price plays an important pull factor, since it is far, far cheaper than a car. Suddenly, the price competitiveness makes cars inconvenient. This is perhaps the most common policy proposal in favor of modal shift: more kilometers, more often. Granada, but also Paris, Milan, Florence and more have line extensions planned. Contrary to LEZs, these kinds of policies have the advantage of being applicable to medium-sized and smaller cities, where the former wouldn't have that much of a quantitative impact, and where public transportation options are scarce to begin with.

Beyond the mere issue of cost, there have also been blunt approaches to tackling the issue of time, for example Paris limited the speed limit on their Boulevard Péripherique, partly to make it safer, but also simply to annoy users enough so that they might take public transport. Paris has in fact been the queen of tackling the time constraint rather than the cost constraint, mostly due to social justice reasons: what good is a policy if the rich can simply buy their way out of it.

Things like an increase in bike lanes and the introduction of dedicated bus lanes were indeed on one hand done simply to increase accessibility, but also on the other to discourage car use. Dedicated bus lanes, also known as bus rapid transit (BRT), have been immensely popular around the world, this time by lowering the travel time of buses and thus increasing their convenience, by having them avoid congestion.

## The "convenience" approach: making public transportation more attractive for commuters

Other than these bold, blunt approaches at improving (or worsening, depending on which transport mode we're discussing) the cost and time of transportation of individuals, many more subtle approaches that can improve the modal shift to public transport exist. After all, if convenience is the name of the game, an accumulation of small changes can be enough to tip the balance in the eyes of users, particularly if they have both cars and access to public transit. In this case, public transportation must wage a war for the user's preference. Things like multimodal nodes can be useful, the typical example being putting up bike infrastructure right around public transport stations and stops, but it also means making transfers from one type of public transport to another as convenient as possible, with bus and tram stops in front of integrated subway/train stations.

In the same vein, integrated fares are also a must-have, and big exceptions unfortunately remain today: in Paris, for example, a user without a pass must pay for two tickets if they use both the subway and the bus, even if they are part of a single journey. Instead of per-trip fare, cities could adopt a more convenient timed fare like the ones in Australian cities, where a user pays for a two-hour unlimited access to all modes of public transport, making modal transfers easier for users. Per-trip fares represent a real loss of potential earnings for operators by driving up average costs. Another important aspect of convenience that is sometimes overlooked is safety. A recurring criticism of public transport in American cities is that it is unsafe. While not as loud in Europe, this criticism remains a real obstacle in the war for convenience, with things like pickpocketing or drug use disincentivizing commuters from hopping on a bus or train.


*Credit: Transdev.*

Finally, an often overlooked in Europe, but important aspect of the modal shift is image and marketing. Often what determines the convenience of a car are cultural and ideological values, with cars often being perceived as maximal examples of individual freedom, and arguments such as "With a car at least I can go wherever I want, whenever I want.". This is by and large not true, because a very developed public transportation system reaches the same objectives. For cities and operators both in places with great and developing public transportation, it is important to outline the real and perceived inconveniences of cars in order to drag people out of them: pollution, noise, accidents, space use, etc. To this aim, very clever marketing campaigns have been developed over the years. But in the minds of users, it is not enough to make cars seem inconvenient: public transport must seem more convenient than cars. This can be a real issue in some cities where public transport has a bad reputation and is seen as dirty, smelly, dangerous, etc. These are issues that can be addressed somewhat easily compared to other grander solutions that exist to tackle modal shifts. Correct upkeep of buses, trams, trains, stops, and stations can transform the image of a city and convince more people to switch to public mobility.

# 3. "IMPROVE" - VEHICLES AND FUELING

**"To have a serious impact we need to make everything as low carbon as possible. Influencing local authorities to make carbon shifts plays an important role, but we can't say 'you have to make this contract electric'."**

Katie Black, Head of Transdev's Energy Transition Department

Even if rethinking the way in which we move is central for reducing the impact we have on the planet and adopting a more sustainable lifestyle, nudge mechanisms (Thaler & Sunstein, 2009) are not sufficient in changing the overall picture. As effective as we can imagine and legislate on alternative, more active mobility habits, we need to take into account that medium-term results depend also on our ability to make existing vehicles and technologies more efficient and less polluting.
The scheme used to understand the efficiency and the potential impact a specific transport technology bears consists of two main components: energy intensity, measured with Joule / passenger-kilometer, and the fuel choice, $CO_2$ / Joule as measurement unity (Schipper et al, 2007). The biggest room for improvement belongs to private vehicles, as public transportation is more effective per definition when considering the amount of energy needed to produce 1 passenger/kilometer.

The global transport sector is overwhelmingly dependent on internal combustion engines (ICEs) and petroleum-based fuels. This reliance stems from the high energy density, ease of transport and storage, and the extensive global infrastructure supporting liquid fuels. Presently, approximately 95% of transport energy comes from petroleum-derived liquid fuels, and about 60% of all oil production is used to make transport fuels (BP Energy outlook, 2017; EIA, 2016; ExxonMobil, 2017; World Energy Council, 2012; OPEC, 2013). Light-duty vehicles (LDVs), primarily passenger cars, consume around 44% of the global transport energy demand, predominantly running on gasoline. The demand for transport fuels is immense, with the world requiring over 4.8 billion liters of diesel and gasoline daily. This demand is expected to rise, especially in non-OECD countries such as China and India, where vehicle numbers are increasing (WEF, 2016; ExxonMobil, 2017). Currently, alternative powertrains to ICEs are limited in their contribution to global transport energy. Bio-fuels, compressed natural gas (CNG), and liquid petroleum gas (LPG) together account for about 5% of transport energy, while electricity and hydrogen or synthetic fuels have negligible shares. Projections indicate that by 2040, around 90% of transport energy will still be supplied by combustion engines powered by petroleum.

