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Report

Funding mobility in a post-carbon world

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Executive Summary

Between 1990 and 2017, the transport sector was one of the only industries to record an increase in total CO_2 emissions, from 22% to 24%. As it currently accounts for around one quarter of these emissions on a global scale, transport is and should be the focus of strategies to combat climate change. However, the demand for travel is constantly rising, as a result of demographic growth and upward trends in incomes related to strong global economic development over the last few decades. In order to successfully reduce the carbon intensity of the various forms of mobility, action must be taken quickly and expensive solutions must be implemented, against a backdrop of increasingly scarce public resources which will further exacerbate the upcoming economic crisis.

This does not mean, however, that cities and States are powerless when it comes to meeting this challenge. As international examples show on various territorial levels, many instruments can be used to finance a reduction in carbon intensity for mobility. By combining technological, technical and political innovations, cities such as Oslo, Hong Kong, Singapore, New York and London have rolled out or are testing effective solutions, based on an overhaul of the conventional fiscal tools (mileage charge, taxes or quotas on vehicle registrations) or on the development of taxes based on land and building assets (land value capture). The strategies selected by these cities all share a roadmap and clear objectives, with the question of instruments only being addressed subsequently. Each has a methodology based on consultation with local stakeholders, a key requisite for a successful transition of mobility funding systems.

Recent news (the Yellow Vest movement in France, protests in Chile against increases in public transportation prices) shows that, while the fight against climate change is now widely accepted, the question of avenues and resources remains debated and unresolved, particularly as changes to mobility costs have a direct consequence on the democratic principles of freedom, equal treatment and fairness. The success of a mobility funding mechanism is therefore highly dependent on its acceptability, which requires an understanding of concerns which may appear contradictory but which cannot be separated: economic efficiency, local area access, the polluter pays principle, social inequality, etc. Information and communication (on phasing over time, the aims of measures and their expected effects) therefore play a key role in this acceptability. Furthermore, as increases to mobility prices may be viewed as a loss by users, equalisation mechanisms that are perceived to be compensatory must be implemented as a necessity. This involves a clear allocation of revenues to reducing the carbon intensity of mobility (by funding additional mobility services) aimed at regulated areas.

The issue of mobility in a post-carbon world cannot be solved by technology alone; solutions will be complex and will require the bridging of gaps over the social, territorial and economic divides.

Funding mobility in a post-carbon world

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Thinking and investing at the right scale

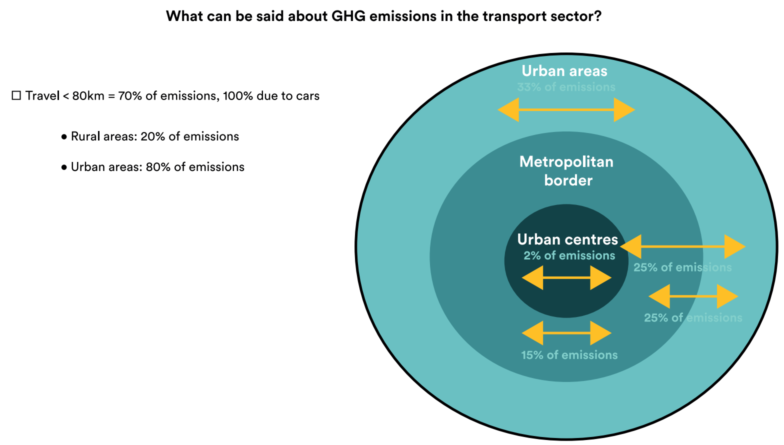
BY **CÉCILE MAISONNEUVE,**
PRESIDENT OF *LA FABRIQUE DE LA CITÉ*

The energy component of the climate change debate often focuses on electricity generation methods, which are the leading source of CO_2 emissions. Yet while there is still a long way to go, statistics show that work has begun to reduce the sector's carbon intensity.

The same cannot be said for the mobility sector, which accounts for one quarter of global emissions: work to reduce the sector's carbon intensity has not yet begun at a time when the demand for travel is constantly growing. Out of all forms of mobility, it is land travel, the focus of this report, which is by far the major challenge for the reduction of carbon intensity in mobility.

Let us start by saying outright that this report does not vehicle a downward outlook, stating from the outset that mobility must be reduced everywhere. First of all, the issue is considered from an international standpoint. While our western societies are - marginally - experiencing a revival of old degrowth arguments, this is not the ambition of the huge majority of people on this planet. Secondly, this report adopts an approach based on history and on the economy, which, far from Marxism, Malthusianism and any form of guilt-inducing moralism, shows that technical progress has always been a means of tackling a lack of resources and that the reduction of spending power and constraint, which are always associated with a reduction in mobility, do not lay the foundations for a sustainable democratic societal project that federates and unites. Lastly, we will see that it is easier to fly the flag for mobility reduction than to tackle the great complexity of carbon intensity reduction in an increasingly mobile world.

Furthermore, this increased demand for mobility is an opportunity as it facilitates a transition of the system. We should instead consider the challenge of reducing the carbon intensity of Europe's electricity generation, against a backdrop of falling demand, which results in an unnatural conjunction of oversupply, increased costs for the consumer and negative price effects on the wholesale markets. Demand for mobility is not only growing but is also changing (more customised solutions) and diversifying, according to the local area.



A spatial approach to land travel emissions: the case in France
(Source: Jean Coldefy)

Against such a backdrop, funding mobility and reducing its carbon intensity seem to be two sides of the same coin. As demonstrated by the practical examples we present, there are many different solutions out there, which combine a range of tools to both finance mobility solutions and reduce the system's carbon intensity. This does not mean hiding behind the tempting excuse of saying "Yes, but in my country/city, it's different" to avoid taking action. This is why, going beyond an analysis of available instruments and solutions, this report looks at how a result can be achieved. It is fascinating to see that despite the diversity of areas and cultures, the principles behind the acceptability of mobility funding measures are relatively uniform.

This report therefore stresses the need to apply tried and tested methods for a local approach to mobility. This analysis is backed up by the fact that forms of mobility have a different impact on climate according to the areas in which they are used. As shown in the following diagram, we can see, and deplore, that once again political and media overinvestment in the city-centre only focuses on a tiny part of the problem.

By contrast, the forgotten forms of mobility, either between the metropolitan area and the periphery of the major city (mobility between suburbs) or between the suburbs and the centre are at the heart of the carbon intensity issue.

As the challenges are clearly spatial in nature, a spatial approach must be adopted, local area by local area, for the solutions to be implemented. The same billion invested will have a very different impact if it deals with the issue at the correct level or if it does not. It must be noted that limiting the issue of carbon intensity reduction to public transportation, which only concerns the centre and immediate suburbs, or instead adopting a wide range of random measures such as a carbon tax which affects rural mobility with a secondary impact on the climate are measures which circumvent or complicate discussions without solving the problem.

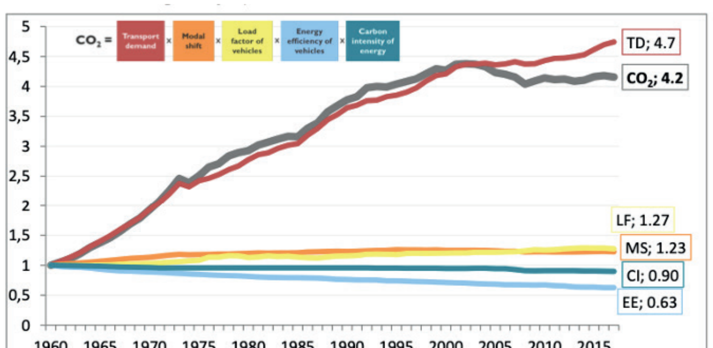
The urgency does not lie in taking sweeping action across the board, instead it involves thinking and investing on the correct sale, by drawing up an order of merit for the solutions to be rolled out and combining them where necessary.

CLIMATE CHANGE IS A MAJOR CHALLENGE FOR HUMANKIND. AS EARLY AS 1992, IN ITS FRAMEWORK CONVENTION ON CLIMATE CHANGE, THE UNITED NATIONS DEFINED AN OBJECTIVE OF "[ACHIEVING] STABILIZATION OF GREENHOUSE GAS CONCENTRATIONS IN THE ATMOSPHERE" TO PREVENT "DANGEROUS ANTHROPOGENIC INTERFERENCE WITH THE CLIMATE SYSTEM[1] ». THE PARIS AGREEMENT ADOPTED FOLLOWING THE 21^{ST} CONFERENCE OF THE PARTIES IN 2015 (COP21) INCORPORATED THE OBJECTIVE OF REDUCING CO_2 EMISSIONS INTO THE INTERNATIONAL LEGAL ORDER.

With energy generation, transport is the focus of attention and of strategies implemented in a bid to achieve this objective. This is because **the sector currently accounts for around one quarter of global emissions** (around 24.5% according to the International Energy Agency[2]). Between 1990 and 2017, only the transport and energy sectors recorded increases in their total emissions, from 42% to 46% and from 22% to 24% respectively. In Europe, a sector-based analysis of CO_2 emissions shows that **the transport sector is the only industry to have recorded an increase in emission levels between 1990 and 2014.** This statement indicates the scope of the action that must be taken in view of the objectives to reduce CO_2 emissions set by the Paris Agreement[3]. To reach this goal, the European Commission aspires in its European Green Deal to cut emissions in the transport sector by 90% by 2050 with a view to achieving carbon neutrality[4]. The actions set out by the European Commission include a modal shift from cars to less carbon-intensive modes and also the development of sustainable substitute fuels (hydrogen, electricity), to be initiated primarily in cities.

While these actions should bring about a reduction in CO_2 emissions in the transport sector, their effects should not obscure the other factors behind the increase in CO_2 emissions in travel, first and foremost the rise in demand. The case in France shows that since 1960, CO_2 emission trends have been guided by that of travel demand (see fig. 1)[5]. **This statement calls for an approach that is not solely focused on the provision of transport, of which the semantic transition from "transport" to "mobility" is an offshoot.**

Fig. 1
Factors of CO_2 emissions in passenger transport (Bigo, 2019)



The incomplete concept of transport has been replaced by that of mobility, which is now preferred in scientific works and political discourse. This is more than a simple semantic shift, **a mobility-based approach provides an understanding of the complexity of the sector and the reality of travel, and therefore its emissions.** For Jean-Marc Offner, General Director of the *Bordeaux Métropole* urban planning agency (A'urba), mobility can be defined as the "space-time of operations"[6]. Contrasting a modal approach focused on vehicles and infrastructure, this definition evokes the **location system** (the way in which activities, places and facilities are designed in the area) and **each person's own activity system** (lifestyles and practices). **It therefore calls for an analysis of factors outside the transport sector that may contribute to the increase in CO_2** emissions, starting with demand trends.

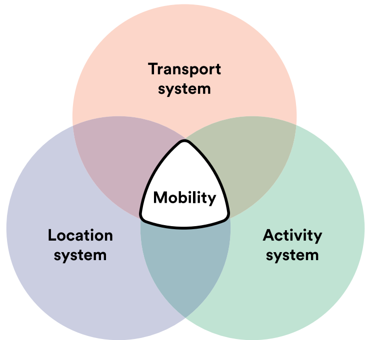


Fig. 2
Diagram illustrating the definition of mobility given by Jean-Marc Offner (Source: *La Fabrique de la Cité*)

Under the combined effect of demographic growth and the upward trend in incomes related to steady growth in the global economy and of per capita GDP since the 1960s[7], **time is increasingly perceived as a scarce resource that can be optimised by increasing the speed of travel**[8]. The latter caused far-reaching changes in how space (urban sprawl, longer commutes, etc.) is used and how time is managed (increasing number of activities). The consequence of the combination of these two factors is an **explosion in travel demand on a global scale, which is still occurring today despite aims to reduce the carbon intensity of mobility and the tight deadline of carbon neutrality by 2050.** There is little time to act and solutions are expensive in relation to the effort to be made. At the same time, **the decrease in national and local public resources makes the equation more complex in most local areas.** In dense urban areas, the issue is exacerbated by the high costs of adjusting transport infrastructure and services. In addition, these must be fast, failing which city accessibility will be overstretched in the long-term. Furthermore, to place the drive to reduce carbon intensity in a long-term perspective, **it will not be possible to ignore infrastructure resilience,** a key condition for the continuity of mobility services and accessibility against a backdrop of increasing climate variations.

How, then, can mobility be financed in a post-carbon world? How can fiscal and financial mechanisms serve the reduction in mobility's carbon intensity? The issue is even more complex as, if a solution is not found, mobility will shift to individual cars, which are mostly carbon-intensive for the time being[9]. The current system is subject to several forms of stress, making its development inevitable. Firstly, **the energy transition has made the transformation of an infrastructure funding model traditionally based mostly on taxation of fossil fuel use unavoidable.**
Secondly, urban growth and sprawl have resulted in an increase in average commutes for city-dwellers and heightened the need for infrastructure. This is compounded by **the need to maintain vital infrastructure and make it resilient.** Lastly, the digital revolution of mobility has brought about new opportunities and also new problems for cities and operators, who must **offset the negative effects caused by these new services**, putting an additional burden on mobility and its funding.

On the basis of these facts, to what extent is the long-term continuation of the current mobility funding models under threat? How can the transition towards a mobility system able to meet the challenges of a post-carbon society be financed and conducted? What solutions exist and how can their acceptability by improved?

01

The shortcomings of the current system

01 The shortcomings of the current system

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MOBILITY IS GOVERNED BY COMPLEX APPROACHES, AS IS ITS FUNDING: EACH INFRASTRUCTURE AND MODE HAS ITS OWN FUNDING SCHEME. WHILE THESE SCHEMES VARY BETWEEN COUNTRIES AND CULTURES, THERE ARE SIMILARITIES BETWEEN THE DIFFERENT SYSTEMS, FIRST AND FOREMOST THOSE WHO CONTRIBUTE TO THE FUNDING SYSTEM. **IN MANY CASES, MOBILITY IS FOR THE MOST PART FINANCED BY THE TRIAD "TAXPAYER, USER, COMPANY"**. STILL USED TODAY, THIS TRIAD IS NOW SHOWING SIGNS OF SLOWING DUE TO CONTEMPORARY TECHNOLOGICAL, ECONOMIC, AND SOCIAL DEVELOPMENTS.

Taking stock of the energy transition in mobility

The first of these developments is technological in nature. To understand its impact, it is worth taking a brief look back at the relationship between mobility technologies and funding instruments.

At the end of the 19th century, horse-drawn vehicles gradually gave way to cars. The question of vehicle propulsion was then raised, though no option really came out on top. In the United States, for example, more electric vehicles were sold in 1890 than combustion-powered vehicles. The turning point came in the early 1900s, particularly with the launch of the Ford T in 1908, when **car manufacturers opted for combustion-powered engines, which could reach a broader customer base, mainly thanks to their greater autonomy**[10]. From 1920, the supremacy of combustion engines was established.

The funding schemes for road infrastructure acknowledged this technological choice. In the Unites States at the start of the 20th century, the Oregon Department of Transportation created the State Highway Commission to consider infrastructure funding with a view to welcoming the massive arrival of cars on roads that were still muddy. This decision was based on the low resources allocated to the State of Oregon, which did not enable it to create a road network commensurate with the constantly rising demand for cars. Until then, **only a three-dollar registration tax was payable, firstly as a one-off payment and then an annual payment from 1911** [11]**. From 1919, Oregon implemented the first tax on fuel consumption which represented one cent per gallon of fuel consumed** [12]. Other federal states and countries followed suit, making fuel taxation one of the main pillars of road mobility funding.

This system is of particular interest in relation to the solutions rolled out up to then. Firstly, **it does away with any need for additional infrastructure related to collection** (tolls, etc.). Secondly, **the cost of collection is reduced as the system needs little or no human presence.** Lastly, **this system creates a correlation between the volume of fuel consumed, therefore the number of kilometres covered, and the revenues allocated to infrastructure construction and maintenance.** La corrélation entre la consommation de The correlation between fuel consumption and the demand for road use appears very clearly. While engines were perfected over the first half of the 20th century [13], the drop in revenues was offset by the increase in the volume of fuel consumed, due to the greater volume of cars.

However, **the oil crisis of the 1970s ushered in a new era. The question of energy independence was pressing, leading the United States Congress to adopt the Energy Policy and Conservation Act in 1975. This law introduces a regulatory measure, the Corporate Average Fuel Economy (CAFE), which requires car manufacturers to improve engine efficiency in light vehicles.** CAFE standards set a minimum ratio of miles per gallon (MPG), miles which can be covered by a vehicle with one gallon of fuel. Similar measures were taken across developed nations. This regulation encouraged improvements to combustion engine efficiency and resulted in the development of hybrid and electric engines [14]. **The financial consequence of this is the growing decorrelation between revenues from fuel taxes and the actual use of road infrastructure.**

As fuel consumption and use of the road network gradually become decorrelated, the pressure on mobility funding systems based on fossil fuel consumption continues to grow[15]. This is the case in the United States, where each electric vehicle sold represents an annual loss of fuel tax revenue of $300. On a national scale, the aggregate impact is $250 million annually[16]. In California, the pioneering State as regards electric vehicle promotion (these vehicles account for almost 5% of the State's car fleet), this decorrelation represents annual losses of around $90 million. Admittedly, this loss only accounts for a 1.47% decrease, with total revenues from fuel tax representing $6.1 billion[17]. However, this percentage is set to grow with the increasing penetration of **electric vehicles in the vehicle fleet on the road nationally. This dynamic has been set in motion: pressure on tax revenues will mount.**

Innovation takes precedence over progress

The transformation of the mobility sector is not restricted to changing the energy sources used for vehicle movement. The second major technological change that this sector is experiencing is related to the current digital revolution. Thereunder, new mobility stakeholders have arrived on a traditionally fixed market, shaking up the established positions by providing new services. **This arrival corresponds to the exponential increase in investments in transport services projects.** Lime, a company operating free floating scooters, was valued at almost $2 billion in early 2019[18]. The Uber platform, leader on the ridehailing market, was valued at almost $61 billion in 2020[19]. **Innovation attracts massive investments which open up new funding avenues to meet the requirements to reduce carbon intensity... provided, however, that they promote the emergence of low carbon intensity modes and uses.**

→ NEW FUNDING MEANS NEW ISSUES

Uber, Ofo, Mobike, Gobee, Lime, Circ, etc.: the list of new urban mobility stakeholders is long. These new services appear and disappear at speeds that are no doubt impressive, but still classic in a field that it not or very little regulated which sees positions consolidated as regulation and alliances are built up. This statement is even more valid in the digital economy where the data battle means that the "Winner takes all" attitude is generally prevalent. The case of Ofo is particularly insightful in this regard. After Gobee and oBike, Ofo, a Chinese company operating free floating bicycles, decided to quit the Paris market in December 2018, eight months after its arrival, even though it had made almost 2500 bikes available, entered into a partnership with the RATP[20] and cumulated more than one million journeys[21]. Like many of these companies, Ofo based its development strategy on hypergrowth to take over the market as quickly as possible. Its strategy involves scaling up with major investments[22], thereby aiming to reach a monopoly rather than short-term profitability by targeting car users, public transportation users, cyclists and pedestrians.

These new services promise convenience and efficiency while highlighting their contribution to reducing the carbon intensity of travel. The reality is more complex, however. These services do not all contribute to reducing the transport sector's emissions in the same way. In the Île-de-France (Greater Paris) region, a study conducted by the research office 6-t demonstrated that the vehicle fleet working for Uber covered an average of 2.4 million kilometres each day, i.e. slightly less than 3% of daily traffic in the region[23]. The same can be observed in the USA[24]: **Lyft and Uber, figureheads of ridehailing services in the country, contribute to increasing the total number of kilometres covered, in particular in city centres, and can account for up to 12% of daily traffic**[25]. With the exception of a small portion of induced journeys[26], most journeys carried out with these new services replace conventional modes. In the metropolitan region of Boston, ridehailing services mainly replace public transportation, walking and cycling, rather than car and taxi use[27]. In 2016, the New York public transportation network saw the number of passengers decrease for the first time since the 2009 financial crisis. The acting Chairman of the Metropolitan Transportation Authority (MTA), which operates transportation in New York, indicated **that this decline in ridership is due to a combination of two factors: many delays on the network and the new competition from on-demand transport applications**[28]. In Paris, the arrival of free-floating scooters resulted in a similar phenomenon: a study conducted in 2019 by the research office 6-t shows that the scooter service operated by Dott in Paris replaces walking (37%), the use of public transportation (36%) and cycling and taxis (9% each).

→ THE MODAL SHIFT AND THE REDUCTION IN CARBON INTENSITY: INSTRUCTION MANUAL

Competition is fierce in urban mobility and is focused on a journey level. **Each service competes for a journey to be conducted with one mode rather than another, far from a complementarity approach.** This has an adverse effect on the conventional modes of motor vehicles (private cars, taxis), public transportation, cycling and walking. As regards the reduction in mobility's carbon intensity, **it can be said that these new services would contribute to the effort to reduce CO_2 emissions if a journey that would have been made in a private car is carried out by bicycle or electric scooter. However, the effect on the reduction of carbon intensity for mobility is not the same when the modal shift occurs from a mode that is already low in carbon intensity (public transportation) or carbon neutral (bicycle, walking) to a mode that is more carbon-intensive (ridehailing).** There are therefore grounds for questioning the goals of these new services regarding the reduction of mobility's carbon intensity: what is the share of communication and marketing, made all the more simple as these ultra-visible modes of transportation in the public space intuitively appear virtuous and from a media standpoint debate is focused on these tools of micro-mobility, when most of the mileage covered is not in the city centre? Behind the deadweight effect and the media focus, another landscape emerges when we look at the documentation intended for the markets. In 2019, in the document submitted to the Securities and Exchange Commission (SEC), the supervisory body for the US financial markets, ahead of Uber's initial public offering[29], **the company states that its main competitor is not motor vehicles (taxis or personal vehicles), which make up the company's current market (serviceable addressable market) but instead public transportation, i.e. the total addressable market**[30].

These new services, therefore, do not aim to contribute to reducing the CO_2 emissions attributable to mobility, even though some, under some circumstances, can. They can even contribute to emissions increases. In other words, the influx of massive investments in mobility services resulting from digital technology does not guarantee a decrease in mobility's CO_2 emissions. Worse still, they can bolster the use of some carbon-intensive modes to the detriment of public or active transportation (walking, cycling) which have a low carbon intensity or are carbon neutral.

In this case, how can additional investments be attracted to reduce carbon intensity in mobility? **Municipalities and States have levers at their disposal to finance new services and infrastructure likely to support efforts to reduce CO_2 emissions in mobility; but these measures must be appropriate.** While it is considered to be the main lever to finance the least carbon-intensive modes of transportation or the energy transition, environmental taxation is sometimes poorly understood and challenged by citizen protests.

Long-standing mechanisms curtailed by mobility developments

Injunctions to reduce the carbon intensity of mobility call for considerations on the resources to be allocated to transforming mobility systems. This question of the mechanisms funding transport services and infrastructure is not new. Levers exist and new ones can be rolled out. **While, in many countries, mobility is traditionally funded through the triad "user, taxpayer and company[31]", the relevance of these mechanisms is challenged by recent developments.** The legitimacy of conventional fiscal instruments and the increase of the user's share in mobility funding is contested now more than ever. In France (*bonnets rouges*, yellow vest movements) and abroad (protests in Chile), **shows of force hint at a drop in willingness to pay[32] which constitutes a risk for the funding of mobility infrastructure and services. This willingness to pay is even lower because, as the French *Conseil d'analyse économique* has demonstrated[33], the increase in taxation appears to be an additional tax motivated by budgetary considerations rather than the climate emergency.** This lack of coherence between the objectives announced and taxpayers' perception of the tax may heighten the lack of understanding and even the rejection of fiscal changes intended to finance the reduction of mobility's carbon intensity.

→ FUNDING MOBILITY IS NOT STRAIGHTFORWARD

Many movements opposing the implementation or revision of fiscal instruments intended to finance mobility, in part or in full, have taken place in France. Recent history has been marked by two colourful protest movements: the *bonnets rouges* (red cap) movement and the *gilets jaunes* (yellow vest) movement.

The former emerged in response to the idea, formulated during the 2007 Grenelle Environment Forum, of creating a mileage charge applicable to national and foreign heavy goods vehicles in France. **The national tax on heavy goods vehicles, known as the "*écotaxe*", was intended to internalise part of the externalities caused by the circulation of HGVs on the non-concession road network**. Revenues were to offset the early deterioration of roads and to finance infrastructure. The bonnets rouges protests resulted in Jean-Marc Ayrault's government suspending the implementation of the écotaxe temporarily. Adjustments were planned to change the écotaxe: a toll charge was discussed for HGVs on a network spanning 4,000 kilometres (compared to the initial 15,000 kilometres[34]). In view of new threats of strikes from lorry drivers, the écotaxe was shelved once and for all in 2014 by Ségolène Royal, then Minister for the Environment, Energy and the Sea, in charge of international climate relations. To make up for the shortfall related to the shelving of the écotaxe, an increase of four Euro cents of diesel tax for road hauliers was voted[35].

The second expression of this opposition to fiscal measures aimed at funding mobility is more recent. It came after the **French government's desire to increase the diesel tax under the 2018 draft budget bill.** This increase was set to launch a convergence of tax systems for diesel and petrol[36] and step up the environmental transition. It was the trigger of the *gilets jaunes* (yellow vest) movement in France. **This movement shed light on citizens feeling fed up with taxation[37].** In November 2018, a survey conducted by Ipsos for *Le Monde* revealed that **almost 73% of French citizens had a negative opinion of the increase in diesel prices in relation to petrol[38]**. In response to the yellow vest protests, the government decided to suspend and then cancel the carbon tax increase for 2019[39].

While these movements have placed the issue of tax justice on the agenda, **above all they illustrated the difficulties that public authorities have in using the traditional fiscal levers to partially finance mobility. In contrast, they shed light on the need to find new finance mechanisms, failing which the funding of mobility infrastructure and services will be jeopardised. At the very least, they call for a comprehensive debate on the costs, prices and value of mobility.**

→ AVOIDING THE QUESTION OF PRICE: FARE-FREE PUBLIC TRANSPORTATION

Such a debate could have happened while in France the municipal elections occasionally revive the idea of fare-free public transportation in public debate and Luxembourg has also made its public transportation free of charge. In the case of France, **this measure intends to meet the objective of reducing carbon intensity by counting on the fact that a decrease in the price signal of public transportation will make the offering more competitive than cars and thereby bring about a modal shift**. Several examples are given to illustrate the benefits of this measure: Dunkirk, Niort, Calais and Tallinn (Estonia).

In the Urban Community of Dunkirk, initial feedback is encouraging with regard to the use of public transportation: since the measure was rolled out in September 2018, the use of buses has increased by 65% in the week and by 125% at the weekend[40]. For Charles Raux and Yves Crozet[41], these results outline a significant modal shift of 24% from cars to buses. However, on the basis of the profile of those polled on buses, it can be observed that fare-free public transportation results in a sharp rise in demand which is only marginally from cars, as most of the former and new users do not own a car (69%). According to Frédéric Héran[42], making public transportation fare-free only has a very little effect on car users (1 to 2%) but has a greater effect on pedestrians (2 to 4%) and cyclists (5 to 7%)[43]. In addition, the announcement of increased use can be explained by a supply-side shock related to a restructuring of the transportation network[44]. Furthermore, according to an information report by the French Senate[45] published in September 2019, although an impact on the modal shift has been recorded, this mainly concerns central areas of the conurbation where there is a concentration of public transportation. It is therefore difficult to make generalisations about a modal shift for the Urban Community of Dunkirk as a whole.

