Shaping the Future of Mobility

Mobility Pricing in Europe and beyond

EPTA

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Impressum

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EPTA

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Preface

Distinguished reader!

By today's standards it is not much more than a surprisingly small, yellow and black lacquered plywood box. But in the 1840's, drawn by five horses, it grandly ushered in a new era, putting Switzerland at the crossroads of major transport corridors in Europe and thereby reshaping the country's geographic, political and social contexts: The first stagecoach negotiating the hair-raising hairpin turns of the then newly opened road over the Gotthard pass.

As in many industrialized countries, the transport system in Switzerland has since evolved with ever increasing speed. Not just in the Gotthard region, where in 1882, the pass road was outclassed by the opening of the railway tunnel. Almost exactly one hundred years later, the motorway tunnel started operating, dwarfed today by the rail base tunnel whose 57 km make it the world's longest tunneling project.

Technology Assessment (TA) is well-placed to know that such technological feats entail opportunities as well as risks. Greater mobility, better means of communication and improved transport systems have to be balanced with ever increasing numbers of infrastructure users, traffic congestion, pollution and environmental impacts as well as exploding costs in financial as well as social terms. By furnishing independent and credible analyses, TA provides policy options intended to guide technological developments for the good of society.

This report provides an overview of mobility pricing in different countries as well as their plan to tackle the challenge of managing mobility in the near future. It is part of a series of similar reports compiled every year by the respective presidency of the EPTA network[1]. As in previous editions, it is a collection of contributions written from the perspectives of different full and associate members of EPTA. As such, it can be read as a stand alone survey of the transport policy situation in a number of industrialized countries, but it also provides an information basis for the issues addressed by the international EPTA conference "Shaping the Future of Mobility" hosted by TA-SWISS in the Swiss Transport Museum in Lucerne on November 8, 2017 – by the way, Switzerland's most popular museum.

I wish to thank all contributors for making each country report in this collection a compelling read and, in particular, Dr Christina Tobler from the team of TA-SWISS, for defining the contextual framework, providing the introduction and synthesis chapters and for joining, with unwavering patience, the individual parts to an enticing and thought-provoking whole. Special thanks go to Christine D'Anna-Huber for editing the contributions as well as taking care of the printing and finishing of the report.

Wishing you an instructive and enjoyable reading

Sergio Bellucci
EPTA President 2017, Director TA-SWISS, Foundation for Technology Assessment/Switzerland

Bern, October 2017

1 See the EPTA project database at eptanetwork.org/database/projects
Download the 2016 EPTA report at http://epub.oeaw.ac.at/0xc1aa500e_0x003469a0.pdf

1. Introduction

Christina Tobler, TA-SWISS

1.1 Shaping the Future of Mobility

Citizens and economic actors in Europe and beyond need a transport system which provides them with seamless, high-quality door-to-door mobility[2]. However, according to the European Commission, many towns and cities increasingly face problems caused by transport and traffic. One dominant problem is severe traffic congestion; its total cost in the EU is estimated at €80 billion annually[3].

The question of how to enhance mobility while at the same time reducing pollution, congestion and accidents is a common challenge to all major cities in Europe[4]. A profound transformation in the transport system will be required in the coming decades. New developments like autonomous and connected driving, sharing economy, mobility pricing or mobility as a service are expected to shape the future of our mobility and revolutionize our transport systems.

The Annual EPTA Conference in 2017 addresses different developments in future mobility and examines them from multiple perspectives. The conference aims to foster debate on shaping future mobility, encouraging parliamentarians, experts and stakeholders to discuss possible solutions as well as desirable and adverse outcomes.

1.2 Aim of this report "Mobility Pricing in Europe and beyond"

The EPTA network of international TA institutions produces an annual report on timely topics concerning the relationships between technological change, society, economy and politics. Each year a different partner assumes the presidency of the network. The main tasks of the EPTA presidency are to create the report based on the contributions from each network member, and to organize a conference on the chosen topic in the presiding country for presentation and discussion of the report's findings with members of parliament. The present report also serves to provide information on mobility pricing for international policy makers, researchers, and the wider public.

The term "mobility pricing" describes charges for the use of any transport infrastructure or services on all transport modes with the objective of influencing travel demand and mobility behaviour[5]. Mobility pricing aims to manage transportation demand in order to reduce peak hour travel, congestions, air pollution or greenhouse gas emissions. Possible instruments are road or congestion pricing as well as transportation fares.

The EU has created a framework to encourage the use of taxation and infrastructure charging, which should promote the 'user pays' and 'polluter pays' principles and contribute to the internalisation of external costs[6]. The aim is a more efficient use of transport infrastructures currently affected by

2 http://europa.eu/rapid/press-release_MEMO-13-1160_en.htm

3 http://europa.eu/rapid/press-release_MEMO-13-1160_en.htm

4 https://ec.europa.eu/transport/themes/urban/urban_mobility_en

5 Rapp, M. (2006). Mobility pricing scenarios for Switzerland. Retrieved from https://www.gised.ch/wAssets-de/docs/trans/fachartikel-referate/2006/dokumente/its-congress-london/mobility_pricing_ch_itslondon-doc.pdf

6 https://ec.europa.eu/transport/modes/road/road_charging_en

congestion. However, despite its potential benefits, mobility pricing is controversially discussed. Critics for instance argue that the transport sector is already overtaxed and predict negative impacts on the economy.

The comparative report should shed light on the implementation of and political debate about mobility pricing in Europe and beyond. To present an overview on the topic, the presidency suggested the following main questions:

1 Mobility: Facts and Figures

What distance does the average resident travel – by which means of transportation? What are the costs of transportation and who funds it? Is there any income from transportation (e.g., from mobility pricing)?

2 Current implementation of mobility pricing in the country or region

Is there a mobility pricing scheme implemented, and if so: on which level (national, regional, local)? How is it implemented (e.g., vignettes, tolls etc.)? Is it charged directly, based on use, distance or time – or is it covered by an annual fee? Does the mobility pricing scheme cover public, private or freight transport? Who are the drivers? Are they from the public, private or industrial sector? If no such scheme is implemented (yet), are there plans to do so and why (not)?

3 Societal and political debate

How is the political and public acceptance, what are the arguments and concerns? What stakeholders are involved? Are there any current political proposals on this topic? Is there any resistance, if so: from whom and why?

4 Experiences and outlook

What are the effects of mobility pricing on traffic, economy and environment? To what extent can Mobility Pricing contribute to solving transport problems? What are the effects of Mobility Pricing on the traffic behaviour?

5 Other approaches to future mobility

Are there any other approaches to solve mobility problems or to prepare for future mobility?

2. AUSTRIA

Stefanie Peer & Tanja Sinozic

2.1 Mobility: Facts and Figures

Austria has a population of 8.4 million and an area of 83,850 km^2. Two thirds of its geographical territory is mountainous, almost one half of the country is covered with forests, and about 16% is arable land[7]. The capital city Vienna is Austria's only major sized city, with approximately 1.84 million inhabitants in 2016. Austria shares borders with eight EU countries. The country's borders as well as its topography have significantly shaped its transportation network. Austria's motorways play an important role for transportation across Europe. Major infrastructure projects are currently taking place, including the construction of three new long rail tunnels and a new subway line in Vienna.

Austria's transportation network is generally advanced, not only in (sub-)urban areas, but also in more rural and remote regions, and the transport system in Vienna in particular is internationally considered to be excellent.[8] The large majority of transportation infrastructure such as motorways, roads and railways is publicly financed, and public means of transportation tend to be heavily subsidized. The main means of transportation are private cars (50.5% of trips on an average working day), public transport (14.6%), walking (17.8%) and cycling (6.4%). On working days, Austrians cover on average 36 km, which takes them about 70 minutes.[9] Commuters are granted various forms of tax allowances, most of which are targeted at car commuters.

There exist several kinds of pricing schemes for mobility, differentiated by transport and vehicle type, as well as by the level at which they are levied (national, federate state, regional or local level)[10]. There is a usage-independent motorway toll targeted at individual travellers, and a usage-dependent toll targeted at trucks. Public transport is generally fairly affordable, especially season passes. For example, the ticket covering all modes of public transportation in Vienna costs 365 Euros per year[11]. Also cycling is promoted by most city administrations, for instance by expanding cycle lanes and by offering bicycle rental (the Citybike scheme in Vienna is virtually free of charge).[12] As a consequence, Vienna has quite a low share of trips made by car (ca. 32%) compared to other cities of similar size.[9]

2.2 Current implementation of mobility pricing

There is no single consistent mobility pricing scheme in Austria. Some steps were made in the direction for specific transport modes, such as trains: the ÖBB (Austrian Federal Railways) "Austriacard" allows for the unlimited use of all trains in Austria for one year for the price of 1.784 Euros[13]. In Vienna, some

7 statistik.at/web_en/statistics/Economy/agriculture_and_forestry/farm_structure_cultivated_area_yields/land_use/

8 migration.gv.at/en/living-and-working-in-austria/austria-at-a-glance/transport/

9 bmvit.gv.at/verkehr/gesamtverkehr/statistik/oesterreich_unterwegs/downloads/oeu_2013-2014_Ergebnisbericht.pdf

10 bmvit.gv.at/verkehr/nahverkehr/verbuende/oesterreich.html

11 wienerlinien.at/eportal3/ep/channelView.do/pageTypeId/66526/channelId/-46642

12 citybikewien.at

13 oebb.at/en/angebote-ermaessigungen/ermaessigungskarten/oesterreichcard

progress has been made towards "mobility as a service" by Wiener Linien: since 2015 the city's public transportation provider offers a "mobility card", which includes public transportation, the use of the Citybike, discounts on taxis, parking garages and the City Airport Train (CAT). Despite optimistic predictions from the public transport agency that the mobility card would be very popular, very few have been purchased so far[14]. The federate state of Vorarlberg has recently rolled out a mobility service card that combines local public transportation (such as buses) with regional train transport covered by a single annual fee[15].

As previously mentioned, road pricing for individual travellers on motorways goes by way of a vignette, which in 2017 costs 86.40 Euros per year (per car), with bi-monthly and weekly options available as well.[16] Moreover, Austria has distance-dependent tolls for vehicles exceeding the weight of 3.5 tonnes on motorways, measured by a small device inside the truck and overhead sensors (Go-Box). The toll further depends on the truck type (with larger, more polluting and noisier trucks paying higher tolls per km). Both for individual travellers as well as for trucks, extra tolls are levied on specific links (especially in Alpine areas such as the Brenner pass) for environmental reasons and/or in order to recover the costs of the infrastructure.[17]

Most cities and towns have implemented some type of parking management[18], which tries to motivate commuters to use alternative forms of transport or park at locations at which public space is less scarce. In Vienna, the parking management includes parking permits for residents, which are an annual fee paid to the city for parking allowance in the district of residence, inner city zoning with fees for short term parking for non-residents[19], as well as some Park & Ride facilities also catering mostly to non-residents. Public transportation fees are quite diverse, with annual, monthly, weekly and daily tickets available, as well as trip and distance based ones. A single trip within a city, e.g., costs between 1.80 and 2.20 Euros in most cases[20].

2.3 Societal and political debate

In general, mobility pricing and related topics such as public transport infrastructure and zoning are highly politicized in Austria. Large infrastructure transportation projects such as the planned rail tunnels are always controversial, because of environmental risks, their massive cost and often very low return on investment. Recent zoning attempts motivated by environmental concerns have been abandoned mainly for political reasons. The implementation of pedestrian zones, such as in one of the boulevard streets in the Vienna city centre (the Mariahilferstrasse), and short-term parking zones to contain car traffic in residential areas have all been preceded by long political processes with much debate in the media and resistance most notably from centre-right parties and private industry (organized by the Chamber of Commerce). Environmental reasons have also been the political drivers to contain traffic in the city

14 orf.at/news/stories/2760445/

15 presse.vorarlberg.at/land/servlet/AttachmentServlet?action=show&id=20173

16 austria.info/us/basic-facts/getting-there-around/austria-by-car/toll-sticker

17 diepresse.com/home/ausland/eu/451455/Entlastung-fuer-den-Brenner_Zeichen-stehen-auf-Oekomaut; https://de.wikipedia.org/wiki/Richtlinie_1999/62/EG_(Wegekostenrichtlinie)

18 salzburg.orf.at/news/stories/2841198/

19 wien.gv.at/amtshelfer/verkehr/parken/kurzparkzone/parkpickerl.html

20 migration.gv.at/en/living-and-working-in-austria/austria-at-a-glance/transport/

of Graz, which has recently contemplated the introduction of a "car free day" to lower the amount of particulate matter in the air.[21] Overall, the debates in Austria focus more on regulation (for example zoning) than on pricing, with the former being more popular due to the distributional concerns raised with pricing (with the concern being that in future only the more affluent members of society will be able to afford car ownership and usage).

There is some persistent discussion on the taxation of gasoline (in particular, Diesel) in Austria, because the levied taxes are considerably lower than in most neighbouring countries. The resulting so-called "fuel tourism" generates substantial revenues for the Austrian government – 830 million Euros in 2017[22]. Low fuel taxes are also linked to environmental concerns, not least because the current CO_2 emissions targets attribute emissions to the country where the fuel is purchased and not where it is consumed[23]. Because of the large revenues obtained from fuel tourism and the high dependency of Austrians on private car travel, an increase in fuel charges is unlikely in the short and medium term.

The political debates surrounding mobility pricing and regulation in Austria are also due to powerful stakeholders and lobby organisations. The two main Austrian automobile clubs with approximately two million members each[24] (ÖAMTC and ARBÖ) play an important role in national decision-making. Both mainly lobby in favour of motorized mobility. Another important organisation with wide media presence is the Verkehrsclub Österreich (VCÖ), which is a lobby and research organisation focusing on ecologically safe, socially just and economically efficient transportation.[25] Other important organisations are the public transport agencies in cities such as the Wiener Linien, Grazer Verkehrsbetriebe and Linz Linien, the transport ministry, the finance ministry, provinces, municipalities and political parties. In the freight sector, the Zentralverband Spedition & Logistik as well as the chamber of commerce are the most relevant stakeholders.[26]

Debates have also been ignited as private companies have entered a previously public domain, such as the rail service provider Westbahn[27] competing with the national railway line ÖBB on Austria's main rail link which connects Vienna, Linz and Salzburg.

2.4 Experiences and outlook

The above-mentioned types of mobility pricing are likely to have affected the behaviour of individual travellers as well as logistics providers, and in turn traffic conditions, the economy and the environment. However, it is often hard to pinpoint the specific cause of certain developments. One example is that road traffic in Vienna has decreased by about 6.3% between 2010 and 2015 despite a growing number of inhabitants.[28] The cause of this decline cannot be attributed to a single measure implemented in that time period. Instead it is likely to be the combined outcome of a number of measures that the city government has taken in past years, including the following: (1) introduction of parking management in

21 kurier.at/chronik/oesterreich/wegen-feinstaub-autofreier-tag-fuer-graz-angedacht/272.478.047

22 derstandard.at/2000054921143/Tanktourismus-auch-bei-hoeherer-Steuer

23 derstandard.at/2000054846297/Rupprechter-stellt-hoehere-Steuern-fuer-Dieselautos-in-den-Raum

24 oeamtc.at

25 vcoe.at/ueber-vcoe/ueber-vcoe

26 spediteure-logistik.at

27 westbahn.at

28 wien.gv.at/stadtentwicklung/projekte/verkehrsplanung/strassen/verkehrszaehlung/index.html

large areas of Vienna (which caused a significant decrease in parking occupancy levels in those areas[29]), (2) introduction of a 365-Euro-annual-ticket that covers all public transport (which induced a substantial increase in public transport usage[30]), (3) extensions and improvements of the network of cycling paths.

As mobility pricing in Austria is fairly moderate, no large-scale effects on the economy are evident. Extensive tax allowances for commuters (Pendlerpauschale, Pendlereuro) are likely to – ex aequo – lead to longer commuting distances, more urban sprawl, and in turn a higher car dependency. Various current and upcoming projects concerning mobility pricing in Austria focus on mobility as a service, and the use of digital technologies (especially smartphone apps) to optimise route and transport mode choice (e.g. the project Smart Journey[31] currently being tested in Carinthia and Styria).

2.5 Other approaches to future mobility

A substantial shift towards *E-mobility* is considered a key instrument for achieving the CO_2 targets set in the Paris Climate agreement.[32] Various subsidies are available for buyers of electric cars as well as for the construction of charging infrastructure both at the national as well as the provincial level.[33] Despite these incentives, the share of electric vehicles in the Austrian car fleet is still very low (0.25% of the overall car fleet, 1.54% of new vehicles).[34] One exception is the federate state of Vorarlberg which has one of the highest shares of electric vehicles of all regions in the EU.[35]

Car-sharing is indirectly supported by the city government in Vienna by providing free parking to operators of free-floating car schemes. In Vienna more than 100,000 persons are subscribed to car-sharing providers.[36]

R&D towards *autonomous driving* is mainly funded by the Austrian Research Promotion Agency (FFG).[37] It for instance funds a test region on autonomous driving around the city of Graz as well as a self-driving bus in a newly constructed district of Vienna (Seestadt Aspern).[38] Graz has been selected due to the large car manufacturing cluster located there (including the availability of test tracks) as well as the presence of related research institutions.

29 wien.gv.at/verkehr/parken/entwicklung/ausweitung/

30 diepresse.com/home/panorama/wien/4839954/365-Euro_Traegt-sich-die-Jahreskarte-von-allein

31 oebb.at/de/umfragen-gewinnspiele/smartjourney/

32 bmvit.gv.at/verkehr/elektromobilitaet/

33 energiemagazin.at/foerderungen-fuer-elektroautos-in-oesterreich-eine-uebersicht-der-bundeslaender/

34 bmvit.gv.at/verkehr/elektromobilitaet/downloads/oesterreich2016_de.pdf

35 vlotte.at

36 wien.gv.at/stadtentwicklung/studien/pdf/b008470.pdf

37 ffg.at/automatisiertesfahren

38 bmvit.gv.at/service/faktenblaetter/automatisiertesFahren_testen.pdf

3. CATALUNYA (SPAIN)

CAPCIT, with the collaboration of the Government of Catalonia

3.1 Mobility: Facts and Figures

The Catalan road network has a total length of 12,060 km, of which 50% are owned by the Catalan Government, 15% by the Spanish Government and the remaining 35% by the four Catalan provincial councils.

High-capacity roads (motorways, dual carriageways and stretches of other controlled-access highways) are particularly important in this network due to their technical characteristics. There are 1,648 km of high-capacity roads and they account for 14% of the total Catalan road network (12,060 km). The Catalan Government owns 762 km (46%) of these 1,648 km of high-capacity roads in Catalonia, the Spanish Government 860 km (52%) and local government 26 km.

As for the management and pricing scheme, the Catalan high-capacity road network consists of 675 km of direct toll roads (with pay-per-use or for mobility), 343 km of shadow toll roads (payment by the government) and the remaining 630 km which are non-concessionary roads (financed directly out of the budget).

Direct toll roads are run under a concession contract whereby in return for building and operating the road the concession operator is paid a charge by users which varies by the type of vehicle and the distance travelled. At present in Catalonia there are 675 km of direct toll roads, of which 474 km are Spanish Government-owned roads (the AP-7 and AP-2) and the remaining 201 km are roads owned by the Catalan Government.