## WHAT ROOM FOR ELECTRIFICATION?

Different degrees of vehicle electrification are primarily based on lithium-ion batteries, the most expensive component whose cost varies with the level of electrification. Only battery electric vehicles (BEVs) rely entirely on electricity, while other «electric» vehicles use hybrid powertrains that derive some power from an internal combustion engine (ICE). Full Hybrid Electric Vehicles (HEVs) use an ICE for all energy, with a battery and electric motor managing energy flow for efficiency and energy recovery in braking. Series hybrids use the ICE to charge a battery that powers the vehicle's motor, while plug-in hybrid electric vehicles (PHEVs) can operate on electric power for about 40 km and use conventional fuel beyond that range. If the battery range in a PHEV is small, owners may not plug in their vehicles, using them as regular HEVs. BEVs require larger batteries and power electronics, making them more expensive. Despite constraints on rapid expansion, hybridization is expected to spread rapidly. BEVs produce no tailpipe pollutants but their impact on greenhouse gases (GHGs) depends on the electricity source.
Manufacturing BEV batteries can result in high GHG emissions, potentially 200 kg $CO_2$ eq/kWh, and in areas like China, BEVs may have higher life cycle CO2 emissions than ICE vehicles due to coal-based electricity (Union of concerned scientists, 2012; Weis et al., 2016). This suggests promoting BEVs might be counterproductive until the power sector is sufficiently decarbonized (Hofmann et al., 2016). Battery size limitations confine full electrification to small passenger cars, with commercial transport impractical. Electric city buses and delivery vans are feasible but expensive. Significant changes in electricity generation and distribution are needed to support widespread BEV adoption. For instance, converting all U.S. passenger cars to electricity would require a 25% increase in electricity generation (Smil, 2010). In the U.K.

the potential increase in peak electricity demand from 9 million BEVs by 2030 is around 8 GW (National Grid, 2017). Moreover, widespread domestic charging could overstress the electricity network, reducing transformer life (Muratori, 2018). A smarter grid to manage charging times and significant investment in public charging infrastructure are essential. For example, the U.K. might need up to 2.5 million new public charging points, costing up to 87 billion euros (Reuters, 2017). Thus, significant investment in power generation, infrastructure, and grid management is required for substantial electrification in the transport sector (IEA, 2017).

## WHERE ARE WE WITH HYDROGEN TECHNOLOGIES?

Hydrogen is likely to be used in fuel cell vehicles (FCVs) for transport due to its higher efficiency, quicker refueling, and longer range compared to battery electric vehicles (BEVs). Hydrogen can be produced from various sources (biomass, natural gas, coal), enhancing energy security and diversity (IEA, 2007). However, FCVs are currently very expensive, with vehicle storage tanks alone costing $3,000 - $4,000

The primary barrier to the rapid growth of FCVs is the development of hydrogen infrastructure. Hydrogen, like electricity, is an energy carrier, and its production requires significant energy (EMPA, 2015; US DOE, 2009). If the production energy is not renewable or $CO_2$-free, the $CO_2$ emissions from hydrogen cars may exceed those of conventional cars. The cheapest hydrogen sources are natural gas and coal, which produce $CO_2$ and necessitate $CO_2$ capture and storage to mitigate emissions. Biological hydrogen production remains in the research phase. These processes consume significant energy; for example, liquefaction can use up to 40% of hydrogen's energy content. These methods also pose challenges for vehicular transport. Transporting, storing, and delivering hydrogen is costly due to the need for high pressure or low temperature. Global investment in hydrogen supply infrastructure for transport is estimated to range from several hundred billion dollars over several decades ($0.1–$1.0 trillion for pipelines and $0.2–$0.7 trillion for refueling stations). Substantial research and investment in transport infrastructure will be required before commercial hydrogen supply becomes feasible.


*Credit: Transdev*

## Pontevedra, the story of a shift away from cars


**"Before, the car was king; it was at the top of the priorities. Today, the circumstances have changed radically, and people are placed above machines."**

Concello de Pontevedra (2024)

Pontevedra is a Spanish coastal city of 84.000 inhabitants, located in the province of Galicia.
It illustrates a winning and virtuous example of a shifted perspective in city planning and urban organization. What needs to be recognized is that effective transformation was achieved in the presence of a strong political will.

From 2000 onwards, the city council decided to drastically reshape the urban landscape by reducing the amount of cars in the city center and controlling the maximum speed for allowed vehicles. The primary aim was not to change mobility to comply with international normative imperatives; differently, the goal was to create vast, accessible public spaces enjoyable for each and every citizen. The outcome, hence, was a remodeled city, rather than a mere mobility plan (Maggi, 2020). As a consequence, noise pollution levels have dropped, GHG emissions decreased by 70%, air quality has increased, road traffic casualties declined to zero and the overall livability of the city has soared bringing 8.000 people back to their hometown. The success of this metamorphosis is measurable not just through the aforementioned figures but also through the broad consensus established,as the municipal administration has been in charge for the past 20 years and the contentment and prosperity is shown by support from citizens. ■