Results vary from one city to another, however: **in Niort, an assessment after two years of free public transportation shows that the measure has not had the expected impact on use.** This is mainly due to the fact that the measure was rolled out at the same time as the decision to reduce the offering of public transportation[46]. **The mechanics of a massive modal shift to public transportation are therefore not automatic. In addition, it is not necessarily beneficial for networks that are already saturated as in some major cities[47].** Before considering free transportation, the objectives of this decision should be defined. If the aim is to strengthen the attractiveness of public transportation and to reduce car traffic, it is by no means certain that fare-free transportation is the most appropriate instrument. **In the Paris region, it would result in an increase in the use of public transportation of 6 to 10% in passenger-kilometres but only slightly more than half would come from car use, resulting in a drop of only approximately 2% in car traffic.** The remainder would come from a shift from walking and cycling to public transportation. The most effective lever to

reduce the modal share of cars and increase that of public transportation remains an increase in the transportation offering[48], which does require additional funding. This is the approach adopted for the *Grand Paris Express* project.

Moreover, free transportation is actually only a transfer of charges from one stakeholder (the user) to another. The decision regarding who will pay must be taken. To offset the costs incurred by fare-free transportation, many public transportation authorities (*AOM* in French) have stepped up their use of the mobility contribution (*Versement mobilité* or VM)[49], i.e. they call upon companies. For the Dunkirk area, the VM was increased from 1.05 to 1.55%, thereby funding the shift to completely free travel in 2018. Today, the VM (€5.3 million) could cover almost all of the costs of fare-free public transportation (€5.7 million)[50] for which revenues represent the loss of ticketing income and the savings made on administrative expenses for subscription management and inspections. The cost of fare-free transportation is therefore different from city to city and therefore free travel cannot be transferred identically to all local areas. For example, making public transportation free in the Paris region would require finding €2.5 billion per year corresponding to fare revenues[51]. In the case of major cities, the use of the VM contribution is limited. **As regards the Paris region, an upward adjustment of the VM rate, paid by companies, could have recessionary macro-economic repercussions in the medium and long term which could result in the loss of 30,000 jobs and €4 billion, i.e. around 0.7 points of GDP on the scale of the region, according to the committee tasked with assessing the feasibility of fare-free public transportation in the Île-de-France region**[52].

Fig. 3
US States that revised their state fuel tax levels between 2013 and 2019 (Source: ITEP)

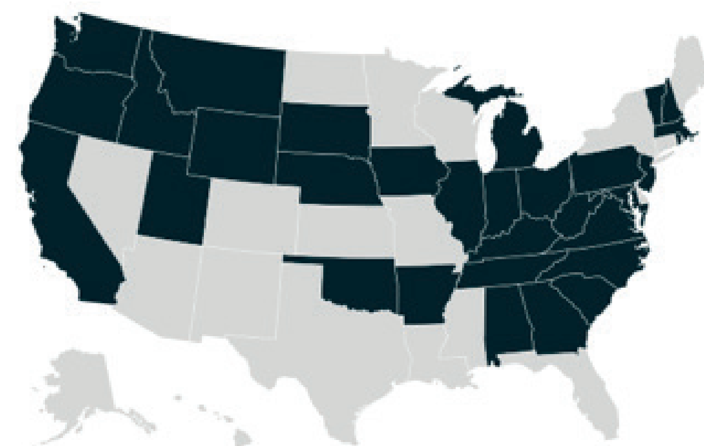
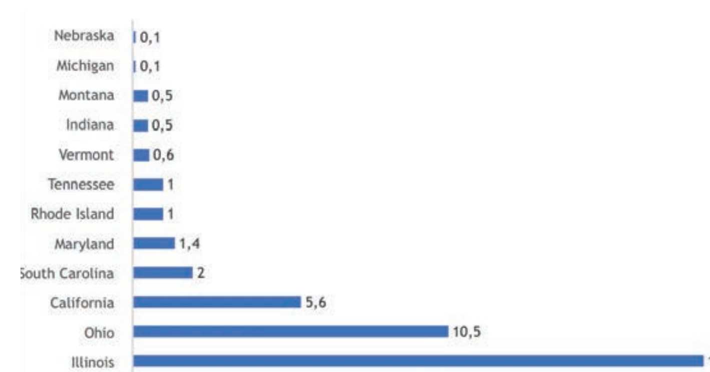


Fig. 4
Increase of the State diesel tax in cents (Source: ITEP)



→ AVOIDING THE QUESTION OF PRICE: FREEZING FUEL TAXES

This avoidance strategy regarding the debate on prices is not only seen in France. It is also applicable in the USA, though it takes another form. In 2018, the federal gas tax was the same as it was a quarter of a century earlier, i.e. 18.3 cents for the diesel tax[53]. This stagnation in tax rates should be set against infrastructure construction and maintenance prices (which are subject to price inflation) and the increase of combustion engine efficiency. **Considered together, these two factors have reduced the tax's purchasing power by around 64%. The direct consequence was a decrease in infrastructure construction and maintenance capacity**. Observing the poor maintenance of the US road network[54], most States launched a revision of state gas taxes from the 2010s[55]. Since 2013, 22 States, representing 59% of the US population, successfully conducted reforms of their fuel tax systems to index them to inflation or make them more dynamic according to various factors[56]. The increases entering into force on 1st July 2019 were 3.5 cents per gallon on average. This figure does not demonstrate the wide discrepancy between States; Illinois enacted an increase of 19 cents per gallon while Nebraska increased state gas tax by 0.1 cent per gallon[57]. In terms of the acceptability of these measures, a survey conducted by the American Automobile Association (AAA)[58], shows that Americans are more receptive to gas tax increases than in the past, even though, for 74% of those polled, the increase must be offset by a change in travel behaviour.

These different observations regarding the current shortcomings of the system call for an overhaul of mobility funding systems, a fortiori to anticipate a system which would also finance its reduction in carbon intensity. **The inertia of national and local fiscal systems and the strength of user habits make the transformation of mobility funding systems a major challenge.**

02

Using funding to reduce carbon intensity in mobility

02 Using funding to reduce carbon intensity in mobility

THE CURRENT SHORTCOMINGS OF MOBILITY FUNDING SYSTEMS MAKE IT DIFFICULT TO MEET THE REQUIREMENT TO REDUCE CARBON INTENSITY IN THE TRANSPORT SECTOR. THE ISSUE IS COMPLEX IN TECHNICALITY, SOCIAL IMPLICATIONS AND IN ITS VERY POLITICAL NATURE. **AVOIDING THE PROBLEM BY PREFERRING TO KEEP THE STATUS QUO MAY AFFECT URBAN AND STATE STAKEHOLDERS' ABILITY TO MEET POST-CARBON MOBILITY CHALLENGES.** YET THE QUESTION OF MOBILITY FUNDING WILL ONLY BECOME MORE PRESSING AS THE CARBON INTENSITY REDUCTION REQUIREMENT GETS CLEARER.

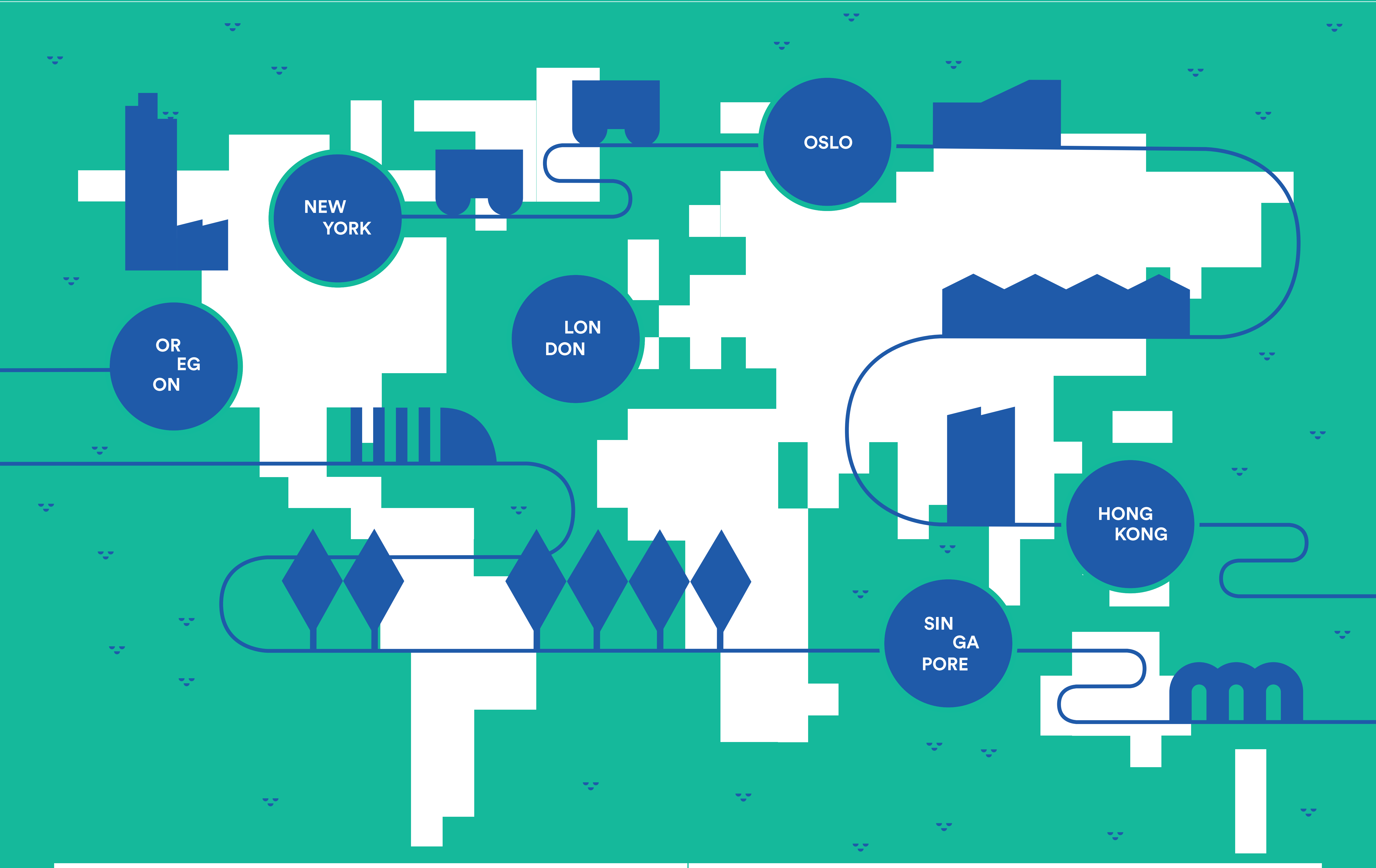
Some cities and States are paving the way today. **By combining technological, technical and political innovations, several cities have successfully come up with solutions or have outlined credibl e avenues to resolve the issue of funding low-carbon mobility.** Mileage charge, city tolls, progressive taxation of vehicles according to their engines, land value capture, etc., there are many avenues to resolving the issue but none which have successfully and independently provided a long-term response to funding issues.

Places as diverse as Oslo, Hong Kong, Singapore, New York, London and the State of Oregon offer up interesting examples in this respect. Firstly, the strategies selected by each one of these areas gives priority to **the definition of clear objectives and a roadmap by the public authority, while the issue of instruments is secondary.** Secondly, while the common denominator of these strategies is reducing the carbon intensity of mobility, there are different goals within the resources implemented to achieve this objective. The idea may be to reduce car use in a restricted area, or to find a long-term solution to reduce the revenues resulting from fuel taxes or to finance and increase the use of public transportation. While they do not constitute an exhaustive list, these examples demonstrate public stakeholders' ability to transform the mobility funding system and their successes in this regard.

These different approaches also teach us something interesting: the issue of funding mobility in a post-carbon world is a means of discussing the issue of mobility regulation by acting on the price signal.

Thirdly: information and communication play a key role in the success of these different cities and States in transforming their mobility funding systems. **Each of these approaches has a methodology based on consultation with the various stakeholders in the local area.**

The transitions launched in these examples demonstrate that transforming funding and regulation systems that are not in line with the objective of reducing carbon intensity in mobility is more a political than a technical challenge.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UNITED STATES

In Oregon, working towards a new system to calculate the cost of road mobility

FACED WITH THE DETERIORATION OF ITS ROAD NETWORK AND NOTING THE GRADUAL DECREASE IN THE REVENUES FROM ITS MAIN RESOURCE TO FUND ROAD INFRASTRUCTURE, THE STATE OF OREGON HAS BEEN EXPERIMENTING WITH AN AMBITIOUS PROGRAMME SINCE 2013, WITH A VIEW TO PROVIDING THE STATE WITH A LONG-TERM FUNDING TOOL: A MILEAGE CHARGE.

In the United States, the start of the 20th century was marked by the rapid development of the automotive industry driven by manufacturers such as Ford, which sold around one million vehicles between 1915 and 1918, despite a road network that was yet to be developed. In the early 20th century, the construction of the main roadways was mainly a private initiative and these roads were subject to toll payments.

However, the network remained broadly unsuitable in view of the increasing demand for car mobility. **Faced with this situation, Oregon decided in 1919 to "get the State out of the mud"[59] and became the first US State to introduce a fuel tax intended to finance road infrastructure.** In 2017, the State fuel tax of Oregon was 36 cents per gallon of diesel purchased, in addition to 18.40 cents/gallon of federal taxes. In 2024, the tax in Oregon will be increased to reach 40 cents/gallon[60] as a result of a four-phase increase plan voted in 2017. **Generating around $600 million per year, this fuel tax is the primary source of revenue for the Oregon Department of Transportation (ODOT).**

The major status of the fuel tax in the State's tax revenues led it to consider the long-term future of this road infrastructure funding model from the 1990s. **Despite tax increases and demographic growth, improvements to combustion engines and the development of electric mobility will inevitably result in a stagnation or even a drop in fuel tax revenues from 2020, according to the ODOT**. As the fuel tax was no longer sufficient to finance the construction and maintenance of a road network made up of around 74,000 miles of roads and 8,000 bridges[61], the State of Oregon launched considerations in the early 1990s regarding the opportunity to rethink its conventional road infrastructure funding model. **If no changes had been implemented, the ODOT estimates the foregone tax revenues at $340 million over the next decade**[62]. Without an increase in federal subsidies, the funds devoted to road infrastructure investments in Oregon will drop by 30%[63].

Fig. 5
Toll bridge in the early 20th century in Oregon

Fig. 6
Road infrastructure in Oregon in 1913

Towards a new mobility funding model

Changes to the car fleet make these considerations even more pressing. The energy efficiency of Oregon's car fleet has increased over the last decade, by 7.5% between 2008 and 2017 and 1.5% between 2016 and 2017. This development is related to two factors:

· **improvements to combustion engines and the development of high MPG vehicles (a large number of miles covered per gallon of fuel consumed);**
· the **development of electric vehicles**, as owners do not pay fuel taxes and therefore do not contribute to funding the roads they use.

These changes to the car fleet have had a major impact on the State's tax revenues. **At equal tax levels, car drivers are contributing less and less to the funding of infrastructure, while using their cars as much, if not more.** At the same time, demographic growth leads to an increase in mobility which, in Oregon, is mainly by car, automatically causing a rise in the number of users on the road. This development is stepping up road wear and tear and a fortiori increases maintenance costs. **These different changes result in growing decorrelation between fuel tax revenues and the use of road infrastructure in Oregon.** Yet an under-investment in the road network is threatening the State's mobility system. In view of this, Oregon has therefore needed to come up with alternatives to the fuel tax.

As early as 2001, a Road User Fee Task Force was created by the ODOT with a view to rethinking the car mobility tax system. In 2003, the Task Force decided to look in greater detail at the road usage charge out of 28 proposed ideas. **The road usage charge is a shift from a tax model based on (fuel) consumption to a model based on usage (infrastructure).** In this system, road users pay a variable amount, depending on the number of miles covered. **The experiment in Oregon is based on the principle of a flat tax; in other words, the amount of the charge is the same for all users, regardless of the type of engine or vehicle used.** This system therefore implies that users pay for their use of the road. It has the advantage of being a "fair, simple and affordable way to generate revenue from road use", according to members of the Task Force.

After two one-year pilot schemes in 2006 and in 2012, the OReGO programme was tested in 2015 on a voluntary basis. Since 2017, vehicles registered in the OReGO programme pay 1.7 cents per mile covered[64],the distance being calculated through various systems ranging from monthly odometer declarations to on-board units in vehicles. **For combustion engine vehicles, which are also subject to the fuel tax, the ODOT undertakes to reimburse volunteer car users to the tune of 30c/gallon of fuel purchased.**

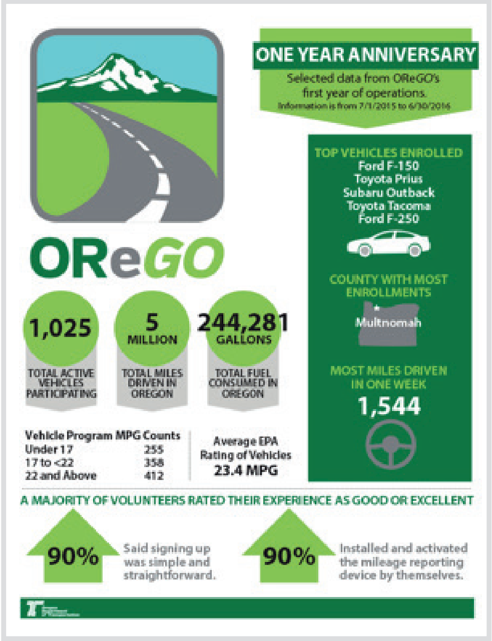


Fig. 7
Assessment of the OReGO programme one year after its introduction

Oregon's experiment has been emulated on a national scale: the ODOT is currently heading a coalition of voluntary States under the name RUC West[65] or Western Road Usage Charge Consortium. **The RUC West contributes to funding road usage charge experiments in 15 Western US States and fosters inter-state cooperation on this issue. While all these States are not at the same stage in the project (research, pilot schemes or upcoming introduction), their coalition aims to establish this new tax system on a multi-state level in order to make economies of scale regarding system administration.**

The challenges and shortcomings of the road usage charge in Oregon

The OReGO programme demonstrates the feasibility of a mileage charge system and therefore the possibility of replacing the fuel tax in the future. In the slipstream of this success, the US Department of Transportation launched a $10.2-million funding programme through which seven US States have received a subsidy called "Surface Transportation System Funding Alternatives" (STSFA). This programme aims to test alternative user-centric tax systems to support the Highway Trust Fund, which depends mostly on the federal fuel tax. Oregon received a subsidy of $2.1 million in order to develop and improve the OReGO programme[66].

While Oregon continues to pioneer the testing of infrastructure funding models, its road usage charge programme can be improved upon. Out of the 5,000 participants expected, only 1,600 are registered with the OReGO programme to date[67]. This low level of participation shows that communication regarding the approach has been ineffective. **A survey[68] conducted by the ODOT in 2016 concerning 650 inhabitants revealed that 71% of those polled had never heard of OReGO and the possibility of registering to take part in the experiment.**

Going beyond an unawareness of the programme, **the survey highlighted that many citizens were ignorant about the mobility funding system on both State and Federal levels.** 64% of citizens polled did not know that they paid 49c/gallon of fuel (Federal and State taxes combined). **This statement goes some way to explaining the difficulty that the ODOT is experiencing to scale up its road usage charge.**

In December 2019, a decision indirectly strengthened the justification of the OReGO programme. The Constitution of Oregon requires that all road users contribute their fair share to road infrastructure funding according to their use of it[69]. The question of fairness is raised in particular for electric vehicles, which will contribute more to road infrastructure funding in view of the number of miles covered, be it, as proposed the ODOP, through greater vehicle registration taxes or a mileage charge. **The first of these levers involves increasing registration taxes payable by car owners to register their vehicle for a two-year period.** This initiative aims to increase the share paid by electric vehicles, which are not subject to fuel taxes, in the funding of road infrastructure. To achieve this, the State decided to index the cost of vehicle registration on its fuel consumption: the lower the petrol consumption, the greater the registration costs[70]. The effects of this measure are very clear, in particular for the owners of electric vehicles, who have had the highest price increase: an increase of $110, or a total of $306 to register an electric vehicle for two years. **While this mechanism does not satisfy electric vehicle users, ODOT proposes a second one which enables them to move to the OReGO programme and thereby pay according to the number of miles covered[71].** In this way, the State strives to increase the number of participants in the experiment. This decision is a first step to standardising this new tax system for all road users. Oregon has set itself the goal of obtaining inhabitants' consent in order to build a robust and reliable funding system which will ultimately replace the fuel tax.

The ODOT has taken measures to raise local populations' awareness of its new source of funding. In 2016, supported by a communications agency, it rolled out an awareness campaign with a view to presenting the OReGO programme to the inhabitants of Oregon; the results are very encouraging. Recent studies have demonstrated that the inhabitants were receptive to this change of model when the programme was clearly explained to them. Once the programme had been presented, a survey of participants indicated that 55% of those polled were in favour of the road usage charge, compared to 35% previously[72], which attests to the need to roll out an educational approach alongside the drafting of a new tax model as regards the challenges of the overhaul.

Fig. 8
The "Keep Oregon Connected" campaign in 2019

In addition to these communication challenges, the ODOT will also have to meet the issues raised by the type of technology used during these experiments. The pitfalls that taint the success of the experiment include the high administration costs, defective or inappropriate on-board units, a lack of precise data due to poor mapping and the issue of data privacy. OReGO can leverage a system made interoperable with separate technological tools. In this way, any technology used to collect and report car users' data can operate under the system created by the ODOT.

Lastly, Oregon is facing a major challenge: the acceptability of this transition. Almost one hundred years after the introduction of the fuel tax with a view to funding road infrastructure, it is difficult to imagine another funding system. **Yet in 2017, a legislative reform provided that the road usage charge will be mandatory for all new vehicles from 2026[73].** Until then, the fuel tax and the road usage charge will coexist. The former will encourage manufacturers to innovate to improve energy efficiency and car users to turn to more fuel-efficient vehicles. The latter will offset the drop in fuel tax revenues while taking into account the user's impact on the road infrastructure.

The challenge of the transition

Like other States and cities in the world, Oregon is now facing a major challenge: to successfully support the simultaneous transition of the mobility funding system and of constantly changing forms of mobility.

The State is attempting to support its inhabitants with this transition. In August 2019, the ODOT launched a communication campaign called Keep Oregon Connected with a view to raising citizens' awareness of the need to keep road infrastructure in good repair, for them and also for future generations. This campaign also strives to demonstrate the opportunity created by the OReGO programme to respond to the current infrastructure funding crisis and to increase its acceptability among inhabitants, as the "Get Oregon Out of the Mud" campaign did in 1917 to make the fuel tax the primary source of mobility funding in Oregon.

While Oregon has understood the urgent need to find a new source of revenue to replace the fuel tax, the effects of this fiscal revolution on long-term mobility behaviours remain unknown. **According to Michelle Godfrey, spokesperson of the ODOT, the advantage of OReGO is that it allows users to have a clear view of the actual cost of the road and to become aware that each mile travelled has consequences on infrastructure maintenance[74].** It is precisely this awareness that can encourage car users to change their behaviours according to the situation. **During the pilot phase of the OReGO programme, the number of miles covered by the test group was 12% lower than the distance covered by the control group subject to the fuel tax, while the cost of the road usage charge proportional to the average number of miles covered was equivalent to the cost of the fuel tax[75].**

However, for the time being, this new system proposed by Oregon lacks incentive and is incompatible with the mobility energy transition objective as it will not be modulated to benefit electric vehicles. Some fears have been expressed: what if the OReGO strategy curbs the development of electric mobility, affecting owners of electric vehicles to a greater extent, who do not pay fuel taxes?

SINGAPORE

Singapore: funding mobility in a restricted territory

OBLIGED TO MAKE DO WITH A TERRITORY LIMITED IN LAND AND NATURAL RESOURCES, THE CITY-STATE OF SINGAPORE HAS BEEN CONDUCTING A PROACTIVE POLICY TO REDUCE CAR USE AND FUND PUBLIC TRANSPORTATION ALTERNATIVES SINCE THE 1970S THROUGH INSTRUMENTS SUCH AS ITS CITY TOLL AND QUOTAS FOR VEHICLE REGISTRATION LICENCES.

Since its independence in 1965, Singapore, an insular City-State in South-East Asia, has constantly developed its attractiveness[76]. With a limited area of 720 sq.km and a population of 5.9 million, the City-State has implemented a series of actions to meet the urban challenges it faces. To achieve this, it uses three instruments: political voluntarism, the development of a highly efficient transport infrastructure network and technological innovation.

However, Singapore's development comes up against a reality: **the capacity of road infrastructure, which takes up 13%[77] of the territory, is not sufficient to absorb the increase in car mobility demand.** This imbalance between the supply of infrastructure and the demand for mobility may constitute an obstacle to the City-State's appeal and development and could affect the well-being of its inhabitants. **To counter the potentially adverse effects of an excessive use of cars, Singapore has relied on the development of efficient public transportation and a series of dissuasive measures in relation to cars.**

Drastic measures aimed at limiting car use

Given the City-State's geographical location, the optimal area[78] for cars is limited in point of fact: there are little or no long-distance or inter-urban journeys by car. International journeys are made by air or sea.
In Singapore, the car is therefore an urban mode of transportation which can be substituted by other solutions. This situation is specific to Singapore. The reality is different in other countries in which cars constitute a multi-purpose mode that is relevant over a greater area.

Singapore's mobility strategy is based on several pillars:

· integrated urban and transport planning;
· priority given to public transportation;
· restrictions on private car use.

Since the 1990s, the right to own a vehicle and to use Singapore's road network is subject to obtaining a Certificate of Entitlement (COE), a vehicle registration licence which is valid for ten years. The number of COEs on sale is subject to a quota updated by the government every six months. **After peaking in 2012, when a COE could cost the equivalent of €57,000, there has been a steady drop in the price of COEs since the announcement at the end of 2017 of a policy in favour of zero growth of the motor vehicle fleet**[79]. Through this policy, Singapore has a means of controlling and limiting the number of vehicles in circulation, while renewing the car fleet.

In addition, Singapore has been taking action regarding traffic flows for several decades through a city toll system. While this system has been operating since 1975 under the name Area License Scheme (ALS), it only became dynamic in 1998, when Singapore's Land Transport Authority (LTA) introduced Electronic Road Pricing (ERP). This instrument, which cost around €110 million to roll out[80], is based on three key components:

· **gantries fitted with cameras,** sensors and short-range communication beacons;
· **an in-vehicle unit (IU),** connected to a bank account or contactless payment cards (EZ-link, NETS, etc.);
· **a control centre** in the LTA offices which centralises the recording of each transaction and the images of vehicles in breach of the system.

City tolls in Singapore

In 2017, around 80 ERP gantries were listed on the island[81], 26 of which were in the Central Business District (CBD). The concept of a dynamic city toll system was created with the ERP. It is in operation from Monday to Saturday from 7.30am to 8pm and includes pricing adjustments according to the level of congestion, in addition to an adjustment per vehicle category (ranked from A to E). This system also introduces the notion of a pay-per-use basis. **The pricing levels are revised every month and adjusted to traffic changes over half-hour periods, with a view to ensuring optimal traffic speeds of 20 to 30 km/h on urban roads and 45 to 65 km/h on expressways**[82]. The strategy intended to dissuade people from using their cars is therefore based on toll charge increases in the event of congestion.