In the case of shadow toll roads the construction and upkeep costs are passed on to the government as a function of their traffic so they are not directly paid for by users. At present only the Catalan Government owns shadow toll concessions.

The direct tolls system in Catalonia has a high degree of maturity, although this is not the case with shadow tolls. In the next few years 515 km of direct toll concessions in Catalonia will expire (87 km in 2019 and 458 in 2021) which are the ones that generate the greatest impact in terms of pricing.

3.2 Current implementation of mobility pricing

To date there has been no consistent or harmonious pay-per-use system, but rather three different models on the Catalan network: direct toll roads, shadow toll roads and direct management roads (non-concessionary roads). The latter two are free for users while on the direct toll roads the user pays a charge based on their use of the road (distance travelled between joining the road and leaving it at the toll). 675 km of the 1,648 km of high-capacity roads have direct tolls, i.e. 40% of the high-capacity network has tolls which are directly paid by users. The other 60% is free for users. The final price depends on the category of the vehicle (motorcycles, cars, bans, coaches or lorries).

On the roads, the unit price (euro per kilometre) and the resulting tolls charged when bringing a particular motorway into service are set in the contract awarding the concession. The charges take into account initial investment costs, maintenance costs and reinvestment, financial costs and the return for the shareholders associated with the funds required to carry out the investment, expected traffic and the years of operation specified.

It should be borne in mind that depending on the location of the mainline toll stations and whether or not there are any slip road toll stations, the final cost to the user will vary depending on where they join and leave the motorway. Under the Toll Homogenisation Plan the number of slip road toll stations on the motorways is being increased in order to adjust the toll paid to the actual journey taken.

For a variety of reasons and under the contracts with the concession operators, there are a number of stretches on the toll motorway network where local journeys and sometimes all journeys are exempt from paying the toll. Some stretches have had this system in place since the start of the concession period, while others have become free of charge later on.

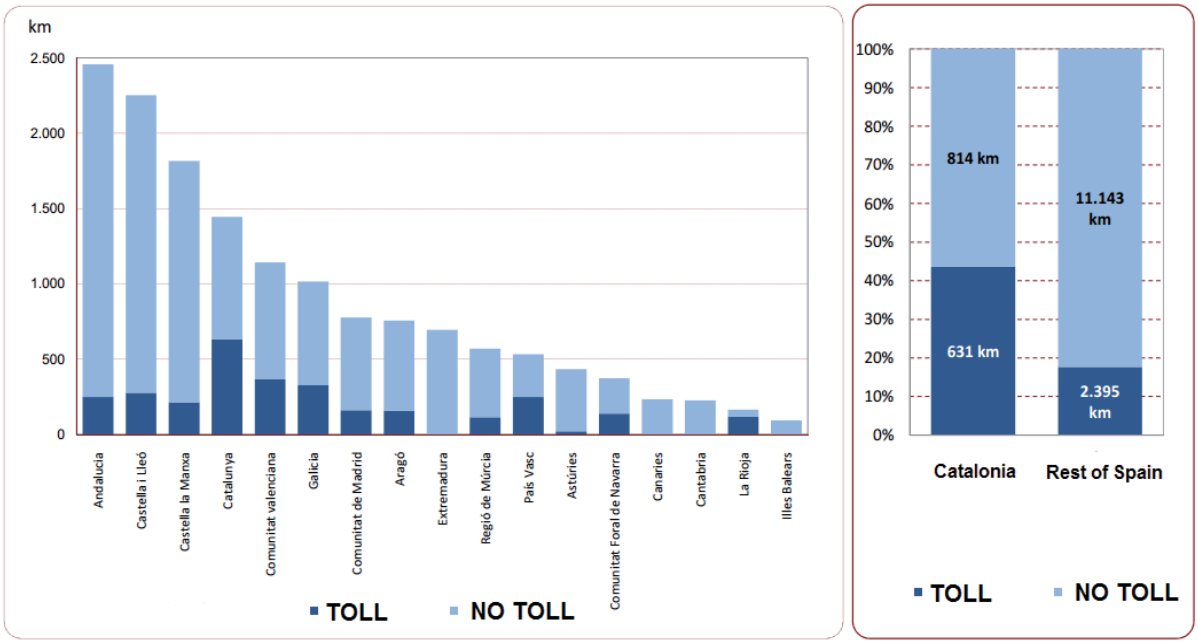
The pricing scheme covers public, private and freight transport. In Catalonia, there are currently six direct toll concession operators.

3.3 Societal and political debate

The current toll system generates a degree of controversy and some rejection in a number of sectors.

The heterogeneity of the system of high-capacity roads – some free and some not – does not have a positive impact on public opinion about road pricing as toll roads are seen as a regional grievance. In Spain as a whole most of the high-capacity road network is free of charge for users, and Catalonia is the region which has the most direct toll roads in both absolute and relative terms.

Figure 1.- Spanish Autonomous Communities and tolls – Source: Viacat Statistical Yearbook (2014)



There are several civic campaigns organised against tolls as they consider the initial investment has been recovered. Other platforms call for greater road safety and criticise the inefficiencies of redirected traffic resulting from toll policies.

Likewise, the fact that some conventional roads run parallel to toll roads leads to an inefficient use of the network which generates externalities such as congestion and accidents.

Other sectors do not so much question pay-per-use as the fact that the tolls are managed by private firms and not state-owned enterprises.

There are other sectors of opinion which argue that taxation on vehicles (road tax, registration, fuel, VAT) easily covers the cost of running the road system.

Finally, one of the criticisms of the current system is that tolls have been used as a financial mechanism and not for mobility management or environmental pricing. In other words, current charges are calculated on the basis of covering costs, which means that in those stretches where construction costs are very high – tunnels and rough terrain – or where revenues are lower – because of low traffic volumes – a system of higher charges per kilometre is required.

At any event there is also greater social awareness of the Eurovignette "the user pays" and "the polluter pays" principles.

The main stakeholders are the concession operators, the tiers of government owning the toll roads, toll road users and civic engagement platforms and civil society.

Over the next few years 515 km of direct toll concessions in Catalonia expire, and this will make it possible to put forward fairer, more equitable and simpler road pricing schemes.

At present the Catalan Ministry of Planning and Sustainability is considering the option of a charging system involving a vignette for the availability and use of high-capacity roads in Catalonia. There is a consensus among the Catalan Government, concession operators, businesses, civil society and academics that any new road charging scenario requires harmonious treatment on all high-capacity roads regardless of who owns them (the Spanish Government or the Catalan Government).

As for the Spanish Government, the inclusion in Spanish law of the Eurovignette Directive has not entailed any change in the current status quo. The Spanish Government enacted the Eurovignette Directive in Spanish law – without any real impact on the current system of toll motorways and toll-free motorways – through the Royal Decree 286/2014, of 25 April, which lays down the principles for deciding on the tolls to be charged to certain freight transport vehicles on concession motorways forming part of the National Highways Network. The Spanish Government's official position is to make motorways free as the concessions expire, an approach that is not devoid of problems given the sunk costs of the roads (final balances) as well as the fact that the upkeep of these roads – until now the responsibility of the concession operator – might generate new costs for the governments owning them at a time of limited resources. The first motorway concession to expire is the AP-1 between Burgos and the Basque Country in 2018 which is owned by the Spanish Government. The charging option the Spanish Government chooses will set the rules of the game for the following reversions.

3.4 Experiences and outlook

The current toll system leads to major inefficiencies due to accidents and congestion on the free conventional roads that run parallel to the toll roads. These inefficiencies take the shape of loss of time and accidents and have been quantified by several studies as running into the millions.

Furthermore, the inefficient use of the network has led to the widening of some stretches of the parallel roads which has required significant amounts of investment. Greater use of the current toll motorways or adding lanes to them are solutions that would solve the problem of road safety and congestion much more efficiently than widening the parallel roads.

In a through-traffic country such as ours, logistics and transport are factors that drive investment and attract companies and industry. In addition, we are also a country with a powerful tourism sector. Hence it is essential to have a well-maintained, affordable, high-quality land transport network that connects companies and logistics, production and distribution hubs at the European and global level featuring infrastructures that carry people and goods and connect us to the world.

The concession operators have the option to give trade discounts to some or all users of their roads. The various tiers of government also implement measures to improve mobility and the environment.

Since 1 January 2012 the Catalan Government has used a system of cumulative general discounts on the roads it owns to subsidise commuting and promote efficient behaviour by users, i.e. recurrent journeys (30%), high occupancy vehicles (40%) and low emissions vehicles (30%).

Since 1 January 2014 the Catalan Government has added other specific discounts on particular stretches or concessions. This measure is designed to continue with the progress made since 1999 in bringing the most expensive stretches of motorway (in terms of euro per kilometre) closer to the average for the network owned by the Catalan Government. There are also special discounts such as the 100% discount for electric vehicles, the peak and off-peak rate system for congested stretches and the Tariff Homogenisation Plan.

In addition, the act accompanying the Catalan Government's budget (Act 5/2017) includes a tax on carbon dioxide emissions by vehicles with mechanical traction (which is payable as of 1 January 2018, except in the case of motorcycles where it is payable as of 1 January 2019).

There is no plan for general or specific discounts by type of mobility or vehicle on the Spanish Government's direct toll roads. However, some local journeys on the AP-7 – the Girona and Tarragona bypasses and the Montmeló – El Papiol stretch – are free in order to improve mobility. In addition, since 2013 in the Spanish Government-owned N-II / AP-7 Girona corridor, lorries with four or more axles have been banned on the N-II in order to cut the accident rate and improve traffic flows on this road. In lockstep the Catalan Ministry of Planning and Sustainability, the Spanish Ministry of Public Works and concession operator Acesa have agreed on a system of discounts for these HGVs on the AP-7 motorway depending on their route.

4. EUROPEAN UNION

Christian Kurrer

4.1 Mobility in the European Union (EU): Facts and Figures

The average EU-28 inhabitant travels about 13,000 km per year by motorised means of transport, of which almost three quarters are travelled by car. While the number of kilometres travelled by car has slightly decreased in recent years, cars still remain by far the dominant mode of transportation in the life of average Europeans.

In terms of kilometres travelled, the other dominant modes of transport are airplanes, busses and trains, which account for a share of about 9.8 and 6.5 percent, respectively.

In 2014, European private households spent about **1,000 billion euro** on transport-related expenses, about a quarter of that amount for purchasing vehicles, 50 percent for operating costs (gasoline etc.) and the remaining quarter for purchasing tickets for other modes of transportation. This expense represents on average 13 percent of the available household income, compared to only 1 percent spent for education, and also still more than expenditure for food and non-alcoholic drinks.

Beside these direct costs, the transport sector generates costs of more than **100 billion euro** per year through the road congestion it causes[39].

In addition to the expenditure of private households, public authorities in the EU spend an additional **100 billion euro** per year investing in transport infrastructure, of which about 54 percent are devoted to road infrastructure and 36 percent to rail infrastructure[40].

The EU budget is contributing to these infrastructure investments to the order of 12 billion euro annually through the cohesion programmes and 1 billion euro annually through Trans-European Transport Network (TEN-T) funding[41].

In addition to the direct cost of transportation shouldered by EU households, in a globalising economy, the costs of freight transport constitute an increasingly important part of the costs of the goods purchased by households.

While the costs of passenger transportation directly impacts European households and consumers, the cost of freight transport indirectly affects them through the price of the goods and services they purchase[42].

Estimates from the US suggests that around 14 percent of the price of agricultural products and 9 percent of the price of manufactured goods are made up of transport-related costs[43].

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39 https://ec.europa.eu/transport/sites/transport/files/pocketbook2016.pdf; https://ec.europa.eu/transport/sites/transport/files/connect-to-compete-people_2016_en.pdf

40 www.eea.europa.eu/data-and-maps/indicators/infrastructure-investments/assessment-3

41 www.transportenvironment.org/what-we-do/eu-transport-spending/background

42 www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/publications/transportation_economic_trends/ch3/index.html

43 https://ops.fhwa.dot.gov/freight/freight_analysis/freight_story/costs.htm

4.2 Current implementation of mobility pricing in the EU

The EU recognises that taxation and infrastructure charging are important for maintaining and developing the trans-european infrastructure network. It has therefore created a framework to encourage member states to use taxation and infrastructure charging in the most effective and fair manner, in order to promote the **«user pays» and »polluter pays» principles**, as enshrined in the treaties.

This framework contributes to the internalisation of external costs related to road transport, such as those generated by the use of infrastructure or its environmental and social impact. With the internalisation of costs, the EU also wants to encourage a more efficient use of transport infrastructure, currently affected by congestion, thus reducing the time wasted due to bottlenecks.

Road charging can also be a useful instrument for generating new sources of revenue to help develop Europe's vital infrastructure, as well as cleaner, more energy-efficient modes of transport.

The different instruments at the disposal of the EU for promoting these goals include vehicle and fuel taxation as well as road infrastructure charging[44].

According to the subsidiarity principle, the charging of private vehicles falls within the competence of member states and therefore no secondary rules on this issue exist at EU level. However, any road-charging scheme put in place by a member state must uphold the fundamental principles of the EU treaties, in particular the principle of non-discrimination on the grounds of nationality.

The legislative conditions for the road charging of heavy goods vehicles (HGVs) are different from those for private vehicles, as the movements of HGVs are directly linked to the EU's core principles of free trade and the free movement of goods. In 1999 the Directive 1999/62/EC[45] «on the charging of heavy goods vehicles for the use of certain infrastructures» – known as the Eurovignette Directive – laid the foundations for the internalisation of the costs generated by HGVs.

The Directive was amended in 2006 (Directive 2006/38/EC) and 2011 (Directive 2011/76/EU), allowing the inclusion of external costs such as air and noise pollution in the calculation of charges. Thus the «user pays» regime was extended to encompass the «polluter pays» principle[46].

While leaving the implementation of road charging systems to the level of individual member states, the EU is promoting the interoperability of electronic road toll systems in the Union[47].

4.3 Societal and political debate

European legislation

On 31 May 2017, the European Commission put forward a new (road) mobility package «Europe on the Move». It contains the following legislative proposals on road charging:

- Smarter Road Infrastructure Charging
- Revision of Eurovignette Directive (1999/62)
- Promoting the European Electronic Toll Service (EETS)
- Recast of the Directive on the interoperability of electronic road toll systems in the Community (2004/52).

44 https://ec.europa.eu/transport/modes/road/road_charging_en

45 http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:31999L0062&from=EN

46 http://www.europarl.europa.eu/RegData/etudes/BRIE/2016/583781/EPRS_BRI(2016)583781_EN.pdf

47 https://ec.europa.eu/transport/sites/transport/files/media/publications/doc/2011-eets-european-electronic-toll-service_en.pdf

In preparation of these proposals, the Commission conducted stakeholder consultations and published studies that give an overview of the main arguments put forward during the stakeholder consultations[48].

While these consultations showed broad support among member states for further incentivising the use of fuel-efficient vehicles in general, not all were convinced of the ease and value of implementing this through CO_2 -differentiated charges.

These proposals have now been sent to the European Parliament and the Council for legislative debate and approval.

European Parliament (STOA) studies

The European Parliament and in particular its Science and Technology Options Assessment (STOA) Panel have repeatedly addressed the issue of mobility pricing and novel transport options and technologies in recent studies, including:

2012 – Technology Options in Urban Transport: Changing paradigms and promising innovation pathways[49]

This report gives a broad overview over the different approaches being pursued for a transition towards more sustainable urban transport systems, ranging from technological options such as electric or fuel-cell cars, ICT solutions to improve traffic flows, e-ticketing systems, changes in urban land use policies, as well as behavioural changes such as the emergence of car- or bike-sharing.

2013 – STOA Study on Eco-efficient transport[50]

This study is aimed at assessing to what extent different concepts and approaches can help to increase the eco-efficiency of the transport system, looking in particular into energy systems, cleaner cars, cleaner trucks, smart logistics, automation, integrated ticketing, access instead of ownership, shift to rail, shift to short sea and inland shipping, awareness of/making use of habit and attitude changes, urban design as well asmobility pricing. To allow the required systemic perspective, the assessment has been supported by scenario building. The feasibility and desirability of the scenarios and their elements were the subject of a stakeholder consultation.

2014 – Integrated urban e-ticketing for public transport and touristic sites[51]

This report deals with the development of integrated e-ticketing systems for public transport and touristic sites in cities. The idea of integrated e-ticketing is to combine several modes of transport (e. g. tram, bus, car-, and bike-sharing) on a single ticket. Modern multi-application smart cards are able to incorporate additional fields of application (e. g. leisure activities or tourist attractions) on one fare medium. Such systems aim at facilitating the combination of modes and the transfer between modes by making the ticketing system as easy and attractive as possible.

48 https://ec.europa.eu/transport/modes/road/studies/road_en

49 http://www.europarl.europa.eu/RegData/etudes/etudes/join/2012/482692/IPOL-JOIN_ET%282012%29482692_EN.pdf

50 http://www.europarl.europa.eu/RegData/etudes/etudes/join/2013/513520/IPOL-JOIN_ET%282013%29513520_EN.pdf

51 http://urban-intergroup.eu/wp-content/files_mf/ipoljoin_et2014513551_en.pdf

2016 – Ethical Aspects of Cyber-Physical Systems (CPS), covering autonomous vehicles[52]
Among other aspects, this report also describes how CPS are expected to revolutionise logistics and transport systems sectors across Europe, with profound implications for safety, emissions and overall efficiency in the transportation of goods and people. In the short term, this presupposes the continued automation of automobiles. Current manufacturers are introducing Advanced Driver Assistance Systems (ADAS), which help to make a car «smarter» through automated assistance for the driver. Logistics will fundamentally change as robotic technologies are deployed to solve last-kilometre problems (traffic congestion and lack of loading and unloading facilities in urban areas), while automation for storage and retrieval systems in warehouses will further increase, with the first autonomous robotic material handling systems currently being built.

In the long term, this means the deployment of fleets of fully autonomous vehicles in both logistics and transportation sectors. Warehouses and shipping centres will automate their storage and retrieval systems, while also automating the handling and manipulation of goods.

4.4 Experiences and outlook

Beside the legislative activities, the European Commission is also sharing the exchange of best practices and experiences between actors across Europe, e. g. through a dedicated webpage on Urban Access Regulations in Europe[53], giving an overview over more than hundred urban access regulations implemented across Europe.

The European Commission also promotes the dissemination of research results through a dedicated website[54] and the publication of a structured guide to the results of relevant research projects carried out at EU level[55].

4.5 Other approaches to future mobility

There is a growing number of cities across Europe and around the world that provide free public transport in an effort to promote more sustainable mobility[56].

Fuel taxation policy can also be used to impact on mobility choices. The taxation of energy products and electricity in the European Union is governed by the provisions of Council Directive 2003/96/EC .

For fuels, the structure of excise duties is harmonised across the EU . The rates themselves still differ from one Member State to the other.

The Commission is currently examining a possible review of the Directive in view of aligning it to the energy and climate change goals of the Europe 2020 Strategy[57].

The EU is also promoting the interoperability of public transport payment systems to render it more attractive for cross-border customers[58].