**PEDESTRIAN STREETS COMPARISON BETWEEN 1999 AND 2015**

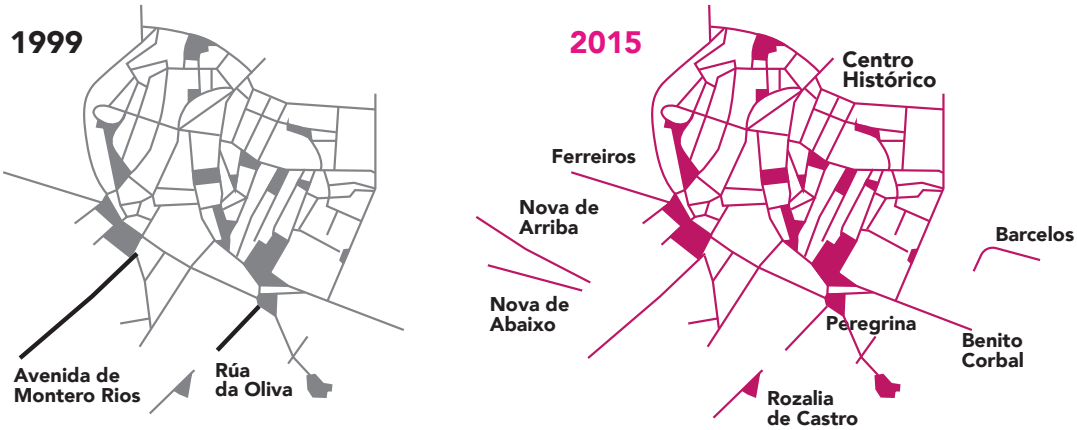



*Figure 11 & 12: Movilidad alternativa | Source: Concello de Pontevedra(2024), https://ok.pontevedra.gal/es/movilidad-alternativa/*

# CHAPTER 3: BEST PRACTICES & TOOLS

Chapter 3 firstly proposes a series of tools available to cities to fund public transport and finance new infrastructures if needed. Then, based on several case studies that have ambitiously - or not - integrated mobility as a component of their transition policies, we aimed to review and share the best practices.


# BUDAPEST (HUNGARY)

*Budapest Tramway (Hungary)*

| ADMINISTRATION | FINANCE | INFRASTRUCTURES | ENVIRONMENT |
|---|---|---|---|
| Capital city of Hungary<br><br>1.7 million inhabitants<br><br>Opposition-led city since 2019 (up to June 2024)<br><br>PTA: BKK PTO: BKV | Municipal budget: €1.1bln<br><br>35% of Hungary GDP produced in Budapest<br><br>Transport sector: 45% of municipal expenditures | Metro: 4<br><br>Tram: 38<br><br>Trolley bus: 16<br><br>Bus: 180 | Climate Strategy, Sustainable Energy and Climate Action Plan (2020): reduce by 40% GHG emissions by 2030<br><br>Sustainable Mobility Plan: reduce car travels at 30% of the share |

## General context

Budapest is one of the European cities with the highest share of public transport modal split (50%) for historical reasons. Nevertheless, the post-socialism period encouraged the spread of private passenger car traffic, and public transport authorities now suffer from decades of low public investment and lack of autonomy. The city recently enacted the will to cut emissions by 40% by 2030 through a drastic reduction of car modal split (BCAP, 2020). One of the main obstacles to renewing the fleet and developing infrastructures remains the lack of public funding due to political disputes.

## Financial impact of political disputes

The public transport model in Budapest is inspired by the Transport for London organization. Since 2012, BKK has been the integrated PTA, and BKV, the PTO. Approximately 98% of the revenues are coming from service fees and collected by BKK, while a very small proportion is coming from other services (touristic operations, value capture, etc.). Both companies are able to receive funding from the government and invest in infrastructure development, even though BKK predominantly financed post-2012 projects (train lines and depots, trams and trolleybuses lines).

> **"The cost of going green is very high and because it is political, the politicians have to finance it."**
>
> Lazló Bátora, BKV CFO

Budapest Municipality has been run by the opposition party since 2019, since then, the national government adopted a restrictive financial strategy. Additionally, Hungary has a centralized governance - and tax - system, decreasing the financial autonomy of the municipalities. Municipalities and PTAs are not allowed to take loans without the consent of the Hungarian government; this is also an effective way to control the autonomy of the opposition-led cities.

The shift to a low-carbon transportation system in Hungary is highly political and illustrates the obstacles encountered by the Municipality. Firstly, Budapest launched a pioneer program in 2016 for the purchase of 30 electric buses, out of which only 10-12 were put in operation. Even though the overall project was a success in getting experience, measuring, and monitoring the operational features of the buses, Budapest PTOs concluded that electrification might not be the best way to improve the financial and environmental situation. The cost of going green is much higher than traditional gas vehicles. One of the biggest challenges for BKV is to renew the outdated bus fleet (around 900 buses) averaging 9-10 years old, with most of the buses in operation for more than 15 years. This comes with a significant part of it ranked in the most European polluting categories (Euro 0 - Euro III). The main issue is to operate efficiently with limited financial resources.

> **"Not everyone agrees that electric buses are the future. We can buy one electric bus. But we can buy two Euro VI diesel buses for that price. And if you can buy two Euro VI diesel buses, emissions levels go down."**
>
> Lazló Bátora, BKV CFO

Recently, the government invested EU funding to purchase 40 electric brand new buses for Budapest. The city center is equipped with electric facilities and faces the biggest emission problem. Yet, the e-buses were given to the state PTOs providing commuter services between the suburbs and the city. Because of political struggle, these buses were not implemented directly because the infrastructure was not ready.

## A costly transition

- **Municipal budget**
  Due to high centralisation, cities are exposed to the central budget and do not enjoy a lot of financial autonomy. Yet, they have a maneuvering power, as illustrated by the extremely high share of public transport expenditures in the Municipal budget (40-50%); this only serves the operational funding.