The dynamic nature of the toll system enables Singapore to leverage a genuine traffic management instrument. The Land Transport Authority which organises, manages and operates the city toll can influence traffic flows by displaying pricing on each gantry. **During the toll's opening times, it costs between S$0 and S$6 according to the road used, and a 100% increase is applied to lorries.** The ERP is important as it encourages car users to shift to other means of transportation or postpone their journey to a time when traffic is flowing more smoothly.

Considerations for the system's long-term continuation

While, until 2004, the ERP's operating costs only accounted for 10% of revenues (€50,000/year), they increased by 80% in the following decade[83], not including maintenance costs. **The lifespan of the current ERP is coming to an end and each three-lane gantry costs 1.5 million Singapore dollars. In its current configuration, the ERP's future remains uncertain.** Despite a rise in revenues (€93 million in 2015), the necessary replacement of end-of-life gantries involves major investments for the Land Transport Authority.

The options made possible by the use of geolocated data generated in real time have motivated the shift to a satellite toll system. In 2020, the ERP will be replaced by an electronic toll system based on satellite technologies (NCS and MIH Engine System Asia consortium), with installation costs reaching up to S$556 million[84]. Road pricing will be applied on the basis of the number of kilometres travelled, with adjustments according to the level of congestion recorded on the itinerary used. **This change will increase the scope for road traffic pricing and management.** This city toll technology heralds a shift from a congestion management system to a mobility management system. The satellite system, also called second-generation ERP (ERP2), has been in the testing phase since 2018 on five of the island's roadways. The transition between the ERP and the satellite toll will begin in 2020; the two systems will operate jointly for 18 months, the time it will take to install new On-Board Unit (OBU) systems[85] in more than one million vehicles. The OBU will replace the in-vehicle unit and will be distributed free of charge to vehicles already in circulation. The current ERP gantries will be removed as the ERP2 does not require ground infrastructure to operate. Only cameras will be installed on pre-existing infrastructure. By notifying of the pricing of each section of road and real-time traffic conditions in advance, the Singaporean authorities hope to promote a decline in car use.

The city toll, one component of a far-reaching mobility plan

The city toll is part of a much broader mobility policy. **Firstly, its revenues contribute to the construction and consolidation of the public transportation system. Secondly, it is one of various instruments intended to restrict car use.**

Singapore's approach is effective: the roll-out of the ERP and other car restriction measures have increased speeds on toll roads and smoothed out peak time congestion. **Drivers in Singapore lose 10 hours per year in traffic jams, compared to 102 hours in Los Angeles, 74 hours in London and 69 hours in Paris**[86]. By promoting the regular renewal of the car fleet, the purchase of fuel-efficient vehicles and the limitation of the number of vehicles in circulation, Singapore has tackled air quality challenges very early on. There is a correlation between the drop in the number of vehicles on these roads and a decline in harmful emissions[87], particularly with air pollution peaks smoothed out at peak hours.

The restrictive initiatives aimed at cars are part of a broader policy to promote the development of the modal share of public transportation, presented in the Land Transport Master Plan 2040. In this document, Singapore sets out its ambition to double the length of its MRT network, to increase it from 229 kilometres to 400 kilometres by 2040[88]. In terms of railway lines, the City-State's network will rival that of London. Through this action, Singapore strives to increase the use of its MRT network to 6 million passengers per day in 2030, compared to roughly 1.4 million in 2014[89].

Map of the Singapore metro according to the Land Transport Master Plan 2040
In green, line extensions
(Source: LMTP 2040)

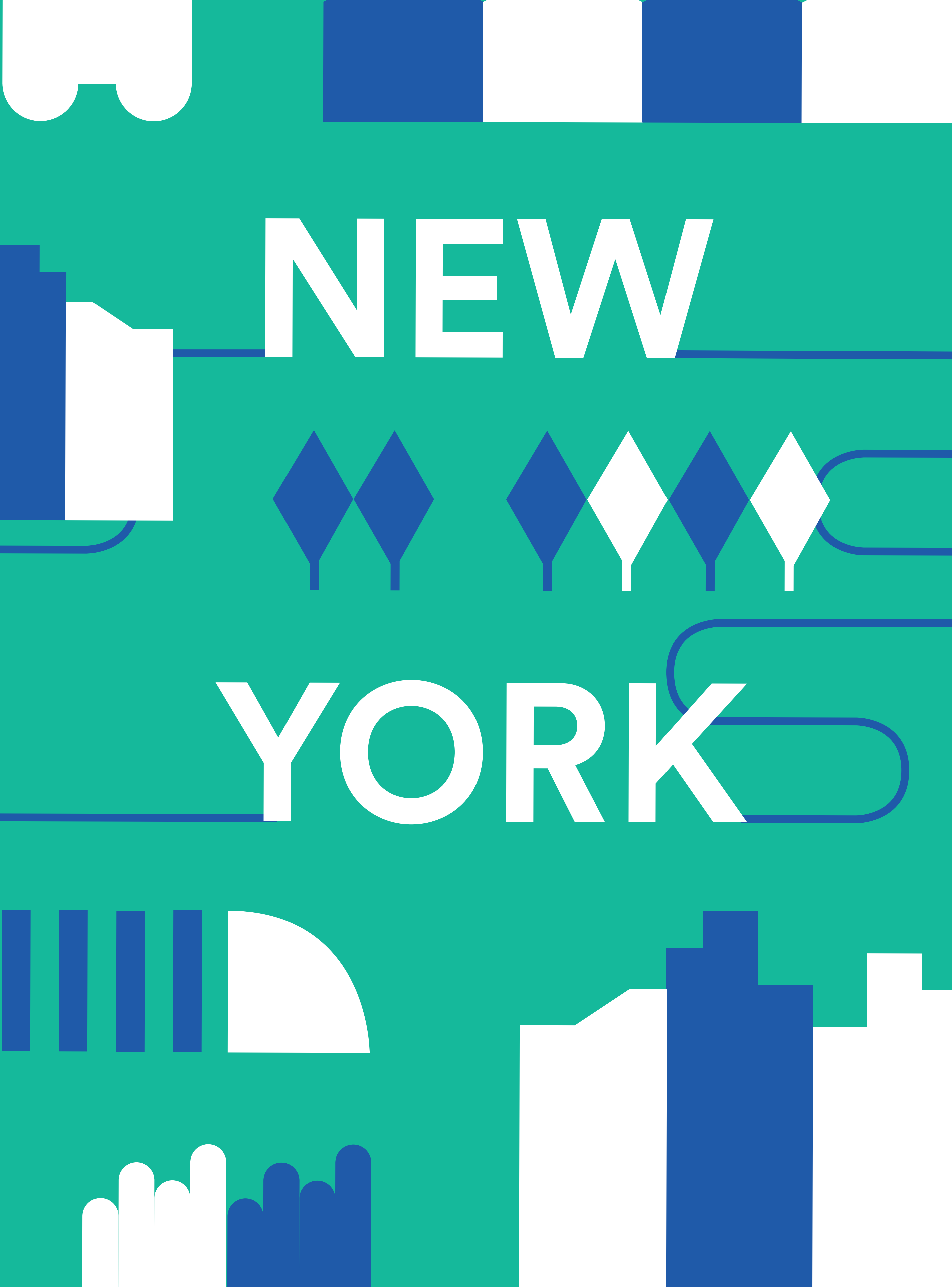
A model of urban mobility?

Singapore views mobility as a system. This consideration shows a keen understanding of mobility and urban planning issues. **The City-State's success is partly due to the highly extensive competences of the mobility authority (public transportation, roads), which facilitates the implementation of a coherent mobility policy.** The roll-out of dissuasive mechanisms aimed at car use and the mobility authority's ability to allocate revenues to public transportation have heightened the appeal of this form of transportation. The modal share of public transportation is slightly higher (44% of journeys) than that of individual vehicles (29%) and walking (22%)[90]. These mechanisms have also influenced traffic and the renewal of the car fleet. The LTA claims that the decrease in the number of vehicles circulating in the city centre has led to a 10-15% drop in CO_2 and other greenhouse gas emissions[91].

Singapore's model also shows an ability to adapt to new challenges raised by the emergence of new forms of mobility. The zero car growth policy has a direct effect on mobility funding in Singapore as it has resulted in a drop in revenues from the sale of COEs of around 6.6%, i.e. €260 million[92]. To offset this revenue shortfall, Singapore has in particular planned to reduce the amount of bonuses applicable to clean vehicles and to increase VAT (from 7 to 9%).

Singapore could not reinvent its city toll system if it was unable to drive the transition. The successful implementation of the ERP in 1998 owes a great deal to a major communication campaign conducted by the Singapore government aimed at its population (newspapers, television, radio, leaflets, posters, etc.). To guarantee the acceptability of such a transition, vehicles already in circulation at the time of the ERP's introduction were fitted free of charge. Owners of vehicles purchased afterwards, however, had to pay $150 for the installation of the OBU.

The future operation of the ERP2 raises a new challenge for Singapore: to make the new overhaul of its city toll system acceptable. This new system, which will be based on the use of Global Navigation Satellite System (GNSS) data, will enable the LTA to monitor each vehicle in real time, which raises concerns among the population, which views the ERP2 as a **breach of users' privacy**[93]. In addition, car users fear higher costs under this new system, as it implies greater price variability according to geographical position and traffic conditions.



UNITED STATES

New York: reconciling modernity and progress

NEW YORK FACES MANY MOBILITY CHALLENGES INCLUDING THE SATURATION AND LOSS OF EFFICIENCY OF ITS PUBLIC TRANSPORTATION NETWORK AND THE CHRONIC CONGESTION OF ITS ROAD NETWORK. THE CITY IS UNDERTAKING MAJOR CHANGES TO FUND AND REPAIR ITS PUBLIC TRANSPORTATION, IN PARTICULAR THROUGH A CITY TOLL AND A TAX ON LUXURY PROPERTIES.

The construction of transport infrastructure which has since become emblematic completely changed New York's cityscape over the 20^{th} century. From the iconic Brooklyn Bridge and Queensboro Bridge to the impressively large Grand Central Station and the construction of the most extensive public transportation network in the world, New York built a mobility system that met the economic and demographic challenges that it had to tackle[94].

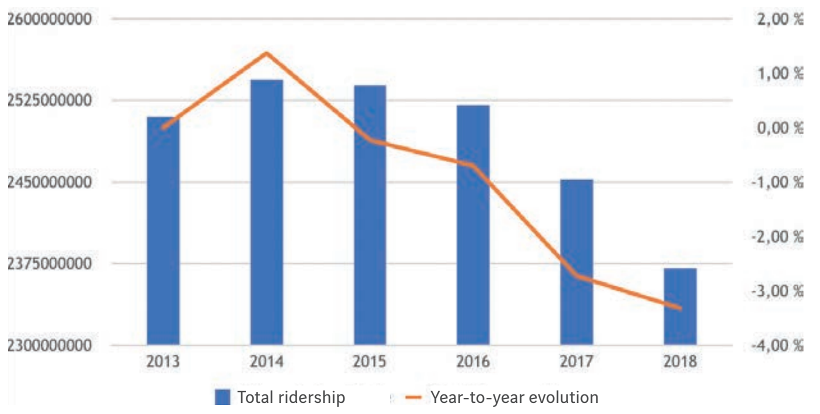
The area is finely cross-crossed by these many facilities: **around 97% of New York City's population lives within a quarter mile of a bus stop, and 71% lives within a half mile of a subway station**[95]. This infrastructure forms the backbone of travel in New York. The city's public transportation system alone conveyed almost 1.7 billion passengers in 2018 [96].

However, this network has now reached its limit for several reasons. Unlike many major cities, **New York has not significantly extended its subway system in the last fifty years, despite strong population growth. The subway network, the first line of which opened in 1904, was mostly constructed in the first half of the 20^{th} century.** The last subway line was opened in 1940. Only a few rare line extensions have updated the transport system which is now more than a century old.

To this can be added the fact that **investments in mobility infrastructure are not commensurate with requirements.** To date, six subway lines operate at or above passenger load capacity during the morning peak[97], while New York remains one of the most congested cities in the world. **The infrastructure networks are suffering from a range of shortcomings.** Faulty signalling, overcrowded subway trains, roads in poor repair and buses with reduced efficiency are all clear examples of this. This combination of factors has resulted in an obvious decline in the use of New York's public transportation since 2014, when the last peak of passengers was recorded. This trend is not specific to New York. It can also be observed in other US cities, with the exception of Seattle. This widespread decline can be explained by the simultaneous drop in fuel prices and the digital revolution in mobility, which resulted in the development of new mobility services, first and foremost ride-hailing services[98].

These services have succeeded in finding customers by promising simple and seamless mobility at a time when the long-standing modes of transportation continued to lose their appeal due to chronic inconveniences (breakdowns, congestion, delays). **Like other cities, New York is witnessing the roll-out of new mobility services which act on the entire mobility value chain, from itinerary calculation to transport and payment.** In the space of only three years, Uber and Lyft, the juggernauts of this new economy, have beaten out the iconic "medallion taxis" in terms of total trips[99]. Praised for their efficiency, in theory these services offer users the chance to go without a private car in urban centres, thereby contributing to the reduction of city-dwellers' use of their cars.

In New York, **these services appear to take advantage of the loss of efficacy of public transportation, which records a significant drop in ridership, mainly due to repeated system failures**. The situation is a paradox: while they promised to solve the system's failings, these new operators appear to feed off them instead. The same can be said in other major cities in the US. In the greater Boston area, a study conducted in 2016 among users of ridehailing services indicated that 42% of users would have taken public transit in the absence of ridehailing services[100]. The case of New York speaks volumes regarding the effects of digital technology on mobility: **rather than solving mobility issues, these new digital services leverage such problems to develop new services.** How does New York intend to curb this dynamic and get out of this situation?



Ridership and transit changes per year in New York (bus and subway)
Source : MTA

Promoting the development of public transportation

Ultimately, if no real action is taken regarding transportation systems, the decline of public transportation and the rise of individual modes (ride-hailing, micro-mobility, cars) are both foregone conclusions. Over the next two decades, the Metropolitan Transportation Authority (MTA), the transport authority operating in New York City, networks north of the city and in Long Island, **will have to adapt its transportation network to serve a region set to grow by about 1.4 million people, and in which more than 700,000 new jobs are projected—more than the population of the entire city of Boston**[101]. The stakes are high for the MTA which must both respond to the current shortcomings and prepare for this increase in demand. **As ridership is conditioned by efficacy, New York is counting on a massive reinvestment in its public transportation network.** It has published its proposed 2020-2024 MTA Capital Program in which the objective is to make the network more efficient and accessible. **This program allocates an exceptional investment of $51 billion over the next five years to meet several challenges, starting with improving the quality of public transportation in the city.** The MTA wishes to focus its action on signal modernisation, the creation of bus lanes and the renovation of urban railway infrastructure. A significant percentage of these investments will go to infrastructure which, while not very visible, is essential for the subway service's efficacy and reliability. Around $7.1 billion will be allocated to modernising the subway signal system in New York city alone, against $6.1 billion to renew around one third of the subway network's rolling stock[102].

For the MTA, the second challenge entails reducing congestion levels by encouraging a modal shift. This will be achieved by scaling up public transit, in particular by adding 175 buses to the existing fleet.

The tax instrument to serve the transition of passenger mobility habits…

The MTA has set itself the objective of proposing credible alternatives to cars by reinvesting massively in its transportation network while reducing the modal share of cars in the city centre. It is, however, aware that acting solely on transport in a system which is among the most developed worldwide, will not be sufficient. **New York State and City will therefore introduce a city toll to combat congestion.** This measure will make ground transport more efficient, while providing the MTA with new financial resources. This city toll will be introduced in 2021 and will be operational within the Central Business District. **According to the MTA's estimates, it will bring in around $15 billion in its first five years of operation. These revenues will be distributed between the networks of New York City (80%), Long Island (10%) and the north of New York (10%)**. New York's city toll alone will cover 34% of the multi-year capital program drafted by the MTA[103].

This tolling system rounds off **an operational approach aimed at increasing ridership in existing modes.** Ultimately, the tool will enable the transport authority to enjoy the additional financial resources required to put an end to the chronic under-investment in mobility infrastructure while acknowledging the value of public space, a scarce resource in the city centre.

…and mobility of goods

In addition to the under-investment in public transportation, the development of e-commerce and on-line sales platforms has further increased traffic in New York. This is demonstrated by the rising number of fines for parking violations accumulated by FedEx, FreshDirect, Peapod and UPS, four of the largest delivery companies in the USA. **Between 2013 and 2018, this figure grew by around 138%, from 372,000 summonses per year to roughly 515,000 today**[104]. The rise in the number of deliveries and the use of the road by urban logistics stakeholders threaten the available public space. **New York therefore strives to use tax levers to mitigate the negative effects related to the e-commerce explosion.**

New York City's 2020 budget introduces an important new feature: **the introduction of an Internet sales tax. This tax**[105] **intends to adapt taxation to changes in the retail sector.** It applies a tax on product sales which these on-line sales platforms had been exempt from paying until now, unlike physical stores[106]. This decision aims to reduce tax unfairness between these two types of trade. **Revenues from the tax, estimated at $136 million per year, will also be allocated to funding public transportation.**

Measuring the value of accessibility

The scale of the challenge is urging New York to explore new mobility funding mechanisms. While its network's structure makes it one of the most accessible cities in the world, **this accessibility has direct consequences on New York's land prices.** Without accessibility, land value is only reliant on natural resources within it and the buildings constructed on it. In New York and in other areas, the value generated by improving the accessibility of an area by installing a new service or optimising an existing one may represent a source of mobility funding, provided that the capital gain related to the completion of new transport infrastructure is recovered.

While the improved accessibility of an area benefits the community as a whole (inhabitants, businesses), most of the land value generated is captured by land owners. Land value capture mechanisms recover a share of this value to finance transport infrastructure. This type of mechanism has **the advantage of contributing to the funding of public transportation without increasing the cost of use for passengers.** Since 1989, New York State has applied a 1% acquisition tax, applicable to all real estate sales of a value exceeding $1 million. In New York City, the tax is higher still and **its revenues are directly allocated to funding the improvement of the public transportation network.** Faced with the challenge of upgrading public transportation, the instrument will once again change from 2020[107]: **while it will remain a flat rate in the rest of the State, the tax will become progressive in New York City.** This means that those purchasing real estate will have to pay an additional charge of 1% for properties with a value ranging from $1 million to $1.99 million and this rate will grow to 3.90% of the property's value for purchases exceeding $25 million. **Revenues from the progressive mansion tax, roughly $365 million, will be allocated to the MTA's budget and used to finance its projects.**

Funding mobility while strengthening urban appeal and economic activity

To stem the decline in its public transportation, New York City is counting on tax levers allowing it to collect new financial resources to finance mobility and also to change mobility habits. The efforts made and the amounts committed must, however, be put into perspective with regard to the positive effects on New York's economic activity and attractiveness.

Firstly, the city toll should reduce greenhouse gas emissions and fine particles from combustion engines. Secondly, New York's public transit network already prevents additional emissions of 17 million metric tons of CO_2 equivalent if journeys had to be made by car. Improving the public transportation network will enable New York State to retain its rating as the US State with the lowest CO_2 emissions ratio per inhabitant.

Lastly, the MTA plays a key role in the construction industry in New York State. Around one quarter of the activities in this sector concern work related to public transit. For every billion dollars invested by the MTA, 7,300 jobs are created. **This multi-year capital program should thereby generate around $75 billion in economic activity and roughly 350,000 jobs across New York State**[108].

UNITED KINGDOM

London: leveraging car costs to develop public transportation

—

TO REDUCE THE NEGATIVE EXTERNALITIES CAUSED BY VEHICLE TRAFFIC IN THE CITY, PRIMARILY CONGESTION AND FINE PARTICLE EMISSIONS, LONDON HAS ROLLED OUT A SERIES OF MEASURES WITH A VIEW TO INCREASING THE PRICE SIGNAL OF VEHICLE TRAFFIC WHILE ALLOCATING THE REVENUES FROM THESE MEASURES TO FUNDING PUBLIC TRANSPORTATION ALTERNATIVES AS A PRIORITY.

As a global economic hub, Greater London concentrates more than 8.8 million inhabitants[109] over an extensive area of 1,500 km^2[110]. The City, at the centre of the British capital, only accounts for 1.5% of Greater London's surface area and yet 26% of jobs are located there. **This hyper-concentration of activity is one of the causes of London's high levels of congestion.** To meet congestion, and therefore pollution, challenges, which are a threat to its competitiveness, **London has developed a holistic mobility approach.** Under the authority of the Mayor of London, Transport for London (TfL) plays a key role in the definition and implementation of the transport strategy. The authority is in charge of public transportation planning but also manages road networks in the UK capital. By integrating all forms of mobility (public transportation, cars, pedestrians and cyclists), London can conduct a consistent and efficient transport policy.

To reduce urban congestion, TfL introduced as early as 2003 a congestion charging scheme over a limited area of 21km^2 including Westminster and the City. Operated and managed by TfL, the city tolling system is part of an extensive mobility policy aimed at funding the development of public transportation.

The city toll as a means of transforming mobility in London

London's toll system means that people must pay a daily charge to drive in the charging zone. **This does not give right of access (to be paid each time the zone is entered) but the right to drive (payment of the congestion charge entitles a driver to circulate for a set period of time).** In force from Monday to Friday from 7am to 6pm and costing £11.50[111] (around €13.50), the congestion charge applies to all vehicles except London taxis and the emergency services. To ensure that traffic runs smoothly, the city toll operates through an automated registration plate recognition system. This technology is costly: **installation costs account for roughly €180 million and annual operating costs reach €130 million, i.e. 46% of revenues in 2008[112].**

At the same time as introducing the congestion charge, TfL rolled out significant measures with a view to developing and modernising its public transportation network to promote a modal shift from cars to public transportation. The revenues from London's tolling system contribute to this by funding an increase in the frequency of buses, creating cycle lanes and lane narrowing, etc. **From 2003 to 2013, about 46% or £1.2 billion of net revenue has been invested in public transportation, road and bridge improvement, and walking and cycling schemes. Of this, a total of £960 million was invested in improvements to the bus network[113].**

In 2014, the congestion charge represented 5% of TfL's revenues. Today, out of the 26.7 million daily journeys, 37% are made using public transportation, 36% in private vehicles, 24% by foot and 3% by bicycle[114].

Air quality and the scarcity of available public space: how can negative externalities be identified?

London is facing major challenges to reduce greenhouse gas emissions. That is why the city implemented an Ultra-Low Emission Zone (ULEZ) in April 2019 in the same area as the congestion charge (21km²) in order to promote the development of electric vehicles or highly fuel-efficient vehicles[115]. A replacement of the "T-Charge", a tax on vehicles below the Euro 4 standard, the ULEZ will be in force seven days a week, 24 hours a day. **Within the ULEZ, vehicles which do not comply with the standards set (Euro 4 minimum for petrol engines and Euro 6 for diesel engines) will have to pay a charge of £12.50.** This amount is payable on top of the congestion charge. HGVs must also pay a tax of £100 (around €117) in addition to the congestion charge. Alongside this measure, TfL is investing in a fleet of electric buses[116].

By introducing a user cost approach, **TfL intends to dissuade some forms of mobility in the city's high-density boroughs, where available public space is in shortest supply.** In October 2021, the ULEZ will be extended. In addition, the rest of Greater London is already a low-emission zone, although this scheme only concerns heavy vehicles such as buses, lorries and vans.

These different measures feed directly into TfL's budget and fund new mobility solutions. The case of London is emblematic of public authorities' capacity to use new resources to finance mobility: the transport authority had around €11.8 billion for the 2016/2017 budget[117], an amount which included public resources (subsidies) and private resources (fare revenue from public transportation, congestion charge, LEZ, etc.).

Positive effects… counteracted by changing forms of mobility

While some major global cities are considering the effects of a city toll system (Paris, New York, etc.), what conclusions can be drawn from the introduction of the congestion charge in London, sixteen years on?

The initial considerations regarding the implementation of the city toll included, ahead of its introduction, an extensive network of stakeholders (urban planners, users, transport authorities, etc.). The project's acceptability was heightened as a result and Londoners very quickly accepted the implementation of the congestion zone in the capital's hyper-centre, even though they were unfamiliar with the instrument. **London has focused its efforts on the social acceptability of its city toll rather than insisting on its efficiency and profitability**[118]. The reduction of urban congestion, following many unsuccessful attempts, further increased the city toll's acceptability after 2003.

The congestion charge has successfully dissuaded Londoners from using their personal cars in the city centre. **Between 2002 and 2014, the number of private vehicles entering the zone fell by 39%**[119]**. Furthermore, the city toll system, rounded off by a more developed public transportation network, has encouraged Londoners to enact a modal shift.** Between 2001 and 2011, public transportation and active modes saw increases in ridership: bus journeys rose by 59.7%, train journeys by 41.9% and journeys by bicycle by 66.6%.

The relationship between the introduction of the congestion charge and the improvement of air quality is difficult to establish, however, as demonstrated in a study conducted by the Health Effects Institute (HEI)[120]. **While TfL estimates that the reduction in congestion led to a 16% drop in CO_2 emissions**[121] **in the congestion zone between 2003 and 2006, these impacts gradually diminished after 2006**. The congestion levels recorded at the centre of London are actually similar to pre-2003 levels despite the charge. **This apparently paradoxical situation results from the reduction in road network capacity and the increase in buses**. Moreover, unlike a cordon charging toll system, London's congestion zone toll does not control vehicle journeys once drivers have paid for the right to travel. **As long as their entitlement to travel is valid, drivers can use their vehicles across the congestion zone as much as they like.**

Lastly, the increase in drivers' financial burden through the congestion charge, in addition to London's public transportation prices, makes the modal shift more difficult, particularly for low-income populations[122].

The challenge of updating London's congestion charge

Despite changing forms of mobility (electric vehicles, soft mobility, ride-hailing services), congestion and pollution are ongoing issues in Greater London. In 2020, Tony Travers, professor at the London School of Economics, provided an overview of the very difficult situation the British capital was facing. **London is currently recording unprecedented levels of congestion, despite the fact that it has successfully got rid of private car traffic in its centre**[123]. The question of the future of the toll system procedure, which is essential for the financial balance of the mobility system, is now raised. Since its introduction, mobility has changed significantly. Firstly, like other cities, London has experienced the sudden emergence of ride-hailing services. **In 2019, almost 18,000 such private hire vehicles crossed into the toll zone every day, as against 4,000 in 2003.** This increase contributed significantly to increasing London's congestion levels, where the space allocated to cars was reduced to leave room for other mobility forms. **London has taken action regarding this trend: from April 2019, private hire vehicles must pay the congestion charge**. In response, Uber decided to apply a £1 surtax for each journey in the zone. Traditional licensed black cabs remain the only combustion-engine vehicles to be exempt from the charge.

Secondly, London is still one of the most polluted cities in Europe: the Mayor of London's office estimates that around 1,000 people per year are hospitalised due to asthma caused by air pollution[124].