52 http://www.europarl.europa.eu/RegData/etudes/STUD/2016/563501/EPRS_STU%282016%29563501_EN.pdf

53 http://urbanaccessregulations.eu

54 http://www.transport-research.info/

55 http://www.transport-research.info/sites/default/files/thematic-analysis/20131119_114039_25650_TRS11.pdf

56 https://farefreepublictransport.com/city/

57 https://ec.europa.eu/transport/modes/road/road_charging/fuel_taxation_en

58 http://www.smart-ticketing.org/

5. FINLAND

Olli Hietanen

5.1 Mobility: Facts and Figures

An overall picture of Finnish passenger mobility and its background is provided by the National Travel Survey, which is performed every six years. The new survey will be finalised by the early 2018 and the latest results available are from the survey covering the years 2010 and 2011[59].

The Finns make an average of three domestic trips per day, travel a total of 41 kilometres taking an overall travel time of one hour and six minutes. The average duration of a trip is 23 minutes. The amount of the long distance trips has grown as has the use of trains and planes rather than of passenger cars for this kind of trips. Travel by foot and bicycle has declined in every age group. An increasing number of households own a second car, and the demand for travel is greatest in sparsely populated areas and in the outskirts of big city regions.

Communes are free to organize traffic in their own region. Public transport is supported by the state. There is financial support to the sea cargo traffic, piloting, archipelago traffic and public transport (bus, train, commune public traffic, flights). Currently, in Finland, there is a period of low national economic performance, which also means massive cut backs in public expenditure. Consequently, there is pressure for opening up transport markets for private actors in order to keep up high-quality services. The monopoly of the state-owned railway company is ending in 2017 and new railway companies will consequently be free to enter citizen transport markets.

In the 2016-20 strategy of the Ministry of Transport and Communications (MINTC) digital services, platform economy, automation and robotisation are emphasized. Consumer pricing focuses on intensifying the usage of the transport system and decreasing the negative external impacts of mobility. Finding new pricing models and private financial sources is encouraged. There is critical consideration of widening the ownership basis of state-owned companies.

5.2 Current implementation of mobility pricing

As far as the costs for a passenger car are concerned, road traffic taxation consists of the common car tax, a vehicle tax and a fuel tax. CO_2 emissions have an influence on traffic taxes. Annual traffic taxes exceed State expenses for the maintenance and development of the traffic net. This means that a part of the traffic income is allocated to cover other, not traffic-related expenses.

Currently, there are no road tolls or highway charges (vignettes) in Finland. Yet, there is a highway between the cities of Järvenpää and Lahti that was constructed and finalized in 1999 as the first – and for now only – road utilizing a lifecycle model with a Public Private Partnership (PPP).

There is a systematic process of trying to get a comprehensive picture on how Finland should proceed with charging road tolls in the long run[60]. Obtaining general acceptance of road tolls via careful

59 Finnish Transport Agency (2015): Public Transport Performance Statistics. Statistics of the Finnish Transport Agendy 3/2015, Helsinki, www2.liikennevirasto.fi/julkaisut/pdf8/lti_2015-03_public_transport_web.pdf

60 MINCT (2013): Tiemaksujen kansainvälinen tarkastelu, kansainväliset käytännöt sekä kehityssuuntien arviointi. Liikenne- ja viestintäministeriön julkaisuja 42/2013, urn.fi/URN:ISBN:978-952-243-377-0

argumentation has been emphasized. In the report by HERMES[61] the stated aim is to «… give orientation for the upgrade of the mobility of people and goods in the transport ecosystem in Finland …» (pp. 1).

In the 2016–17 period, the Minister of Transport and Communications Anne Berner started a discussion about road tolls as a part of a more comprehensive renewal plan called the Act on Transport Services[62]. The Act will bring changes to the current state of the transport market which is regulated and guided by public measures. The Act is expected to promote fairness of competition in the passenger transport market and competitiveness of the service providers of both passenger and goods transport. The MINCT set up a parliamentary group for one year with the aim of recognizing targets for developing traffic networks (connections, roads) including e. g. financing, investments, digitalization and decrease of emissions. There is a financial deficit of 2,5 billion euros, which increases by 100 million euros annually, if no new financing solutions can be made available[63].

The road toll initiative by Minister Berner was strongly rejected followed by a downward slope of car sales. Now, the European Commission has a plan of launching uniform road tolls in all European countries by 2030 at the latest[64]. The pricing is digital and based on kilometres and emissions. Tolls will also be applied in countries that do not have road tolls yet, e.g. Finland.

Before selecting pricing models (public/ private) there is a major problem of fitting together targets of economic balance and ecological sustainability. There are well-reasoned arguments for both sides and no obvious answers available. The Act on Transport Services is currently in preparation and no uniform pricing schemes can be identified at present. Once the Act will have come into effect in 2018 it should be possible to recognize different pricing models. In any case, new private and semi-private actors will enter into the picture and the field of mobility will be more diversified.

The share of foreign freight transport has grown and reached 9,1 percent in June 2017. There is a demand by Finnish Transport and Logistics SKAL (consisting of haulage entrepreneurs) to charge vignettes from foreign transport rather than having Finnish taxpayers covering the costs of foreign commercial transports[65].

5.3 Societal and political debate

Mobility pricing is seen as a potential new policy tool to create and ensure sustainable mobility. There are Key Performance Indicators (KPIs) with relevance to mobility and transport and an evaluation of the relevance of selected fields to these KPIs: robot cars, mobility as a service (MaaS), mobility pricing, innovations in freight and logistics, transport, infrastructure, energy, environment, safety and health, ICT and economy. Mobility pricing is seen as equally relevant to a variety of KPIs from value-adding services and the number of accidents to the costs of the health care system. And it is seen as most relevant for the tax subsidies of public transportation.

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61 Healthy, Safe and Ecological Roar Transport, Mobility and Energy use for better Sustainability in Finland with ITS-Intelligent Transportation Systems (2016) Moving Forward Consulting (HERMES). MINTC, April 2016, moving-forward-consulting.com/wp-content/uploads/2016/06/20160411-HERMES-Study-for-MINTC-final.pdf

62 Good and flexible transport services through a new act (2017) Press release of MINCT. Date 24.05.2017, lvm.fi/en/home

63 Parlamentaarinen työryhmä selvittämään liikenneverkon tulevaisuutta (2017) MINCT:n tiedote 08.02.2017, lvm.fi/-/parlamentaarinen-tyoryhman-selvittamaan-liikenneverkon-tulevaisuutta-921464

64 Komission suunnitelma: Tietullit koko Eurooppaan (2017). News of Kauppalehti –journal, date 27.3.2017, kauppalehti.fi/uutiset/komission-suunnitelma-tietullit-koko-eurooppaan/pCbfRwd7

65 Kuljetuskalusto kansainvälistynyt Suomen tiestöllä 5 vuodessa – Raskaan liikenteen vinjettimaksu on otettava välittömästi käyttöön (2017) SKAL:n tiedote 16.6.2017, skal.fi/ajankohtaista/skal_tiedottaa/kuljetuskalusto_kansainvalistynyt_suomen_tiestolla_5_vuodessa_raskaan_liikenteen_vinjettimaksu_on_otettava_valittomasti_kayttoon.13443.news

One of the leading arguments pro road tolls is acquiring resources in order to decrease emissions and enhance sustainability. However, researchers claim that road tolls have a marginal impact on enhancing sustainability and that land use planning and infrastructure are the most effective means for a radical decline of traffic emissions[66]. In HERMES, available road capacity and the amount of users of public space are registered as relevant to infrastructure. Mobility pricing, environment, energy, economy and MaaS are scored as relevant to the sustainability of transport. Economy and MaaS are highlighted as most influential.

Sustainable transport and mobility are seen as key elements in gaining the UN goals of sustainable development and there are ambitious goals of decreasing traffic emissions. The key challenges concerning Finland's environmental policy for transport in the 2013–2020 period are: 1) mitigating climate change, 2) improving the living environment and reducing the detrimental health effects associated with transport (air quality, noise and groundwater issues) and 3) protecting the Baltic Sea. The work on environmental matters in transport will also support opportunities for green growth[67].

The Committee for the Future at the Finnish parliament points out that sustainable development is not only a challenge, but also an opportunity: it is a source of new specialisations and job opportunities (e.g. clean technology) and green businesses[68]. In the international comparison of national digital performances Finland scores second, after Norway[69]. Thus, Finland has excellent possibilities to enhance a sustainable mobility by adopting and creating digital services (pricing, accessibility, education, coordination etc.) e.g. in the vehicle production sector or with regard to route and timetable data delivery and mobility systems.

There is demand for better and shorter traffic connections and visions about intensified work-based travelling especially between Helsinki, Turku and Tampere in the future[70]. Government supports work trips of over 3 hours per day since Jan. 2017, but there are few applications from the citizens. Only 2 percent of 2000 citizens would be willing to spend more than 3 hours commuting to work each day and 70 percent would like to spend no more than 2 hours on commuting[71].

By international comparison Finland scores high in mobility, but in order to reach the ambitious targets of the government it should score even higher. The expected share of housing costs in the overall income will increase by 2,8 percent in the 2016–18 period[72]. Finally, there is a contradiction between increasing mobility and enhancing sustainability.

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66 Tuominen A., Tapio P., Varho V., Järvi T. & Banister D. (2014) Pluralistic backcasting: Integrating multiple visions with policy packages for transport climate policy. Futures 60 (2014) 41–58, Elsevier Ltd, dx.doi.org/10.1016/j.futures.2014.04.0140016-3287

67 MINCT (2013): Environmental Strategy for Transport 2013–2020. 2013/2013, Date Nov 28, 2013, urn.fi/URN:NBN:fi-fe2016110427996

68 Report of the Agenda 2030 Action Plan (2017). Eduskunnan tulevaisuusvaliokunta, TuVM 1/2017 vp – VNS 1/2017 vp, eduskunta.fi/FI/lakiensaataminen/valiokunnat/tulevaisuusvaliokunta/Sivut/default.aspx

69 MINCT, Tekes, Technology industries of Finland & Internet-based Industries of Finland (note. freely translated) (2017). Digibarometri 2017, Helsinki: Taloustieto Oy, digibarometri.fi

70 Saario Kaisa (2017) Työvoiman alueellisen liikkuvuuden esteet identifioitava, date 8.5.2017, keskuskauppakamari, date 8.5.2017, kauppakamari.fi/2017/05/08/tyovoiman-alueellisen-liikkuvuuden-esteet-identifioitava/

71 Kysely: Enemmistö ei halua käyttää työmatkaan tuntia enempää – selittää myös, miksi liikkuvuusavustus ei innosta (2017), Talouselämä, date 16.5.2017, talouselama.fi/uutiset/kysely-enemmisto-ei-halua-kayttaa-tyomatkaan-tuntia-enempaa-selittaa-myos-miksi-liikkuvuusavustus-ei-innosta-6649538

72 Asumismenojen osuus tuloista kasvaa edelleen (2016) PTT Pellervon taloustutkimuksen uutisia. Date 17.8.2016, ptt.fi/ajankohtaista/uutiset/asumismenojen-osuus-tuloista-kasvaa-edelleen.html?p104=21

The growth of traffic has followed the population growth from 2005 to 2016 in Finland. Citizens use multiple transportation modes and there is research claiming that «peak car» has been reached and vehicle use will now decline. From the point of view of sustainability, citizens should replace private cars with other types of transport modes. Cycling and walking promote health and decrease health care costs, but – otherwise – citizens should avoid mobility[73]. In Section 5: «Other approaches to future mobility» there are examples of new innovative services that try to overcome the contradiction between decreased emissions and the human need for mobility.

In the foresight study by VTT Technical Research Centre of Finland Ltd and the Tampere University of Applied Sciences there are four possible development paths (scenarios) for the Finnish transportation infrastructure until 2040: 1) intelligent 2) amazing 3) loyal and 4) scarce (freely translated). The scenario qualified as «amazing» is most desirable from the point of view of internationalisation. Here, the focus is on business transport (raw materials and products) combined with a broader workforce mobility between geographical regions, e.g. a tunnel between Helsinki and Tallinn with an extension to the north-east region. Implementing this scenario would mean increasing expenditure on transport infrastructure from 3,2 billion (current) to 4,2 billion euros by 2040. Until 2040 there is an overall need for investing 77 to 105 billion euros in transport routes in Finland[74].

5.4 Experiences and outlook

There are no studies showing how the introduction of low-cost bus operators on the market and the reduction of fares by the passenger train traffic monopoly VR Group Ltd have affected mobility volumes[75]. However, the Finnish Transport Agency monitors prices on a general level and the reduced prices of VR Group Ltd seem to have stopped the decreasing slope of passenger train traffic, though with only a modest increase of passengers.

The government commissioned a study on developing traffic networks in April 2016. As a result, there is a suggestion of establishing a traffic network company in 2018–19 funded by the state with a share of 65 percent and by the regions (35 percent). A part of the transport taxes would be replaced by user fares based on the monthly or annual traffic demand (with no location info) or kilometres (with enough for competition and location info). There would be a pricing scale according to vehicle emissions[76].

As a part of planning the establishment of a new traffic company there is a foresight report commissioned by MINCT considering the impact of prices on passenger traffic[77]. In order to reach (and maintain) the revenue target of 1,6 billion euros/year it will be necessary to charge 3,8 cents/ km in 2019 and 6,1 cents/ km in 2030 (prices include value added tax). In the transition period fixed taxes will be replaced by taxing fuel and car usage (kilometres). The difference between prices in 2019 and 2030 will be caused by the anticipated behaviour of drivers trying to cut back on their driving. Even if there are releases in fixed taxes, citizens are supposed drive less and – therefore – the revenue target of 1,6

73 Tapio Petri (2017) Liikenne Muutoksessa in Mitä, Missä Milloin: Liikenteen tulevaisuus. Luonto ja ympäristö, pp. 113-119. Will be published in 2017.

74 Liikenneinfrastruktuuri 2040 -hanke: Suomi ohjattava matelukaistalta ohituskaistalle (2017). Teknologian tutkimuskeskus VTT Oy:n uutisia, pvm. 16.1.2017, vtt.fi/medialle/uutiset/suomi-ohjattava-matelukaistalta-ohituskaistalle

75 An e-mail review of traffic expert Harri Lahelma, Finnish Transport Agency, e-mail-message, date June 19, 2017

76 Liikenneverkon kehittäminen (2017) LVM:n faktalehti 3/ 2017, uutisia, lvm.fi/live

77 Strafica Oy (2017): Liikenneverkkoyhtiön hinnoittelumallin vaikutustarkastelut Liikenneverkon taloudellista kehittämistä selvittävän hankkeen taustaselvitys. MINCT, memorandum 10.1.2017/Moilanen, lvm.fi/lvm-site62-mahti-portlet/download?did=223950

billion euros will call for a steady increase of prices/km. Parallel to the decreased driving, CO_2 emissions are expected to decrease by 10 percent by 2030.

5.5 Other approaches to future mobility

Intelligent Transport Systems Finland (ITS) Finland is a non-profit association that promotes the development and deployment of transport and logistic telematic services and improves the awareness of Finnish ITS expertise. Its members include private corporations, public agencies, and academic institutions and it is a part of National ITS Associations network. The website of ITS Finland presents three innovative cases called 24Rent, Go now! and MaaS.[78]

24Rent is a carsharing company that rents cars around the clock. It has been awarded the Finnish Key Flag symbol as a sign of high quality service provided in Finland. The service is available for everyone and it requires no visits to offices or registration fees. All reservations are made online either on a computer or with a mobile device. Vehicles may be reserved and picked up in five minutes and the doors can be easily opened by the customers mobile phone. Customers of 24Rent only pay for actual usage of the car and not for the car waiting unused. Prices vary according to the selected car, starting at 13 euro for 2 hours for a new car.

Go now! offers carsharing for one way trips via a userfriendly smartphone application giving access to ecological hybrid vehicles. The all inclusive service is available round-the-clock and fuel or parking costs are included in the pay-per-minute price: 0,47 euro/min. for driving and 0,10 euro/min. for standing. See more in www.gonow.fi.

Mobility as a Service (MaaS) is a mobility distribution model in which customers' transportation needs are met by a single service provider offering a platform orchestrating individual transport service components. The app-service by Maas Global Oy creates mobility «packages combining public transport, driving, cycling and transportation services (so called mobility chains). The app for example includes knowledge about a taxi's estimated time of arrival and location on the map. The journey is paid through the Whim app. Pricing is a combination of prices of single mobility modes, a so called «clearing» system. There is a monthly cost based on «clearing» that depends on customer mobility service selections and single vehicle prices. In order to make the clearing between different prices possible, the MaaS needs to get free access to the pricing systems of single mobility services (vehicles). The service will be available on a monthly subscription basis or by purchasing single tickets or trips. There are e.g. urban (95 euro/month), business (800 euro/month) and family (1200 euro/ month) service packages and 15 minutes service (135 euro/ month) (more details on the ITS Finland website). Currently, there is a pilot of 1300 cars of the Taksi Helsinki Oy offering services through the MaaS.

The first **robot car** of Finland was tested by VTT Technical Research Centre of Finland Ltd in Tampere in May 2017 in an authentic traffic environment[79]. According to VTT, in 2030–40 there will be cities with robot cars and affiliated traffic systems. In 2016, the Metropolia University of Applied Sciences tested robot busses in Helsinki, Espoo and Tampere.

78 ITS Finland Oy. Site of the ITS Finland, date 19.6.2017, http://www.its-finland.fi/index.php/en/palvelut/liikennelabra.html

79 Robottiauto nimeltä Martti pääsi liikenteeseen Tampereella – VTT teki ensimmäisen testinsä liikenteen joukossa (2017) HS:n uutinen 18.5.2017. hs.fi/autot/art-2000005216305.html

A suggested **hyperloop** link between Helsinki and Stockholm could cut the travel time between the two capital cities down to 28 minutes (instead of a one hours flight plus waiting time at airports) and bring annual savings of 321 million euros from the reduced travel time[80].

Other sources: Discussions

Boedeker Mika, Clerk at the Transport and Communications Committee, Parliament of Finland
Eiro Laura, Director, Unit of service, MINCT
Hemmilä Annika, Administrative manager, Pellervo Economic Research PTT
Ikävalko Hellevi, Clerk at the Finance Committee, Parliament of Finland
Kiikka Sinikka, Unit of information, Finnish Transport Agency
Lahelma Harri, Transport expert, Finnish Transport Agency
Tapio Petri, Professor, Finland Futures Research Centre, University of Turku

80 Finland primed for world's first Hyperloop transportation (2017) News by goodnews From Finland date Sept 14, 2016. goodnewsfinland.com/feature/high-speed-rail-transportation-vacuum-tubes/

6. FRANCE

OPECST

6.1 Mobility: Facts and Figures

The impact on mobility demand of the traditional criteria (places of dwelling and work, age, gender, income) tends to decrease in the Ile-de-France region. The statistical data available shows that the average travel distance goes from 4 km for women to 6 km for men, longer by public transport (9 km and 11 km respectively) than by car (5 km and 8 km), the average travel between place of residence and place of work – 13% of the distance travelled – being also longer than the general average (about 10 km and 12 km respectively).