- **EU funds**
  Budapest largely benefited from the Cohesion Policy fund in the past. It allowed major infrastructure investments such as the refurbishment of the Metro Line 3 with the past-period budget. Nevertheless, the European fundings are either project-based or allocated by the national government, which does not represent a reliable nor a continuous source of funding. Moreover, funding largely decreased in the past few years due to the conservative political decisions of the current Hungarian president. In fact, Hungary remains the only member state that did not receive COVID recovery funding.

- **Private capital**
  The municipality public transport operators are not autonomous, yet, they have project plans waiting for funding and are already supported by the banks. BKV has an application for HUF 30 billion for an investment loan program which just misses the approval of the central government.

## Future prospects depending on financial support

- Further develop of the tramway network, which is already extensive. There are plans to develop it and buy new vehicles. Trams are perceived as a lever for emission reduction and are more financially sustainable than e-buses.
- Enhance potential of the trolleybuses in Budapest - already a fleet of 150 - which are less and less dependent on the grids. Could significantly contribute to reducing emissions and low-carbon modal shift.


*"If you're a public company, you can sit at home and wait for the government to give you money for being public, or you can manage the company like a private firm. We wanted initiative and decisions, so we managed it like a private company."*

Alberto Alonso, Strategy and Finance Director of EMT Madrid

# MADRID (SPAIN)

*Madrid EMT Bus*

| ADMINISTRATION | FINANCE | INFRASTRUCTURES | ENVIRONMENT |
|---|---|---|---|
| Capital city of Spain<br><br>3.34 million inhabitants<br><br>PTA: CRTM (Consorcio Regional de Transportes)<br><br>PTO: EMT (Empresa Municipal de Transportes) | Stock exchange<br><br>Companies headquarters (Telefonica, Repsol, Iberia) | Metro: 12 (287 km)<br><br>Light rail: 4 lines (35,4km)<br><br>Cercanias ferroviárias: 9 lines (391 km)<br><br>Urban buses: 203 lines (3.562km) | SUMP approved in 2022, it will run until 2030. They have planned metro line extensions and green corridors.<br><br>EMT Madrid wants all buses to be electric by 2033. |

## General context

Madrid is the richest city located in the richest region in Spain. It is the center of the country in almost every sense of the word and the most populous city in the country. This translates into a very complete and high-quality public transport system. Transport in the city is arranged and coordinated by the CRTM, the Regional Consortium of Madrid Transports. The public authority administers a variety of public transport means in the region, but the main three in Madrid are the city's metro, the city's light rail (or tram) system, and the city's buses. Buses are operated by the municipal transport company EMT Madrid, a public entity with a fleet of 2,100 buses.

## A successful decarbonisation story?

EMT Madrid is an example of a decarbonisation success story, but not necessarily in the way we might think. To start, not one of the company's buses is a diesel engine bus, which is 0 out of 2,600 buses. Out of the whole fleet, 1,800 buses run, on natural gas, and 300 are fully electric vehicles. In 2024 they expect another 150 electric buses to enter the fleet, and they are running a test pilot for hydrogen buses. Bus depots are being covered with solar panels, in order to be self-sufficient, although in the long run they will not provide enough energy to cover all vehicle consumption.

Madrid is an interesting case because we may see in it a very gradual shift towards full-electric. The goal that the company has set to itself is that the entire fleet must be fully electric by 2033, meaning it must add to its fleet 180 buses on average per year in order to achieve that goal. With 150 to be added this year, the EMT is not that far off and seems poised to reach the target. This contrasts, however, with cases like Bogotá or Goteborg, which have pushed for an all-electric fleet at an accelerated pace. The gradualness comes, of course, from the choice of natural gas engine buses as an explicit transition mechanism. While natural gas engines still emit $CO_2$, they do so less than traditional diesel engines, and they have the added advantage of emitting less NOx, which have more severe adverse health effects than $CO_2$ and are also a GHG. The issue remains, however, of the emission of $CO_2$, a GHG gas. A small concern in the eyes of EMT's strategy and finance director, who outlines that Madrid buses have an average age of 5 years, one of the youngest fleets in Europe, meaning that even carbon-emitting buses are as efficient as they get.