While the Low Emission Zone and the Ultra-Low Emission Zone are focused on pollution, they have in fact reached the objective to reduce congestion by restricting access for polluting vehicles. However, this effect is diminishing as the car fleet is reducing its carbon intensity. The rise in hybrid and electric vehicles, which are similar in size to their combustion-engine counterparts, once again raises the question of the role of LEZs in the preservation of available public space in dense urban centres, particularly as these vehicles are exempt from paying the congestion charge. **In view of this and owing to the potential increase in electric vehicle purchases in London, the local authority is attempting to adapt its action to the issues raised by the upsurge in new forms of mobility. TfL is planning to include electric and hybrid vehicles in its tax system (congestion charge, LEZ and ULEZ) by 2021.**

London is therefore showing its ability to adapt to new issues related to urban mobility and is rethinking the objectives of its city toll system. **The Mayor, Sadiq Khan, has discussed a merger of the congestion zone with the Low Emission Zone, stretching over 1,600 km², which would give rise to an emissions-based charge.**

NORWAY

Oslo : a holistic approach to develop electric car mobility

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TO MEET THE AMBITIOUS OBJECTIVES IT HAS SET ITSELF WITH REGARD TO ELECTRIC VEHICLE MARKET GROWTH, NORWAY HAS ROLLED OUT A SERIES OF INCENTIVE TAX MEASURES WITH A VIEW TO REDUCING THE COST OF PURCHASING (LOWER VAT) AND USING (EXEMPTION FROM TOLLS, FREE PARKING, ETC.) ELECTRIC VEHICLES.

In 2019, the European Automobile Manufacturers Association estimated that the share of electric vehicles in circulation in Europe was 0.2% of the total car fleet. A very high majority of vehicles have either petrol engines (54%) or diesel engines (41.9%)[125]. Faced with the climate change challenge, tomorrow's automotive sector will have to make significant efforts to reduce vehicle emissions.

One possible avenue for reducing the automotive industry's share of CO_2 emissions is the use of electric vehicles. These vehicles have the advantage of generating fewer negative externalities than combustion-engine vehicles. **When in circulation, they do not emit CO_2 or fine particles caused by combustion and at low speeds are less noisy than combustion-engine vehicles**. While electric vehicles offer many advantages regarding carbon intensity reduction, they still only account for a minority share in the European car fleet (less than 1%) as their high cost is currently a deterrent. A study conducted in March 2019 by McKinsey indicated that there is a cost gap of around $12,000 between electric vehicles and internal-combustion-engine vehicles[126]. This average sales price has tended to rise since 2011: it increased by 42% in Europe and by 55% in the USA[127]. **To foster the transition towards an electric vehicle fleet, the challenge for public authorities and car manufacturers is now to reduce the initial cost of the electric vehicle.**

At a time when many States are struggling to scale up electric vehicle sales, Norway is an exception. **In 2019, almost half (42%) of newly registered vehicles were electric**[128]. This figure can be partly explained by the fact that Norway, with Switzerland and Luxembourg, is one of the only European nations with a per capita GDP in excess of $70,000 per year. However, while Norwegians could simply prefer luxury combustion-engine vehicles, how can this considerable share of electric vehicles in new registrations be explained? How has Norway managed to trigger a genuine energy transition in its car fleet?

Creating the conditions to make electric vehicles the norm

Norway's drive to promote the share of electric vehicles in its fleet is not recent. It is the result of an approach rolled out both locally and nationally from the early 1990s and which is ongoing today. **Norway's action intends to meet the target set by the parliament of putting a total stop to sales of vehicles emitting CO_2 from 2025.**

The development of the electric vehicle must be supported by the development of a charging network, an infrastructure which did not yet exist in the early 1990s. To allay citizens' concerns regarding the ability to recharge vehicles in public spaces, **the city of Oslo launched a programme to build additional charging stations in 2008.** The aim was to build 400 slow-charge points in the city within four years[129]. One year later, the Norwegian State launched a €7-million investment programme to build 1,900 additional charging points across the country in four years. The aim was to increase the density of the charging station network nationally so that the users of electric vehicles could find a station every fifty kilometres.

This plan was supplemented by subsidies aimed at increasing the number of domestic charging terminals. To achieve this, the State used its sovereign fund to finance local subsidies applicable to the installation of home charging stations. The State contributes up to €1,200 per charging point with a maximum of 60% of the total installation cost[130].

This infrastructure-oriented approach, which is key to the development of electric vehicles, was rounded off by a series of measures aimed at making them more affordable.

Taxation and tangible benefits to reduce to the total cost of electric vehicles

While electric vehicles enable owners to get rid of often high fuel budgets, they are not able to be consistently convincing. Rightly so. **For an equivalent model, electric vehicles are more expensive to purchase than combustion-engine vehicles.** Norway has nevertheless succeeded in reversing this situation and in making electric vehicles an economically viable solution while ensuring their users tangible daily benefits. **From the early 1990s, the Norwegian government decided to remove import taxes for electric vehicles. In 1996, electric vehicles were exempted from the annual transportation tax. In 2000 and 2001 these measures were followed by a 50% reduction in the tax on corporate fleets and the removal of VAT on electric vehicle purchases respectively[131].**

This tax regime intends to foster the development of electric vehicles by making them more attractive purchases. At the same time, **other taxes aim to discourage the use of combustion-engine vehicles. Like the Netherlands and unlike Germany, Norway has one of the most progressive car tax systems in the world,** used to surtax large vehicles with high CO_2 emission levels. This is the role of the Norwegian registration tax, calculated on the basis of several criteria[132]:

· CO_2 emissions (six bands ranging from €97 per gram for vehicles emitting less than 95g of CO_2/km to €366 per gram for vehicles emitting more than 195g of CO_2/km);
· NOx emissions (linear rate of €7.50 per mg/km);
· Vehicle curb weight (five classes ranging from €2.61 per kg for vehicles weighing between 501 and 1,200 kg; €23.68 per kg for vehicles weighing more than 1,500 kg).

They are rounded off by a set of advantages granted to electric vehicles to reduce their everyday cost of use.

On a local, then national level, Norway has implemented free tolls (1997), parking, charging in public spaces and car parks (1999 and 2008), ferries (2012) and access to bus lanes (2003) for electric vehicles. These measures, which were initially developed in Oslo, come in addition to the tax benefits already allocated to electric vehicles on a national level. Some of these measures have since been adopted broadly by the government, following on from local experiments.

What does the future hold for this system?

The Norwegian incentive system has proven itself to be effective, but does that mean it is sustainable? **The incentive system intends to develop electric vehicles but does not call into question the place of cars in certain areas, particularly urban ones**. These tax measures may result in negative externalities, for example by promoting the use of private cars while other cities strive to reduce all forms of individual car mobility. These incentive mechanisms are also proving to be increasingly expensive as the development of the electric vehicle is pursued. **Reductions in the costs of using certain infrastructure or services intended for electric vehicles (tolls, car parks, charging stations, ferries) may ultimately put a strain on tax resources and actually reduce Norway's investment capacity.**

This fact has urged Norway to **consider adapting this incentive system over time.** The State and cities plan to launch a transition by removing and/or gradually reducing some incentives from 2020.

For Sture Portvik, project leader for electric vehicles at the City of Oslo, "driving electric must remain attractive but, at the same time, must contribute to funding public transportation and to reducing air pollution"[133]. **To achieve this, VAT exemption for zero-emission vehicles will be revised in 2021 and adjusted in accordance with the number of electric vehicles on the road.**

In addition, these incentives have repercussions on mobility-related behaviours and in particular the use of certain infrastructure. **Bus lanes are often congested by electric cars, which are entitled to use them and are growing in number. This situation results in the deterioration of public transportation performance. In view of this, the City of Oslo is now requiring electric vehicles to convey at least two people to be able to use bus lanes**. This measure aims to promote carpooling and restore proper traffic conditions for public transportation.

Lastly, **given the significant rise in the number of electric vehicles on the road, finding a charging station is proving more complicated today than was previously the case for Oslo's residents. The number of available charging points per vehicle have dropped from one charger per four cars in 2008, to one charger per ten cars[134] in 2018**. The challenge for Oslo and Norway will therefore be to maintain the charging infrastructure network at the scale required for the electric vehicle market. To do so, the capital is working with private companies and drivers' associations to target streets in which electric vehicles are present. With the support of electricity distribution companies, Oslo has identified the substations that can be used to install new charging stations. These efforts remain insufficient, however, in view of the considerable rise in the number of electric vehicles. The City is therefore planning to make major investments to extend its electricity network and continue to deploy new charging stations.

For Norway, this incentive-based tax system is not intended to be long-term but rather to bring about the optimal conditions to support the development of the electric vehicle market. As the share of electric vehicles in the car fleet increases, the question of revising this incentive system is raised.

Norway is considering its options, while bearing in mind the example of Denmark: **the electric vehicle market of its Scandinavian neighbour collapsed in 2015 when Denmark replaced electric vehicle tax exemption with a 20% purchase tax[135]**. The Danish example illustrates the fragile nature of electric vehicle market development. Rather than focusing on the mechanisms to be implemented, the issue of this system's long-term development is essential.

Charging station in Trondheim, 2015

CHINA

Hong Kong : real estate as the focus of the public transportation funding model

BY INCLUDING A PROPERTY ASPECT TO ALL ITS PUBLIC TRANSPORTATION PROJECTS, THE REVENUE FROM WHICH IS ALLOCATED TO THE COMPANY OPERATING THE TRANSPORTATION NETWORK, HONG KONG HAS A VIABLE FUNDING MODEL DESPITE A LACK OF SUBSIDIES.

Is there a public transportation network that turns a profit? This is a recurring question. Rightly so, as most transportation systems would be insolvent without any public financial contribution. **This statement raises the question of the sustainability of public transportation funding against a backdrop of public authorities' reduced project funding capacity.**

Hong Kong provides a response to these questions. **Its public transportation system management stands out for the lack of direct public subsidies for its operation.** This does not prevent the network from bringing about 12.9 million journeys each day and accounting for more than 90% of all motorised travel. Inhabitants can rely on a dense urban rail network made up of various modes of transportation. The Mass Transit Railway (MTR), the first line of which was opened in 1979, is the backbone of Hong Kong's urban rail network. In forty years, this network has been extended to reach a length equivalent to the Paris network (220 km). It is supplemented by the Light Rail Transit (LRT), a 36-km-long secondary network built in 1985. The lack of direct subsidies for its funding model does not prevent the company which operates mobility in Hong Kong, the Mass Transit Railway Corporation (MTRC), founded in 1975 and the majority shareholder of which is the Hong Kong government, from maintaining affordable pricing and a level of investment in new lines, all without public subsidies.

The key to Hong Kong's model lies in the inclusion of a real estate aspect in all public transportation projects conducted since the 1980s, the revenues of which are directly allocated to the MTRC. What are the specific features of this system? Is it replicable?

Leveraging the features of a restricted territory

Hong Kong (2017)

Hong Kong's public transportation funding model is intrinsically linked to the territory's features. Hong Kong is located on the south coast of China and adjoins the Chinese province of Guangdong. It is made up of a peninsula in the north and an archipelago of 200 islands. With a surface area of roughly 1,100 km^2, its territory is considerably restricted by its topography: only one fifth of it is buildable land. Approximately 7.3 million people live in a territory equivalent to five times the size of Paris[136]. **As a result of this restrictive geography, the average property value in Hong Kong is the highest in the world, ahead of Singapore, Shanghai and Vancouver**[137].

Through the MTR, the Hong Kong government has decided to leverage this situation. However, a strong real estate market value does not automatically lead to mobility funding. Effective tools must be implemented to recover this land value. **This is the role of so-called land value capture mechanisms which are used to finance the construction of infrastructure or the operation of a service through land value gains related to the improved accessibility in an area.**

The Hong Kong government owns all land. The City grants rights to property developers through public auctions. However, as regards transportation line construction projects and the building of stations and depots, the government grants exclusive building rights to the MTR. **The Hong Kong government makes the land available at the greenfield price, which does not include value increases related to future transport construction. In this way, the transport authority can acquire plots of land at more attractive prices than on the market.** Land development rights are negotiated for periods ranging from 50 to 70 years. For the MTR, they include the option of building housing and shops overhanging stations and depots and along lines.

As the contracting authority, **the MTR allocates the various plots of land in order to make them more manageable in terms of costs for developers. It grants exclusive development rights to developers through public contracts. It makes these rights available at the "after-rail price", which includes the value gain related to improved accessibility brought about by the future proximity to transport infrastructure. A first capital gain is thus generated.** There is a significant difference between the greenfield price and the after-rail price. Very often, this difference alone can cover a considerable percentage of total development costs (purchase of the plot, construction, marketing, etc.).

The sale of these permits enables the transport authority to transfer business risks and those related to the construction of property to developers, while remaining the prime contractor. In 2018, the MTR managed around 100,000 apartments, 13 shopping centres and five office buildings representing roughly 772,000 m^2. **Developers undertake to sell properties and shops before a deadline set down in a contract. Before the deadline, Hong Kong's transport authority receives a percentage of the profit resulting from the sales made by the developers. After this date, the MTR can decide to sell or rent out any unsold properties or premises.** By leasing retail spaces, the MTR can enjoy long-term revenues[138].

The success of the transport-property pairing

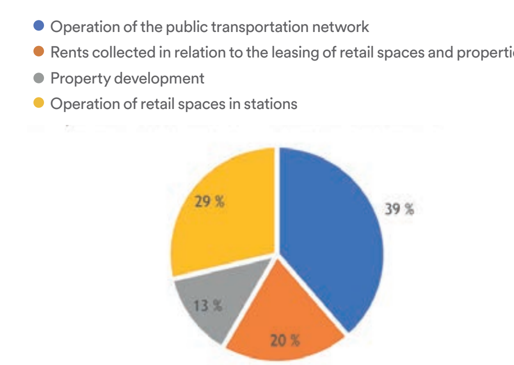
This model developed by the Hong Kong government and the MTR ensures that **this funding mechanism is sustainable without public subsidies and also allows them to have a real hand in urban development.**

Between 1975 and 1986, the transport authority applied its Rail + Property (R+P) model for around 18 sites located near the three transport lines completed over this period. Around 28,000 apartments, 128,500 m^2 of office space and 150,000 m^2 of retail space were constructed. The MTR retains the right to manage these spaces. The revenues generated from their leasing represented around 10% of the MTR's revenues at the time[139]. In 2018, profits from the MTR's activities in Hong Kong accounted for $HK 20.6 billion (around €2.30 billion). Out of this total amount, **39% was generated through operation of the public transportation network, 29% through operation of retail surfaces in stations, 20% through rent collected through the leasing of properties and retail spaces and 13% through property development; in other words, 62% of the MTR's profits are generated through the company's property businesses**[140].

This model fosters the joint development of construction and public transportation. There is a correlation between the type of project and the land value gains made. The design of high-quality public and pedestrian spaces, easy links to the public transportation network and the proximity of shops ensure greater revenues for the MTR. This illustrates the key role that the quality of development plays in the success of the R+P model. **The economic viability of this public transportation funding system requires in-depth consideration of urban development.**

In addition, R+P projects stand out for their intermodal connectivity, which guarantees high levels of public transportation ridership. The R+P model is similar in this respect to the Transit-Oriented Development (TOD) model in which the primary goal of residential and commercial area development is to promote the use of public transportation. **The creation of a property project near a railway station increases ridership by 35,000 passengers per day on average during the week.** The projects which increase ridership the most are those which foster the construction of large spaces intended solely for housing[141].

Profits of the MTR in 2018
Data: MTR



A replicable model ?

The development of shops and housing near rail stations is not practised in Hong Kong alone. **However, the scale of the model's success in Hong Kong is mainly due to the territory's features and its mobility governance.**

The success of Hong Kong's R+P model can be explained by the fact that new transport lines are built exclusively in areas which are already densely populated. **Population density guarantees the financial viability of line operation. This means that new public transportation lines are profitable by nature.** In addition, the high land value, which is characteristic of the restricted territory, ensures major revenues for the MTR through its property business. **The economic outcome would be different in a territory in which urban sprawl is possible and unrestricted.** In addition, this financial model's resilience remains to be seen: **the potential collapse of the land market constitutes a risk to the model's viability.**

Lastly, the success of Hong Kong's model is intrinsically linked to the governance of the mobility company. The MTR has the particular feature of having opened up its capital in 2000, a move which enabled it to conduct operations with a primarily commercial approach. Its listing on the Hong Kong stock exchange was followed by the launch of many R+P programmes. **One of the criticisms levelled against the MTR was the risk that future projects would not place emphasis on affordable housing in order to maximise profits. However, the majority presence of the Hong Kong government guarantees that local issues are taken into consideration despite the presence of private shareholders**.

Lastly, Hong Kong's public transportation network remains relatively recent, unlike those in a great many major cities, **in which mobility funding issues are related to ageing infrastructure.** Will the Hong Kong transportation network be able to do without public subsidies to compensate the ageing of its networks?

While the model is replicable, the scale of its success in Hong Kong is mainly due to the MTR's specific status, governance and the territorial geography[142]**.**

West Kowloon Station, Hong Kong

03

The search for resources to fund mobility in a post-carbon world

03

The search for resources to fund mobility in a post-carbon world

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IN THIS SECTION, WE PROPOSE TO IDENTIFY THE VARIOUS LEVERS THAT MAY BE ROLLED OUT TO REDUCE CARBON INTENSITY IN MOBILITY AND/OR INFLUENCE ITS FUNDING ON THE BASIS OF INTERNATIONAL EXAMPLES. FROM CONVENTIONAL LEVERS (FUEL TAX, CONCESSIONS, ETC.) TO THE MORE FORWARD-LOOKING (ZOMBIE TAX) INCLUDING NEW SOURCES OF FUNDING (TAXES ON OFFICE PREMISES, LAND VALUE CAPTURE, ETC.), THERE ARE MANY SOLUTIONS SUITED TO SEVERAL TYPES OF GEOGRAPHICAL AND POLITICAL SITUATIONS.

Effective ways of reducing carbon intensity in mobility...

While the reduction of carbon intensity in mobility is not given as a matter of course, it may be built up in several ways.

In its Guide to daily low-carbon mobility published in 2020, the Shift Project think tank presents three actions which have a broadly accepted effect on CO_2 emission reduction[143]. The "avoid - shift - improve" model is based on:

· **an avoidance strategy,** which entails reducing the need for travel upstream to cut the number of kilometres travelled;
· **a modal shift strategy,** which entails fostering a change in habits from more carbon-intensive modes of transportation to less carbon-intensive modes;
· **a strategy to improve the environmental efficiency of modes** to make progress in vehicle energy performance.

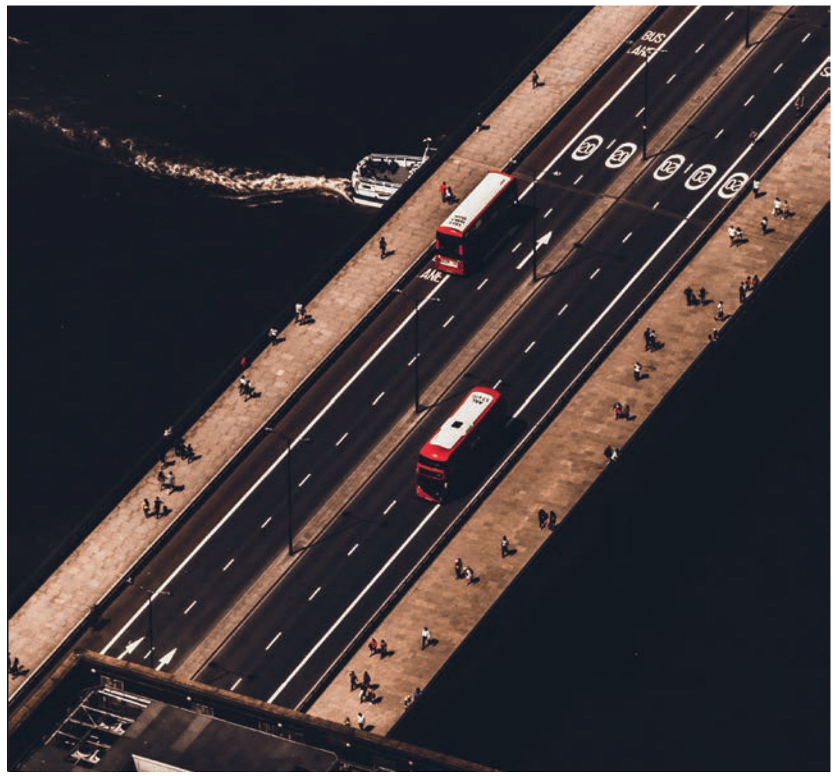
However, all these actions do not bring about the same effects on carbon intensity reduction. The Shift Project identifies the risks of rebound effects[144] for some of these actions. In practice, **while working from home results in a direct reduction of CO_2 emissions due to the lack of commutes to work, this decrease may be offset or even cancelled out by the indirect consequences of this shift.** Firstly, working from home requires the creation of new spaces (third places, for example), which leads to additional emissions due to construction, network connections and building heating systems. Secondly, by encouraging households and companies to move further away from city centres, the regular practice of working from home may result in an increase in the number of passenger kilometres[145] travelled. Similarly, the improvement of the car fleet's environmental efficiency as a result of electric vehicle development may be cancelled out by the simultaneous increase in average vehicle weight, in particular due to the rise of SUVs[146].

The modal shift is the most effective solution to reduce carbon intensity in mobility[147]. The savings made on CO_2 emissions are greater when the shift is made from a highly carbon-intensive mode (private car) to a carbon-neutral or less carbon-intensive mode (cycling, walking, carsharing). However, it would be a mistake to think that this shift is that simple. In general terms, the complex nature of travel requirements calls for a multimodal approach. It therefore seems difficult, as it stands, to systematically replace a journey by car with another mode of transportation. For some people (people with reduced mobility, large families, etc.), needs (transportation of heavy loads, etc.) or long distances, the use of cars may be more rational despite their carbon intensity. **The challenge is therefore to develop mobility solutions able to bring about a modal shift towards less carbon-intensive solutions (carpooling, public transportation, etc.), in particular for travel over longer distances.** While some of these solutions already exist, they are struggling to compete with private cars and remain anecdotal for travel of medium (10 to 100km) and long (over 100km) distances. During the strike action affecting public transportation in the Paris region at the end of 2019, on average 15,000 people used carpooling services every day (as against 3,000 at the start of the year)[148]. There is therefore potential for a shift from public transportation to carpooling. However, these figures must be considered in relation to the total number of journeys made each day in the Paris region: 43 million in 2018, a 5% increase compared to 2010, in particular due to population growth in the region.

…that must be funded in the long-term

Establishing the credibility of a reduced carbon intensity offering that can compete with cars entails significant investment in mobility services and infrastructure. These investments must boost the attractiveness of reduced-carbon solutions such as carpooling and public transportation, in particular for distances predominantly travelled by car. **Several levers exist for the long-term funding of these investments. Regulations, a market for the right to pollute and taxation are among the instruments commonly used as part of environmental protection policies and in particular CO_2 emission reduction.**

In its *Fiscalité et environnement* (Taxation and Environment) report published in 2005, **the French *Conseil des impôts* (tax board) stated that quota markets and environmental taxes offer the advantage of decentralising the adjustment decision, seen as a consumer choice and deemed rational**[149]. In other words, regulations enforce a choice that consumers may view as irrational. In practice, this may mean for mobility that a travel ban, for example, may be perceived as a particular hindrance by a user. Conversely, taxation and quota markets take action on the price signal of a journey, leaving users the choice.



Another important difference is that **taxation and quota markets allow for external costs which were not internalised until now to be taken into account**[150]. **Taxation corrects prices while quota markets set a maximum level (of CO_2 for example) which may not be exceeded,** and create a market so that companies can exchange these quotas. The difference is, however, that for a tax, the revenue goes to the State or to the transport authority, **thereby generating budgetary resources that may be allocated to funding compensatory measures, while for quotas, they are exchanged between private stakeholders, thereby encouraging them to reduce their emissions directly,** making the system more effective than the tax itself[151] with regard to carbon intensity reduction. It is, however, important to note that the tax system remains easier and less expensive to manage.

We generally speak about the "polluter pays" principle, "according to which the costs arising from measures to prevent, reduce or combat pollution must be borne by the polluter"[152]. **In the mobility sector, this implies that the revenues from these tax measures may be allocated to funding reduced-carbon solutions, particularly public transportation and active forms of mobility. Environmental taxation is an interesting lever to promote the reduction of carbon intensity in the mobility sector while allowing for new budgetary resources to be mobilised at a time when public funding for reduced-carbon mobility solution funding is growing scarcer.**

Reducing the carbon intensity of mobility and funding it is the same struggle

Economic theory assumes that environmental taxation may give rise to several simultaneous effects[153]. Firstly, by regulating a practice, particularly through taxation, it is possible to reduce the negative externalities (pollution, noise, congestion, etc.) related to certain types of journeys. **The improvement resulting directly from the incentive effect of the price signal on uses is known as the "first dividend"**[154].

A second, separate advantage may emerge when the budgetary revenues generated by environmental taxation create a collective gain. This is a "second dividend": revenues from the tax (first dividend) are used to finance an additional benefit (infrastructure, service, tax reduction, etc.)[155].

In other words, maximised effects of tax mechanisms on carbon intensity reduction will be subject to:

· The mechanism's capacity to influence mobility's price signal with a view to reducing the negative externalities of certain journeys;
· The existence of a rule allocating budgetary revenues to mobility.

We can therefore develop a typology to distinguish between several mechanisms:

· **regulation without influence on the mobility price signal,** for example in the case of low-emission zones or a travel ban; the measure is used to regulate mobility but does not generate any tax resources and therefore does not contribute to mobility funding;
· **mobility funding that does not give rise to mobility regulation**; this is the case of the mobility contribution and land value capture instruments which, while used to finance mobility, do not have a direct effect on the mobility price signal and do not allow for a regulation of travel habits;
· **regulation with influence on the mobility price signal for which revenues are allocated to mobility**, such as fuel taxes and motorway concessions to a certain extent and city tolls. The latter type of instrument has a direct effect, to varying degrees, influencing mobility behaviours by acting on the price signal of journeys and is a means of funding mobility.

This typology can be used to identify a few major categories of instruments. However, the actual effect of these mechanisms on mobility and its funding vary according to the location and the means of implementation (acceptability of the measure, exemptions, etc.). Using international examples, a quick, non-exhaustive overview highlights their advantages and also their shortcomings which could make their roll-out more complex.