The number of daily trips decreases with age, with a maximum of 3.8 for the 26–45 year-olds, and a minimum of 1.6 for people over 75 years old. In the long run, the travel expenses converge gradually whatever the income or the socio-professional category, even if the rate of equipment by household continues to reflect a disparity (91% of higher income households have at least one car, vs 81% for the middle class and 28% of households with lower income).

6.2 Current implementation of mobility pricing

The issue of transport policies and of the internalisation of their costs does not fall within the area of competence of the OPECST, the role of which is to provide technical expertise only. However, the following suggestions on the topic can be made:

Several public policies in France aim at or used to aim at «taxing» certain forms of mobility, mainly on the road, e. g.

a) **Standard forms of taxation of use**, which authorize the use of a given road for a given period of time without taking into account the distance covered during this period

- The annual automobile label, the so-called «vignette», was removed for individuals in 2003, and for professionals in 2006.
- Meanwhile the tax for the registration of motorized vehicles still applies, for the benefit of the French Départements; so does the «bonus-malus» system related to the motorisation and the engine capacity, the tax on automobile insurance contracts, the annual fees on tourism vehicles used by companies, linked to the age of the vehicle and the emissions of CO_2), etc.
- The Special tax on certain road vehicles (TSVR), with a quarterly or daily rate, aims to compensate for the maintenance expenses of the roadway system, caused by the circulation of certain categories of heavyweight freight vehicles. The chargeable event is the use of a public highway by a vehicle registered in France or in a Non-member state without any reciprocal exemption agreement with France, presenting an authorized weight equal or greater than 12 tons and not especially conceived for the transport of persons. This tax generates 170 million euros for the State.

b) The taxations (called «tolls») **more or less related to the distances covered**

- Since the transposition of the «Eurovignette 3 directive» in 2013, it is mandatory in France to modulate the rates of tolls for heavyweights according to their level of greenhouse gas emission. It is also possible – but not compulsory – to modulate them according to traffic congestion.
- The ecotax on road freight was extremely controversial and was suspended in 2014, before being altogether abolished. It was supposed to apply to vehicles heavier than 3.5 tons transporting goods on certain national and departmental roads in France. Its aim was to provide financial compensation for the use of these roads (degradation of the roadway system, financing of the road infrastructures). This cost is now completely covered by general taxation. The product of this green tax, which could have reached 10 billion Euro for the 800 000 trucks travelling over a total of 15'000 of roads, was supposed to finance transport infrastructure, through the assignment of this income to the Financial agency of transport infrastructures (AFITF).
- Indirectly, the TICPE (Domestic Consumption Tax on Energy Products) is an excise duty proportional to the volume of fuel bought. TICPE is the primary levy on oil products. It applies to a number of products, all of which appear on a list shared by every EU member state. The TICPE is important for the central government budget, bringing in an average of €25 billion each year. It is also important in terms of informing energy policy and – increasingly – for environmental reasons, as the rates have an influence on the choice of products.
- In addition, the Carbon tax was created in 2014 as a «component carbon tax», proportional to the CO_2 emissions in the taxation of fossil energies with a rate of 7 Euro per ton of CO_2; it went up to 14.5 Euro in 2015, 22 in 2016 and 30.5 in 2017. It has been designed to go up to 56 Euro in 2020 and 100 Euro in the 2030's. The rises must however be ratified each year by Parliament
- More recently, within the scope of a different policy, the label Crit'Air was introduced in 2017 in Paris, the first zone with restricted circulation (ZCR) of France. It aims to facilitate the identification of the least polluting vehicles by means of a colored pastille fixed on the vehicle and named «certificate air quality». The most polluting vehicles can no longer be driven in Paris between 8 AM and 8 PM from Monday to Friday. The cost is symbolic (4.18 Euro).
- Along the same lines, the generalisation of the fees charged for parking vehicles in town centres constitutes a form of mobility pricing by increasing the overall cost of car usage.

6.3 Societal and political debate

The ecotax on road freight discussed above is all the more peculiar as it leads to heated discussions in professional circles, and even to the destructions of many detection devices. According to report mentioned above («Beyond the world of road transport»), the ecotax on road freight concerned and sometimes angered in particular managers of handicraft businesses and SMEs, especially in the agrifood sector. The critical situation of small businesses in Brittany revealed a generally adverse situation the causes of which are undoubtedly deep rooted and cannot be attributed to the sole implementation of the ecotax. The French Government first decided to delay the reform, before abolishing it.

In broader terms, the 2014 OPECST report showed that the debate on mobility within society is linked to various issues such as:

- the need for limiting air pollution and for addressing the challenges of climate change
- the energy transition, which will enable the evolution towards a greater share of renewable energies
- the role played by cars within urban environments
- the impact of new services and mobility
- and, more generally speaking, the current transport model itself

The conclusions of this report can be summarized as follows:

- The idea of freedom associated with travel is expanding: it is now also seen as the ability to move as one sees fit, and less linked to vehicle ownership. Time management appears as a more important factor for travel optimisation, time increasingly replacing distance. The demand for a chosen form of mobility also becomes more and more important. It is facilitated by the development of new communication services.
- The «all-car mobility» of the last decades led to the concept of «auto-immobility», because of increasing congestion in the big cities. The model whereby cars are used «to do everything» in all circumstances is no longer fashionable.
- In its standard form, the vehicle is increasingly perceived as a source of nuisance: it is less and less adapted to big cities, where parking is getting more difficult and where car-freeareas to tend to gradually extend. As cars consume too much energy, their cost of usage is becoming excessive. They also remain parked most of the time (95% of time).
- The image of the vehicle is also evolving: Vehicle-sharing is now not only possible but has also become the standard for an growing fraction of the population, in particular under 30 year-olds: for them, use replaces ownership. The development of auto-sharing and of car-pooling illustrates this new form of vehicle-use. Younger people are buying fewer cars and are obtaining fewer driving licences. The median age of new car-buyers has been steadily increasing is now 54.5 years. All this in the context of a tightened market where purchase costs are increasingly out of reach for the general public.
- The Parisian Velib' and its extension in various forms in the bigger French cities has been a success. The underlying idea is the same: the vehicle is no longer owned and can be shared. The success of the BlablaCar website shows that sharing does not only apply to «anonymous» cars, but also to privately owned ones. The vehicle is more and more perceived as a service, rather than as a good or an investment.
- The debate on mobility also includes the question of the reliability of methods of measuring pollutants and particulate matter emissions. The reliability of manufacturer advertisements has also been called into question. In light of false advertising and fraud by some manufacturers, the European Commission has proposed to reinforce independent controls.

6.4 Experiences and outlook

Transport is responsible for 28 percent of greenhouse gases emissions, 95 percent of which are due to road travel . To meet the goals of the Paris Agreement, an average car sold in 2050 will have to have its CO_2 emissions reduced to about 10% of the current car emissions. This cannot be achieved by combustion-engine vehicles, regardless of the level of sophistication of its particle filters.

In addition, transport-sector CO_2 emissions in developing countries are likely to continue to increase, because of demographic growth and the associated demand for mobility. Emission reduction in will therefore be necessary in Europe and North America.

The vehicle performance of Europe's car manufacturers is increasing with each new generation of vehicles. The stagnation of CO_2 emissions despite a strong demand for mobility showcases real improvements in energy efficiency.

The acceleration of technology leads to a growing number of technical options. All manufacturers diversify their vehicle range, including electric vehicles, compressed-air, gas or hydrogen fuelled cars, or hybrid models. Thermic engines remain most commonly-used, but their drawbacks lead to an acceleration of research projects into alternative engines. Hybrids are spreading.

The design of new vehicles is also changing, with two, three or four wheel-vehicles. A range of vehicles, adapted to the specific needs of each kind of travel, is appearing. Some are smaller, others lighter. The experience of the self-driving car opens the door to new possibilities. New information and communication technologies allow the collection and use of real-time information, with an impact on user choices. New motorisations and fuels also contribute to this increasing diversity.

However, the main axis of technological development remains electrification, even if the global impact on CO_2-reduction depends on the share of carbon in the production of the electricity used.

The market share of electrified – refillable hybrid and electric – vehicles could reach 22 percent in 2030, *vs* 1 percent today. Nevertheless, this market share will greatly depend on the deployment of appropriate charging infrastructures and on the cost-reduction of these types of vehicles.

Territorial and national public policies tend to support the development of vehicle electrification by supporting the users' demand directly or indirectly through infrastructure, their intensity decreasing with the share of this energy source.

The new Environment Minister announced in July 2017 that the sale of petrol and diesel vehicles will be banned by 2040. Of the 5 billion euros spent by French manufacturers on R & D, one third is already devoted to electrification. With the Energy Transition Act of 2015, the State subsidises the purchase of a hybrid vehicle with up to 10,000 Euro (6,500 Euro for a rechargeable hybrid). A «transition bonus» for the replacement of older vehicles is also being discussed.

There are many local or regional initiatives within this scope:

- Since 2016, the Grand-Paris metropole area has proposed financial support for the purchase of a new or second-hand electrical, hydrogen-fuelled, hybrid refillable or NGV vehicle.
- The City of Paris supports electric mobility through various instruments, among which:
- Direct aid for vehicle purchase and refill, but also through easier available parking,
- Networks of electric vehicles: Autolib' is a network of more than 1100 stations in more than 90 towns in Île-de-France. For professionals, Utilib' is a complementary offer of 200 vehicles accepting up to 230 kg of load. A private offer of electric scooters has also been launched recently ;
- Shared vehicles: several private carsharing operators propose vehicles in Paris in one hundred 2 place stations. Various types of vehicles are available (for example refillable or electrical hybrids, as well as light vans in commercial districts), in partnership with car- and vehicle-refilling-device-manufacturers.
- In addition, internet-based technological innovations in the mobility sector, in particular with a connection to the car dashboard, could modify medium-term mobility. The development of so-called «smart roads» for example allows the dialogue between vehicles and road infrastructure.

Sources:

New sustainable mobilities : To conceive and use ecological vehicles (OPECST, January 2014), http://www.assemblee-nationale.fr/14/dossiers/mobilites_durables_vehicules_ecologiques.asp

The state of the art regarding measurement of the pollutant and particle emissions by the vehicles (OPECST public hearing, February 2016), http://www.assemblee-nationale.fr/14/dossiers/mesure_emissions_polluants_vehicules.asp

The contribution of innovation and of the scientific and technological evaluation to the implementation of the decisions of the COP21 (OPECST public hearing February 2017), http://www.assemblee-nationale.fr/14/dossiers/apport_innovation_mise_oeuvre_cop21.asp

Report (May 2014) of the National Assembly on the road freight-ecotax, http://www.assemblee-nationale.fr/14/pdf/rap-info/_i1937.pdf

7. GERMANY

Torsten Fleischer, Maike Puhe, Max Reichenbach and Jens Schippl.
Research assistance: Lemana Babovic

7.1 Mobility: Facts and Figures

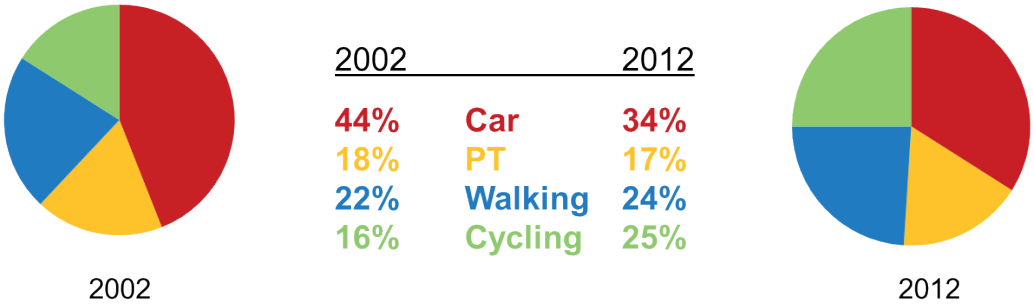
As in other western countries, after WW II, car mobility has gradually become the dominant form of transport in Germany. Motorized transport has a particular political impact because of the strong position of the automotive industry in the country. Some of the globally most successful Original equipment manufacturers (OEMs) and Tier-1s, supplemented by a dense network of additional suppliers, are based in Germany. It is estimated that about 5–7 million jobs in Germany depend directly or indirectly on the automotive sector. The car industry is well organized in formal and informal networks. But there are also strong critical voices which address the negative impacts of cars on the environment, human health and quality of life.

The dominant mode of disposition in the German mobility regime is full private car ownership, or at least permanent access to a personal vehicle. Between 1992 and 2017, the motorized vehicle stock in Germany has grown from 44.3 million to 55.6 million. Against this background it is no surprise that the dominance of the car becomes visible also in the modal split. In 2015, 82.5 % of all trips are done by cars and 17.5 % by public transport (incl. 3.8 % railways, 0.3 % air). In terms of person kilometers, cars cover 80.3% and public transport about 19.5%, (incl. railway 7.7 %, air 6.7 %) (BMVBS 2017)[81]. According to the German mobility panel (MOP), the average distance a German citizen travels per day (in 2015) is 40.9 km. Women travel significantly shorter daily distances with 35.8 km as compared to men (46.2 km).

However, in many urban areas non-motorized transport is highly important. In urban areas the modal spilt differs considerably from the German average – but there are also substantial differences between German cities. Some cities such as Karlsruhe or Freiburg implemented ambitious transport development plans and achieved significant improvement in term of sustainable transport over the last decades.

81 BMVBS, 2017. Verkehr in Zahlen [Transport in Figures], Hamburg, 2016/2017. DVV Media Group GmbH, Hamburg.

Modal Split Karlsruhe:



In Germany, the car density reached about 680 per 1000 inhabitants (KBA, 1.1.2017).This value, however, is also much lower in larger cities. With only about 350 cars per 1000 inhabitants, the lowest figure can be found in Berlin.

7.2 Current implementation of mobility pricing

According to the editorial guidelines, the term mobility pricing «describes charges for the use of any transport infrastructure or services on all transport modes with the objective of influencing travel demand and mobility behavior. Mobility pricing aims to manage transportation demand in order to reduce peak hour travel, congestions, air pollution or greenhouse gas emissions.»

Based on this definition, a quite extensive list of instruments that are applied in Germany in the different transport modes in various forms could be presented. These include, but are not limited to: emission and/or pollution taxes, fuel taxes, vehicle taxes, special assessment taxes, emission certificates, REN levies, road tolls for trucks on motorways and selected long-distance roads, parking fees, transportation fares, and subsidies (e.g. subsidies for clean fuels, electric vehicles, and public transportation, or VAT exemptions). A comprehensive discussion of the design and the impact of these instruments on mobility behaviour can be found elsewhere in the scientific literature as well as in numerous policy documents and would go well beyond the scope of this paper.

This report will focus on two current policy projects in Germany that are related to mobility pricing schemes:

a) the planned introduction of a road charge for passenger cars in Germany (Pkw-Maut)
b) access regulations for selected German cities, motivated by the need to reduce pollutant emissions

a) Pursuant to a resolution of the German parliament in March 2017, an infrastructure charge for the use of German federal motorways and federal highways will be introduced for owners of passenger cars and motor homes registered in and outside Germany alike. Owners of passenger cars and motor homes registered outside Germany will only have to pay for the use of federal motorways. The resolution has been initiated by the Federal Ministry of Transport and Digital Infrastructure (Minister: Alexander Dobrindt).

The infrastructure charge will have to be paid for one year by all owners of motor vehicles registered in Germany. The price of the annual vignette for passenger cars will be calculated based on their engine displacement and environmental performance (emission standard). Owners of vehicles not registered in Germany will have to buy a vignette valid for either 10 days, 2 months or one year. The

charge will be levied in the form of an electronic vignette (e-vignette) which will be linked to the vehicle number plate.

b) The EU limit of fine dust excesses is 50 micrograms of fine dust per cubic meter of air. If this value is exceeded for more than 35 days a year, it is considered being harmful to people's health. For many German cities it has become a challenge to remain below this limit. Due to its topographical situation by far most problematic is the City of Stuttgart. In 2016 Stuttgart exceeded the EU limit value for a total of 63 days and had the highest transgression rate of all German cities; it holds the record as the German city with the highest level of air pollution.[82]

So far, during periods of pollution alarm, citizens are still allowed to drive their cars within the city borders. The city of Stuttgart is asking inhabitants and commuters to leave the car at home and switch to public transport, start carpooling, use electric cars or ride bikes. However, this is all voluntary for the moment. At the same time, some incentives are given, for example when using public transport during a pollution alarm period in Stuttgart, adults can buy a (lower priced) children's ticket and use it for the entire network. Nonetheless, so far these measures do not seem to be sufficient to reduce traffic. Furthermore, new tests revealed that Diesel cars emit even more particulate matter and also nitrogen oxide than originally expected. Therefore, in order to improve air quality in Stuttgart, it is now discussed to impose bans for diesel cars which do not meet the latest emissions standards from entering the city on days when pollution is heavy. Promoters of the ban want it to be implemented already at the beginning of 2018.

7.3 Societal and political debate

a) The planning of the toll has been accompanied by intensive controversies. On the one hand, promoters of the toll, such as the initiating Ministry of Transport, expect net revenues of around 520 million euros from the planned passenger car tolls, which should be directly used to finance the road infrastructure. The car toll in Germany is to be accompanied by car tax cuts, so that no car driver in Germany is subjected to additional financial loads. Central argument of the ministry and other promoters is that foreign drivers also have to contribute to maintaining the roads in Germany when they use them. This approach has been (and still is) massively attacked by some neighbouring countries as «discriminatory». After the European Commission having closed its own probe in May 2017, some member states consider having the issue clarified by the European Court of Justice.

On the other hand, there is a heterogeneous group of opponents ranging from environmental NGOs to governmental organisations. The ADAC (the largest German automobile club) warns that there are no financial advantages to be expected for Germany and maybe even losses (250 million euros until 2023). As a main reason for this, they see the high administrative cost that comes along with collecting the toll. Several scientists from the field of transport economy support this view. The environmentally oriented political party Bündnis 90 / Die Grünen (a.k.a. The Greens) argues that the «Dobrindt-toll» will hurt the economy and does not even generate revenue for the transport budget. Instead, it would be a bureaucratic monster, not using potentials for a environmental-oriented kind of governance, thereby missing the aims of mobility pricing as set out in the definition above. The Federal Environmental Agency criticizes above all that the system is not based on the length of trips; that it is a kind of "flat rate" for

82 http://www.umweltbundesamt.de/themen/luft/luftschadstoffe/feinstaub

people who drive very often and will therefore have no ecological effect. It also calls for the revenue from the toll not to be invested in the expansion of roads alone, but also in the rail network.

b) Diesel emissions are increasingly discussed as a health issue, especially after a number of studies has found that most diesel cars fail to meet nitrogen oxides (NO_x) emission standards in real-world conditions and that some current diesel cars emit more than twice as much nitrogen oxides (NO_x) as HGVs or buses – even in the Euro 6 class. According to the European Environmental Agency, about 10.000 premature deaths are reported in Germany every year as a result of the high NO_2 pollution.