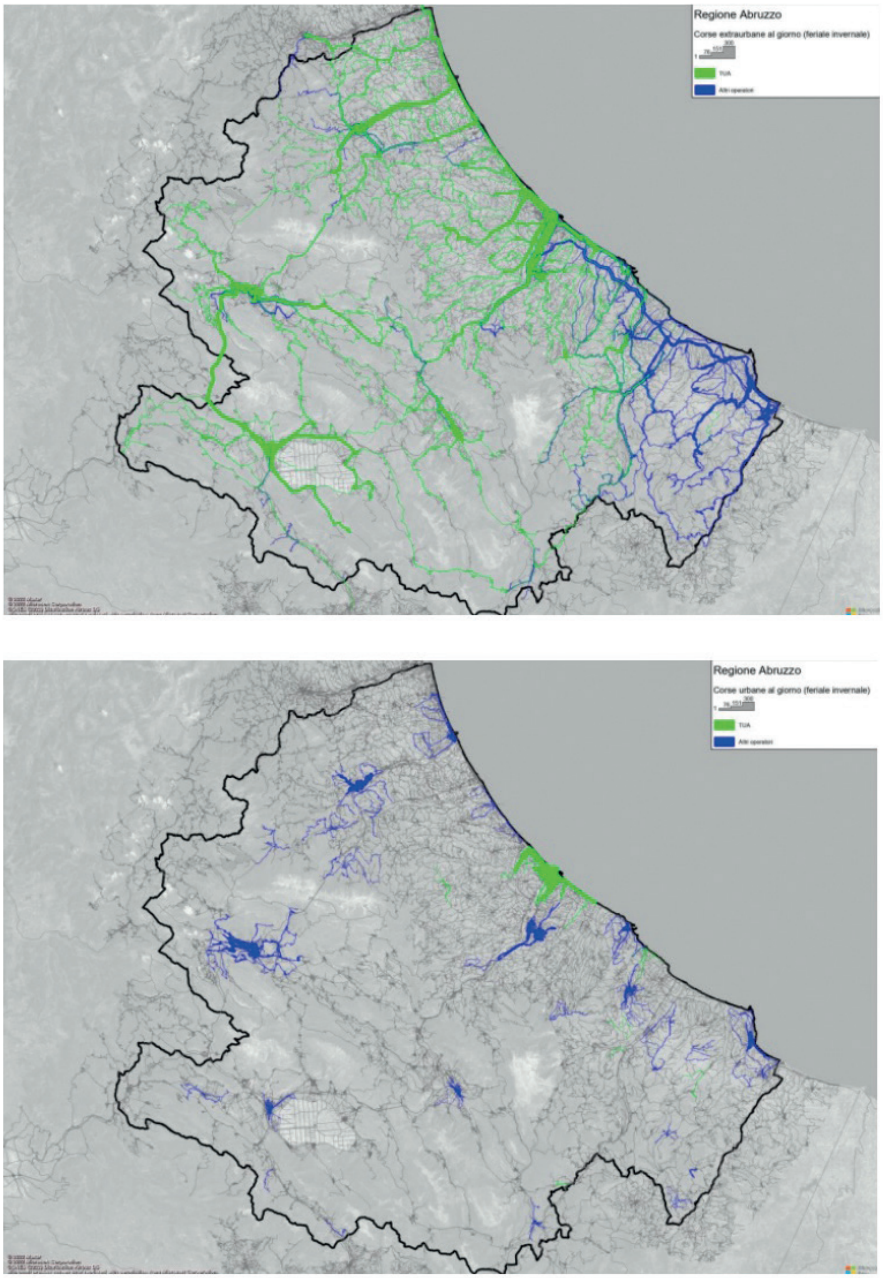
## Financing the EMT with EU funds

The main tool used to finance this transition so far has been NextGenEU funds, which EMT managed to access. This money allowed to halve the price of electric buses, bringing them closer to the price of the less onerous natural gas buses. Now that NGEU money has been exhausted, the company has turned to other sources of financing. Their main one remains the wealthy Madrid city and region, with the CRTM amortizing the capital expenditures (paid upfront by the EMT) for new buses over the course of 10 to 15 years. It also still turns to EU money, applying for CEF (Connecting Europe Facilities) funds for the purpose of electric recharge infrastructures, specifically depots and inverted pantographs. And to the EMT's delight, operating expenditures for gas and electric buses are actually lower than for diesel buses, mostly because maintenance costs are cheaper. This brings up the share of user fee revenue up to 40 to 45% of all income, compared to Paris' 30%. Attempts at modal shift also enter into their financing strategy, since ridership today is perhaps surprisingly higher than pre-covid pandemic, bringing down the average operational cost of a bus.

## The liberal governance of public transport

EMT Madrid is an example of liberal management of public transportation, as per the strategy and financing director's own words. The company, he says, ought to be managed like a private enterprise. That is what allowed him to obtain EU funds, for example. It is also what has pushed the EMT to pursue alternative transition fuels for decarbonisation, natural gas, and hydrogen since he does not believe in coercion or an accelerated transition. The not-unimpressive figure of 40 to 45% of revenue coming from user fares is also in part due to this style of management: the EMT refuses free public transportation, fearing that users will not value it and will take it for granted, and of course tax increases are not desirable eithe. This leads to an attempt to maximize the number of customers. It also attempts to retain users through brand loyalty, which raises ridership numbers. Finally, in the same liberal vein, there is a strong emphasis on innovation as a means to decarbonize faster, with a brand new hydrogen plant having been created in recent years, and the ingenuous addition of inverted pantographs to bus depots, which automatizes electric bus recharges.

EMT Madrid remains a public company, with a majority of its revenue coming from state subsidies, and a general understanding that despite its style of management, it remains a public service tasked with providing Madrilenians with a cheap and reliable form of mobility that they could otherwise not afford.




*TUA bus routes (green): extra-urban (above), urban (below)*

# ABRUZZO (ITALY)

| ADMINISTRATION | FINANCE | INFRASTRUCTURES | ENVIRONMENT |
|---|---|---|---|
| Southern Region, Italy<br>1.281.012 inhabitants | Regional Budget (2022):<br>€4,2 B<br><br>Net revenues, TUA (2022):<br>€117 M<br><br>Net income, TUA (2022):<br>€337 K | Railway: 9.5 km<br><br>Buses: 845 in total, CNG urban buses.<br>E-Buses (Pescara): 48 by 2026<br><br>Km/year: 29.462.478 | Regional Integrated Transport Plan (2022): expand and augment infrastructure and intermodality hubs. |

## Context

Situated in the southern part of Italy, Abruzzo presents some of the typical characteristics of the socio-economic situation of the South of the country. Chronic issues such as depopulation, the shifting of the age pyramid, the reduction of public spending, and economic-industrial stagnation create a vicious cycle with a tendency to self-perpetuate in the absence of strong political will.
The Local Public Transportation (TPL) sector is no exception. In the 1990s and 2000s, Italy's public transport sector underwent significant changes, as a consequence of EU competition measures to reduce public involvement and promote private sector engagement through competitive bidding processes. However, Italy's pre-existing situation was highly fragmented, with continuous renewals of concessions and inadequate service planning and execution.