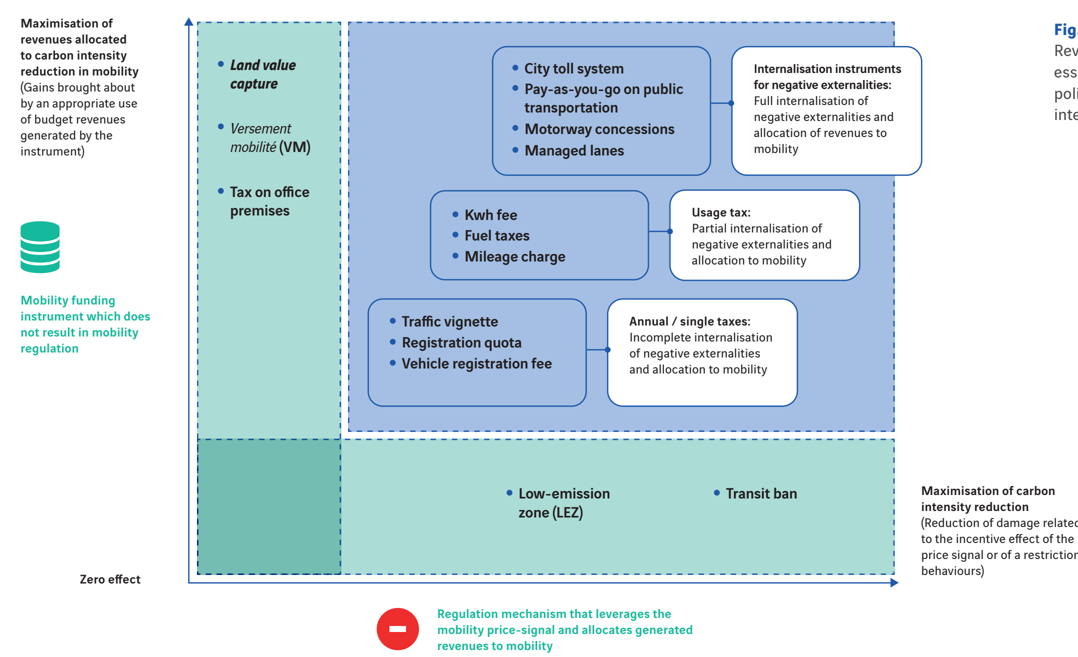


Fig. 9
Revenue allocation is essential for effective policies to reduce carbon intensity in mobility

01 **Allocating fuel taxes to mobility**

02 **kWh fee: taxing electricity consumption in mobility**

03 **Increasing registration fees for electric vehicles**

04 **Singapore and the issuance of a quota of licences to fund mobility**

05 **Road usage charge: the roll-out of a mileage charge**

06 **Zombie tax: emptying the streets, filling (robo)taxis**

07 **Weight tax and taxes on HGV traffic in Europe**

08 **Emission-sensitive tax**

09 **The concession model: taking a long-term view of carbon intensity**

10 **City tolls, an opportunity to finance mobility**

11 **Infrastructure usage rights: comparing the Eurovignette and the Swiss vignette**

12 **Managed lanes: funding infrastructure projects while considering contemporary pressures**

13 **Revitalising mobility pricing in the digital era**

14 **Free public transportation to change behaviours**

15 **Transportation/mobility contribution: employer funding of public transportation services**

16 **Land value capture: leveraging accessibility to finance transportation networks and infrastructure**

17 **Forfait post-stationnement: using stock to finance flows**

18 **Lane rental scheme: reducing the time limitations of roadworks**

19 **Tax on office premises to finance public transportation projects**

Glossary

Acceptability

Assesses acceptability of a mechanism. The determination of this criterion depends on whether the setting up of the mechanism may have raised opposition. The scale goes from 1 (very contested measure) to 5 (accepted measure).

Revenues

Evaluates the revenues generated by the mechanism in relation to its cost. This assessment does not include savings from positive externalities created or negative externalities avoided. The scale ranges from 1 (mechanism producing few financial resources) to 5 (mechanism producing large financial resources).

Longevity

Assesses the relevance of the measure in time. This criterion depends on the efficiency of the measure to be regulated and funded in the medium and long term. The scale ranges from 1 (mechanism relevant in the short term) to 5 (relevant in the long-term).

Horizon

Evaluates the speed of deployment of the mechanism. The determination of this criterion depends on whether or not the mechanism is proven and on the national and local contexts. The scale ranges from 1 (implementation of the mechanism can be considered in the long-term) to 5 (the mechanism can be implemented immediately).

Cost

Evaluates the cost associated with setting up the mechanism (administrative costs, installation, purchase of equipment) in relation to the revenue it will generate. The scale ranges from 1 (setting up the mechanism is very expensive) to 5 (setting up the mechanism is inexpensive).

Allocating fuel tax revenues to mobility

—

The early 20th century was marked by a more widespread use of cars. The release of Ford's T model, the first mass-produced model at an affordable price, "put America on wheels" and on a road network unsuited to the automotive revolution, which raised the issue of how its upgrading was to be financed.

Traditionally, US States used vehicle registration fees, firstly as a one-off payment and then as an annual tax; from 1919 and the introduction of a fuel tax, infrastructure construction became financed through an indirect tax collected on the fuel sales price [156].

→ INTERNALISING SOME OF THE EXTERNALITIES RELATED TO INFRASTRUCTURE USE...

The primary goal of this tax was to make drivers pay for infrastructure use by insisting on the correlation between fuel consumption and the number of miles travelled. The revenues of this new tax resource were a way to ensure that the cost of funding road construction and maintenance was borne by road network users. The solution was appropriate for several reasons: first of all, unlike an infrastructure toll system, it does not require any additional developments to collect the tax. Secondly, this tax has a very low unit cost (a few cents) for the user. Lastly, it does not apply solely to residents but also to foreign users who buy fuel in the area.

→ ... WHILE REDUCING FUEL CONSUMPTION

Tax increases have a causal effect on the reduction of fuel consumption. By acting on the tax, it is therefore possible to directly influence fuel consumption and indirectly act on CO_2 emissions.

However, as stated in its name, this tax only applies to vehicles which consume fuel, resulting in a de facto increase in running costs. Conversely, more fuel-efficient vehicles, such as hybrid and even electric vehicles are either partially or completely exempt from this type of tax. They do use the infrastructure network to the same degree, but their contribution falls short of their use of it.

→ A CHALLENGING FOOTHOLD IN THE REALITY OF THE MOBILITY SECTOR

Improvements to combustion engines and the development of hybrid and electric vehicles have established a decorrelation between road use and fuel consumption. The latter no longer reflects the former.[157]

This downward trend in long-term fuel tax revenues is heightened by the fact that the level of taxation is not automatically indexed on inflation. In other words, increases to roadworks and maintenance costs will not necessarily result in a similar increase in total revenue from the fuel tax. This shift sparks concerns of a decline in resources to fund roads, the corollary of which could be a deterioration in infrastructure networks. Nevertheless, States have options to respond to this issue. They may decide to increase the tax level to offset the drop in revenue. However, the unpopular reaction to this lever may encourage them to maintain the status quo, even if that poses a threat to mobility funding.

→ A PAST RESOURCE TO BE RECONSIDERED

Revenue from this tax remains a solid and significant resource... provided that it is used to fund mobility. In France, the State pays half of the domestic consumption tax on energy products (TICPE) to the general budget without revenues from this tax being allocated to mobility[158]. While the TICPE is the fourth form of tax revenue for the French State (€30 billion in revenue in 2017), only €1.5 billion are allocated to the budget of the AFITF, the funding agency for French transport infrastructure, the purpose of which is to finance transport infrastructure projects in urban areas, waterways, railways or road networks. One third of the TICPE's revenues is allocated to local and regional authorities and 19% to funding the environmental transition, while the remainder (45%) goes to the general State budget. In other words, fuel taxes can be powerful levers to finance mobility, provided that revenues are allocated to just this.

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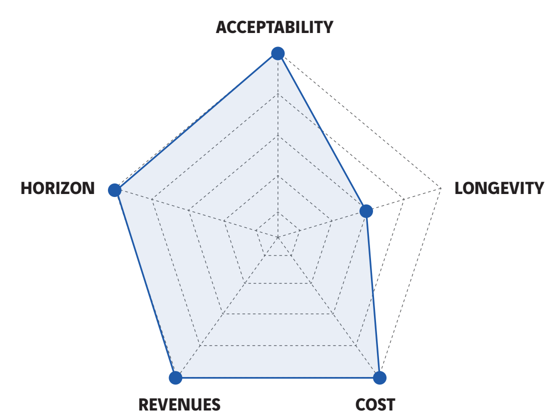
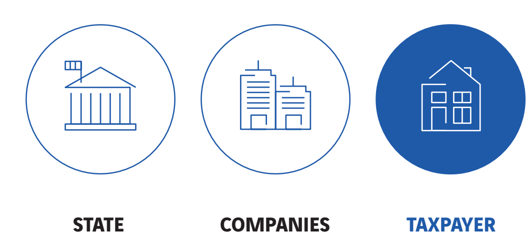


Who pays?



What scale of implementation?

Kilowatt-hour fee: taxing electricity consumption in mobility

→ TAX EXEMPTION FOR ELECTRIC VEHICLE USERS: A BLESSING IN DISGUISE

The difference between internal-combustion vehicles and electric vehicles cannot be summed up by engine type alone. The difference is also tax-related, as electric vehicles do not consume fuel and are therefore not subject to taxes on petroleum products. In a country like the United States, where the revenues from the fuel tax are allocated to road network construction and maintenance, electric vehicles do not contribute to funding the road infrastructure that they use. While electricity consumption when charging a vehicle at home or in a public charging station is subject to tax, the revenue of this tax finances the use of infrastructure related to electricity generation, transmission and distribution, and not mobility.

For the moment, electric vehicles only account for a small fraction of the car fleet in circulation. They do not consume fuel and are therefore exempt from fuel taxes. As yet, their use has only led to a very slight decrease in revenues for this tax. This lack of tax is offset by other fiscal resources collected in particular from internal-combustion vehicles in circulation. In other words, a realignment mechanism of combustion vehicles to electric was implemented and the use of an electric vehicle is therefore subsidised[159]. This inconsistency is intentional. Tax exemption is used as an argument to promote the widespread take-up of electric vehicles. The lack of taxation aims to make electric vehicles more attractive by reducing their cost of use.

→ ELECTRICITY, AN ENERGY PRODUCT LIKE ANY OTHER?

However, as the proportion of electric vehicles in circulation increases, the tax shortfall will also grow, making the use of a charge on the use of electric vehicles inescapable. Several solutions can be considered.

One such solution would be to tax vehicle electricity consumption by importing the current fuel tax model: this would be a tax on electricity consumption (kWh fee), which considers electricity as an energy product that can be taxed like fuel. This type of instrument requires appropriate measurement infrastructure. Charging stations set up in public spaces are already applying these rates. This is in particular the case of the superchargers network rolled out by Tesla, which bills its charging service by number of kWh consumed[160]. However, as most electric vehicles are charged at users' homes, a meter must be installed to ascertain the quantity of energy consumed to charge the electric vehicle.

→ APPARENT LIMITATIONS

This system appears coherent when vehicles are charged using the public network of charging stations. In this case, the electricity consumption tax can be viewed as a fee for using public space during the charge time. The cost may vary in accordance with the service provided, in particular for fast recharging, which reduces vehicle downtime.

However, for home charging, the main challenge is to reduce recharge cost variability. According to time (peak or off-peak hours), location and provider, the electricity price and therefore the mobility cost may vary significantly[161].

Lastly, this type of tax instrument raises a more fundamental question: how to justify a difference in the applicable prices between electricity used by a household for cooking, heating, lighting and using electronic devices and electricity used to drive an electric vehicle?

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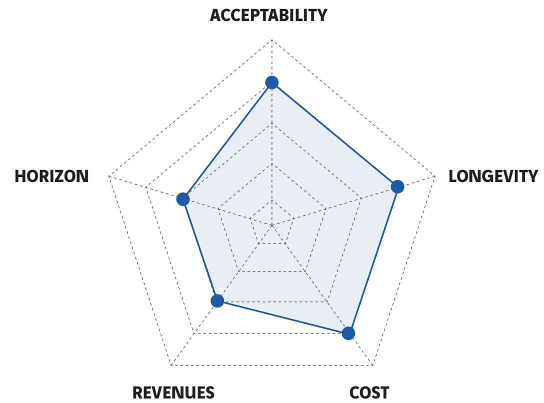

Who pays?

STATE

COMPANIES

TAXPAYER

What scale of implementation?

LOCAL

NATIONAL

Setting registration fees for electric vehicles

Vehicles must be registered to be entitled to move around freely. Registration involves vehicle owners paying a tax, after which a registration number and certificate are issued so that authorities can establish the link between a vehicle and its owner. Although some exceptions apply, these registration fees are applicable to all vehicles, regardless of their use (private car, public transportation, lorries, agricultural vehicles, etc.). This type of tax is different from a form of road tax, for example vignettes, which users must pay in order to access the road network in a predefined geographical area.

Vehicle registration tax provides a financial resource while having an influence over the type and number of vehicles in circulation. Various cases exist, in which either registration fees are payable upon the vehicle being brought into circulation or must be renewed after a period that varies from one State to another.

→ MITIGATING THE TAX INCOHERENCE OF ELECTRIC VEHICLES

In the United States, to counteract the fact that electric vehicles do not pay fuel tax, leading to a downward trend in fuel tax revenues[162], some States[163] require electric vehicle owners to pay annual additional registration fees (EV fees)[164], on top of the initial vehicle registration fees.

In California, the State Bill-1 Transportation Funding approved in 2017 provides in particular that owners of "zero-emission" cars produced from 2020 must pay this additional registration fee[165]. This tax will be indexed on inflation. This decision strives to generate additional revenues of $200 million over the next decade. The revenues from this tax will be allocated to funding the State's road network rehabilitation programme.

→ A RESOURCE WITHOUT REGARD FOR INFRASTRUCTURE USE

This mechanism has been met with several criticisms. First of all, while they can be adjusted in accordance with vehicle type, power, weight or age, registration fees are applicable regardless of vehicle use[166]. In other words, whether a vehicle is used every day or only a few times a year, the amount collected by the tax administration is the same.

Lastly, as the number of electric vehicles in circulation remains low in the United States, the low revenues from this tax will not make up for the shortfall related to these vehicles not paying fuel tax. To increase revenues, authorities must act on two levers: increasing the number of vehicles in circulation or increasing the amount of the tax. However, the latter solution will have counter-productive effects on the former: applying additional registration fees to electric vehicles on an annual basis has direct repercussions on the cost of electric vehicles and therefore on the number of sales if these fees are deemed too expensive[167].

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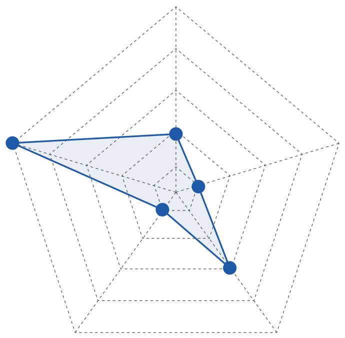
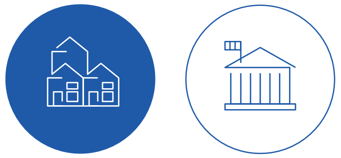


Who pays?

STATE | COMPANIES | **TAXPAYER**

What scale of implementation?



LOCAL | NATIONAL

Singapore and the issuance of a quota of licences to fund mobility

The scarcity of available public space drives Singapore's mobility policy. The City-State occupies a territory restricted to the south by the ocean and to the north by the Johor Strait which marks the border with Malaysia. Public space is a fixed and extremely limited resource given Singapore's urban development.

→ DRASTIC MEASURES FOR A RESTRICTED TERRITORY

Currently, around 12% of the territory is devoted to road infrastructure, while car parks account for roughly 4% of the City-State's total surface area. This means that cars occupy 16% of Singapore's surface area… compared to only 14% for housing. By 2030, the percentage of territory allocated to cars is estimated to rise to 19%, while population growth is set to rise from 5.6 to 7 million. Furthermore, Singapore's isolated status tends to make the car an exclusively urban mode of transportation, as regional journeys do not exist and international journeys are made by air or sea. This specific status of cars and the situation in Singapore has led it to take drastic measures to reduce the modal share of cars.

In 1990, to mitigate vehicle traffic and contain the growth of road infrastructure, Singapore rolled out several measures: a city toll (Electronic Road Pricing) and the Certificate of Entitlement (COE). The latter measure aims to control and limit growth in the number of vehicles in circulation.

→ REDUCING THE IMPORTANCE OF CARS AND PROMOTING OTHER MODES OF TRANSPORTATION

In Singapore, to own, register and use a vehicle, a COE is required. This certificate is valid for a ten-year period. It is obtained through an auction system managed by the Singapore Land Transport Authority (LTA). The number of COEs on sale is set by a quota updated by the government every six months.

The price can vary significantly depending on the vehicle category. It can even exceed the price of the car itself. In 2019, the price of the COE for a vehicle with less than 1,600cc ranged from 25,500 to 36,000 Singapore dollars (between €17,000 and €23,500). In 2018, the COE provided the LTA with revenues of $3.1 billion (roughly €2.2 billion).

Like other taxes applicable to vehicles in circulation, revenues from the COE are fully allocated to funding mobility. Following on from its car quota policy, Singapore is leveraging the development and competitiveness of public transportation. By 2040, the City-State plans to extend its MRT network and improve bus circulation by creating 211 km of priority lanes.

→ AN EFFECTIVE SYSTEM WITH FAR-REACHING IMPLICATIONS

The COE offers Singapore two main advantages. Firstly, it enables the City-State to control the number of vehicles in circulation to a very precise degree. In October 2017, the LTA decided to reduce the growth rate of new vehicles in circulation, which had been 0.25% additional vehicles per quarter[168], In 2017, less than 400 vehicles were granted a COE each quarter. This policy had a very clear effect on the population's car ownership rate: 11% in Singapore, compared to 36% in Paris[169] and 45% in New York[170], cities with the lowest car ownership rates in their respective countries. Moreover, the COE contributes to limiting congestion. The second advantage of the COE is that it enables the LTA to enjoy tax revenue[171] which contributes to funding alternatives to cars and in particular the development of the public transportation network[172].

However, the cost and the scarcity of COEs may penalise low-income households. In addition, COE renewal fees once the ten-year validity period has expired may lead some inhabitants to give up their car, which reduces vehicles' shelf life in Singapore. According to the saying, "even cats and dogs live longer than cars in Singapore"[173].

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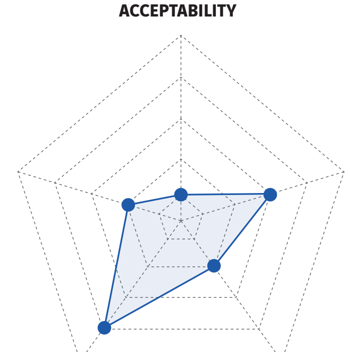

Who pays?

STATE
COMPANIES
TAXPAYER

What scale of implementation?

LOCAL
NATIONAL

Road usage charge: charging users rather than consumers

—

Faced with congestion, pollution and mobility funding issues, cities such as Singapore and States such as Oregon are currently testing a mileage charge system which entails charging users in proportion to their use of the road network.

→ THE "PAY FOR WHAT YOU USE" PRINCIPLE

In Oregon, revenues from the fuel tax will dwindle inexorably from 2020 while at the same time mobility infrastructure is deteriorating and there is an increased need for road network maintenance. This decrease in fuel tax revenues is due to the increasing numbers of more fuel-efficient vehicles and demographic growth, which always results in more vehicles on the road. The upsurge in hybrid and electric vehicles on the car market is shaking up the conventional mobility funding model in the United States by reducing the fuel tax base. Yet this state fuel tax, introduced for the first time in Oregon in 1919, is the primary source of revenue for the funding of the State's mobility infrastructure, generating no less than $600 million in revenue each year. It is therefore essential to depart from the "fuel purchase mirrors road use" model of the 20th century, which is becoming both obsolete and unequal[174]. With the launch of the Oregon Department of Transportation (ODOT) OReGO pilot programme on 1 July 2015, the Beaver State is once again the first US State to try out the road usage charge[175].

Five thousand miles from Oregon, Singapore has one of the most developed road pricing systems based on a city toll which taxes drivers in line with congestion levels[176]. This dynamic pricing system is made possible through cameras installed on gantries and on-board units in vehicles. Not only does it regulate (mainly at peak times) Singapore's road traffic but it also encourages users to consider alternatives to cars[177]. However, Singapore hopes to further develop its road pricing system by using vehicle geolocation, thereby establishing pricing according to the number of kilometres travelled.

→ A VIABLE MODEL ?

The Road Usage Charge Program tested in Oregon requires an electronic unit to be fitted in the vehicle's interior to record the number of miles covered. Data on mileage and fuel consumption are collected each month by private companies and passed on directly to the ODOT, which then bills users. Studies conducted among the 1,600 volunteers taking part in the pilot programme have demonstrated that this new tax was fairer than the fuel tax, in that all vehicles are subject to the same rate of 1.50 cent/mile and less fuel-efficient vehicles, which already pay fuel tax, have 30 cents/gallon credited to their account. This mileage charge is above all a means of securing a stable flow of revenue, dependent solely on the number of miles covered and not on fuel consumption. This experiment is proving to be a success: volunteers feel it is a positive experience and the OReGO programme received a $1.2 million subsidy from the federal government to perfect its model, which has, incidentally, attracted other US States.

→ SOME USERS REMAIN RELUCTANT

Most of the different models of mileage charge require new technologies and GPS data to improve and establish their services among users. In the digital era, however, users are sometimes reluctant to share their personal mobility data with private stakeholders, fearing that the data is used without their consent and for other purposes than the calculation of their travel costs. The various tests conducted by the ODOT between 2006 and 2015 have demonstrated that many car users are unwilling to approve a programme such as OReGO if it involves installing an electronic unit that collects GPS data[178].

In response to this, the pilot programme launched in July 2015 gives the option of installing a unit without GPS; though many volunteers were unaware of this. There is therefore a real communication challenge that must be met to increase the programme's acceptability so that it can ultimately replace the conventional fuel tax.

The success of Singapore's system can be explained in particular by the roll-out of an information campaign aimed at car users[179]. However, the 2020 upgrading of the City-State's city toll remains subject to the population's acceptance of the toll's operating conditions, in terms of both privacy and cost.

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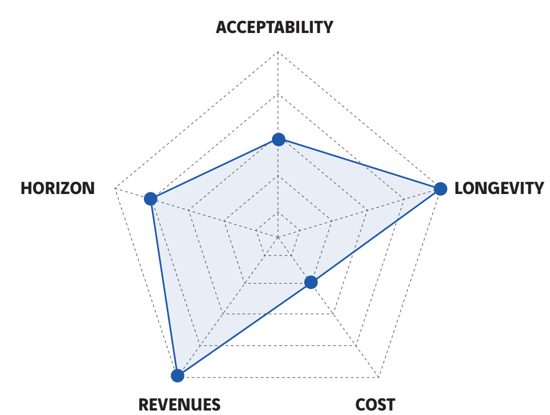
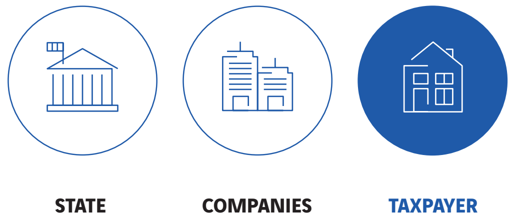


Who pays?



What scale of implementation?

Zombie tax: emptying the streets, filling (robo)taxis

→ THE END OF CONSTANTLY PARKED CARS

Taxis, ridesharing services and robotaxis[180] all have a common feature: their effectiveness depends on their ability to be rapidly available in various places. Increased reliability is subject to their good knowledge of demand (trends, data, algorithms) and their capacity to provide a significant number of vehicles. In real terms, this means that vehicles roam the streets waiting for a customer to hail a ride, even riding with no passengers sometimes when demand is too low.

This trend is known as zombie cars. The constant circulation of several thousand passengerless vehicles heightens congestion without contributing to urban mobility[181]. Yet this trend is developing as it is economically more advantageous for a driver to travel with an empty car as parking would result in higher costs than driving. An American study[182] conducted in New York stated that out of the total distance covered by ridesharing vehicles, less than half (45%) were made by vehicles with no other occupant than the driver.

→ ANTICIPATING THE ADVENT OF THE SELF-DRIVING VEHICLES

Ultimately, this trend will be heightened if robo-taxis become the standard for urban car journeys. To be profitable, it is in fleet operators' interest to minimise vehicle downtime. In other words, self-driving vehicles will spend most of their time roaming the streets waiting for customers.

In 2019, the State of Massachusetts considered a draft bill aimed at rolling out a series of actions to promote the rational development of self-driving vehicles in the State[183]. This bill would include the introduction of a fixed-rate tax of 2.5 cents for every mile driven by autonomous vehicles. This amount may be reduced if the self-driving vehicle belongs to a local or regional authority, if it transports several people, if it is driving in off-peak times or if it operates in an area with limited public transportation options.

→ TAXATION TO URBANISE SELF-DRIVING VEHICLES

This type of tax aims to steer autonomous vehicles towards certain uses (shared vehicles rather than empty vehicles), in certain areas (with limited public transportation) and at certain times (off-peak hours). It also enables authorities to have a tax lever at their disposal, the revenues of which could partially offset the drop in fuel tax revenues.

Such a solution has not yet been tested. It raises the question of the quantity of parking spaces required to protect public spaces.

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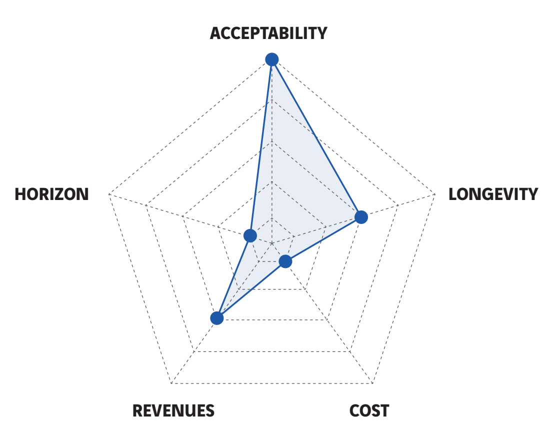

Who pays?

STATE

COMPANIES

TAXPAYER

What scale of implementation?

LOCAL

NATIONAL

Weight tax and taxes on HGV traffic in Europe

—

According to the CITEPA[184], in 2017, HGVs accounted for 5.7% of total CO_2 emissions in France and roughly 20% of annual CO_2 equivalent emissions in the transport sector[185]. In addition, a significant share of negative externalities related to the road (pollution, congestion, noise, etc.) is due to HGVs which damage roads more than passenger cars. However, goods carriers do not contribute to road network maintenance proportionately to their effect on it. This inconsistency further complicates the funding of mobility[186].

→ THE "POLLUTER PAYS" APPROACH

In view of this inconsistency, effective solutions have been implemented for several decades. This is particularly the case in Switzerland[187], where the performance-related HGV fee (RPLP), in force since 2001, applies to Swiss and foreign HGVs weighing over 3.5 metric tons. This tax is indexed on vehicle weight, the number of kilometres travelled and emissions. It aims to foster a shift in goods transport from road to rail. The success of this type of tax instrument is dependent on two factors: reaching an optimum tax price and the existence of an efficient rail infrastructure network.

The results are significant: a drop in the number of HGVs driving with empty loads achieved through optimised loading, a renewed fleet through a shift from HGVs to lighter (and therefore less polluting) vehicles and a 6.4% reduction in the distance covered by heavy traffic between 2001 and 2005, according to a report published by the Swiss Federal Office for Spatial Development (ARE) in 2011. The Swiss RPLP tax has also constituted a means of reducing CO_2 emissions by 105,000 metric tons since its entry into force. It has also represented revenues of €1.2 billion intended to maintain the road network and develop rail infrastructure. The Swiss success is coveted by others: six countries have already followed suit, introducing taxes of this kind with a view to departing from the highly competitive fuel tax model.

→ REVIEWING THE SHARE OF HGVS IN INFRASTRUCTURE FUNDING

Following the first failure of the *écotaxe*, the collapse of the Morandi motorway bridge in Genoa in August 2018 re-opened debate on the HGV tax in France, as Italy was among the European nations which had not introduced such a tax. In France, no fewer than 4,000 bridges on the non-concession road network require repair[188], according to a study commissioned by the French Transport Infrastructure Department in July 2018. Unlike the concession network, the public road network suffers from "chronic under-investment in road maintenance"[189]. The introduction of a mileage charge applicable to lorries weighing over 3.5 metric tons on France's non-concession road network would reduce pollution and, to a lesser extent, congestion and would finance network maintenance, with HGVs bearing the real costs of road haulage.

Over the last decade, the modal share of rail freight plummeted to the benefit of road haulage. Besides the funding of maintenance works on the French road network, the development of rail and river transportation was also at stake with the introduction of this *écotaxe*. Its revenues were to be allocated to the AFITF, the funding agency for French transport infrastructure, to finance infrastructure projects, most of which were rail-based.