The ban of diesel cars would be accompanied by a broad range of different potential consequences. According to statistics of the Kraftfahrt-Bundesamt (the Federal Motor Transport Authority), about 13.2 million diesel cars would be affected as only around 1.3 million of the total of 14.5 million diesel cars currently registered in Germany, meet the Euro 6 standard. Cities still struggle with the practicalities of enforcing a diesel ban within their jurisdiction. A reduction of the residual value of diesel vehicles is expected; in some regions, the market for these kinds of cars might completely break down. Also, the existence of many companies that massively rely on diesel vehicles (taxi companies, package delivery companies, etc.) is endangered since they may have to renew their vehicle stock. According to the German Taxi- und Mietwagenverband, nearly 85 percent of all taxis in Germany would be affected by such a ban. Many tourists or workers from the outside would also be prevented to enter the city. Further, a highly crucial debate focusses on potentially massive job losses in the auto industry.[83]

7.4 Experiences and outlook

a) So far, there are no experiences with a general highway toll for passenger cars in Germany, as it still hasn't been implemented in practice yet. Already existing toll schemes for motorways are limited to trucks of 7.5 and more tons of gross weight.

b) In 2016 and 2017 (15th April–15th October) Stuttgart had a «pollution-alarm period». During such periods, the city calls on citizens to abstain from driving as soon as there is a risk of exceeding the limit values of air pollutants, especially in case of fine dust. It is argued though that such appeals for voluntary car abandonment have failed.[84]

According to measurements recently carried out by the Landesanstalt für Umwelt (governmental body) at the Neckartor Stuttgart measuring station, 30 percent of particulate matter is produced by abrasion of tires and brakes, only 7 percent come from internal combustion engines. 55 percent come from heaters and fire systems. These results led to a still ongoing debate whether a diesel ban can be a useful measure at all to reduce particulate matter. But these figures are also discussed controversially. Just recently, the environmental NGO Deutsche Umwelthilfe started a law suit against the federal State of Baden-Württemberg, where Stuttgart is located. In its verdict (dated 27th of July 2017), the administrative court decided that the State has to take more effective measures to guarantee clean air in the city. The court put the focus on nitrogen oxides and indicated that a ban of non-Euro 6 diesel cars could well be an appropriate measure to reduce emissions of NO_x.

83 https://www.bussgeldkatalog.org/dieselfahrzeuge-verbot/#was_bedeutet_es_fuer_die_staedte_wenn_dieselfahrzeuge_mit_einem_verbot_belegt_werden

84 http://www.stuttgarter-zeitung.de/inhalt.stuttgart-zieht-bilanz-trotz-alarm-zu-viel-feinstaub-am-neckartor.3e3e808b-a3a2-4210-9389-73c525fd663c.html

7.5 Other approaches to future mobility

Several trends in the transport sector indicate that the pace of change in the transport system will be much higher in the coming 20–30 years than it was in the past 20–30 years. Amongst them are:

- There are significant changes in mobility behavior, especially in urban agglomerations. This becomes particularly evident for the young urban generation (18-35 years), which manages more trips a day than other age groups, while rates of car ownership and kilometers driven by car decrease[85]. Reasons are seen in various aspects: (1) the access regulations described above; (2) the postponement of economic independence and family planning, (3) an increasing pragmatism in relation to cars, and (4) information and communication technologies and how they restructure the way people connect with each other and the way daily life is organized. It remains unclear though, whether this generation is going to maintain this behavior during later phases in life or if the behavior will be adjusted to the one of older generations.
- With rising shares of online shopping across product categories, logistics get increasingly relevant for cities and communities. The movements and stops of delivery vehicles can affect the traffic situation and can often be organized more efficiently, in economic terms as well as in terms of ecological impact. While logistics service providers are already testing electric vehicles[86],[87], they are also analysing the suitability of new vehicle and logistics chain concepts, looking to optimize delivery processes as well as user experience. For example, delivery robots are tested (currently still accompanied by staff)[88], or delivery drones are used to reach distant locations with limited accessibility[89]. In some cities, micro depots are used to enable the use of cargo bikes for the last mile[90].
- Another current development is the massive political support for research, development and the deployment of automated and connected road vehicles. The highly complex task of automating driving tasks in road vehicles seems to be manageable to many developers on the basis of the latest developments in information and communication technologies, and also appears to be economically and politically attractive. According to the expectations of the main stakeholders, automation and interconnectedness of future modes of transportation could help to improve the quality of life and provide increased road safety, facilitate better access to mobility services, and, in combination with electric mobility, reduce the adverse effects of mobility. The long-term development goal is not only to automate (road) vehicles extensively, but to develop them to the extent that they can in fact become independent participants in road transport. Whether and when this might be realized is still quite controversial. However, if realized, automation could enable completely new transportation technology and traffic management solutions and thus might even lead to a transformation of the entire mobility system. German policy has turned its attention to this subject at an early stage. In 2015 already, the Federal Government adopted

85 Weiß, C.; Chlond, B.; Hilgert, T.; Vortisch, P. (2016): Deutsches Mobilitätspanel. Wissenschaftliche Begleitung und Auswertungen. Bericht 2014/ 2015: Alltagsmobilität und Fahrleistung.

86 https://www.pressroom.ups.com/pressroom/ContentDetailsViewer.page?ConceptType=PressReleases&id=1457450373691-925

87 http://www.dpdhl.com/de/presse/specials/elektromobilitaet.html

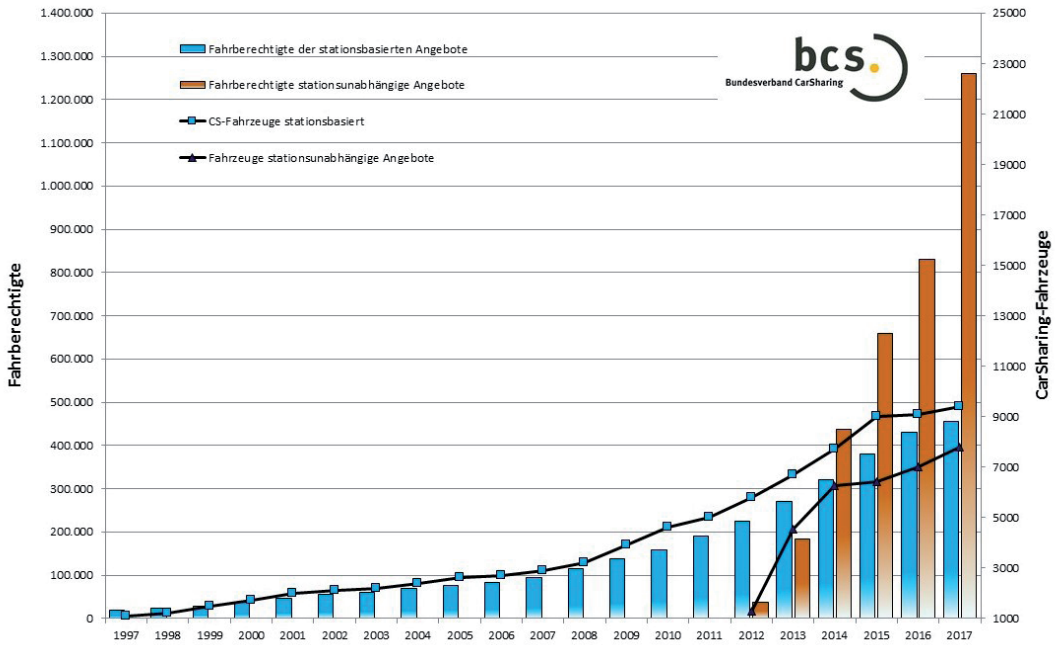
88 https://newsroom.hermesworld.com/starship/

89 http://www.dpdhl.com/de/presse/specials/paketkopter.html

90 http://www.posttip.de/pakete/artikel/mikro-depots-nachhaltige-paketzustellung/

its «Strategy for Automated and Connected Driving», underlining and emphasizing the significance of these developments for industrial and mobility policies. It is aiming at shaping the entire innovation cycle for automated driving and at maintaining Germany's position as a leading provider of transportation technologies and as a lead market. Numerous innovation policies and legal fields of action have been identified and appropriate measures proposed and implemented. These include not only scientific, technical and regulatory issues, but explicitly also the «social dimension» without fully specifying the latter.

- Another trend to be mentioned are the strong growth rates in the field of car-sharing and related services such as taxi sharing and ride sharing. Over the last twenty years, the traditional station-based car sharing had constant growth rates between 10-20 percent per year. Since a couple of years, in the 14 largest cities in Germany, so called free-floating schemes have been implemented and have grown extremely fast in terms of both car fleet and users (see figure below). As of 01.01.2017 there were 1.715 million carsharing customers registered in Germany, 36.1 percent more than one year before. Carsharing services are now available in 597 cities and communities across Germany – 60 more than the year before. The German government has passed a federal law to stimulate further growth. A number of related app-based services show promising developments as well. Just to mention a few, there are peer-to-peer car sharing services such as TAMYCA, ride-sharing services such as BlaBla car or apps for sharing taxis such as MyTaxi. Many other services in this highly dynamic field have recently been set up. It is discussed controversially whether these developments will remain niche-applications or will be able to transform the whole mobility regime by breaking the dominance of private car transport.



8. GREECE

Costas Papadimitriou

8.1 Mobility: Facts and Figures

The average annual mileage, per vehicle, on the mainland, is approximately 12,900 km. On the islands (except Crete) it is about 5,000 km. For taxis, in the Attica region, the average mileage per year equals 83,950 km. In the other prefectures of the mainland, the average mileage per year is 67,160 km and on the islands 50,370 km. As for the two-wheelers, in the region of Attica the average mileage per year is 7,500 km, in the prefectures of Thessaloniki, Larissa and Achaia 5,000 km and for the other prefectures 3,000 km.

Urban travel in Athens is as follows:

- Bus and private cars are the most frequent means of transport of the Athenians with 33% of the citizens prefering the first, while another 34% insist on the car.
- The second most popular way of traveling is the metro with 31%, while 27% of the capital's inhabitants seem to go on foot for their daily journeys.
- The electric railway, trolleybuses and trams accrue to 21% of the preferences, with to 10%, 9% and 2%, respectively.
- The most important reasons for non-use of transport means, according to the Athenians, are that they «do not need it / everything is close» (38%) and «transport means do not serve the needed routes» (34%).
- 56% of Attica households own a private car, while 22% have two.
- The variations in the travel choices of the residents of Attica according to the geographical area of residence are significant. For example, for 56% of the northern suburbs, the car is the most common means of transportation, while the figure falls to 21% for residents of the City of Athens.
- The residents of the centre use far the trolleys and the electric railway much more than residents in other areas, while residents of the northern suburbs use the bus and their feet much less.
- Last but not least, first in the use of the bus are residents of the western suburbs and Piraeus.

Road transport covers the 98% of all mobility.

All major costs for maintaining the existing infrastructure or build new infrastructures are funded by the Greek Government (National Funds), the European Union, the European Investment Bank and the Community Support Framework.

8.2 Current implementation of mobility pricing

In order to achieve a better use of the public transportation, there is (in Athens) a fare for all transportation valid for one and a half hour from the moment of its validation. There are also fares for daily and weekly use and monthly or annual cards.

All major national highways have tolls that are payed by cash or by a prepaid multiple pass. As some of them are operated by the public sector and some by private companies there is no common card for all.

These charges are not calculated based on distance or time. The tolls are on random spots along the highways. The pricing scheme covers private, public and freight transport and is free for governmental vehicles.

Due to the remoteness of some mountainous or islands regions of the country, there are subsidies for ships and airplanes.

In large cities there are parking management schemes that include free parking zones for citizens and zoning with fees for non-residents. There are several free parking areas managed by the municipalities and also many private parking lots with varying fees.

8.3 Societal and political debate

Many new parts of the national highways have recently opened and for that reason new toll stations have been added along the way. In many regions, because each fee covers a very short distance, there has been strong opposition from the regional authorities and from citizens. In some cases toll stations have postponed taking up their operation but there is a heated debate since these fees are an obligation to the country by the loans' agreement.

8.4 Experiences and outlook

In large cities, mostly Athens, the expansion of the metro lines and the reduction of the annual public transportation card has helped curb the use of private cars as well as traffic congestion through rush hours.

Efforts will be made to inform citizens to realize that the combined use of transport means is less time-consuming than the use of the car, more ecological, since it significantly reduces pollutants and moreover provides a solution to the traffic problem while at the same time considerably reducing the cost of daily commutes.

As for the urban highways recently constructed in many major cities, although the toll fee is not low, drivers prefer to use them because of the significant gain of time they offer for getting from one part of the city to the other.

8.5 Other approaches to future mobility

In the Ministry of Infrastructure and Transportation, the Department of Transport Design & Development works on these tasks:

- The development of national strategy proposals in the transport sector
- The documentation, monitoring and implementation of TEN-T policy and the coordination of the timely and correct management of the respective databases, in cooperation with the competent bodies
- The preparation, development and implementation of a national ITS strategy and architecture, as well as the evaluation, promotion and implementation of the related actions
- The planning and development of sustainable and innovative transport systems by promoting and managing research and structural programs and projects in the transport sector
- Monitoring and continuous information on the European and international developments in the above areas, at both technological and institutional level and active participation in related actions
- The planning, implementation and follow-up of the territorial cooperation programs (INTERREG)
- The operational transport planning (railways, urban transport, airports)
- Exploitation of the available resources and opportunities in order to serve the transport policy and, where appropriate, in collaboration with other bodies.

9. JAPAN

Yasuyo Takamine

9.1 Mobility: Facts and Figures

In Japan, the average distance travelled per mode of transportation has not been studied per se, but the following table gives passenger-kilometers of domestic passenger transportation, broken down per mode of transportation.

Passenger-Kilometers of Domestic Passenger Transportation by Mode of Transportation, Fiscal Year 2012 (in million persons-km) [91]

	Total	Railways	Motor vehicles			Maritime	Aviation
			Total	Buses	Passenger Cars		
Passenger-Kilometers	1,377,541	404,394	892,157	68,458	823,699	3,092	77,898
Share	100.0%	29.4%	64.8%	5.0%	59.8%	0.2%	5.7%

Whereas the construction and improvement of public roads are financed by national and local tax revenue, those of expressways are financed through loans, which are repaid primarily with toll revenues. The toll revenue of the six companies that operate expressways in Japan totaled 2.74 trillion yen during fiscal year 2016, which was 76% of the expense incurred.

Management of the railways is in principle vertically integrated and financially self-supporting, with a single entity using revenue from fares collected to pay for both train operation and maintenance of the railway infrastructure. In rural areas, however, where railway lines in sparsely populated areas are often unprofitable, the cost of the railway infrastructure is gradually shouldered by local governments adopting vertical separation.

9.2 Current implementation of mobility pricing

a) Traffic Management in Japan

Initiatives to relieve traffic congestion in Japan generally comprise road improvements to increase traffic capacity, provision of real-time traffic information, and other supply-side measures rather than mobility pricing and other forms of traffic demand management (TDM). In fact, there have been few attempts in Japan to reduce travel demand by increasing the burden on travelers through higher fares on public transportation during peak traffic hours or tolls on public roads. In the few cases where mobility pricing schemes have been implemented in Japan, it is generally with the intent of inducing users to travel in areas or during hours that are less congested by offering a lower cost.

91 Information Policy Division, Ministry of Land, Infrastructure, Transport and Tourism (MLIT) ed., "Transportation statistics handbook in Japan 2013/14," Japan Transport Research Institute (in Japanese); other MLIT statistics.

b) Environmental Road Pricing Schemes in Kawasaki and Amagasaki

Two of the few cases of TDM in Japan were the implementation in 2001 of environmental road pricing schemes by Kawasaki City in the Tokyo area and in Amagasaki City in the Osaka area. Both of these schemes were intended to provide an incentive for trucks and other large vehicles to avoid traveling on roads that pass through the inner-city by reducing the tolls on roads and expressways that cross less-populated areas near the shoreline.

Part of the reason such schemes were implemented is related to lawsuits over pollution from automobiles. Both of these cities have had to deal with lawsuits related to severe air pollution as well as road noise and vibration since the 1970s, when increasingly large volumes of truck and other large-vehicle traffic passed through residential areas in the inner city on their way to nearby industrial areas. During the 1970s and 1980s, the victims of diseases caused by pollution and their families filed multiple lawsuits against the Japanese government and the public agencies that operated expressways. When these lawsuits were settled between 1998 and 2000, the terms of the settlements included recommendations to implement measures to improve the transportation environment. Prompt introduction of environmental road pricing schemes was one of these measures.

Research conducted over a 10-year period after these schemes were implemented shows that they have had a quantifiable effect, and that the volume of truck and other large-vehicle traffic diverted to routes through less-populated areas is between 10 and 15% in either city.[92] It should be noted, however, that in Amagasaki the total volume of truck and other large-vehicle traffic passing through residential areas has not been reduced, because the overall volume of truck and large-vehicle traffic in the city has increased. Additionally, some critics maintain that such pricing schemes actually encourage the increased use of trucks and other large-vehicles, which are a major source of pollution.[93]

c) Off-Peak Multiple-Trip Tickets

One measure to ease rush-hour congestion on commuter trains is the implementation of off-peak multiple-trip tickets, which are offered by many railway companies operating in the Tokyo and Osaka areas. Less expensive than regular multiple trip tickets, they can only be used during off-peak hours on weekdays as well as all day on weekends and holidays.[94] But these off-peak tickets are not popular and have had little effect on rush-hour congestion, since commuter passes are a lot more convenient than multiple-trip tickets and most commuters are reimbursed by their employers for the cost of commuting.