## Abruzzo and TUA

In Abruzzo, the corporatization of former public companies did not result in a change in management philosophy. Economic sustainability, a crucial aspect of corporatization, was largely overlooked. By 2014, the main company faced a complete collapse of financial balance due to the lack of business management criteria.

The region controlled three main transport companies:

- ARPA: Established in 1978 to rescue private operators, with 95% owned by the region and the remainder by local entities.
- GTM: Managed the former Penne-Pescara railway, and transformed it into bus services within and beyond Pescara.
- Sangritana: Operated a largely disused 200 km railway, with only 9 km in use at the time.

ARPA received funding based on a per-kilometer fee due to a concession agreement, with the region commissioning an annual amount of kilometers and contributing approximately €2 per km. GTM and Sangritana operated under service contracts, with Sangritana receiving additional maintenance contributions.

## Financial and operational challenges

> *"Corporatizing management means having a car with a working engine; deciding where to go is a political choice. Corporatization means creating value. What to do with this value is a political choice."*
> (Luciano D'Amico. Former TUA president)

The former concessions operated on a philosophy of spending all allocated funds, or more, without regard for financial balance. This generous funding, combined with easier operational planning, allowed Sangritana and GTM to maintain balance. However, ARPA faced difficulties with regional extra-urban services, where subsidies were only provided for routes not covered by rail. Additional unnecessary routes led to significant annual losses. Funding reductions by the Ministry of Transport, cascading to the regional government, resulted in limited contributions and an aging, polluting fleet. Despite this, ARPA carried out an expensive investment campaign, leading to a severe financial crisis by September 2014. In contrast, GTM achieved balance by converting much of its fleet to methane in 2008 for environmental and economic reasons. The three companies collectively covered 70% of Abruzzo's TPL.

## Resolution and restructuring

A mid-year extraordinary budget revealed significant capital erosion and a major deficit, necessitating a capital reset and reconstruction without relying on public funds. The solution involved merging the companies, with ARPA's capital reconstructed by acquiring 100% of GTM and Sangritana shares. This streamlined procedure led to the creation of a new company within a year, resulting in immediate financial benefits, including a €10 million cost reduction in the first year, from a total production value of €140 million, and the elimination of non-subsidized kilometers. The merger created the sixth largest Italian TPL company.

## Why go public?

> *"Public sector presence is justified if it allows for the implementation of a political vision through experimentation and innovation: if it serves as a driver of development."*
> (Luciano D'Amico. Former TUA president)

Public ownership of TPL is justified when public interest benefits are accomplished through value creation mechanisms. In the case of TUA, the non-plus-ultra would have been represented by a public company covering 100% of TPL, achieving maximum economies of scale, and organizing a regional TPL not strictly driven by economic conditions. Experimentation and innovation are applied also to fleet maintenance not constrained by profitability, such as reducing pollution through alternative fuels and technologies. The experimental approach ceased with a political shift in the regional administration. TUA now operates some electric buses but has abandoned a broader experimentation and vision of sustainability. The Filovia project aimed to create an efficient service in the densely populated metropolitan area, using an exclusive transit road, but this was also halted.

## Future prospects

In the metropolitan area from Ortona to Silvi and up to Manoppello, a plan to enhance public transportation efficiency was designed (2014-2017) by establishing two main routes: vertical and horizontal, forming a large «T.» The trolleybus system was proposed to meet this need, utilizing exclusive transit rights. The project aimed to create four strategic barriers to make Pescara free from internal combustion engine buses. The north-south axis would have been served via the trolleybus; westwards, barriers were to be set to halt extra-urban buses, transferring passengers onto the «T» structure, with urban lines operated by electric buses. An additional tool to reduce reliance on private vehicles was the proposition of increasing fuel excise taxes, partially financing free public transport, promoting decarbonization, and enhancing the social prestige of public services. The overarching goal is to change perceptions, demonstrating the environmental and social benefits of public transportation, and align with a vision of systemic infrastructure enhancement.

# RABAT (MOROCCO)

*Rabat Tramway (Morocco)*

| ADMINISTRATION | FINANCE | INFRASTRUCTURES | ENVIRONMENT |
|---|---|---|---|
| Capital city and Royal City of Morocco<br><br>2.1 million inhabitants (metropolitan area) | Municipal budget: €0.1bln<br><br>Massive financial support for infrastructural development by the central government | Tramway: 2 lines/30 stops<br>LRT: 3 stops<br><br>Buses: approx. 400 | Few climate policies: social and economic development is being prioritized over mitigation |

## General contex

As the Royal City, Rabat enjoys a privileged status in Morocco, often receiving more attention from government actors and the Monarchy than other cities. Its transportation system reflects its significance. Although the city is, like most urban centers in Morocco, still overloaded with road traffic, it now benefits from a well-developed network.

The city's public transportation network is anchored by the Rabat-Salé tramway, a 19.5-kilometer system that connects Rabat with its twin city, Salé. This tramway has significantly alleviated traffic congestion and provided a reliable alternative to private car use. Additionally, the city is served by Morocco's most extensive bus network - approximately 400 buses run through the city as of 2024.

## Future prospects

Looking ahead, Rabat's transportation system is poised for significant growth and enhancement, driven by Morocco's great investments in infrastructure development and the upcoming 2030 World Cup, which the country will co-host. Rabat, as a host city and showcase for the Monarchy, is set to receive substantial investments aimed at upgrading its transportation infrastructure.

Key future projects include the expansion of the tramway network, with new lines planned to cover additional districts and improve coverage. There are also plans to modernize and increase the capacity of the bus fleet to the 500-bus mark. Furthermore, Rabat is greatly investing in smart city initiatives, incorporating technology to improve traffic management, reduce congestion, and enhance the overall efficiency of public transportation.