→ THE QUESTION OF ACCEPTABILITY

The liberalisation of the road haulage industry heightened sector-based competition which is now played out on national and European levels[190]. The year 2013, in which the écotaxe went live, was marked by several protests by road hauliers. These professionals rejected the measure, stating that it created distortions of competition between areas, thereby affecting attractiveness for some of them. In addition, they believed that reinforced taxation on road haulage would put a strain on companies' competitiveness[191].

Three years after this failure and given the success of its European counterparts[192], the écotaxe resurfaced in the French political arena[193]. This option remains disputed by the FNTR, the national road transport union, for the aforementioned reasons. Road hauliers demand a prior audit of all that is collected under road usage and that the revenues related to the 4-cent increase in the domestic consumption tax on energy products (TICPE), agreed when the écotaxe was shelved in 2016, are allocated to road network maintenance.

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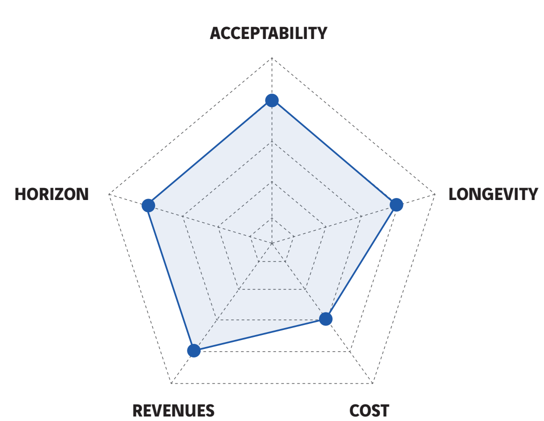
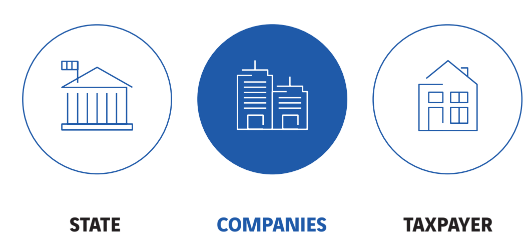


Who pays?



What scale of implementation?

Putting a price on carbon to control emissions more effectively

—

In France, alongside the construction sector, the transportation sector accounts for the most CO_2 emissions, namely approximately 30% of national emissions. Due to the climate emergency, around 80 countries made a commitment to the UN to reduce their greenhouse gas (GHG) emissions significantly by 2050 or even 2030, under the Paris Climate Agreement. The carbon tax and carbon emission quotas are economic measures aimed at making polluters pay in proportion to their emissions (the polluter pays principle) and ultimately to steer companies' and citizens' behaviours and decisions towards a reduction in polluting emissions. Although many countries claim to be willing to apply an emission-sensitive tax, in 2018 only 21 countries and two Canadian provinces had actually introduced an environmental tax on CO_2 emissions.

→ WE ARE ALL CONCERNED

Road haulage is not the only sector to be concerned by the carbon tax. In July 2019, the French government decided to require a solidarity tax on air tickets from air transport companies, the so-called "Chirac tax". This tax, which was created in 2005, applies to all airlines embarking passengers on French territory. Its revenue was initially intended to finance developing countries. Article 20 of the 2020 budget bill[194] recently provided for an increase of this tax on air tickets, revenues from which will be allocated to the AFITF's budget, the funding agency for French transport infrastructure. This "eco-contribution"[195] accounts for a price increase ranging from €1.50 to €18 according to booking class[196]. Alongside eight other countries, France has called for the European Union to revive debate on civil aviation pricing through new tax measures with a view to fostering the reduction of the sector's greenhouse gas emissions.

→ THE CHALLENGE OF PRICE ... AND OFFSETTING

The amount of this tax varies greatly. It ranges from €0.9 per metric ton of CO_2 emitted in Ukraine to €118 per metric ton of CO_2 in Sweden. In France, the *Contribution Climat-Energie* (CCE) was introduced in 2014. Initially set at €7 per metric ton of CO_2, the energy transition act provides for a CCE of €100 per metric ton of CO_2. In 2020, in line with the set increase, the amount of this carbon tax was €44.60 per metric ton of CO_2, i.e. an increase of 537% in four years, since the introduction of the measure[197]. One of the challenges of the carbon tax is related to setting the pricing level: it must be high enough to change purchasing behaviours but not excessively so as this would result in market distortion. In other words, what is the maximum limit of the effort we are prepared to agree to in order to reduce CO_2 emissions?[198]. The second challenge is that of offsetting measures intended to correct the financial effects of the carbon tax on low-income households, without these measures weakening the incentive to change behaviours.

→ A RESOURCE HIT BY TAXPAYERS' DECREASING CONSENT TO PAY

In France, the carbon tax is a component of domestic consumption taxes (TIC) which are applicable to fossil fuels consumed. Its constant rise is increasingly disputed by households and small companies, for whom the tax burden is higher than for others in proportion to their incomes: the 10% poorest are 2.7 times more affected by this tax than the 10% richest. This is compounded by the fact that major companies, which generate high levels of CO_2 emissions, are exempt from the carbon tax, as they are subject to CO_2 emission quotas, which were introduced before the carbon tax was established.

The increase of the CCE from €44.60 to €55 per metric ton of CO_2 was one of the triggers of the "Yellow Vest" protest movement. This led the French government to cancel the carbon tax increase in December 2019[199]. The carbon tax is still perceived as punitive in that very few alternatives or support solutions aimed at changing consumption habits are implemented to help households mainly in suburban and rural areas, who are restricted in their behaviours (poor housing insulation, systematic car use, etc.).

→ DISPUTED REVENUE REDISTRIBUTION

Securing the acceptability of such a tax entails improved communication regarding the allocation of revenues from the carbon tax component. While the World Bank announced that it wanted revenues collected by the carbon tax to be entirely allocated to funding infrastructure that promotes less carbon-intensive uses, in France, 20% of revenues from the TICPE's carbon component is allocated to funding the energy transition[200] and 3.2% is transferred to the AFITF which invests in transport infrastructure projects[201]. The remaining 77% is allocated to funding local and regional authorities (32%) and to the State's general budget (45%)[202].

However, unlike the carbon component of the TICPE, revenues from certain taxes are allocated in a clear manner[203]. This is in particular the case of the ecotax on kerosene that France will introduce in 2020. Revenues from this air travel sector contribution (€182 million per year) will be devoted to investments in transport infrastructure which emits lower levels of CO_2, mainly in the rail sector. However, for Christian Gollier, Director of the Toulouse School of Economics (TSE), the carbon tax is not designed to finance the environmental transition[204]. Its environmental nature is more to do with its existence than with its use. One of the challenges lies in setting the price level. It must be high enough to change purchasing behaviours but not excessively so as this would result in market distortion. In other words, "what is the maximum limit of the effort we are prepared to agree to in order to reduce CO_2 emissions?"[205] reminds Christian Gollier.

The actual challenge of the carbon tax therefore lies in the setting of its price level, transparency, the allocation of revenue use and the introduction of offsetting measures. For Jean-Charles Hourcade, economist and Director of the EHESS (School of Advanced Studies in the Social Sciences), "We must define a new social contract which incorporates the climate issue; the use of money generated from the carbon tax is a key element of its construction"[206].

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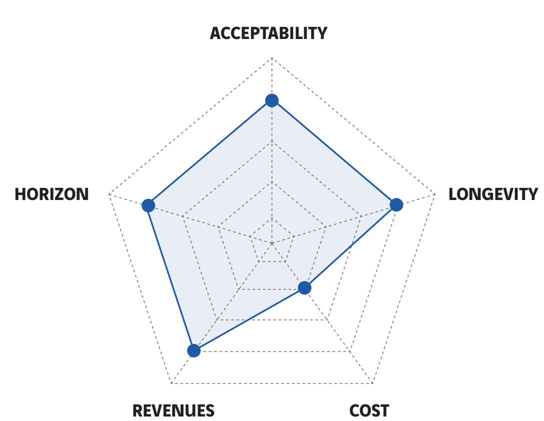

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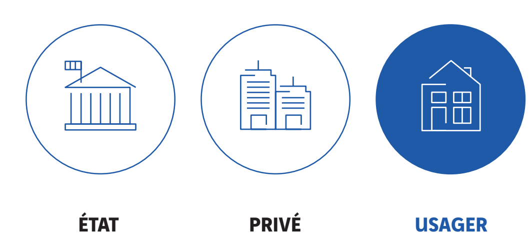

What scale of implementation?

The concession model to step up carbon intensity reduction in medium- and long-distance mobility

—

There are many solutions to reduce transport sector emissions in dense areas and over short distances. However, many of these mechanisms are not ineffective for medium distances (from 10 to 100km). As regards commutes to work in France, two thirds of the working population work outside their municipality of residence. While the share of journeys made to conduct a professional activity only accounts for 29% of the total number of journeys, these journeys nevertheless represent a significant share of total distances travelled. On the motorway network entrusted by concession to VINCI Autoroutes, commutes to and from work account for 41% the distances covered.

Reducing carbon intensity in mobility cannot ignore motorway travel over medium and long distances. Journeys made by motorway account for 6% of France's total CO_2 emissions and 20% of the transport sector's CO_2 emissions. To what extent can the concession model step up carbon intensity reduction in medium- and long-distance mobility?

→ FUNDING WHILE REGULATING VEHICLE TRAFFIC

A concession agreement is an instrument that enables the State to carry out a public service mission (investment, construction, operation of services) through a concession holder. Through this instrument, the State transfers a large portion of the risks (concerning roadworks, funding, traffic) to the concession holder. In return, the holder collects payment by installing a toll bridge with a view to covering the costs invested by the concession holder for the construction, operation, maintenance and improvement of the infrastructure[207]. The toll also introduces a cost for using the infrastructure. The concession model is based on the "user pays" principle[208], which ultimately limits use of the infrastructure. The toll is a regulation instrument which is also used to cover total external costs[209] related to vehicle traffic. A working paper by the French Treasury Directorate states that only the long-distance network comes close to near-total (87%) and even total (125%) coverage of total external costs of vehicle traffic[210].

Infrastructure tolls on the concession network internalise a large portion or even all externalities generated by vehicle traffic and the amounts of tolls cover the external costs generated by pollution or congestion for example. On the non-concession network, these costs are only covered to a very low extent due to the lack of a mechanism to internalise them.

→ TAKING A LONG-TERM VIEW OF CARBON INTENSITY REDUCTION

The concession model is a comprehensive agreement used to create synergies between infrastructure operation and investments made. By entrusting an infrastructure to a concession holder, the State can also promote the development of innovations in the construction and management of road infrastructure.

Various innovations are leveraged to take action on all scopes. These are analysed as part of corporate greenhouse gas assessments. The ranking into scopes creates emissions categories according to various operational perimeters and separates direct emissions related to the company's activity from indirect emissions. Thereby scopes 1 and 2 focus on direct and indirect emissions related to energy consumption while scope 3 focuses on other indirect emissions which, in the case of motorway concessions, account for the majority of emissions, as these are their customers' emissions.

In November 2019, VINCI Autoroutes and *Région Sud* entered into a partnership agreement to promote the *Autoroute Bas Carbone* (Low-Carbon Motorway)[211]. This approach strives to reduce the carbon footprint of the motorway sector. It is organised into four priorities to act on all scopes.

As regards scopes 1 and 2, the strategy is to reduce emissions generated from the energy consumption of buildings and vehicles used for network operation and to promote the production of renewable energy near points of motorway access (toll bridges, services, etc.) and agricultural areas, recycling of non-hazardous waste collected on the network and of materials used for motorway surfaces and the creation of environmentally-friendly networks.

For scope 3, the challenge for motorway concession holders is to promote the reduction of carbon intensity in everyday forms of mobility. This means that the concession holder wishes to leverage the motorway network to develop new uses of less carbon-intensive mobility, in particular in rural and peri-urban areas. The aim is to promote the provision of mobility which meets the requirements and expectations of French citizens with a view to reducing the share of car journeys. Motorway concession holders are in particular relying on the development of public transportation (express buses, carpooling) or carsharing to reduce the carbon intensity of journeys on the concession network. This ambition also demonstrates the key role played by infrastructure, and therefore the concession holder, in stepping up a transition through several means (carpooling parks, priority lanes, multi-modal transit hubs, etc.). Moreover, other innovations reduce emissions generated by traffic. The presence of 675 non-stop toll collection lanes on France's concession network prevented emissions of more than 124,000 metric tons of CO_2 equivalent in 2019[212]. Ultimately, the development of free flow lanes ensuring maximum speeds under toll bridges will bring about additional savings in CO_2 emissions. The concession model also allows the concession holder, who is in charge of operating the network, to implement and finance measures with a view to reducing the carbon intensity of mobility[213].

→ THE RISK OF A DISTINCTION BETWEEN COLLECTOR AND OPERATOR

The current changes with regard to road pricing, in particular aimed at HGVs, create a clear distinction between the management and operation of infrastructure and the collection of the toll. Under the French *écotaxe*, which is set to apply to HGVs on the non-concession network, the company collecting the toll (*Ecomouv'*) should have maintained only the gantries. This separation between collector and operator may bring a risk to bear on the long-term continuation of the concession model if a concession holder decides to no longer allocate revenues to road maintenance. It makes systemic action on mobility and the operation of the infrastructure concerned by the concession impossible.

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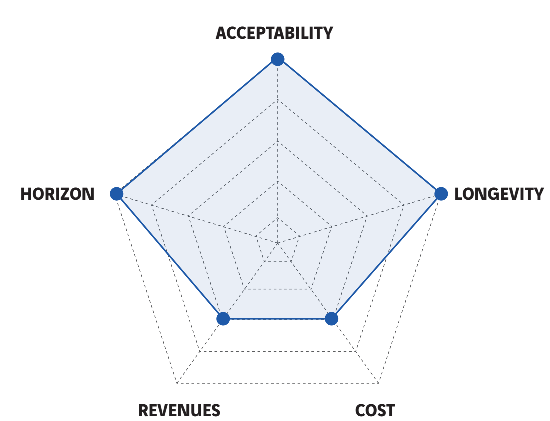
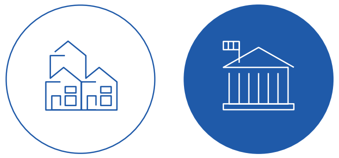


Who pays?

STATE | COMPANIES | TAXPAYER

What scale of implementation?



LOCAL | NATIONAL

City tolls, an opportunity to fund mobility

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The main goal of most 20th-century road developments was to adapt towns and cities to cars[214], not only in the suburbs, where available space resulted in the construction of large access roads, but also in city centres and districts, in cities which were traditionally sized for journeys made by foot or by horse. Buchanan's Traffic in Towns Report, commissioned by the British Department for Transport, set out this statement as early as 1963, calling for solutions to what was defined as "the problem of traffic in urban areas", i.e. to roll out a series of developments so that cars could circulate in towns and cities[215].

→ INTERNALISING EXTERNALITIES TO REDUCE THEM MORE EFFECTIVELY

Today, major cities are once again considering traffic in urban areas, but this time with the opposite starting assumption: how can the space taken up by cars in cities be reduced? This turnaround is predominantly due to the fact that cars are increasingly judged by the externalities they generate. There are three categories of externalities: congestion, disturbances (noise, pollution, stress, loss of productivity, etc.) and the deterioration of road networks. To reduce them, several global cities have introduced city tolls, obliging drivers to pay in order to increase the share of total traffic levies in urban areas.

The results of this type of system are promising in a number of respects. Firstly, city tolls have a real effect on car traffic and its externalities. In London, the volume of traffic decreased within the congestion charge zone from 185,000 vehicles per day to 125,000 vehicles today, representing a 15% drop in traffic density. It is also the case that traffic jams fell by 30% initially. In Stockholm, the city toll reduced traffic across the cordon per day by 28%. The effect is even more notable as the population grew by almost 22% between 2005 and 2015. The corollary of this reduction in traffic is a clear improvement of air quality with, for Stockholm, fine particle emissions cut by half over the period[216].

→ AN INSTRUMENT TO FUND AMBITIOUS MOBILITY POLICIES

City toll revenues also enable municipalities to increase their investments in mobility services and infrastructure. However, the city toll is not a yield tax but an incentive instrument. For the incentive to work, the introduction of the city toll must be preceded or followed very quickly by an enhanced public transportation system in terms of quality and quantity. Stockholm was endowed with approximately one billion Swedish Krona (around €95 million) by the State to develop alternatives to cars alongside the introduction of its city toll system[217]. Successful city tolls are generally part of a broader mobility policy. Since 2003, London has allocated the revenues from its congestion charge to the Transport for London (TfL) authority. The net revenues of the congestion charge account for 5% of TfL's total revenue. Over the 2016-2017 period, revenues from the toll, representing £164million (roughly €185 million), were allocated to funding mobility services and infrastructure: improvement of the bus network (81%), roads and bridges (9%), road safety (1%), cycling and walking and local transportation (7%).

In Stockholm, revenues resulting from the spatial extension and revised pricing of the city toll are allocated to co-funding new underground lines (46% of total costs), thereby adding to the contributions of municipalities of the Stockholm region (27%), from Stockholm County (3%) and the national government (24%)[218]. In 2018, 50% of toll revenues were allocated to funding the Förbifart Stockholm, the road bypass of the Swedish capital set to open in 2025. The city toll is said to contribute SEK 23 billion (€2.5 billion) out of a total of 28 billion, with the State paying the remainder.

→ A TECHNICAL, FINANCIAL AND ABOVE ALL POLITICAL CHALLENGE

The city tolls that have lasted for longer periods of time stand out for their incremental approach (gradual installation), which is flexible and able to adapt to real movements. Durham (United Kingdom) introduced a toll on one street. Before selecting this solution, the city council tested many other forms of toll systems. The incremental approach fosters user understanding and future acceptability for the project. The approach was accompanied by communication regarding the effects brought about by the introduction of the road user charge zone and in particular improved traffic speeds and public transportation, which is something that London has fully understood and carried out.

The introduction of a city toll system must ideally be supported by a process of acculturation and awareness-raising of the population and road users regarding the positive impacts of the system. Cities in the United Kingdom and Norway have focused their communication on the issue that the city toll intended to tackle: for Bergen, in Norway, this was infrastructure funding while for London, it was congestion reduction. For users, the toll system then becomes a solution to an urban problem rather than a mere tax. Toll system acceptability is conditional on users understanding the situation at the outset: congestion, pollution and/or the lack of funding for new infrastructure must be perceived as real problems for the city.

Lastly, one of the factors of the city toll's success is its financial viability. The initial investment costs and operating costs depend on technological choices and on the area defined. This statement can be underscored by comparing London and Stockholm. London made lower levels of initial investment than Stockholm but the operating costs in the city are fifteen times greater[219]. The system's operating costs account on average for 50% of total revenues of London's congestion charge, compared to only 7% in Stockholm. The Swedish municipality has successfully improved its toll's balance sheet by reducing operating costs since the introduction of the system in 2006 (SEK 250 million per year in 2006 compared to SEK 100 million per year in 2016) and by increasing revenues through an extension of the toll area and an upward revision of rates voted in 2016.

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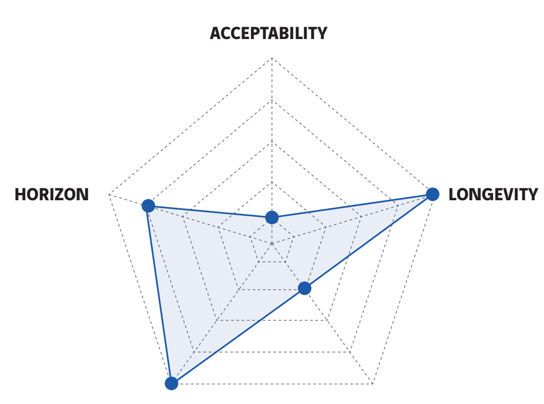

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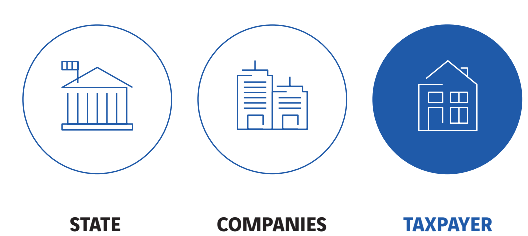

What scale of implementation?

Infrastructure usage rights: an analysis of the *Eurovignette* and the Swiss vignette

→ A MECHANISM IN KEEPING WITH THE TIMES

With the exception of the removal of the French vehicle vignette tax in 2000 and the shelving of the *écotaxe* in 2014, there is an upward trend in Europe for users' contribution to funding road infrastructure. This trend is particularly clear in the road transport sector, in which various instruments intend to internalise negative externalities more effectively by acting on the price signal of traffic. Two instruments are commonly used for this purpose: the mileage charge for HGVs and the introduction of a road usage charge.

The latter type of contribution is often implemented through the display of a *vignette* (sticker) which gives the holder the right to use all or part of the road network. The road usage charge does not stop toll systems from being added, even though, in most cases, the *vignette* exempts the holder from paying tolls. For States, it guarantees that foreign drivers contribute to funding national road infrastructure.

→ AN INSTRUMENT IN LINE WITH CONTEXTS AND CHALLENGES

In Europe, several countries have opted to internalise the negative externalities related to road haulage through an infrastructure usage charge[220] : the *Eurovignette*. To travel on motorways and expressways in the Netherlands, Luxembourg, Denmark and Sweden, vehicles weighing 12 tons or over must pay this charge. Coaches are not subject to this regulation. In May 2019, after twenty years of application, the *Eurovignette*'s pricing structure has been modified to offer more differentiation and to take into account environmental aspects more effectively. Since this date, the cost of the vignette depends on several factors: the vehicle's emission class (*EURO*), the number of axles and the term of validity of the vignette (from a minimum of one day to a yearly basis).

Using a different model, Switzerland made the purchase of a motorway vignette mandatory in 1985 for cars, motorcycles, trailers and caravans using the Swiss road network[221]. The *vignette* grants access to a toll-free road network with the only exceptions being the Grand Saint-Bernard Tunnel at the border with Italy and vehicle loading operations for rail transfer. Revenues from this tax are paid to the *Caisse Routière* and allocated to the construction, operation and maintenance of national roadways. In 2018, 9 million *vignettes* were sold, 3.2 million of which to foreign drivers. According to the Swiss Federal Council, gross revenues amounted to around 360 million Swiss Francs, 132 million of which come from foreign car users.'[222]

→ AN INACCURATE ROAD USAGE CHARGE

These taxes do not reflect the use of the infrastructure, however, as they are not correlated with the number of kilometres travelled. This is why Germany and Belgium replaced the *Eurovignette* with a mileage charge. Each HGV must now be fitted with a system used to pay the toll, via an on-board unit[223].

Unlike a mileage charge, for which the cost directly depends on the number of miles travelled according to a scale defined using several criteria (vehicle type, emissions, etc.), the price of the vignette is not dependent on road use. This means that the *vignette* is more of an access charge than a usage charge, as it grants the right to circulate over a given period and at a set price which is not correlated with the distance covered.

The flat-rate approach weakens the effect that action on pricing may have on the volume of traffic and externalities. The *vignette* could have a very high price for a tourist travelling in Switzerland for a day (40 Swiss Francs for one day) but is very attractive for a resident commuting between France and Switzerland every day (40 Swiss Francs for several hundred days).

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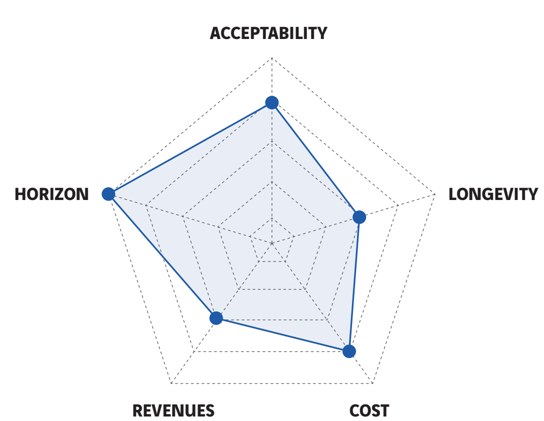

Who pays?

STATE | COMPANIES | **TAXPAYER**

What scale of implementation?

LOCAL | **NATIONAL**

Managed lanes: promoting some uses while funding infrastructure

→ INFLUENCING TIME AND PRICE TO CHANGE HABITS

Managed lanes resulted from the oil crises in the 1970s[224, 225]. To increase the occupancy rate of vehicles, bus lanes on key thoroughfares were opened to carpooling. This network of managed lanes has stood the test of time. The increase in federal funding for infrastructure projects aimed at reducing CO_2 emissions has led many US States to develop managed lane projects with a view to enhancing public transportation and carpooling. In the mid-1990s, this network of lanes reserved for buses and carpooling was rounded off with priority lanes, for drivers who placed great importance on saving time[226], i.e. they would prefer to pay more to reduce their journey time and use the time saved for other activities. These new lanes guarantee optimal journey times by acting on congestion levels through dynamic infrastructure pricing[227].

→ MAKING THE ROAD A VEHICLE FOR CHANGING BEHAVIOURS

The spatial, financial and environmental pressures cities face limit municipalities' ability to build new lanes in built-up areas or extend existing road networks. Future public transportation requirements can no longer be met by building new road or rail infrastructure.

Managed lanes meet three objectives: maintaining an optimal service level on the road in question or the motorway, achieved through a reduction in the volume of traffic by influencing the price or journey time, improving the commercial speed of public transportation lines and producing revenues to finance projects on the thoroughfare concerned. The benefit of managed lanes lies in their ability to promote certain uses, ultimately to make them the majority and strengthen the efficiency of the public transportation networks.

Furthermore, as the road network is already established across the territory, the cost of introducing a managed lane is lower than that of building a new infrastructure or dedicated routes (high-service buses, trams, underground trains, etc.).

→ A NEW FINANCIAL RESOURCE TO IMPROVE A THOROUGHFARE WHILE PROMOTING "EXEMPLARY" TRANSPORTATION

The revenues from managed lanes depend greatly on the volumes of traffic and infrastructure operating costs, which themselves are dependent on the technology used and the length of the road. When operating costs are too high, as is the case for example on the I-95 in Miami ($8.2 million for 2011 alone), the revenues of managed lanes are used to cover operating and infrastructure maintenance costs. Conversely, if a managed lane generates net revenues (after payment of operating costs), the scope for funding is greater. This resource can then be used in several ways: debt repayment, investment in improving the road network or funding new mobility services[228]. This is for example the case in California, in the County of Santa Clara, where, according to the California Streets and Highways Code, the revenues from managed lanes have the primary purpose of funding road maintenance and improvements. However, in the event of revenues exceeding infrastructure maintenance costs, the Code provides for the surplus to be used to finance transportation services on the roads on which they were generated[229]. The Santa Clara Valley Transport Authority has financed an express bus route and a regular bus service (Express bus 104 and bus 120)[230].

Two pitfalls exist, however. Firstly, the ability to build a managed lane is subject to the presence of sufficient space, which is not always the case in areas that are already developed or are geographically restricted. Secondly, the issue of such a measure's social acceptability remains a challenge. The choice of promoting some uses over others may upset some people, particularly those working in professions in which competitiveness depends on traffic flows and the cost of using roads (taxis, ridehailing services, crafts industries, etc.).