In the early 2000s, the Ministry of Land, Infrastructure, Transport and Tourism studied the possible introduction of peak load pricing and off-peak commuter passes for railways in the central Tokyo area.[95] But the study made little progress for a number of reasons, including the difficulty of reaching a consensus with all the railway companies operating in the area, technical difficulties related to infor-

92 Yoshitaka Takahashi, "Environmental Road Pricing: Environmental Measures for Urban Expressways," The Journal of the Institute of Electrical Engineers of Japan, vol. 136 no. 11, 2016.11, pp. 748–750. (in Japanese)

93 Hiroshi Nishimura, "Current Status and Issues in Japanese Traffic Demand Management Policies: Traffic Demand Management in Areas with Road Pollution," Toshinori Nemoto et al. ed., Gendai Kotsu Mondai Ko (A Study of Contemporary Transport Issues), Tokyo, Seizando-shoten, 2015, pp.86-98. (in Japanese)

94 The normal discount rate for multiple-trip tickets is 9.1%, while that for off-peak multiple-trip tickets is 16.7%.

95 At the same time, a tax break for businesses that adopts off-peak commuting was studied.

mation processing for IC ticketing systems, and concerns over a backlash from peak-hour travelers who would be forced to bear additional costs at a time when prices overall were deflating.[96]

9.3 Societal and political debate

a) Road Pricing plan by Tokyo Metropolitan Government

Starting in the mid-1990s, the Tokyo Metropolitan Government conducted studies on measures to mitigate the road congestion and air pollution that chronically affected central Tokyo by imposing TDM measures and tighter regulation of emissions.[97] A Transport Demand Management Tokyo Action Plan was announced in 2000 and a committee to study the feasibility of a road pricing scheme was established. This committee published a report the following year, which described a plan to levy a toll on vehicles entering central Tokyo from 7 a.m. to 7 p.m. on weekdays.[98] Although emission regulation for diesel vehicles was implemented in 2003, the road pricing plan that had been intended to start in 2003 faded in the face of strong opposition, technical difficulties related to collecting tolls at a large number of checkpoints, and other concerns.

b) Road Pricing plan in Kamakura

Kamakura, an old capital located 40 km south of Tokyo, is conducting a study for future adoption of road pricing in 2020. Road capacity in the city is limited due to its geography. The city is surrounded by mountains and the sea and suffers chronic traffic congestion on weekends and holidays. One plan to introduce road pricing in 2000 was abandoned due to factors such as opposition from local merchants who were concerned that the number of visitors might fall. The city restarted the study in 2013. The road pricing scheme under consideration is as follows.[99]

- Tolls are collected from 8 a.m. to 4 p.m. on weekends and holidays
- Tolls are primarily for non-residents, while city residents pay only 0 to 10% of the charges levied to non-residents. Welfare and disabled vehicles, local buses and taxis, home delivery and local business vehicles are exempt.
- Charge for each entry, tracked using an ETC system[100] and photography of vehicle

c) Road Pricing plan in Kyoto

Kyoto is another tourist destination with problems similar to those experienced in Kamakura. Kyoto City presented a plan to study the introduction of road pricing in its Comprehensive Transport

96 Railway bureau of Ministry of Land, Infrastructure, Transport and Tourism, "Submitted Material for Hearings regarding Land and Housing at Working Group for Agriculture, Estates and Housing, Council for the Promotion of Regulatory Reform," 2005.11.11. (in Japanese) http://www8.cao.go.jp/kisei-kaikaku/old/minutes/wg/2005/1111/item051111_02-01.pdf

97 Katsutoshi Ota, "TDM in Metropolitan Cities: Applications for Tokyo," Toshi-Mondai (Urban issues), vol. 94 no. 3, 2003.3, pp. 55-64. (in Japanese)

98 Bureau of Environment of the Tokyo Metropolitan Government, "Exploratory Committee for Road Pricing." (in Japanese) https://www.kankyo.metro.tokyo.jp/climate/management/price/conference.html

99 "Special Committee of Kamakura City Transportation Planning Exploratory Committee," 2017.3.29. Kamakura City website. (in Japanese) https://www.city.kamakura.kanagawa.jp/koutsu/special_iinkai.html

100 Electronic Toll Collection (ETC) is a system which collects tolls via wireless communication between the in-vehicle device and the toll gate antenna. It is adopted in many of Japanese expressways and toll roads.

Strategy of 2010.[101] Although other schemes to control car traffic demand, such as park and ride, have been implemented, the road pricing plan is still under study and , as of fiscal year 2016, has not concretized yet.

d) Bottlenecks and Opposition

There are many common bottlenecks and much opposition to such pricing plans. The leading opponents are the truck industry, the taxi industry, car drivers who would be forced to bear additional costs, and local merchants fearing a drop in visitor numbers.
There are also technical difficulties inherent to assuring that the tolls levied are equitable as well as legal issues related to keeping public roads in Japan free of charge.

One likely bottleneck is a lack of alternative routes and transportation. Urban railways already have a similar congestion problem. Diverting vehicles could cause additional congestion in surrounding areas if the alternate routes are not sufficiently developed.

9.4 Experiences and outlook

Environmental road pricing on urban expressways has a quantifiable effect when the overall volume of traffic in the area is fixed. It does not, however, restrain traffic and is ineffective when the total volume of traffic increases in a designated area. Some critics insist that pricing schemes increasing the travelers' burden might be necessary to control traffic volume effectively.

Road pricing on local roads has failed to gather momentum due to the bottlenecks and opposition described above. At the moment, the study for a road pricing scheme in Kamakura is practically the only ongoing project, and is essentially a feasibility study of mobility pricing schemes in Japan.

9.5 Other approaches to future mobility

Public transport surcharges during rush hour have not really been discussed and they are unlikely to be adopted, although there have been some programs initiated to suppress demand. One is an early-bird campaign conducted by the Tokyu Den-en-toshi Line[102] and Tokyo Metro Tozai Line[103], both of which give preferential treatment to passengers who ride in early-morning, off-peak hours. For example, the Tokyu Den-en-toshi Line awards registered participants 50 points for entering designated stations using an IC smart card prior to 7 a.m. Each reward point counts as a one-yen discount when making a deposit to a smart-card account or when purchasing goods and services at the railway company's group retailers. These programs are still in the trial stage and are conducted only at a limited number of stations on just two lines during specific times of the year.

101 Kyoto City, "Pedestrian-friendly City, Kyoto" Comprehensive Transport Strategy, revised edition, 2017.3, p.21. (in Japanese) <http://www.city.kyoto.lg.jp/tokei/cmsfiles/contents/0000094/94578/2.pdf>

102 "Den-en-toshi Line Hayaoki Ouen Campaign." Tokyu Corporation website (in Japanese) <http://ii.tokyu.co.jp/event/814/>

103 "Tozai Line Hayaoki Campaign." Tokyo Metro Co., Ltd. website (in Japanese) <https://metro-hayaoki.jp/>

10. MEXICO

Brenda Ávila, José Franco & Víctor Hugo Guadarrama

10.1 Mobility: Facts and Figures

Over the last 30 years, Mexican cities have experienced chaotic and exponential growth, resulting in long commuting distances and times for residents. Today, cities in the country face big mobility challenges, such as low-quality public transportation systems, high levels of pollution, traffic congestions and car accidents[104].

According to the United Nations, Mexicans spend more time commuting to and from work (5.7 hours a week) than they spend in recreational and sport activities[1]. In Mexico City, the average daily commute is 2 hours, and up to 5 hours for the metropolitan region[105]. The combined cost of mobility shortcomings represents a loss of 3.3 million man-hours a day, which equals 33 thousand million pesos a year[106] (1.6 billion Euros). Unfortunately, the lower income population is the most vulnerable because they tend to live in the outskirts of the metropolitan areas. Thus, they experience longer commutes and lower average speeds than the rest of the population[1].

Compared to the other two partners of the North American Free Trade Agreement (NAFTA), Mexico has the highest costs of transporting goods[107]. Depending on the city, the cost of public transport accounts for 12.5-50% of the minimum wage[1]. None of these two types of transport is regulated by the state, and rates are calculated freely between carriers and users.

Historically, transport policy and land use permits in Mexico have been designed to suit private drivers. Medina (2012) performed a quantitative analysis of the negative externalities of car use in 5 of the main metropolitan areas in the country. Pollution, greenhouse gas emissions and car accidents represented a total social cost of 173 billion pesos (8.5 billion Euros) in 2009, or about 4% of the Mexican GDP for that year. This analysis did not take into account the impact on health and welfare, so the actual total cost for Mexican society could even be much higher[108].

10.2 Current implementation of mobility pricing

Mobility pricing has not yet been implemented as such in Mexico. However, governments have undertaken different actions to reduce the impact of car use externalities.

A) The program "Hoy No Circula"

This program is known as "No-drive days". Its goal was to improve the air quality by reducing the pollution caused by vehicle traffic. The program started in 1989 and operates only in the Mexico

104 ONU-Hábitat (2016). Reporte nacional de movilidad urbana en México 2014-2015.

105 Ciudadanos con visión (2012). Acuerdos para la movilidad en la Zona Metropolitana del Valle de México.

106 IMCO (2011). Índice de Competitividad Municipal en materia de Vivienda 2011. México.

107 KPMG (2016). Competitive Alternatives 2016. KPMG's Guide to International Business Locations Costs. Complete report, pp. 48.

108 Medina S. (2012). La importancia de reducción del uso del automóvil en México. Tendencias de motorización, del uso del automóvil y sus impactos. Institute for Transportation & Development Policy, Mexico.

City Metropolitan Area. It bans the circulation of 20% of vehicles each day during weekdays, according to the last digit of their license plate. Today, all cars must undergo vehicle verification, which involves a visual inspection and electronic testing for gas emissions. The results determine how many days of the week the car can be driven[109],[110].

A recent assessment of the program suggests that while it has promoted replacement of older vehicles with new ones, traffic has not really diminished substantially. The same study noted that the "no-drive days" program should be accompanied by other measures such as improvement of public transport and the use of environmentally-friendly vehicles (such as hybrid and electric cars)[111].

B) Parking management

Every car ride begins and ends in a parking lot. A bigger availability of parking spaces encourages more cars on the road[112]. Most Mexican cities allow on-street parking with no regulation and usually with no cost. Aside from this, informal car guards are common on the streets, causing traffic problems, and imposing irregular fees. An alternative for managing parking spaces is the installation of parking meters.

In 2008, the municipality of San Luis Potosi – a city in northern Mexico – implemented a parking meter system with 200 devices and 3,000 parking spaces. The local government reported reductions in traffic congestion, parking violations, and pollution. Additionally, the municipality collected more than 100 million pesos (4.9 million euros) in revenue during the first three years of the program[113].

Another successful program was Ecoparq, a parking meter program in Polanco, – an upper middle-class neighborhood in Mexico City. It started in 2012 with 426 parking meters and 6,000 parking spaces. After the first year, on-street parking occupancy rates decreased in the area. As a result, the current average cruising time is estimated at only 3:04 minutes, compared to the 13:26 minutes required for a motorist to find a parking space before the program. This reduction in time is equivalent to a reduction of 18,079 tons of CO_2 per year. According to a 2013 assessment by Sañudo and Treviño, the reduction in cruising time alone brought social and environmental benefits of around $287 million pesos (14 million euros) per year. Other main cities in México have implemented similar programs (e.g. Monterrey and Guadalajara)[114].

C) Pay-per-distance schemes

A private multi-lane barrier-free toll road (free-flow system) operates in Mexico City under this model. User fees are determined by the size of the vehicle and the number of kilometers driven. It employs an electronic toll collection system, which automatically debits the accounts of registered users, and thus reduces greenhouse emissions by avoiding vehicle stops at tollbooths. The system also analyzes the number of users, travel times and weather, among other parameters, to make decisions and mini-

109 http://www.fisica.unam.mx/personales/hgriveros/docu/RAMAmayojulio2007.295192214.pdf

110 http://www.hoy-no-circula.com.mx/

111 8 Centro Mario Molina (2014). Evaluación del Programa Hoy No Circula.

112 Sañudo A. (Coord.) (2014). Menos cajones, más ciudad. El estacionamiento en la Ciudad de México. . Institute for Transportation & Development Policy, Mexico.

113 Medina S. y Veloz J. (2012), Guía de estrategias para la reducción del uso de auto en ciudades mexicanas. Institute for Transportation & Development Policy, Mexico.

114 Sañudo A. y Treviño X. (2013). Impactos del programa EcoParq en Polanco. Balance preliminar a un año de operación de programas de tarificación de estacionamiento. Institute for Transportation & Development Policy, Mexico.

mize vehicle traffic by allowing, for instance, reversible lanes during rush hours[115],[116]. On June 2017, the city government announced a discount of 20% for hybrid cars using this road[117].

10.3 Societal and political debate

The transition to a mobility pricing scheme in Mexico will be difficult in the short term. The main reason is the lack of a legal and institutional framework that addresses mobility in a broader sense, considering also urban planning, the environment and socioeconomic development[9]. In addition, as stated before, the country has a shortage of quality public transportation systems, there is no sufficient alternative offer, while excessive policies and programs encourage the use of cars.

At the national level, there is an initiative promoted by the Institute for Transportation and Development Policy (ITDP) in collaboration with the Mexican Institute for Competitiveness (IMCO) to support the design, implementation, and evaluation of public transport projects and non-motorized mobility. Since 2015 this initiative has been included by the Ministry of Finance and Public Credit (SHCP) in the programmatic structure of the Expenditures Budget Project. However, so far, there are no rescources allocated to this initiative for the execution of projects[118],[119].

At the local level, many metropolitan areas have implemented their own Sustainable Urban Mobility Plan (PIMUS). However, in most cases, these plans have been made to meet the requirements for accessing federal funds for the development of transport infrastructure. Local governments used the funds for the construction of Bus Rapid Transit systems[120]. The PIMUS plans were not necessarily based on an integral vision of urban development, nor were they incorporated into the corresponding state or municipal planning systems.

10.4 Experiences and outlook

At present, contradictory mobility programs and initiatives prevail in the country. Such inconsistencies exist because each administration at each level of government has proposed different solutions not framed as part of a comprehensive long-term plan[9]. The commitment and collaboration between local and federal governments will be fundamental to achieve sustainable mobility, and to integrate mobility pricing schemes. Planning efforts should be needs-oriented with a focus on mobility management, traffic engineering, urban planning, and governance.

115 http://www.indracompany.com/es/noticia/indra-ohl-ponen-marcha-telepeaje-free-flow-avanzado-latinoamerica-viaducto-elevado

116 http://www.ohlinnovacion.com/soluciones-tecnologicas-innovadoras/carreteras-inteligentes/

117 http://www.cdmx.gob.mx/comunicacion/nota/dara-gobierno-de-cdmx-vehiculos-sustentables-descuento-en-cobro-de-autopistas

118 http://mexico.itdp.org/noticias/grandes-ausencias-en-movilidad-urbana-sustentable-en-el-proyecto-de-presupuesto-de-egresos-para-la-federacion-2016-ppef-2016/

119 Presupuesto de Egresos de la Federación Ejercicio Fiscal 2017. http://www.pef.hacienda.gob.mx/

120 ITDP (2012). Planes Integrales de Movilidad: Lineamientos para una movilidad urbana sustentable. Institute for Transportation & Development Policy, Mexico in collaboration with Centro Eure.

10.5 Other approaches to future mobility

This year, Mexico City will begin a program for replacing 10+ year old taxis by hybrid and electric vehicles[121]. Also, the subway in Mexico City will implement payment with a MasterCard electronic wallet system, which will replace both the traditional magnetic tape tickets and rechargeable electronic cards. This will open the possibility of implementing differential pricing based on distance or time of the day. In addition, users can use their e-wallet to make purchases at any establishment where MasterCard payments are accepted[122].

Other regions in the country are experimenting with mobile apps. In three cities of the State of Sonora and in the city of León in Guanajuato, commuters can access route maps, informations on travel distances and time, service timetables and GPS-enabled location services directly on their smartphones. In some municipalities in Puebla and Tlaxcala mobile apps can be used to find and pay for on-street parking[123].

121 http://www.semovi.cdmx.gob.mx/programas/programa/sustitucion-de-taxi

122 http://www.excelsior.com.mx/comunidad/2017/07/05/1173874

123 Medina S. (Coord.) (2016). Movilidad Inteligente. Diagnóstico de la situación actual en México.

11. NETHERLANDS

Marijn Biesiot, Melanie Peters, Magda Smink & Rinie van Est

In the Netherlands, dynamic road pricing is a controversial topic. It is debated for thirty years already and even though policy plans have been made, dynamic road pricing is not implemented in any form. Meanwhile, mobility in the Netherlands is clearly in transition. Dutch smart mobility policy aims to make the future of mobility safer, more efficient and accessible, and more sustainable[124]. In order to achieve these public goals, policy focuses on innovations related to automated driving, traffic information and traffic management[125].

Smart mobility policy remains, however, a point of public and political discussion. The debate on dynamic road pricing somewhat revived during the national elections of 15 March 2017. This was fueled by heavy traffic congestion and the Netherlands' Institute for Transport Policy Analysis (KiM), which stated that in 2021, traffic congestion will be 38 per cent higher than in 2015. KiM calculated that the pressure on the Dutch infrastructure will rise in the coming years, regardless of the extra roads built and other initiatives to make better use of existing highways.[126] The governmental Study Group on Sustainable Growth considers «pay as you drive»-schemes, and specifically congestion pricing measures, a desirable intervention.[127] Some others, however, see implementing dynamic road pricing in the Netherlands as «political suicide».

In order to enhance the reader's understanding of the Dutch smart mobility policy, this report explores three approaches: dynamic road pricing, car sharing, and car robotization.

11.1 Facts & figures

Dutch smart mobility policy focuses on meeting public goals of safety, accessibility, and sustainability. KiM estimates that the societal costs of traffic accidents in the Netherlands in 2015 are between 13–15 billion Euros, which is about 2 percent of GDP.[128] These costs include both material damage and immaterial costs related to health. Traffic congestion and related delays on main roads in the Netherlands are measured to cost between 2–3 billion Euros in 2015. «Cleaner» cars and a decrease in car usage could positively affect sustainability goals. For example, on 1 January 2016, 95 percent of all passenger cars

124 Ministry of Infrastructure and the Environment (2016). Bijlage bij Kamerstukken II 2016/2017, 31 305, nr. 218. https://zoek.officielebekendmakingen.nl/blg-790143

125 Ministry of Infrastructure and the Environment (2013). Kamerstukken II 2013/2014, 31 305, nr. 207. https://zoek.officielebekendmakingen.nl/kst-31305-207.html & Ministry of Infrastructure and the Environment (2016). Bijlage bij Kamerstukken II 2016/2017, 31 305, nr. 218. https://zoek.officielebekendmakingen.nl/blg-790143

126 KiM (2016). 'Mobility Report 2016'. https://english.kimnet.nl/mobility-report/publications/reports/2016/10/24/mobility-report-2016

127 Studiegroep Duurzame Groei. (2016). 'Rapport werkgroep bereikbaarheid'. https://www.rijksoverheid.nl/documenten/rapporten/2016/07/06/rapport-werkgroep-bereikbaarheid

128 KiM (2016). 'Mobility Report 2016'. https://english.kimnet.nl/mobility-report/publications/reports/2016/10/24/mobility-report-2016

in the Netherlands were still petrol or diesel powered cars.[129] These figures indicate that improving the mobility system could potentially have great societal benefits.

This report focuses on technological innovations related to passenger cars, as this is the most used mode of passenger transportation and often-mentioned in debates. Of the 186 billion passenger kilometers in the Netherlands in 2015, almost three quarters are done by car (see figure 1). Due to the concise nature of this report, other relevant developments in smart mobility related to, for example, public transport or freight traffic are not discussed in detail.

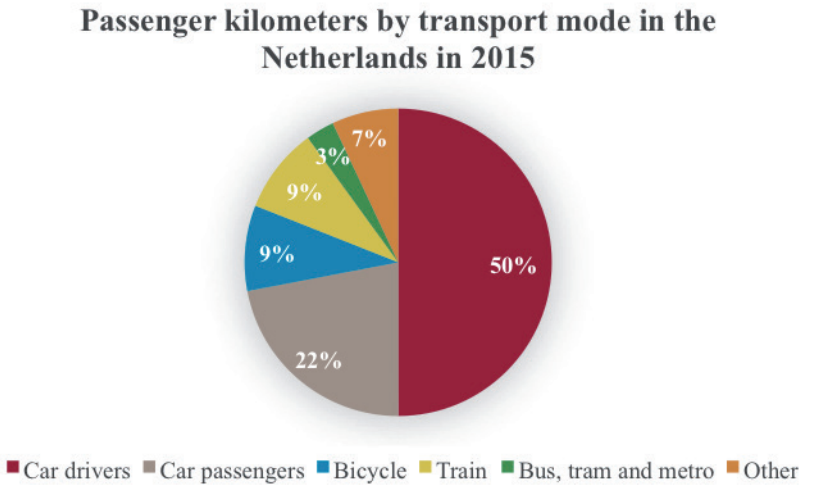


Figure 1: Passenger kilometers by transport mode in the Netherlands in 2015. Source: KiM 2016.