The development of a high-speed rail network, Al Boraq, linking major cities, including Rabat, to Tangier, Casablanca, and eventually Marrakech, is another significant project that will improve the city's connectivity. These advancements will not only accommodate the anticipated influx of visitors for the World Cup but also support Rabat's rapid urban development: the urban area's population is growing at an annual rate of almost 2%.

## Financial constraints

Despite the ambitious plans, Rabat faces serious financial constraints. There is little doubt that these projects, driven by government investments, will be completed by the time of the World Cup; the long-term financing of these operations, however, could pose a problem given local administrations' limited resources. Rabat is already the second most indebted city in the Kingdom, closing most of its budgets with a considerable deficit. It remains to be seen whether the city's rapid economic development will be able to support the massive expansion in public spending planned over the next few years (extension of public transport, opening of new cultural infrastructure).

Climate change will also have a profound effect on Morocco. The probability of natural disasters (drought, but also earthquakes and floods) will increase by unclear proportions, but is likely to be much higher than the global average given Morocco's geography and geology. Yet, the Moroccan government's investment projects generally pay little attention to adaptation to climate change - as proven by the 2023 earthquake, which had an intensity of only 6.8 and 6.9 on the Moment Magnitude (Mw) scale yet had destructive consequences on Casablanca's infrastructure, is a reminder of this unpreparedness. Rabat's transport system, in this context, is hardly resilient to potential natural disasters; unless further measures are taken soon, disasters' increasing likelihood makes the long term sustainability of the transport system uncertain.

# RECOMMENDATIONS

Existing funds tackle either individual mobility, specially in terms of personal electric vehicles acquisition, or heavy infrastructure development for long distance travels, such as railways, missing day-to-day urban mobility as a key investment area that requires strong support from public and private financing sources. Given the public service obligations that weight on its economic balance, the industry requires more support than any other.

Green financing schemes go mainly towards mitigating Climate Change under the current mobility paradigm (maintaining individual flows but electrified) instead of fostering adaptation for meaningful change (massifying mobility flows). This does not provide the adequate incentives to change our existing urban models into more sustainable ones.

Transit-Oriented Development & Multimodal Metropolitan Public Transport are the two most efficient investment areas in the filed of urban development to avoid Climate Change; however, these require integrated urbanism & transit planning at the right level of governance. Current funds do not enhance the emergence of such institutional set-ups, and still give to much weight to national entities in terms of fund distribution and allocation decision-making.

Public Transit generates value; however, this does not appear today in companies' balance sheets. Financial institutions need to think holistically about an economic activity's impacts if they want to optimize investment where it has the most positive effects for our communities.

Having individual vehicles as the major referential of mobility in decision-makers minds does not enable accurate representations of what will build a truly sustainable future for all: efficiency and good use of resources through shared means is still today, by far, the most adequate answer to meet our generation and future generation's needs.

# BIBLIOGRAPHY


Alonso, W. (1964). *Location and Land Use.* Cambridge, MA: Harvard University Press.

Ayuntamiento de Granada. (2003). *Plan de Acción de la Agenda 21 Local de Granada.* Retrieved from the Municipality of Granada website.

Bertaud, A. (2004). The spatial organization of cities: Deliberate outcome or unforeseen consequence? Retrieved from Alain Bertaud's website.

BP. (2017). *Energy Outlook 2017.* Retrieved from here.

C40. (2021). *How to make public transport an attractive option in your city.* Retrieved from C40 Knowledge Hub

Capello, R., Nijkamp, P., & Pepping, G. (1999). *Sustainable Cities and Energy Policies.* Berlin: Springer-Verlag.

Cardesin Diaz, J., & Mirás, J. (2017). Historic Urbanization Process in Spain (1746-2013): From the Fall of the American Empire to the Real Estate Bubble. Journal of Urban History, 43, 33-52. https://doi.org/10.1177/0096144215583481

Chestney, N. (2017). "Britain Faces Huge Costs To Avoid Power Shortages With Electric Car Plan". *Reuters* [online]. Retrieved from here.

Coldefy, J., & Gendre, P. (2020). *Retours d'expériences Cars Express* [Feedback on Express Coaches]. Government of France, Ministère de la Transition Écologique, Paris. Retrieved from Francemobilité.fr.

Concello de Pontevedra (2024). "Movilidad alternativa"https://ok.pontevedra.gal/es/movilidad-alternativa/

Dunedin City Council. (2023). *Zero Carbon Plan 2030.* Dunedin City Council. Retrieved from Dunedin City Council website.

European Commission (2023). "Transport and the Green Deal". European Commission [online] Transport and the Green Deal - European Commission (europa.eu).

Eurostat. (2022). Household expenditure by consumption purpose - COICOP, EU, 2022, share of the total. Retrieved from Eurostats: DOI.

ExxonMobil. (2017). *Outlook for Energy: A View to 2040.* Retrieved from here.

Gao, Y., & Newman, P. (2018). *Beijing's Peak Car Transition: Hope for Emerging Cities in the 1.5 °C Agenda.* Urban Planning, 3, 82-93. DOI.

González, S. (2024, April 24). La revolución ciclista de París continúa: El uso de la bici ya supera al del coche dentro de la capital. *El País.* Retrieved from El País [online].

Hawkins, T.R. et al. (2013) Comparative Environmental Life Cycle Assessment of Conventional and Electric Vehicles. Journal of Industrial Ecology, 17: 53-64. DOI.

Hofmann, J., Guan, D., Chalvatzis, K., & Huo, H. (2016). Assessment of electrical vehicles as a successful driver for reducing CO2 emissions in China. *Applied Energy*, 184, 995–1003. DOI.