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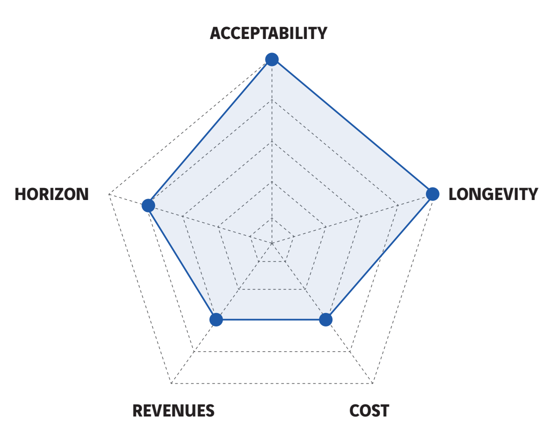

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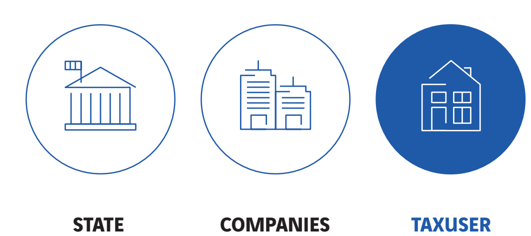

What scale of implementation?

Public transportation passes and the limits of influencing flows

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From the 1970s, mobility authorities started to offer weekly, monthly and annual travel passes. These passes gave their holders unlimited access to the entire public transport network for a single price generally dependent on a geographical criterion (zones). The pass is very convenient for regular public transportation users: it facilitates the use of public transportation by creating a single ticketing system while each mode required a specific ticket before. The pass therefore enables users to make savings on the cost of their travel.

→ THE TRAVEL PASS, A COMMODITY WHICH HAS BECOME THE NORM

For the operator, this new pricing system has its benefits: it brings about greater revenue predictability, as income is no longer dependent solely on the potentially volatile sale of single tickets. The pass guarantees a revenue over a given period, regardless of whether the holder uses the transportation network.

In Paris, from the *Carte Orange* to the *Pass Navigo*, the pass has changed over the years. Today, it is used for more than 70% of journeys. This major use of the pass can be explained by two factors: the obligation for employers to pay 50% of the price of passes purchased by their employees and, in the case of Paris, the affordable end price of the pass, that the company's contribution makes even more attractive[231].

→ THE SIDE EFFECTS OF THE TRAVEL PASS IN CITIES

From an economist's standpoint, the pass is not an ideal incentive to use public transportation. It brings about a zero marginal cost for journeys made by public transportation, which means that the cost of an additional journey will be nil. This may lead to an over-use of public transportation, i.e. disproportionate use that does not generate value for the local authority. This is particularly the case when a journey that could have been made by active modes (cycling, walking) is instead made by public transportation.

This trend has implications on the system. It may lead to a saturation of transportation networks at an early stage and some users preferring a shift to other modes, such as the car. Preventing the early saturation of networks is a major challenge: the low cost of transportation in some cities (Rome, Paris) leads users to react to quality of service rather than the cost of transportation. A fixed-price unlimited pass prevents transportation regulation by means of influencing the price signal. Transportation saturation is thereby the only means of regulating demand.

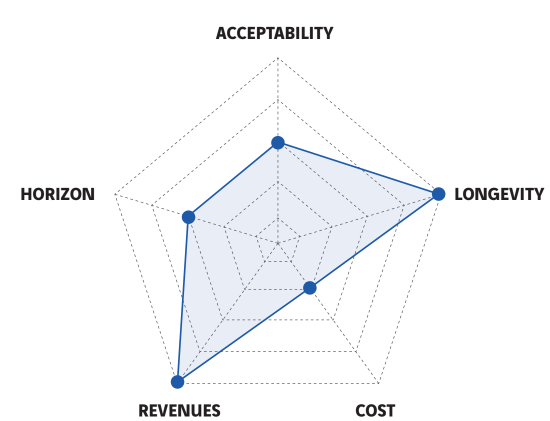
→ TRAVEL PASSES IN THE DIGITAL ERA

As congestion is worsening in cities and public transportation networks are reaching saturation point at peak times, we can question whether the use of the travel pass is actually appropriate in view of the demand smoothing objectives at peak hours. Is this practice an effective means of combating public transportation network saturation or bolstering the attractiveness of public transportation compared to cars? Nothing could be less certain. However, developments made possible through digital technology (pay-as-you-go, smart pricing according to journeys) and ticketing innovations (paperless tickets) open up new prospects. How can the fixed-rate pass be modified to foster a change in behaviour and to prevent the early saturation of public transportation networks?

One solution may be to limit fixed-rate pricing to a commuter group between home and work or between home and the user's place of study[232]. Journey data generated each time a travel pass is used can provide more information about a journey than a stamped ticket. This new capacity means that it is possible to introduce a fixed-rate fare restricted to commuters. For other journeys, a usage-based fare may be applied and facilitated through a post-payment system in which customers pay in accordance with their actual use of the transportation network and are billed at the end of the month[233] or pay in advance for a quota of journeys per day. This usage-based pricing is made easier by the use of journey data obtained when a pass or ticket is used (travel pass or NFC device). Unlike the travel pass which does away with the marginal cost of additional journeys, this system gives the option of modulating fares according to the geographical zone and/or the time of day, thereby giving the mobility authority another lever to influence demand regulation: price.

This solution, which requires the roll-out of major education and communication efforts if it is to be accepted, would enable mobility authorities to regulate demand by influencing the price signal and recreating a correlation between actual use of public transportation and ticketing revenues.

→ DISCOVER OTHER SOLUTIONS FOR FUNDING MOBILITY BY SCANNING THIS QR CODE.



Who pays?

STATE

COMPANIES

TAXPAYER

What scale of implementation?

LOCAL

NATIONAL

Fare-free public transportation

—

In increasingly congested urban centres where cars account for an overwhelming share of journeys, municipalities are seeking a way of promoting the modal shift from the car to public transportation. In recent years, cities have considered making public transportation free of charge. In France, Châteauroux, Niort and Dunkirk have made their transportation networks free to use, as have Tallinn and Luxembourg.

The first question raised by free transportation is semantic. The term "free" is misleading in several respects. While the service has no price, it still has costs. This is why the expression "fare-free" is more correct: the transportation service is only relieved of the requirement of purchasing a ticket. Secondly, "free" is vague in economic terms: it covers several very different types of funding ranging from the temporary waiving of a price (which limits the cost of the measure while attracting users) to a "free" service paid by taxes or other levies, in which case the free service provided is considered to be an element that benefits the service provider. This latter case can be illustrated by Waze, which offers a free service for users as it is financed through advertising. In short, in the case of fare-free transportation, the cost of the measure will be borne by others. The next question to be asked is therefore: who pays?

→ IN FRANCE, THE ROLE PLAYED BY THE '*VERSEMENT MOBILITÉ*' EMPLOYER CONTRIBUTION IN FARE-FREE TRANSPORTATION

If going fare-free did not have the devastating effects on mobility funding that were expected in the French towns that implemented this, it is because ticketing only accounted for a small portion of the network's budget. In Niort, for example, the sale of fares only covered 10% of network costs. In Dunkirk, where revenues from ticket sales peaked at €4.5 million per year, this loss was offset by an increase in the *versement mobilité* (VM - employer mobility contribution) rate[234], which has replaced the *versement transport* (VT) contribution since the entry into force of the Framework Mobility Act (LOM) in 2019. This tax contributes to funding public transportation and is payable by public- and private-sector employers with eleven or more employees. Its rate, which it set by the mobility authority, may not exceed a ceiling which varies according to municipality size. It ranges from 0.55% for municipalities with 10,000 to 50,000 inhabitants to 2.95% for the municipalities of Paris and the Hauts-de-Seine département. This rate applies to the gross payroll under the scope of the urban transport plan (PTU).

In other words, the loss of revenue resulting from fare-free travel has been offset by increasing the VM rate. Not everyone can roll out such an operation. It is difficult to implement in other urban situations in which network costs are much higher and in which the VM is already at a higher rate (2.95% in Paris and the Hauts-de-Seine département).

In Paris, revenues from users account for slightly less than €3 billion. However, unlike smaller urban areas, a major city such as Paris cannot rely on an increase of the VM to offset the loss of revenue resulting from going fare-free without adversely affecting company competitiveness.

→ IN TALLINN, FARE-FREE TRAVEL IS FUNDED THROUGH TAX REVENUES

Tallinn has often been used as an example in debates on this measure. In 2013, the capital of Estonia became the largest city (slightly less than 450,000 inhabitants) to make its transportation system fare-free. There are a few conditions, however: to be able to travel on Tallinn's public transportation network without paying for a ticket, you must live in the city, as this measure only applies to residents within the city boundaries. Fare-free travel therefore aims to increase Tallinn's attractiveness. The measure has enabled Tallinn to reach its goal: between 2013 and 2016, 25,000 additional inhabitants were recorded. The corollary of this increase in the city's population is the increase in local tax revenues which cover the cost of fare-free travel[235].

Funding this measure through tax revenues is justified by the fact that fare-free travel benefits all users: it makes public transportation more attractive and contributes to reducing car traffic. This means that car users also benefit as the measure cuts their journey times by reducing congestion.

→ FARE-FREE TRAVEL, A COMPONENT OF A HOLISTIC POLICY

The implementation of fare-free public transportation in large urban areas does not have a major effect on road traffic and is not a long-term means of ensuring public transportation development. The example of Niort shows that this measure may not have the expected results if the transportation offering is reduced at the same time. In addition, fare-free travel can have adverse side effects for the transportation network, including a deterioration of service quality, for example. Similarly, it encourages inappropriate uses of public transportation (short distances, etc.). By doing so, fare-free travel misses its target public and instead attracts pedestrians and cyclists, which results in an early saturation of the network while failing to reach the objective of reducing the car's modal share[236].

However, these measures may be incorporated in a broader mobility strategy provided that investments are made to step up the public transportation service. It is against this particular backdrop that Luxembourg decided to make its public transportation network fare-free[237]. In January 2019, the Luxembourg Ministry of Defence, Mobility and Public Works announced a major plan to make Luxembourg a "laboratory for 21st century mobility". This announcement included a series of measures regarding the introduction of fare-free public transportation to step up competitiveness in a country in which cars are used for 69% of journeys. The announcement did not go unnoticed. Luxembourg has become the first country to make all of its public transportation fare-free.

However, fare-free public transportation is not an end in itself for Luxembourg. It is part of the "Modu 2.0" strategy launched by the Grand Duchy in 2018 with a view to reducing the modal share of cars and increasing that of public transportation[238]. This strategy, which the Deputy Prime Minister calls a "multi-modal revolution", can be broken down into a series of investments and projects to be rolled out gradually until 2027. Luxembourg will invest €3.2 billion until this deadline to improve the capacity of its rail network, increase the capacity of its park & ride systems and develop its network of cycle lanes and carpooling.

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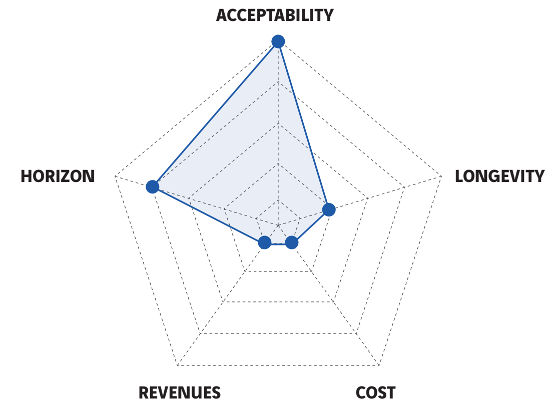
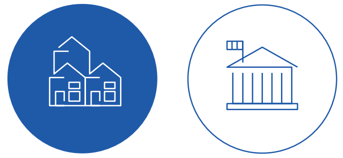


Who pays?

What scale of implementation?



The specific case in France: public transportation funded by employers through the 'versement mobilité'

As early as the 1970s, the negative effects of the prevalence of the car, a victim of its success, were starting to be felt in France: a lack of space in cities, noise and air pollution and congestion therefore urged mobility authorities to step up urban public transportation services[239]. This was achieved through the *versement transport* (VT) contribution, which was replaced by the *versement mobilité* (VM) upon the entry into force of the Framework Mobility Act (LOM). The VM is a local contribution payable by public- and private-sector employers with more than eleven employees, which supplements the funding of transportation networks. It is a production levy borne by companies' economic performance.

This mechanism is specific to France and plays a key role in the funding of investment expenditure and the operation of mobility services[240]. Article L. 2333-64 of the French Local Authorities Code provides that municipalities and inter-municipal associations with more than 10,000 inhabitants and municipalities competent as mobility authorities and ranked "Tourist resorts" can establish a VM in their area, of 0.55% of payroll at the most and 0.2% for tourist resorts[241].

The VM is the main component of urban public transportation funding in France, as it accounts for almost half of total revenues for mobility authorities at €8.2 billion per year[242]. Far from restricting itself to a mere stimulation of public transportation, the VM has been used to finance its modernisation, invest in alternative means of transportation, contribute to improving intermodal connections and even to plan fare-free travel in certain medium-sized urban areas such as Aubagne in 2009 and Dunkirk in 2018. The VM can be considered as the backbone of the French mobility funding model[243].

→ DISAGREEMENTS BETWEEN PUBLIC TRANSPORTATION STAKEHOLDERS AND INDUSTRY REPRESENTATIVES

While the VM is broadly supported by public transportation stakeholders and the State, companies, which in major cities also contribute to paying 50% of their employees' travel passes in addition to the VM, are bearing a double taxation on transportation. Entities such as the *Mouvement des Entreprises de France* (*Medef* - the largest employers' union), the Chambers of Commerce and Industry (CCI) and the *Confédération générale des petites et moyennes entreprises* (*CGPME* - Employers' confederation for small and medium enterprises) oppose the tax burden represented by this tax levied on payroll, which effects jobs and competitiveness[244]. These bodies criticise the territorial inequality resulting from this tax, which was initially introduced in the *Île-de-France* region around Paris in 1971 and has been constantly extended, from municipalities with 300,000 inhabitants to municipalities with more than 10,000 inhabitants. It is mainly companies operating outside conurbation centres which are suffering from the extension of the scope of application of the versement transport (Chevènement Act of 1999), as they still do not have appropriate urban public transportation infrastructure in their area of work.

→ A FUNDING SYSTEM WHICH HAS ALREADY REACHED ITS LIMITS

The successive extensions of the scope of mobility authorities in the last forty years bear witness to the VM's inability to provide a long-term answer to the need to finance urban public transportation infrastructure, notwithstanding the financial windfall generated by this tax. Mobility authorities have on several occasions increased the VM rate to finance many transportation infrastructure projects that are currently underway, in particular those of the *Grand Paris Express*.

Furthermore, a study conducted by Ernst and Young in March 2017 demonstrated that transport fares increased by 2.85% on average between 2010 and 2015[245]. There is therefore a widespread increase of all funding instruments in large cities in France, and particularly in Paris. For now, it has to be said that the VM has reached its maximum yield in most cities (in Paris and in the Hauts-de-Seine département, the applicable rate is 2.85% of payroll, while it is 1.50% in other municipalities in the Paris region). This is why mobility authorities are considering new sources of funding for their urban public transportation.

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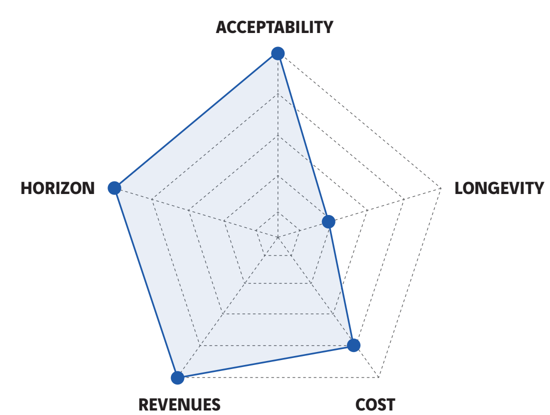
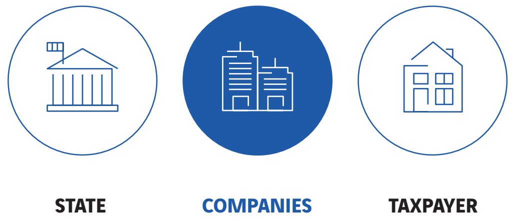


Who pays?



What scale of implementation?

Land value capture: harnessing the value generated by accessibility

→ THE VALUE OF URBAN ACCESSIBILITY

The creation of transportation infrastructure enables cities to improve accessibility in certain areas. The concept of accessibility may be defined as the number of activities (jobs, services, leisure activities) which city-dwellers can access in a given time, regardless of the mode of transportation.

This concept is a strong determining factor of land value in urban areas. Without accessibility, the value of a property is only reliant on natural resources within it and the buildings constructed on it. As Adam Smith theorised in 1776, the improvement of accessibility in certain areas, related at the time to the construction of passable roads and canals, has a direct impact on the value of plots of land, as this new transportation infrastructure reduces the time necessary to access the properties in the area and thereby the cost of travelling to them. The accessibility of a geographical area, which may be improved by constructing infrastructure and efficient transportation networks, therefore has a direct effect on land value[246]. However, when considering the total value of a property, it is important to distinguish between the value of the land, which depends on accessibility, and that of the structure, which depends on the type of building (individual house, residential building, etc.).

→ FUNDING TRANSPORTATION THROUGH INCREASES IN LAND VALUE

In highly accessible areas, land value will automatically be greater. The value generated by the improved accessibility of an area may be a source of mobility funding provided that the capital gain related to the completion of new transportation infrastructure is recovered. This is exactly what the land value capture mechanism intends to achieve. Through this measure, it is possible to recover part of the land value generated and to allocate it to mobility funding[247].

While the gain in accessibility benefits the entire community (residents, activities), most of the land value generated predominantly benefits landowners. It must also be said that this type of tax does not affect the cost of using an infrastructure[248].

To finance an upgrading of its public transportation system, the MTA, New York's transport authority, introduced a Progressive Mansion Tax on 1 July 2019. This instrument enables to municipality to capture part of the value of properties with a value greater than $1 million by applying an additional charge set in accordance with the property's value, for which the base ranges from 1% for properties with a value between $1 million and $2 million and 4.15% of the sale price for properties with a value exceeding $25 million[249]. Over the 2019-2024 period, this mechanism will contribute $10 billion to the budget of the Capital Program, the MTA's multi-year investment plan.

→ EFFECTS ON URBAN DEVELOPMENT

Other things being equal, the increased taxation on plots of land encourages developers to build more on a single plot. To cover the expenditure related to tax increases, it is in their interest to increase the surface area of the properties constructed. This mechanism therefore fosters urban densification. It may be heightened by a reduction of the tax levied on constructions to further encourage the construction of buildings with large living areas[250].

However, this increase in taxes related to the value of a plot of land may entail a risk, among people who do not use public transportation, of refusing the construction or improvement of a transport link near their home, as they may fear an increase in this additional charge.

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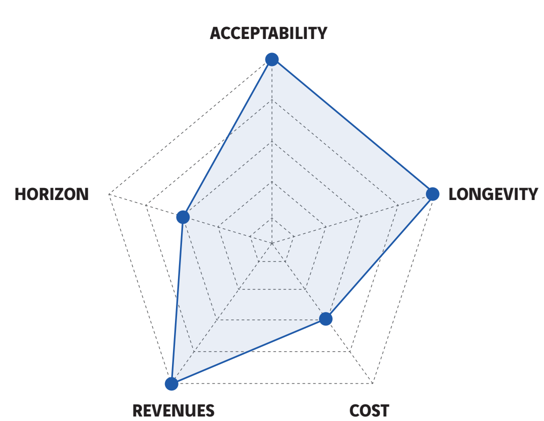
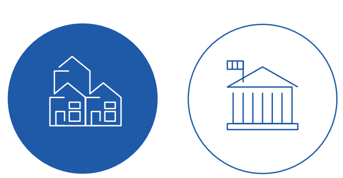


Who pays?

STATE | COMPANIES | TAXPAYER

What scale of implementation?



LOCAL | NATIONAL

Public space taxation: leveraging stock to finance flows

→ PARKING, AN URBAN SPACE MANAGEMENT INSTRUMENT

Parking takes up a significant share of public space. Around 4% of Singapore's territory is devoted to parking (car parks and on-road parking). In Lille, on-road parking accounts for roughly 11% of urban public space. While transportation conjures up an image of flows and movements, it is important to state that parking -stock- is of key importance in mobility policies.

Availability (available space) and accessibility (cost) of parking are a powerful lever in the modal choice, as are average transportation speeds, the average distance travelled, price and public transportation investments[251]. When parking is present (free and available or private), the car is used in 80% of cases (compared to 58% if parking is not guaranteed)[252].

→ CONSIDERING PARKING AS A PUBLIC SPACE USAGE FEE

In 2018 in France, the MAPTAM Law (*loi de modernisation de l'action publique territoriale et d'affirmation des métropoles*) introduced the decentralisation and decriminalisation of ticket parking, transferring the competence and organisation of the public service of parking to local authorities. The MAPTAM Law established a fixed post-parking fee (FPS or *Forfait post-stationnement*) instead of penalties, in cases of partial payment or non-payment of parking fees. This legal amendment introduced a major shift in the system: the fixed fee (€17 in all towns and cities) became a public space usage fee that varies according to the amount of time the parking ticket was exceeded. In addition, the law gives municipalities the option of changing the amount of the FPS fee, thereby making parking a major component in their mobility policies[253].

Like penalties, the revenues of the post-parking fee are intended to finance environmentally-friendly public transportation policies and traffic and mobility policies.

→ POOR PARKING PRACTICES TO FUND VIRTUOUS USES

The first effect of the introduction of the FPS fee is a change in mobility behaviours. In Lyon, a drop in car traffic in the city and a rise in public transportation ridership and the use of park and ride systems (+4.6%) were observed. The introduction of the FPS also coincided with a 2.5% fall in vehicle traffic between September 2017 and September 2018.

The second effect is financial in nature. In Lyon, the introduction of the FPS resulted in a sharp rise in payments for parking (50% compared to 25% before the FPS). This trend can be explained in particular by the use of the penalty allocation system being delegated to private companies, which enables municipalities to increase the number of inspections conducted. This increase in the rate of payment for parking has led to a rise in revenues. In Lyon, revenue from parking rose to €24.5 million in 2018, compared to €16.6 million the year before the FPS was introduced[254].

However, while the FPS contributes to a budget allocated to funding more sustainable mobility, parking revenues continue to be allocated to the general budget. This choice therefore means that revenues are not necessarily used to finance mobility.

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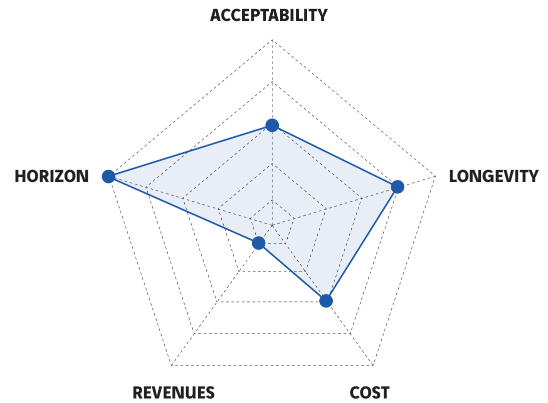

Who pays?

STATE

COMPANIES

TAXPAYER

What scale of implementation?

LOCAL

NATIONAL

Lane rental scheme: funding road infrastructure by reducing the time limitations of roadworks

—

Road infrastructure maintenance is essential if network performance is to be preserved. It requires regular interventions by public works companies. However, these roadworks also vehicle negative externalities which may prove to be expensive to users (longer journey times) and may put a strain on cities' attractiveness.

→ RENTALS TO REDUCE THE NEGATIVE EXTERNALITIES CAUSED BY ROADWORKS...

In 1991, the UK New Roads and Street Works Act strove to offset these externalities. To achieve this, the government gave public authorities in charge of motorway management the option of making the companies in charge of maintenance operations pay overrun charges[255] in the event of an "unreasonably" prolonged occupation of the highway. In 2012, the first programme of its kind was tested in London: an additional charge, commonly known as "lane rental" is applied on a daily basis. Calculated according to the level of congestion in the area and the time, it applies to companies conducting works likely to disrupt traffic[256].

The programme also enables public authorities to reduce the price of lane rental if companies working in different sectors (coatings, utility lines, gas, water, etc.) agree to conduct their work successfully over the same period. In this way, public authorities create an economic incentive with a view to preventing work on the same sections of road being conducted at different times. London has been operating its own lane rental scheme since 2012, through which the rate of companies working together on a single site has increased by 65% while the amount of work conducted at night has increased by 30%.

To ensure that the scheme is effective in the long term and to avoid potential adverse effects, the government has recommended that this type of additional charge should focus on the busiest sections of the road network and on peak times to encourage companies to reduce their occupation of these sections of road during peak demand. London has defined a price scale with amounts calculated according to congestion levels recorded on certain thoroughfares.

→ ... TO MAINTAIN AND PROMOTE INNOVATION ON THE ROAD NETWORK

Revenues from the lane rental scheme are used for two purposes. Firstly, they cover the programme's administrative expenses, meaning that it is financially self-sufficient. Secondly, regulations require that net revenues are allocated to roadworks, be it financial provisions for future works or funding for innovations which reduce the negative externalities related to road traffic (noise barriers, road safety, etc.).

In London, the transportation authority Transport for London (TfL) is also in charge of maintaining and managing the TfL Road Network, also known as "red routes". This 360-mile network accounts for 5% of London's road infrastructure. In 2019, the lane rental scheme applied to 56% of this network. TfL announced that, since its introduction in 2002, the programme had prevented traffic jams and therefore non-productive time for a total estimated cost of £100 million. In 2019, TfL reinvested roughly £6.1 million from lane rental scheme revenues in the road network. Out of this amount, around £350,000 were invested in the RoadLab, an innovation centre devoted to developing solutions to make road networks smarter and safer[257]. While the lane rental system only accounts for a minority share in road infrastructure funding, it enables TfL to leverage a new resource, at a time when public funding for road networks is tending to decline.

→ DEVELOPMENTS UNDER CONSIDERATION SINCE THE SCHEME'S SUCCESS

In 2019, a proposal by TfL suggested extending this scheme so that charges would apply over a greater share of the red routes network (72%)[258]. The transportation authority also recommending applying a £350 daily additional charge for work on the busiest sections of road[259], while significantly reducing the number of sites on which minimum rents are in practice.

London's scheme has been emulated: in 2018, the UK Department of Transport announced its wish to extend lane rental schemes across the country, thereby giving other towns and cities the option of regulating the externalities caused by roadworks and, in doing so, funding part of road maintenance costs and innovation.

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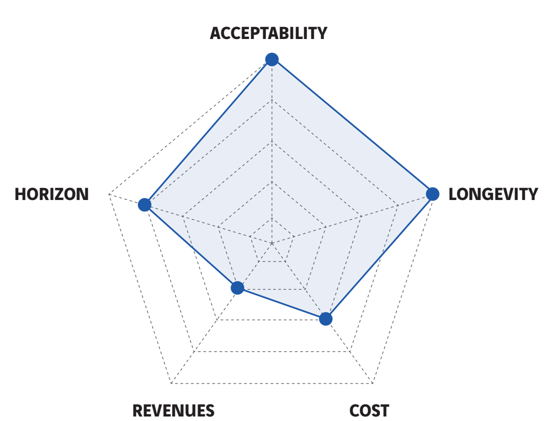

Who pays?

STATE

COMPANIES

TAXPAYER

What scale of implementation?