11.2 Dynamic road pricing[130]

The debate on road pricing can be traced back to 1987, when Minister of Transport Smit-Kroes predicted this new, fair system would be implemented in 1995. Succeeding ministers were enthusiastic about the idea, pushed it forward and even implemented some bills on dynamic road pricing. Still, all failed to implement it.

Minister Eurlings (2007–2010) developed a plan based on the «pay as you drive» principle. Road pricing would be differentiated by time, place and the characteristics of each car in question. Cars would not only be tracked for payment, but also for traffic management, for example by predicting congestion and informing drivers about it. The plan also involved public transport. Combining a national database on road traffic with one on public transport, the government, as well as business and citizens, would gain a full overview of mobility in the Netherlands, which would lead to more intelligent mobility behavior. However, Eurlings had not yet decided on the type of registration box to be used in cars.

As Eurling's ambitious plans were revealed, the responses in Dutch newspapers and Parliament ranged from cynicism to outrage. A survey held among members of the ANWB (the Royal Dutch Touring Club, an association that represents most car owners in the Netherlands) showed that most people feared that the new system would be too expensive and that they had no guarantees their privacy would be sufficiently protected. Meanwhile, the Dutch government had fallen and the implementation

129 Ibid.

130 This section is strongly based on the chapter 'Networked Cars' written by C. van 't Hof, R. van Est and S. Hofman, which was published in Van 't Hof, C. Van Est, R. Daemen, F. (eds.). (2011). Check In / Check Out. The Public Space as an Internet of Things. Rotterdam / The Hague: NAi Publishers / Rathenau Instituut, p. 51-65.

of dynamic road pricing vanished from the political agenda. It resurfaced during the national elections in 2012, however, the final coalition agreed against it.[131]

In light of the formation of a new government in 2017, the environmental commissions of six political parties proposed a new road taxation system, which takes into account the characteristics of each car and the number of kilometers driven. This plan contains no registration box in the car, but makes use of an annual registration system of kilometers driven.[132] This should lead to less privacy issues compared to other types of registration systems. In September 2017, a plan to introduce road pricing for freight traffic in the Netherlands surfaced during the formation process. The scheme is mentioned in relation to sustainability goals, as trucks that are more polluting would pay more. Trucks are already equipped with registration boxes to drive in neighboring countries such as Belgium, which should ease the implementation. The transport sector questions, however, whether a road pricing scheme exclusively for freight traffic will improve mobility overall. How this agenda will develop remains to be seen.

Minister Schultz van Haegen (2010-present) believes there is insufficient societal support for dynamic road pricing in general, and that the required adjustments in the taxation system will take a long time to implement. Public sentiments are summarized by the director of the ANWB, who said in 2011 that such a system would only lead to «paying while you wait in a traffic jam».[133]

All-in-all, Minister Schultz van Haegen sees other technological developments, such as connected and autonomous cars, as more promising ways to meet public goals.[134] Therefore, the next sections focus on two approaches that are part of the current Dutch smart mobility policy: car sharing and car robotization.

11.3 Car sharing

The idea behind dynamic road pricing («pay as you drive») is closely aligned to the vision of paying for use rather than for ownership, which is central to the sharing economy. Our recent report *A Fair Share* (2017) discusses the development of car sharing in the Netherlands.[135]

In recent years, peer-to-peer (P2P) car sharing between consumers has sharply increased. In the spring of 2016 some 19,000 car owners rented out their car to other consumers, which is almost a doubling compared to 2015 (see figure 2).[136] Most of the shared cars are rented via the SnappCar platform. The number of shared cars which is offered via traditional business-to-consumer (B2C) models, which exist for already twenty years, is smaller and stagnating. However, these cars are more often rented out

131 Giebels, R. (2016). 'Waarom het rekeningrijden in Nederland nooit komt'. http://www.volkskrant.nl/binnenland/waarom-het-rekeningrjiden-in-nederland-nooit-komt~a4417362/

132 NOS (2017). 'Wat zou een nieuwe wegenbelasting jou gaan kosten?'. http://nos.nl/artikel/2170332-wat-zou-een-nieuwe-wegenbelasting-jou-gaan-kosten.html

133 Van 't Hof, C. Van Est, R. Daemen, F. (eds.). (2011). Check In / Check Out. The Public Space as an Internet of Things. Rotterdam / The Hague: NAi Publishers / Rathenau Instituut, p. 51-65.

134 NOS (2016). 'Schultz: rekeningrijden is niet dichtbij'. http://nos.nl/artikel/2143739-schultz-rekeningrijden-is-niet-dichtbij.html & NOS (2017). 'Schultz: kilometerheffing vrachtverkeer? Doe het niet!'. https://nos.nl/artikel/2194267-schultz-kilometerheffing-vrachtverkeer-doe-het-niet.html

135 Frenken, K., A. van Waes, M. Smink & R. van Est, A fair share – Safeguarding public interests in the sharing and gig economy. The Hague, Rathenau Instituut, 2017. https://www.rathenau.nl/en/publication/fair-share%C2%A0%E2%80%93-safeguarding-public-interests-sharing-and-gig-economy

136 Crow-KpVV (2016). 'Dashboard Autodelen'. http://kpvvdashboard-4.blogspot.nl/

than P2P-cars are shared. Approximately 90,000 people in the Netherlands make use of car sharing services[137], which is almost 1percent of all people owning a driving license.[138]

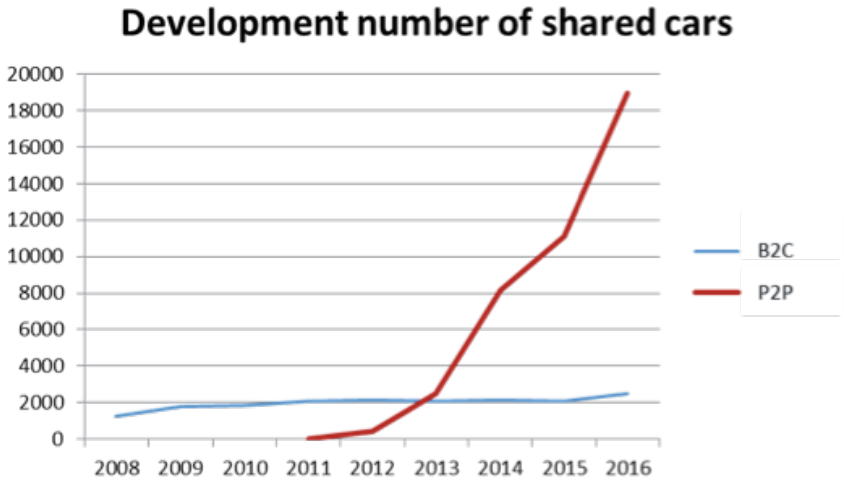


Figure 2: Development of car sharing in the Netherlands. P2P car sharing refers to consumers renting out their own cars. B2C refers to companies renting out shared cars to consumers. Source: Crow-KpVV, 2016.

In June 2015, the Dutch government, providers of car sharing services, lease firms, insurers, municipalities, companies and civil society signed a «Green Deal Car Sharing». The goal of this Green Deal is to grow towards a network of 100,000 shared cars in 2018. This should lead to a reduction of car kilometers and CO_2 emissions, improved air quality, more efficient use of existing infrastructure and less traffic congestion, and improvement of the quality of life in cities through a reduction parking spaces. P2P-car sharing specifically could stimulate social cohesion, as consumers regularly share cars with people in their neighborhoods.

First studies show that car sharers own around 30 percent less cars than before they started sharing.[139] However, the actual societal benefits of car sharing also depend on technological innovations and the ways in which these are used. A technological development such as the *smart lock* (which only requires a smartphone to open a car), might actually hinder social cohesion as it makes personal contact between the car owner and consumer unnecessary. Furthermore, there are policy issues around car sharing that require attention, such as taxation (how much is a private car sharer allowed to earn tax free?), privacy, and securing a level playing field for car sharing services providers.

11.4 Car robotization

In the book *Just Ordinary Robots*, Royakkers & Van Est (2016) define car robotization as a combination of developments in the following technologies: automation, traffic management, and cooperative systems.[140] Automation levels can range from no automation (driver has full control over the car) to fully self-driving automation (driver has no control over the car).[141] Low levels of automation, such as driver

137 This estimation excludes the people who share a car with friends, neighbors or family.

138 PBL (2015). Effecten van autodelen op mobiliteit en CO_2-uitstoot (Publicatienummer 1789).

139 Ibid.

140 Royakkers, L. & R. van Est (2016) Just ordinary robots: Automation from love to war. Boca Raton, FL: CRC Press.

141 KiM (2015). 'Driver at the wheel? Self-driving vehicles and the traffic and transport system of the future.' https://english.kimnet.nl/publications/reports/2015/10/14/driver-at-the-wheel

assistance systems, are already part of the standard equipment of many cars. Traffic management guides a driver's choice of route, time of travel and driving behavior with real-time information about traffic congestion, roadworks and accidents. Connected navigation systems cause a shift from merely providing information to advising and guiding motorist. TomTom Traffic, for example, uses anonymous location data from mobile phones to estimate local traffic flow. Cooperative systems are vehicles that are networked with each other (vehicle-to-vehicle, or V2V) and with the surrounding infrastructure (vehicle-to-infrastructure, or V2I) through navigation systems, roadside systems and traffic services. V2V, for example, makes truck platooning (intelligent trucks that can drive closely together in «road trains») possible.

In fact, these technologies together form the building blocks for the fully connected and autonomous car.[142] Dutch smart mobility policy currently focuses on the phased implementation of all these building blocks in order to meet public goals of safety, accessibility, and sustainability. In 2015, legal adaptations were made to allow pilot projects with autonomous vehicles on public roads in the Netherlands. It is recognized that regulation and car systems in Europe need to be compatible in order to ensure that drivers can travel smoothly between countries. Therefore, in 2016, the European Declaration of Amsterdam was signed. All EU countries and European car manufacturers have committed themselves to work together to pave the way for the introduction of self-driving vehicles.[143]

Public acceptance of cooperative and autonomous driving remains a challenge. Smart information and communication technologies are the driving force behind developments in the car and infrastructure. The possibilities provided by the collection and exchange of mobility data, such as location and identification, lead to heated discussions on privacy interests of citizens. Those interests already constituted a major obstacle in introducing dynamic road pricing in the Netherlands. The debate on that matter has shown that public acceptance of a technology solution is crucial.[144] Dutch smart mobility policy recognizes that next to privacy, security (protection against car-hacking), road safety and liability are societal issues that need to be addressed.[145]

Car robotization and car sharing are innovations that are seen as complementary and taken to the next level in the broader development of *mobility as a service.*[146] This model provides consumers with flexible mobility services at any place and any time, such as door-to-door travel arrangements and sharing cars that park themselves automatically.[147]

11.5 Concluding remarks

The Rathenau Instituut closely monitors developments around smart mobility in the Netherlands. This report combines insights from previously published studies to explore three different approaches to the future of mobility: dynamic road pricing, car sharing, and car robotization. Dutch smart mobility policy aims to achieve a transition to a safer, and more efficient, accessible, and sustainable mobility model.

142 Royakkers, L. & R. van Est (2016) *Just ordinary robots: Automation from love to war*. Boca Raton, FL: CRC Press.

143 Ministry of Infrastructure and the Environment (2016). *Bijlage bij Kamerstukken II 2016/2017, 31 305, nr. 218.* https://zoek.officielebekendmakingen.nl/blg-790143

144 Timmer J., Pel, B. Kool, L. Van Est, R. & Brom, F. (2015). Converging roads: *Linking self-driving cars to public goals.* The Hague: Rathenau Instituut

145 Ministry of Infrastructure and the Environment (2016). *Bijlage bij Kamerstukken II 2016/2017, 31 305, nr. 218.* https://zoek.officielebekendmakingen.nl/blg-790143

146 KiM (2015). 'Driver at the wheel? Self-driving vehicles and the traffic and transport system of the future.' https://english.kimnet.nl/publications/reports/2015/10/14/driver-at-the-wheel

147 Connekt. 'Thema Mobility as a Service'. https://www.connekt.nl/thema/mobility-as-a-service/

There are high expectations from the phased implementation of connected autonomous vehicles and flexible mobility services, including car sharing. However, some experts argue that dynamic road pricing schemes will still be necessary to achieve the above public goals, and road pricing for freight traffic is on the agenda of the «new» government. For the last three decades, however, road pricing has been a very controversial topic and neither societal nor political support has been found for this policy option. This history shows that for a successful mobility transition it is necessary to address numerous societal questions related to privacy, security, safety and liability.

Publications by the Rathenau Instituut in the field of smart mobility:

- Frenken, K., A. van Waes, M. Smink & R. van Est, *A fair share – Safeguarding public interests in the sharing and gig economy.* The Hague, Rathenau Instituut, 2017. https://www.rathenau.nl/en/publication/fair-share%C2%A0%E2%80%93-safeguarding-public-interests-sharing-and-gig-economy
- Royakkers, L. & R. van Est (2016) *Just ordinary robots: Automation from love to war.* Boca Raton, FL: CRC Press.
- Timmer J., Pel, B. Kool, L. Van Est, R. & Brom, F. (2015). *Converging roads: Linking self-driving cars to public goals.* The Hague: Rathenau Instituut
- Timmer, J., Smids, J., Kool, L., Spahn, A. & Van Est, R. (2013). *'Op advies van de auto: Persuasieve technologie en de toekomst van het verkeerssysteem'. ('On Advice of the Car').* Den Haag, Eindhoven. Rathenau Instituut & TU/e.
- Van 't Hof, C. Van Est, R. Daemen, F. (eds.). (2011). *Check In / Check Out. The Public Space as an Internet of Things.* Rotterdam / The Hague: NAi Publishers / Rathenau Instituut, p. 51–65.

12. NORWAY

Joakim Valevatn

12.1 Mobility: Facts and Figures

Most daily travel happens by private automobile

The average Norwegian resident travels 42.45 km per day. 90 percent of the population live in households with access to a car. 45 percent of the population have access to two or more cars.

Road tolls fund 9 percent of transport projects

The National Transport Plan (NTP) gives a measure of how much is spent on transportation, and how it is funded. The NTP is a ten-year investment plan for all modes of transport that the parliament passes and revises every four years. The most recent NTP was passed in June 2017, and is the biggest infrastructure investment plan ever in Norway. The total budget from 2018–2029 is NOK 1064 billion, of which NOK 536 billion is related to road transport. Road tolls cover about NOK 95 billion of the total transportation budget from 2018 – 2029, while the state funds the rest.[148] The table below illustrates the development in transport budgets since year 2000 (in NOK billion):

Plan period	Total transport budget	Road related spending	Toll revenue
2002–2011	217	105	17
2005–2016	192	122	11
2010–2019	322	219	60
2014–2023	508	311	98
2018–2029	1064	536	95

12.2 Current implementation of mobility pricing

First urban toll rings in Europe

The first urban toll ring in Europe was created in 1986 in Bergen, Norway. The cities of Oslo and Trondheim followed shortly after in 1990 and 1991. The toll rings were created in order to deal with heavily congested roads. At first, most of the revenue from urban toll rings went to improving city roads, as well as creating tunnels and new roads routing traffic outside of city centres. In 1990, 20 percent of the toll revenue in Oslo went to finance public transport projects. In the most recent local transport deal concerning the Oslo area, 73 percent of the toll revenue will go to public transport investments.

Point payments only

Currently there are 11 urban toll rings in Norway. Altogether there are 60 local road tolling companies in Norway, managing about 60 different road tolling projects. In the most recent NTP it was decided to create 5 regional companies that will manage all tolling projects, in order to cut down on operating costs and improve the user experience. Drivers are charged through point payment, when crossing a

148 English reference: http://www.ntp.dep.no/English

bridge, taking a ferry or entering the city. Most cars have a wireless tag (AutoPass) that registers crossings. AutoPass users receive a 10 percent discount, while those who do not have the tag are registered using cameras. There are no schemes based on usage, distance or time. Toll stations usually have different fees for cars over and under 3.5 tons. This effectively differentiates private automobiles from freight transport. Public transport (excluding taxis) is exempt from paying tolls.

Congestion pricing since 2010

Four urban areas have implemented congestion pricing since 2010. The purpose of these projects is to limit traffic during rush hours, and spread out the traffic more evenly throughout the day. Congestion pricing will be implemented in Oslo, starting in October 2017.[149] In Bergen, the price is more than doubled (from NOK 19 to NOK 45 for personal cars) during rush hours (06:30 – 09:00 and 14:30 – 16:00). In Oslo the price is increased by about 25 percent (from NOK 44 to NOK 55) during rush hours.

Measures to limit local air pollution

Local air pollution can be a severe problem during winter in Norwegian cities. In Bergen road space rationing was implemented during the winter of 2015 – 2016. Cars with licence plates ending in either odd or even numbers were banned from driving into the city every other day in periods of heavy pollution.

Starting the winter 2017, Bergen will implement a 5-doubling of tolls during days of heavy air pollution. In rush hours, drivers will have to pay NOK 225 in order to enter the city. This scheme will replace road space rationing. In Oslo, the option to ban diesel cars from driving into the city on days with severe pollution was passed in 2015.[150] The ban has only been implemented once, in January 2017.[151]

Electric Vehicles (EVs) strongly incentivized since 1990

In 1990 EVs were exempt from purchase and import taxes, and in 2001 they were exempt from the 25 percent VAT. The yearly fee for owning an EV is 1/6th of a regular car.[152] There is a national rule that tolls for EVs should not exceed half of the price for regular cars. Local authorities can choose if EVs are granted additional advantages, such as free parking, free charging, use of the public transport lane and no tolls. Starting 2018, EVs will have to pay road tolls in the Oslo area, although they will be significantly smaller than for other vehicles.

12.3 Societal and political debate

The first urban toll ring created in 1986 spurred massive protests, and even death threats against the planners.[153] Since then, tolling has remained a politically heated topic, although most parties are in favour of some kind of road tolling.

Political standpoints vary locally

Among political parties, the right wing Progress Party (FrP) is the only Norwegian party that state they are against road tolling. With the Minister of Transport representing FrP, the share of road tolling has decreased in the current NTP. The party has met some criticism for not living up to their promises of re-

149 https://www.fjellinjen.no/privat/nyhetsarkiv/tids-og-miljodifferensierte-takster-i-oslo-article912-966.html

150 https://www.aftenposten.no/osloby/Oslo-har-vedtatt-dieselforbud-40571b.html

151 https://www.oslo.kommune.no/gate-transport-og-parkering/dieselforbud/effekt-og-historikk-om-dieselforbud-article67423.html

152 English reference: https://elbil.no/english/norwegian-ev-policy/

153 https://www.nrk.no/hordaland/xl/bompengebyen-bergen-1.12733618

moving road tolling altogether.[154] Support for congestion pricing varies locally for other political parties: In Bergen, the conservative party Høyre voted in favour of congestion pricing after opposing it for several years. In Oslo, the same party has been consistently opposed to it, but voted for time differentiated tolling for high emission cars.