ICLEI (2016), "Curitiba, Brazil A model for Transit Oriented Development". ICLEI Case Study, 190 [online] iclei_cs_190_curitiba_urban-leds_0_0.pdf (thegpsc.org)

International Energy Agency (IEA). IEA. (2007). *Energy Technology Essentials: Hydrogen Production and Distribution.* Retrieved from here.

___ (2016). I*nternational Energy Outlook 2016.* Retrieved from here.

___ (2017). *Global EV Outlook 2017.* Retrieved from here.

___ (2020a). *World Energy Outlook 2020.* Paris. Retrieved from here.

___ (2023). *Tracking Clean Energy Progress 2023.* Paris. Retrieved from here.

___ (2020). *Changes in transport behaviour during the Covid-19 crisis.* Retrieved from here.

IPCC. (2014). *Climate Change 2014: Mitigation of Climate Change.* Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. Full Report.

___ (2022). *Climate Change 2022: Mitigation of Climate Change.* Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK and New York, NY, USA. Full Report.

ITF. (2023). *ITF Transport Outlook 2023.* OECD Publishing, Paris. Retrieved from here.

___ (2024a). *The Future of Public Transport Funding.* OECD Publishing, Paris. Retrieved from here.

___ (2024b). *Transport at the nexus: Reflecting on COP28 and looking ahead to COP29.* Retrieved from here.

___ (2024c). *How serious are countries about decarbonising transport?* Retrieved from here.

Litman, Todd (2005) : London Congestion Pricing – Implications for Other Cities, CESifo DICE Report, ISSN 1613-6373, ifo Institut für Wirtschaftsforschung an der Universität München, München, Vol. 03, Iss. 3, pp. 17-21. Retrieved from London Congestion Pricing – Implications for Other Cities (econstor.eu)

Maggi, S. (2020). Mobilità sostenibile, muoversi nel XXI secolo. Il Mulino

Martiskainen, M., et al. (2021). New dimensions of vulnerability to energy and transport poverty. *Joule,* 5(1), 3-7. DOI.

Muratori, M. (2018). Impact of uncoordinated plug-in electric vehicle charging on residential power demand. *Nature Energy*, 3(3), 193–201. DOI.

Muth, R. F. (1969). *Cities and Housing*. Chicago: University of Chicago Press.

National Grid. (2017). *Forecourt Thoughts: Mass Fast Charging of Electric Vehicles*. Retrieved from here.

OPEC. (2013). *World Oil Outlook*. Retrieved from here.

Owens, S. (1992). Energy, environmental sustainability, and land-use planning. In M. Breheny (Ed.), *Sustainable Development and Urban Form* (pp. 79–105). London: Pion.

Parodi, M., & Timbeau, X. (2023). MEAPS: Modelling commuter flows [Translation by Scotia Hille]. *OFCE Working Paper n°2023-15*. Retrieved from https://preview.meaps.fr

REN21 Secretariat. (2019). *Renewables 2019: Global Status Report*. Retrieved from here.

Romano, B., Zullo, F., Fiorini, L., Marucci, A., & Ciabò, S. (2017). Land transformation of Italy due to half a century of urbanization. *Land Use Policy*, 67, 387-400. DOI.

Schipper, L., Lv, T., Zhan, J., Wang, S., & Pan, F. (2022). Carbon Emission Measurement of Urban Green Passenger Transport: A Case Study of Qingdao. *Sustainability*, 14(15), 9588. Retrieved from DOI.

Smil, V. (2010). *Energy Myths and Realities: Bringing Science to the Energy Policy Debate*. Washington, D.C.: AEI Press; Lanham, Md.: Distributed by Rowman & Littlefield. Retrieved from here.

Thaler, R. H., & Sunstein, C. R. (2009). Nudge: Improving decisions about health, wealth, and happiness. *Penguin.*

UN DESA. (2019). *The Future is Now: Science for Achieving Sustainable Development*. Global Sustainable Development Report 2019. United Nations, New York. Retrieved from United Nations.

UN-Habitat. (2011). *Global report on Human Settlements 2011: Cities and Climate Change*. United Nations, New York. Retrieved from UN-Habitat.

___ (2014). *Inclusive and Sustainable Urban Planning: A Guide for Municipalities*. UN-Habitat, Nairobi. Retrieved from UN-Habitat.

Union of concerned scientists (2012). State of Charge. http://www.ucsusa.org/assets/documents/clean_vehicles/electric-car-global-warming-emiss ions-report.pdf

US DOE (2009). Energy requirements for hydrogen gas compression and liquefaction as related to vehicle storage needs. http://www.hydrogen.energy.gov/pdfs/ 9013_energy_requirements_for_hydrogen_gas_compression.pdf

Weis A. et al. (2016). Consequential life cycle air emissions externalities for plug-in electric vehicles in the PJM interconnection. Environ Res Lett;11:024009. https://iopscience.iop.org/article/10.1088/1748-9326/11/2/024009

World Commission on Environment and Development (1987). Our Common Future (Oxford: Oxford University Press).

World Energy Council. (2012). *Global Transport Scenarios 2050*. Retrieved from WEC.

Zhu, L., et al. (2021). Los Angeles' Housing Crisis and Local Planning Responses: An Evaluation of Inclusionary Zoning and the Transit-Oriented Communities Plan as Policy Solutions in Los Angeles. *Cityscape*, 23(1), 133–160. Retrieved from Cityscape.

SciencesPo
ÉCOLE URBAINE

# PUBLIC TRANSPORT AS A LEVER FOR THE ECOLOGICAL TRANSITION