LOCAL

NATIONAL

Tax on office premises in the Île-de-France (Greater Paris) region

Since its launch, the *Grand Paris Express* (GPE) project, which plans to double the length of the Paris Métro and extend some lines to the inner and outer suburbs, has reached consensus in the region. However, the launch of the implementation phase from 2017 highlighted several challenges and tensions. Doubt was cast on the ability of the *Société du Grand Paris* (SGP)[260], the public entity established by law and tasked with designing and completing the future network, to meet deadlines while maintaining a reasonable cost level. This concern led the government to raise the issue of the long-term nature of the project company's business model guarantee.

In 2017, a report on the SGP was published by the French *Cour des Comptes*, expressing doubt regarding the sustainability of the business model, following a reassessment of project costs. In 2019, a report submitted to the French National Assembly by Gilles Carrez, representative of the *Val-de-Marne* département, recommended an increase in the tax revenues allocated to the SGP[261].

→ TAXATION AS A MEANS OF ENSURING THE SUSTAINABILITY OF THE BUSINESS MODEL

One of the main contributors to the funding of the SGP's operations is the tax on office premises (TSB - *taxe sur les bureaux*). Initially limited to office premises, this annual tax introduced in 1990 had its base extended in 1999 to retail and storage premises, then in 2011 to parking spaces. Today, the TSB also applies to parking spaces in the Île de France region.

It is payable on 1 January for an entire year, even if the premises change usage, owner or become vacant during the year. Since 2011, part of the TSB revenues are allocated to the SGP. Its ceiling has been gradually raised to reach €464 million in 2019, i.e. roughly 60% of total operating revenues.

In total, around 15 rates are applicable, depending on the type of premises and its location. The amount is calculated by multiplying the surface area of premises subject to the levy by a rate per square metre which varies depending on the district in which the premises is located:

· 1^{st} district (so-called "premium" zone): 1^{st}, 2^{nd}, 7^{th}, 8^{th}, 9^{th}, 10^{th}, 15^{th}, 16^{th} and 17^{th} arrondissements of Paris, Boulogne-Billancourt, Courbevoie, Issy-les-Moulineaux, Levallois-Perret, Neuilly-sur-Seine, Puteaux.

· 2^{nd} district: other arrondissements of Paris, other municipalities of the Hauts-de-Seine département (reduced rates for Bagneux, Chatenay-Malabry, Colombes, Fontenay-aux-Roses, Gennevilliers, Malakoff, Villeneuve-la-Garenne).

· 3^{rd} district: Seine-Saint-Denis (93), Val-de-Marne (94) and the municipalities of Seine-et-Marne (77), Yvelines (78), Essonne (91) and Val-d'Oise (95) which are part of the urban unit of Paris.

· 4^{th} district: other municipalities in the Île-de-France region[262].

This tax is supported by the SGP for its recurrence and as it is applicable to a broad base. In addition, for companies, the contribution to funding the SGP is part of an economic approach: the project will improve the international appeal of the Paris metropolitan region and the mobility of the working population within its territory.

→ A MEASURE THAT PLACES A BURDEN ON ECONOMIC ACTIVITY AND IS DIFFICULT TO REPLICATE

Like the versement mobilité (VM), the tax on office premises is criticised by companies. According to employers' union *Medef*, the increase of a tax on office and retail space may threaten the region's attractiveness and encourage companies to move elsewhere. Furthermore, against a backdrop of strong competition between London and Paris, heightened by Brexit, some believe this tax is a negative signal likely to damage the region's appeal to companies[263].

Lastly, while it is adaptable, the measure appears difficult to replicate in lower-density areas. Does the tax revenue of such a measure cover the potential economic losses resulting from the decline in company attractiveness? Nothing could be less certain, particularly in sparsely populated areas which are already making significant efforts to attract new companies.

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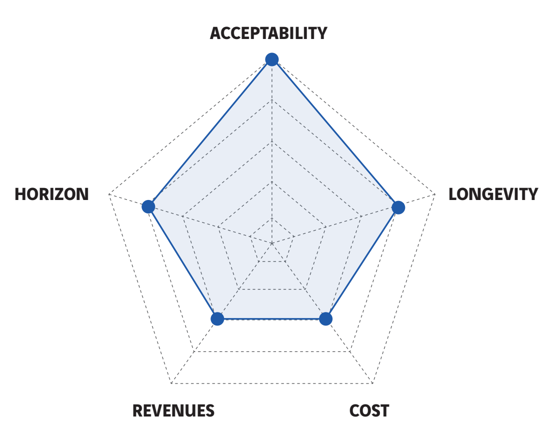
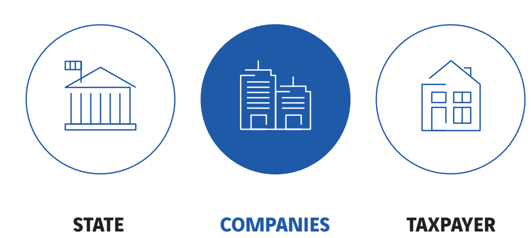
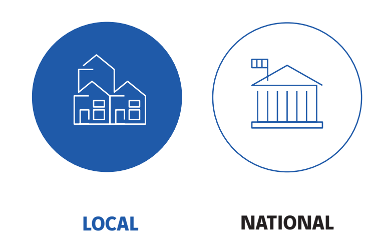


Who pays?



What scale of implementation?



04

Methodology

"As for the future, your task is not to foresee it, but to enable it."

Antoine de Saint-Exupéry, Citadelle, 1948

04 Methodology

The first observation that can be made is that the fight against climate change is agreed and accepted in many countries. A survey conducted in Europe in 2019 demonstrated that 92% of Europeans agreed with the fact that greenhouse gas emissions must be reduced to reach carbon neutrality by 2050[264]. In the United States, climate change was seen as the second biggest challenge after access to healthcare, and more important than the third biggest threat — political instability — in 2020[265].

It remains to be seen how solutions to engage in a long-term fight against climate change can be financed in different sectors. Once again, many international examples show that **there is no lack of solutions.** In the area of funding the reduction of carbon intensity in mobility, in particular, various instruments may influence certain behaviours while funding low carbon intensity or carbon-neutral solutions. The most advanced cities and States in this field constitute an open-air laboratory which can be observed to gain a better understanding of how a funding strategy is built up.

The road ahead looks clear, with a convergence of intentions and resources. However, examples in France and Chile of oppositions to increasing mobility prices, the carbon tax and the price of travel fares respectively, show that **the issue of resources required to reach this objective remains a major source of debate**[266]. The transition to a carbon-neutral mobility system is not given as a matter of course; it is built up by including each stakeholder in the process. How, then, can the endorsement of each stakeholder for an overhaul of the mobility funding system be strengthened? How can acceptability for the measures taken be secured?

The many aspects of acceptability

A commonly agreed definition of the concept of acceptability is a set of conditions that make something acceptable or tolerable. This concept is key in the case of mobility, as regulation by law or through prices has repercussions that may be negatively perceived by residents of urban areas. Rightly so: **the decisions made have direct consequences on certain pillars of our societies, such as freedom, equal treatment and fairness**[267]**. However, it would be simplistic to reduce the analysis of acceptability to an assessment of opinion polls**. Acceptability is a complex and multifaceted phenomenon.

In 2001, Charles Raux, research engineer at the French National Scientific Research Council, CNRS, and researcher at the Transport, Urban Planning and Economic Laboratory (LAET), and Stéphanie Souche, university professor and professor-researcher at the LAET, defined an analysis framework of acceptability in the event of changes to fares in the transportation sector. This framework combines several dimensions[268]:

· **economic efficiency**, i.e. the capacity to steer demand efficiently and meet set operational objectives;
· **territorial fairness**, i.e. the guarantee of territorial accessibility;
· **horizontal fairness**, which corresponds to the equal treatment of users (polluter pays principle);
· **and lastly vertical fairness** and the acknowledgement of the social inequality generated by transportation-related decisions.

These aspects are interdependent. **Seeking a project's economic efficiency or horizontal fairness may result in increases in transportation costs which go against vertical and territorial fairness.** This relationship of interdependence was underscored in a study conducted by Ipsos in 2019 on mobility divides in France[269]. The economic divide of mobility illustrates the lack of territorial fairness in mobility systems. **People in the most vulnerable social and occupational categories, who sometimes live far from high-density areas either because they have left urban centres because of land pressure or because they have never lived there, are captives of cars due to the lack of more efficient options, even though the use of a car generates high levels of expenditure for them.** The use of a private vehicle on a daily basis may account for a significant portion of a household's budget, in particular in low-income households. For example, at the time of the study in 2019, the working class was the social and occupational category which was spending the most on daily travel: €115 per month (Ipsos, 2019). Similarly, 56% of them believed that this amount places a significant burden on their budget. This fracture has also been observed between inhabitants in central urban areas and in suburban areas: those living in a conurbation's centre allocate an average of €94 per month to travel, compared to €130 and €139 per month for inhabitants of suburban and rural areas respectively[270].

By contrast, **a mobility policy which focuses on the most vulnerable goes against economic efficiency and horizontal fairness**. In the same way, preserving territorial fairness generally implies smoothing fares which could counteract economic and territorial efficiency. In the Île-de-France (Greater Paris) region, the pricing of public transportation has changed over the decades; the sale of daily tickets has given way to a travel pass approach, firstly with the *Carte Orange* from 1975 then with the *Pass Navigo* in 2005. **This transition was justified by a territorial fairness objective which resulted in a decrease in users' contributions**[271]. The debate on fare-free travel is along the lines of this development of public transportation pricing in the name of territorial and vertical fairness. **However, like the development of the travel pass, fare-free transportation is an additional challenge in terms of public transportation funding, which takes the price lever of flow management away from the transportation authority and thereby impacts economic efficiency.**

While they are contradictory in nature, these aspects are interrelated. Furthermore, the analysis shows that it is impossible to ignore the various aspects of fairness, otherwise the project is doomed to failure. Lastly, while economic efficiency and horizontal fairness go together easily, they very often have a negative effect on the other aspects of fairness. **While it is possible to ignore a project's economic efficiency to strengthen acceptability, this position cannot be sustained, given the strong injunctions to finance carbon-neutral solutions and to maintain existing systems.**

Defining the transition: information as a lever of acceptability

It is of the utmost importance that objectives are defined in a way that brings about a shift in the mobility funding model. **The perception of the issues to be resolved (congestion, reduction of CO_2 emissions, incentive to increase public transportation services, etc.) differ depending on whether the challenges are related to mobility or the climate**[272]. The aforementioned examples illustrate this point: there is not a single method for reducing the carbon intensity of mobility. **It is therefore necessary to break down this strategy into concrete goals**.
Each measure and objective have their own specific acceptability, which depends on many factors. **Acceptability is mostly dependent on subjective criteria, including the social norm, personal expectations and perceived efficiency. A study conducted in four European cities shows that these factors contribute up to 40 points in the variability in a project's acceptability.** These various factors have a common denominator: they are a matter of personal opinion. Acceptability is dependent on another subjective factor: inhabitants' problem perception at the outset[273]. This tends to be greater in densely populated areas[274]. **The roll-out of a series of measures aimed at reducing urban congestion will be deemed more acceptable if it occurs in an area in which inhabitants believe regular traffic jams to be restrictive and problematic**. This problem perception varies depending on the area. There are as many methods to increase the acceptability of a mobility funding transition strategy as there are problems at the outset.

This predominance of subjective factors is above all due to a lack of experience or knowledge of the instruments used. The use of communication and information tools is particularly necessary as general knowledge on urban mobility demand regulation mechanisms is low. **Yet knowledge and experience of instruments are correlated to a better project acceptability**[275]. In Stockholm, the acceptability of the city toll was assessed following its introduction. When the experiment was launched in 2006, the project was judged negatively by 62% of those polled. At the end of the seven-month test period, the congestion tax scheme was judged positively by 53% of the population. In 2010, this rate even rose to 74%. As part of the introduction of road pricing, acceptability follows a typical three-phase pattern[276]:

"Initial idea" - When the project is initially presented, part of the population tends to support the idea. This proportion depends on the way in which the proposal is presented (effects, allocation of revenue) and the way in which it intends to meet mobility challenges as perceived by residents.

"Acceptability decreases with details" - There follows a period in which acceptability decreases under the effect of communication regarding the details and effects the instruments used will have on mobility. Acceptability also decreases when fears are expressed regarding the fact that the technical system of road pricing is too costly to operate.

"It's easier to accept what we know" - Lastly, once the system is in place, support tends to grow. In Stockholm, the acceptability of the city toll rose when the real effects of the instrument on mobility far exceeded the initial predictions. Acceptability is also heightened when the initial fear of an unbearable increase in journey times and budget ultimately prove unfounded.

This statement illustrates the key role that information and communication play in the acceptability of mobility regulation projects[277]. **Several solutions ensure appropriate acceptability for these projects:**

· **Definition of the initial situation** and of mobility issues: the perception of negative externalities concerning mobility must be shared among residents.

· **Definition of the objectives set** and the way in which they solve the initial problems.

· **Description of the instruments used** to resolve the situation: if the instrument used is not the only possible solution, the instrument must at least be perceived as an effective means of meeting the objective set.

· **Communication on the expected effects compared to the initial situation:** how do the planned solutions reach the objectives set?

· **Setting of revenue allocation:** acceptability will depend greatly on the way in which the revenues generated will be used, allocating revenues to the general budget is often viewed as particularly unacceptable.

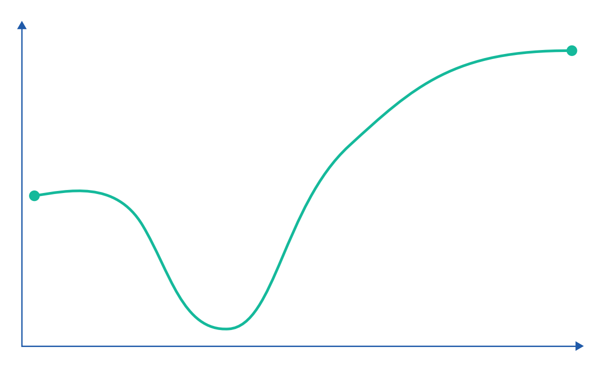
· **Information on additional services provided:** which services will be provided in return for the introduction of this road pricing instrument? Who will benefit from them?

·**Information on the costs of use:** what additional costs for users will result from the application of these measures?

· **Information on the expected user benefits:** besides the effects related to the solving of the initial problems, what benefits can the user expect from this measure?

· **Demonstration that the measure's introduction will leave the user a choice** by presenting alternatives that will be developed on the thoroughfare concerned, supported by the revenues generated by the new road pricing system.

Fig. 10
OECD diagram of the evolution of the acceptability of road pricing over time



Information campaign on the deployment of electronic city toll in Washington State

The space-time of the transition of the mobility funding system

The meeting of operational objectives alone is not enough to make a project acceptable. **However, the difficult conjunction of the various components of acceptability makes the transition to a model funding carbon-neutral mobility more complex.**

The transition marks the shift from an initial state to another by changing certain parameters. **As part of the changes to the mobility funding system, the transition will have repercussions for regulation via strategies including bans, overhauls of pricing, leverage of taxation of certain uses and the provision of existing (additional capacity) or new services.** These changes entail consequences for users. **Citizens judge the acceptability of a transition through a cost-benefit analysis that establishes a comparison with the initial situation**[278]. The acceptability of an overhaul of the mobility funding system will depend on the outcome of this analysis and demonstrates the importance of working on the "benefits" component. Making efficient solutions acceptable to reach the carbon-neutral mobility objective is a major challenge[279]. How can this challenge be met? What lessons can be learned from international projects in this field?

Campaign for the introduction of congestion pricing in New York in 2008

→ CREATING A TIMESCALE

The acceptability of a project to overhaul mobility pricing is not subject to linear developments. This is demonstrated in the case of Stockholm: **the initial perception of a mobility regulation measure is no indication of its acceptability once established.** There are many examples of strong regulations of mobility, such as city tolls, which were broadly accepted subsequently. **A common factor in these examples is an implementation schedule which makes it possible to change the system in accordance with feedback**[280].

Even before a new mobility regulation measure is tested, **the process of defining the instruments to be introduced may take some time, depending on the acceptability of the measure.** As early as 2007, Michael Bloomberg, Mayor of New York, proposed to introduce a city toll to finance public transportation. While supported by many bodies in charge of mobility, the proposal was rejected by law in 2008. It took until 2019 and the announcement from the Metropolitan Transport Authority (MTA) of the investment programme for the 2019-2024 period for the city toll to be introduced from 2021. Secondly, the testing phase includes several key stages. **There is an initial period of analysis (financial and on the effects of the measure) and of designing the regulation instrument.** Then comes **a communication phase** used to officially launch the programme and recruit participants. Once the recruitment is completed, **a testing phase** begins. Feedback from this phase is used to develop the system. Lastly, **the test is assessed and recommendations are madewith a view to planning changes prior to the instrument's full implementation.** From 2012, the State of Washington launched a consultation on changing its infrastructure funding model. Like its neighbour Oregon, Washington State set itself the goal of finding revenues to replace the fuel tax. **For the time being, only a pilot programme has been launched. From the initial analysis period to its final assessment, this will have taken almost eight years**. This first pilot has been used to draft recommendations for political decision-makers with a view to preparing a possible implementation of such a system.

The scalability of systems must also be considered once the regulation instrument has been implemented. Some of these systems regulate usage on the basis of technical criteria, tsuch as engine type, the Euro class of the vehicle or emissions of CO_2 or fine particles. **However, continual technological advancements, particularly in the automotive industry, can make some regulations ineffective in the long-term, forcing authorities to review the regulation criteria or even revise the system**. This was the case in particular for the city toll in Milan. From 2008, Milan introduced ECOPASS, a **system aimed at reducing the number of polluting vehicles circulating in its city centre. The system also aimed to foster a renewal of the car fleet in favour of less carbon-intensive vehicles**. The experiment in Milan enjoyed only limited success: while the number of polluting vehicles entering the city centre decreased considerably, **the measure did not have any significant impact on congestion**. Following a referendum proposing to adopt a new system with a view to reducing congestion, supported by roughly 80% of voters, the municipality introduced Area C in 2012. **The aim of this new version of Milan's city toll was to tackle congestion itself.** This development resulted in a total change in usage discrimination criteria[281].

The scalability of the system is necessary so that regulation can act on the negative externalities caused by mobility. **Furthermore, changes to some instruments are inevitable when they result in unplanned negative externalities.** To promote the sale of electric vehicles, Norway made it possible for electric vehicles to use bus lanes, thereby reducing journey times[282]. Faced with the increase in bus lane congestion, particularly in Oslo, the Norwegian government decided to leave it up to local authorities to authorise or prohibit electric vehicles in these lanes[283].

→ ENHANCING ACCEPTABILITY THROUGH A CLEAR REDISTRIBUTION AND ALLOCATION OF REVENUES

Increasing the price of mobility through revised pricing or the introduction of a new tax may be perceived by users as a loss. This shows just how difficult it is to implement measures that meet the twofold objective of "horizontal fairness and economic efficacy". While complex, this balancing act can be resolved. The solution lies in operators, mobility authorities and public authorities' capacity to apply effective pricing and the polluter pays principle in exchange for the provision of a service, such as, for instance,

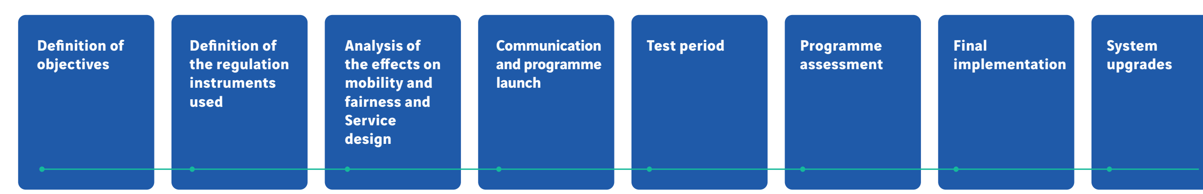


Fig. 11
Diagram of urban mobility regulation instrument implementation

Abildsø city toll (E6) in Norway has funded part of the Oslo Package 1

the roll-out of additional transportation[284]. This type of equalisation can offset the user's perceived loss.

Users will feel more compensated if they perceive a direct link between an increase in journey costs and what they get in return[285]. For road usage pricing, acceptability is particularly high if the revenues are used to benefit road users. This is even more the case when revenues are used to reduce the level of other levies related to road traffic, whether fixed (toll price) or variable (fuel tax)[286].

In 2018, **almost 73% of Americans claimed they were willing to increase their financial contribution to upgrade their road infrastructure system. 63% of them agreed to pay additional tolls; while conversely only 37% accepted to finance this upgrading through additional taxes**[287]. Similarly, several surveys conducted in the United States demonstrate a preference for a toll system rather than a tax increase for the funding of road infrastructure upgrades and construction. This preference for usage charges (tolls, fees) rather than the use of additional taxes **can be partly explained by the perception of an excessive number of taxes and because, unlike tax increases, the toll system guarantees horizontal fairness (user pays principle)**[288].

→ REINVESTING IN SOLUTIONS IN REGULATED TERRITORIES

A second type of redistribution may be conducted by funding additional mobility services. A survey carried out in 2000 in several European cities underscored the acceptability of measures aimed at an improved management of travel flows, such as reducing the number of parking spaces, the opening of park & ride facilities and the creation of a city toll. **It can be noted that those polled prefer the improvement of public transportation and the construction of additional park & ride facilities, for which acceptability rates stand at 94% and 91% respectively**. This appetite may be explained firstly by the fact that **these two measures constitute new solutions and therefore an extended choice of travel options**[289] and, secondly, that residents are familiar with these types of instrument, commonly used to regulate travel demand. **Acceptability is further heightened when the revenues related to an internalisation of negative traffic externalities, in particular through tolls, are reinvested in public transportation. Once again, the effect is greater when these investments are made in the area in which pricing has been introduced**[290].

This is what Norway decided to do. At the end of the 1980s, **Oslo City Council teamed up with neighbouring county Akershus to implement an infrastructure funding programme (Granfoss Tunnel, Festning Tunnel, E18 E-road, etc.) and mobility services** (Oslo Package 1). In 1990, the programme was endowed with an instrument that would enable it to secure the funding it required: the Oslo city toll. The main argument in favour of this city toll is that the lack of public funds made it impossible to finance the road and public transportation investments defined in the agreement. The Oslo Package 1 allocates revenues very clearly: 20% are invested in the development of public transportation. In 1996, faced with unexpected changes to car mobility, a second agreement (Oslo Package 2) was

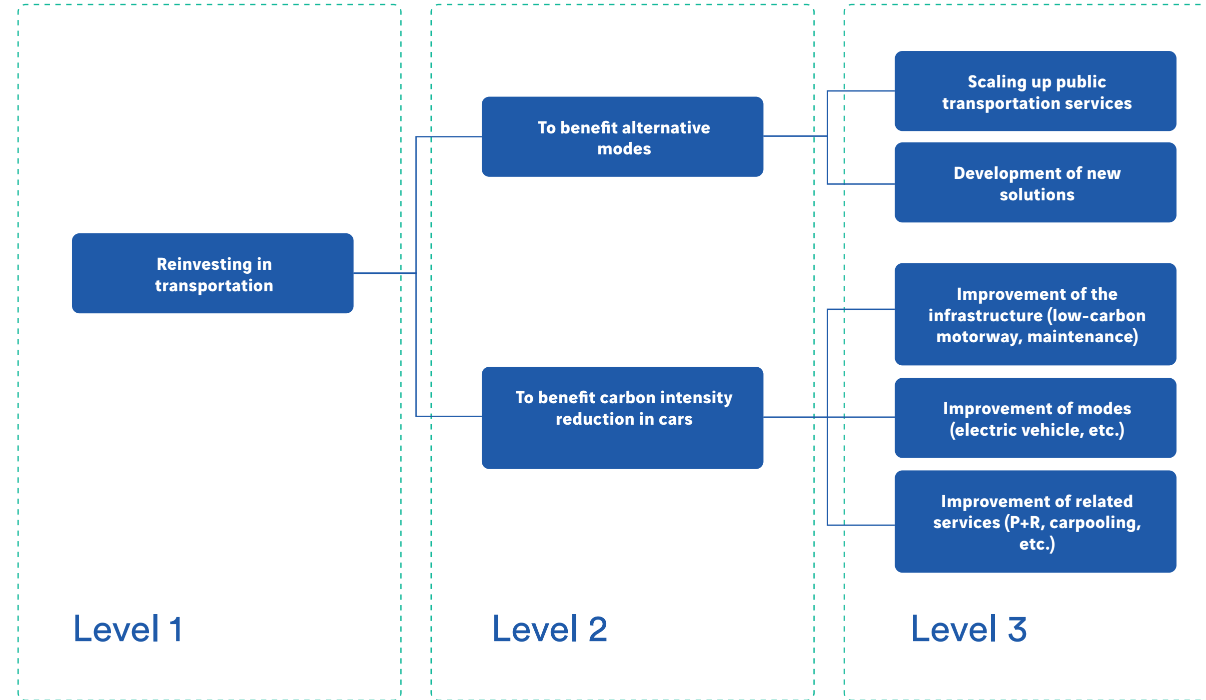


Fig. 12
Scheme for funding the decarbonisation of mobility

signed to develop public transportation, this time incorporating co-funding from the government. **In practice, the Oslo Package 2 applies a toll price increase of €0.25 for each crossing, the total revenues from which are allocated to investments in public transportation infrastructure, and a €0.10 increase in public transportation fares, total revenues of which are allocated to rolling stock investments**[291]. In 2008, a third agreement was signed between Oslo and Akershus (Oslo Package 3). As part of the investment programme for the 2008-2032 period, €11 billion financed by the city toll and local and national contributions will be invested to reduce congestion and improve air quality. To achieve this, 85% of the budget will be allocated to public transportation and to developing cycling and 15% to the construction of new roads[292].

Oslo's strategy has paid off in terms of acceptability. **A survey conducted in 1990, prior to the installation of Oslo's city toll, demonstrated that roughly 70% of those polled were not in favour of the instrument**. In 2009, while 54% of those polled still had a negative perception of the city toll, **74% claimed that they were willing to pay more if revenues were allocated to improving road infrastructure, public transportation and environmental improvements through municipal initiatives**[293]. This demonstrates the key role that information and knowledge play in the building up of such projects' acceptability and their success.

CONCLUSION

The political challenge of funding mobility in a post-carbon world

Reducing CO_2 emissions is no easy feat, especially in a sector such as mobility, and particularly as it plays a key role in our lifestyles. It conditions access to the city and its amenities in addition to the upkeep of social and professional relations. The regulation of travel has direct repercussions on the fundamental values of our societies, such as freedom and fairness. In France, recent protests against attempts to change taxation with a view to generating new resources to reduce carbon intensity ended in resounding defeat. These movements have highlighted the fact that carbon intensity in mobility must be reduced with inhabitants and not against them.

This statement raises two questions: "what should be done?" and "how can it be achieved?". It is impossible to give a universally valid answer to the first question. Reducing mobility's carbon intensity is not subject to a single practice. It is multifaceted. The challenge is therefore to be able to propose a solution appropriate for each situation.

The method is a key factor in the success of the transition of the mobility funding system. It is the common denominator of the various international examples explored in this report. It must propose an analysis shared by all, which requires a definition of initial issues from the outset, followed by a description of the objectives to be met and lastly the selection of instruments that take into account the initial situation, the objectives set and the acceptability of the measures. Building up a clear methodology that is shared as widely as possible is a key condition for the project's acceptability and ultimately its success.

The complex balancing act of mobility in a post-carbon world cannot be resolved by technical means. Solutions - which must be considered in the plural - will be necessarily complex, and will require the creation of convergence beyond social, territorial and economic divides.

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