The socialist-left party, SV, has been a proponent of congestion pricing in some municipalities, while opposing it in the Stavanger-region, due to concerns about economic inequality. The social democratic Labour party has gone from opposing congestion pricing before 2010 to being in favour of it in most municipalities.

Population slowly warming up to urban tolling

In Oslo and the neighbouring county Akershus, 70 percent of the respondents were opposed to the urban toll ring before it opened in 1990. In 2016 56 percent of the respondents were in favour of the toll ring.

In Bergen, the increases in road tolls and congestion pricing has led to resistance. In December 2016 and April 2017, several hundred truck drivers participated in a go-slow protest against road tolling. Support for public transportation projects has also decreased in Bergen, due to a large amount of the road toll revenue being used to finance it.[155]

12.4 GPS-based road pricing

The Norwegian Board of Technology (NBT) released a briefing on GPS-based road pricing in 2010[156], which spurred a debate on data privacy. Since then, all major transport organizations as well as the Institute of Transport Economics have proposed GPS-based road pricing as an equitable and effective way of charging for road use.

Most political parties want to investigate opportunities for GPS-based road pricing, except FrP.[157] In an informal online newspaper poll there is a 50-50 percent preference towards either being charged through point payment or GPS-tracking.[158] The Norwegian Data Protection Authority have been sceptical towards GPS-based road pricing. However, more recently they have stated that it may improve privacy compared to registering each passing through point payment, if the data is treated in a way that anonymizes each driver's data.[159]

12.5 Experiences and outlook

Urban toll roads have not affected traffic volumes

The urban toll rings have had little effects on the traffic volumes, but they were a successful means of financing infrastructure projects faster. In Oslo a new tunnel allowed for redirecting 90.000 vehicles passing through the city each day in 1990. Bettering the traffic flow has positive effects on the environment, as cars spend less time standing still on the roads. More recently, urban toll rings have been an important factor for the financing of public transport projects. From 2005 to 2014 the national share of public transport grew from 10 percent to 14 percent. In Oslo it increased from 21 percent to 25 percent in the same period.

154 https://www.aftenposten.no/norge/politikk/i/xoaWX/Frp-forsvarer-131-milliarder-i-bompenger

155 https://www.nrk.no/hordaland/stotten-til-bybanen-i-bergen-faller-1.13293294

156 https://teknologiradet.no/wp-content/uploads/sites/19/2013/08/SF-GPS-basert-veiprising-2010.pdf

157 https://www.abcnyheter.no/motor/bil/2017/09/08/195330796/dagens-bompengeniva-tvinger-oss-til-tenke-nytt

158 http://www.nettavisen.no/nyheter/innenriks/vil-fjerne-alle-bomstasjoner-og-innfre-gps-betaling/3423375505.html

159 http://bil24.no/vil-erstatte-bombrikkene-med-gps-overvakning/

After being implemented, congestion pricing contributed to reduced traffic during rush hours: 10 percent in Trondheim, 3 percent in Kristiansand and 14 percent in Bergen. The attempts with road space rationing were not successful in Bergen. Among other reasons, because they were difficult to sanction and created much confusion among drivers.

EV-incentives have put Norway in the lead

Since 2010, the share of EVs sold per year has gone from close to 0 percent to 35 percent (18 percent all electric, 17 hybrid cars) in 2016.[160] The average share of EVs sold per year in EU-countries is 1.4 percent. By December 2016, 5 percent of the cars on Norwegian roads were EVs.

However, as the proportion of EVs continues to rise, the financial incentives result in less revenue for financing transport projects and road construction. The VAT-exemption will last until 2020[161], while EVs will have to start paying tolls in Oslo starting in 2019. The new NTP states the goal that all cars sold after 2025 should be zero emission vehicles. However, the plan does not specify how this goal can be reached while incentives for buying EVs are getting smaller.

12.6 Other approaches to future mobility

Car free city centre in Oslo:

A gradual ban on cars has started in the Oslo city centre.[162] In the first phase, this will mean a ban on parking in the streets, while allowing for some parking in garages. The parking ban will at first be implemented inside "Ring 1", the innermost part of the city centre, where very few people live and the car ownership rate is low. The Norwegian Institute of Transport Economics highlights parking restrictions as an effective means to reduce unwanted car traffic in urban areas.[163]

Autonomous vehicles on public roads in 2018:

A law proposal regarding testing of autonomous vehicles on public roads will be treated in parliament during the fall of 2017. Testing of autonomous vehicles will most likely be legal on public roads from 2018, without requiring a driver to be present in the vehicles. Each company or person testing vehicles has to apply for a permission.[164]

The recent National Transport Plan gives much attention to smart mobility and autonomous vehicles, although this increased awareness of new transport technology does not significantly affect how infrastructure is planned. NOK 1 billion of the total budget of NOK 1064 billion has been set aside for innovation and technology projects. Ruter, the public transport company in Oslo, will start testing autonomous shuttle buses in certain parts of the city starting 2018.

The NBT released a briefing on driverless cars in 2016[165], and is currently working on a project regarding driverless cars and city traffic. In this project, we will examine how driverless vehicles may affect traffic congestion, areal planning and the relation between shared and private transport in urban areas.

160 English reference: https://www.ft.com/content/84e54440-3bc4-11e7-821a-6027b8a20f23

161 https://www.tu.no/artikler/elbilfritaket-fortsetter-til-2020/358957

162 English reference: https://www.theguardian.com/cities/2017/jun/13/oslo-ban-cars-backlash-parking

163 https://www.toi.no/forskningsomraader/kollektivtrafikk-areal-og-transportplanlegging/parkering/

164 https://www.regjeringen.no/no/dokumenter/prop.-152-l-20162017/id2556972/

165 English reference: https://teknologiradet.no/english/driverless-cars-need-for-political-action/

13. POLAND

Mirosław Sobolewski

13.1 Mobility: Facts and Figures

At the end of 2015, approximately 20 million motor vehicles were in use in Poland, including almost 15 million passenger cars and 3 million trucks. Road transport is very important in Poland, since over 85 percent of freight is transported by trucks. In addition, numerous vehicles travel across Poland as part of the transit between Western and Southern Europe and the countries in the Eastern part of the continent. Transport services, including those provided on the European market, are an important sector of the Polish economy. Polish carriers have one of the most modern fleets of trucks in Europe, which is one of determinants of this sector's competitiveness with respect to companies from other EU member states.

The total length of the road network in Poland exceeds 400.000 km, but express roads constitute only a small part of the network. There are currently approx. 1700 km of motorways and over 1600 km of expressways. The network of express roads is constantly developed. According to the current plans, it will cover approx. 7650 kilometers, including around 2000 kilometers of motorways and around 5650 kilometers of expressways, while in Germany the length of the motorway network exceeds 10.000 kilometers.

13.2 Current implementation of mobility pricing

The main mobility pricing instrument in Poland is the viaTOLL system, i.e. an electronic toll collection system aimed in particular at registrating trucks. The system has been in place in Poland since July 2011. It covers sections of motorways, expressways and selected national roads managed by the General Directorate for National Roads and Motorways (GDDKiA)[166]. The total length of toll roads amounts currently to approx. 3660 kilometers. The networks is consistently expanded (e. g. in July 2017 new sections of 360 km in length were added). The use of public roads other than toll roads is free of charge.

The viaTOLL system is obligatory for vehicles with a maximum permissible weight of over 3.5 tons, and for buses regardless of their maximum authorised mass. All such vehicles using the sections of toll roads must have a special viaTOLL device. Electronic readers have been installed on selected road sections. They connect with the devices wirelessly and charge the toll. The device may be charged on selected petrol stations and in some dedicated points.

Passenger cars and vehicles with a maximum permissible weight of less than 3.5 tons (so-called «light vehicles») use toll roads pursuant to different rules – they are covered by the manual toll collection system at special gantries on selected motorway sections (the toll road network of for light vehicles includes considerably fewer sections than the network for trucks). However, light vehicles may use the viaTOLL system voluntarily. The drivers of such vehicles may decide whether they want to pay manually at the gantries or electronically using the viaTOLL system. An advantage of the latter solution is the reduced waiting time at the toll collection points.

The electronic toll rates in the viaTOLL system depend on the road category, type of vehicle or its maximum permissible weight and the EURO exhaust emission standard. For example, tolls for 1 km

166 Apart from road network managed by the GDDKiA, some motorway sections are managed by concession holders who financed the construction of the motorways in return for the right to collect tolls for a specific period of time.

of the road with motorway parameters amount to PLN 0.2–0.53 (4,7–12,5 eurocents) (see Table). The toll for low-emission vehicles is twice as low as for vehicles with the highest exhaust emissions. Penalties for using the toll road section without a viaTOLL device range from PLN 750 (176 euro) for vehicles with a maximum permissible weight of 3.5–12 tonnes to PLN 1500 (352 euro) for trucks with a weight exceeding 12 tons.

Table. Electronic toll rates on motorways

Vehicle category	Electronic toll rate for 1 km travelled on a national road (in PLN)			
	Vehicle classes (EURO) depending on the exhaust emission limits.			
	max. EURO 2	EURO 3	EURO 4	min. EURO 5
Vehicles with a maximum permissible weight of over 3.5 tons and less than 12 tons	0.40	0.35	0.28	0.20
Vehicles with a maximum permissible weight of at least 12 tons	0.53	0.46	0.37	0.27
Buses regardless of their maximum permissible weight	0.40	0.35	0.28	0.20

The viaTOLL system operator, acting on behalf of the GDDKiA, is the Austrian company *Kapsch* Telematic Services, which has won the international tender for construction, management and maintenance of the viaTOLL system. From the date of its implementation, the proceeds from the national toll collection system on the road network managed by the GDDKiA have exceeded PLN 8 billion (1,88 billion euro), including over PLN 1.7 billion (400 million euro) in 2016. The tolls constitute revenue of the National Road Fund and are used to cover over 10 percent of expenditure for the National Road Construction Programme.

The significance of road tolls is not purely fiscal. The toll collection is also important for managing the traffic flow on the national road network. One of the purposes of introducing the toll collection has been to concentrate interregional traffic on express roads, at the same time reducing local traffic on those roads (local traffic deteriorates traffic parameters and safety, in particular on motorways and expressways near the hubs).

Experience has shown, however, that the introduction of tolls resulted in a partial transfer of interregional and regional traffic to parallel toll-free roads. The above problem is corrected by introducing tolls on parallel roads, which motivates the carriers to return to express roads.

In general, it can be said that the introduction of the toll system is one of the factors indirectly contributing to improving the safety on the Polish national road network (the number of road accidents and their consequences have been declining steadily in recent years).

13.3 Societal and political debate

The electronic toll collection system has been the subject of a fierce social and political debate. The original government project raised a lot of controversy and caused protests from the transport community. Truck drivers protested against the replacement of the previous vignette system with a new solution, even carrying out actions such as parking their trucks for one hour on road shoulders. In consequence, the government decided to introduce the electronic toll system with a three-year delay compared to

original plans. The change of the launch date of the new system was considered justified and giving entrepreneurs sufficient time to prepare for new solutions.

The electronic system has replaced the vignette system which covered the entire network of national roads, along with concession-covered motorway sections. Although the previous system was more favourable for carriers, it was inefficient from the economic point of view, also because trucks with toll stickers could use toll motorways for free. This generated losses for the state budget, since – pursuant to agreements with concession holders – the State Treasury paid them compensation for trucks driving on concession-covered sections. In 2007 the total amount of compensations equalled the proceeds from vignettes.

In addition, numerous users considered the vignette system to be unfair. The vignettes were obligatory even when driving on only a small section of toll roads. This was beneficial for users who used the public road network intensively. The cost of vignettes incurred by small and medium-sized transport companies was relatively high. In the new system the toll amount corresponds to the number of kilometres travelled, which is more in line with the «polluter pays» principle.

The vignette system was also inefficient and ineffective in terms of control, while its electronic version guarantees increased and effective toll collection. In view of the above mentioned shortcomings of the toll sticker system, the decision to replace it with a new solution was rational. The introduction of an electronic toll system resulted in increased operating costs of some carriers, but due to universality of this instrument, the toll collection did not undermine the balance on the transport market.

13.4 Experiences and outlook

The introduction of electronic toll system in Poland, including the introduction of different rates for heavy vehicles according to their EURO exhaust emission class, contributed to a more rational use of the transport fleet and to its renewal, which helped to directly reduce the negative environmental impact of transport. The national transport fleet is currently among the youngest in Europe, which translates into the competiveness of national road transport companies. The national road transport companies have become an important part of the Polish economy, improving the competiveness of the companies they serve, as well as benefitting the entire EU economy.

At the same time, there is an increasing awareness that the negative impact of transport on the environment, in particular on air quality, is a serious problem. The necessity to reduce emissions from transport results also from Poland's commitments to climate goals. Therefore, methods of curbing emissions must be sought that meet the social and environmental needs without causing difficulties for companies operating in this area. The main lines of action in this regard may include:

- Extension of the road toll system (viaTOLL or introduction of a universal, alternative solution) to all national roads and all types of vehicles;
- Support of efforts at the European Union level aimed at introducing emission standards (CO_2/km) or fuel standards (fuel consumption per 100 km) for trucks;
- Greater differentiation of toll rates for trucks depending on their emission standards.

The current system of road toll collection for trucks in Poland does not cover a large part of national roads. This leads not only to reduced proceeds for the state budget, but also to an excessive exploitation of the road sections which are not covered by the toll system. As a result, the maintenance and repair costs of those road sections increase. The system does not account for other important factors, such as the disproportion of the costs of road and railway transport. The gaps in the toll system adversely affect the competiveness of Polish railways.

The extension of the viaTOLL system (or creation of an alternative, universal road toll system) will have a number of positive consequences, such as:

- Additional proceeds for the state budget as a result of a practical implementation of the «polluter pays» principle;
- Prevention of the spread of traffic to non-toll roads and a more equal distribution of heavy vehicle traffic on all types of roads, leading to a reduction of external transport costs and their negative impact;
- Elimination of one of the competitive inequalities between road and railway transport.

Another prospective area of action is the integration of the data on traffic streams generated by the electronic toll system, with data from smart traffic management systems. In future, the electronic toll system could thus be used as an active traffic management instrument (e.g. to reduce traffic congestion).

14. RUSSIAN FEDERATION

Victor Krivov and Timur Semenov

14.1 Current implementation of mobility pricing

Intensification of traffic flows, caused by the multiplication of personal and commercial vehicles, is the main trend in all major cities of the Russian Federation.

The state policy of mobility pricing is aimed mainly at:

- the maintenance and development of transport infrastructure;
- fighting against traffic jams and environmental pollution;
- ensuring mobility of citizens and uniform loading of road and transport infrastructure;
- guaranteeing social welfare;
- optimization of transport operator costs;
- creation of comfortable conditions for doing business.

There are a number of programs for subsidizing internal flights at the expense of the Federal budget in Russia. In particular, such programs are used for flights to the regions of the Far East, the Kaliningrad Region and the Republic of Crimea. The program of subsidizing flights in the Far East was launched in 2009. Citizens under 23 and over 60 years can buy air tickets at a special price. About 300 routes are currently subsidized within five programs. In 2016 the amount of subsidies amounted to about 8.5 billion RUB.

Progressive schemes for multimodal transportation by public transport on a single ticket start to appear in Russia. At the same time, an effective development of toll roads and parking is deployed.

From November 15, 2015 vehicles exceeding 12 tons of gross weight are charged for using Russian Federation highways to offset the road damage caused they cause. In order to ensure the collection of the compulsory payment a collection system has been created («Platon» system).

In some regions of the Russian Federation subsidies are paid to encourage the use of electric vehicles. In Moscow, for example, electric vehicles can be kept free of charge in paid parking lots. In the Kaluga Region the owners of electric vehicles are exempt from transport tax.

Currently a draft for a government program for the deployment of electric vehicles in the Russian Federation until 2025 is underway. The proposed measures include:

- the free travel of electric vehicles on toll roads at the federal level;
- cancellation of the transport tax; admission of electric vehicles to dedicated lanes;
- the creation and development of a network of charging stations.

Differentiated transport tax rates are applied in Russia. They depend on the engine power of the vehicle. Transport tax rates can also be increased or reduced by regional laws taking into account the age of vehicles and their ecological class. One of the goals of this kind of tax policy is to stimulate the purchase of more environmentally friendly cars.

Since 2015, a network of car sharing services has been developing in Moscow with the support of the city authorities. Today the number of users registered in the system of Moscow's car sharing ser-

vices exceeds 445,000. On average, every shared car is rented by 8 people per day. For these cars, free parking is available throughout the city.

In addition, an important element of the state policy for a modern transport system is to encourage citizens to use ecological transport modes, including electric vehicles, as well as the development of a network of public and rental bikes and bicycle transport in cities. There are about 210 km of bicycle paths in Moscow.

The state power bodies at the federal and regional level are the main policy initiators for mobility pricing.

14.2 Societal and political debate

Platon Electronic Toll Collection System

Before April 15, 2017 a reduction coefficient (0.41) was applied for the basic fare of the Platon System (3.7 RUB per 1 km) and thus the charge at that time was 1.53 RUB per 1 km. It was anticipated that after April 15, 2017 a new coefficient (0.82) would be applied and the fare for one kilometer would rise to 3.06 RUB.

The planned increase of the tariff led to strikes by truck drivers. The Government estimated that about 500 drivers participated in these protest actions throughout the country.

As a result of a meeting between Russian Prime-Minister Dmitry Medvedev and representatives of small and medium-sized businesses in the transportation sector, a decision was taken to apply a coefficient of 0.51 instead of 0.82. This reduced the charge per kilometer from 3.06 to 1.91 RUB.

The following issues of mobility pricing are under active consideration nowadays:

- how best to take into account the interregional nature of passenger transportation services in suburban areas of the cities of federal significance when fixing toll charges and price policy-making;
- which methodology should be implemented in order to evaluate the economic cost of the negative impacts of mobility issues (accidents, traffic jams, environmental pollution etc.)
- what mechanisms are best suited for informing and motivating drivers to use environmentally friendly vehicles (i.e., electric cars) as well as car sharing services;
- how to best introduce new principles and methods of developing a multimodal city transportation systems linked to urban and territorial planning;

On the expert level, special attention is given to the examination of the relationship between volumes of passenger transportation by various types of transport and economic growth indicators. Another issue of special interest is the analysis of paid-parking models in Russian cities and abroad and proposals to improve parking-choice models.

14.3 Experiences and outlook

The Ministry of Transport of Russia estimates that the Platon System implementation levied about 22 billion RUB to the federal budget. These funds have been used for renovation roads and bridges in various regions. The development of public transportation and car sharing services together with new road constructions has positively impacted traffic capacity in the big cities. In 2016 the level of traffic congestion in Moscow declined by 6 percent.

A positive dynamic has also been noted in the number of passengers on domestic flights. From May 2016 to May 2017 it increased by 14 percent, reaching 9 million passengers.

The key task in the near future will be to provide effective coordination between transport and urban development policies as well as policies in areas such as land-use, environmental protection and healthcare based on the further use of new transport pricing schemes.

15. SWEDEN

Helene Limén & Bo Nyström

15.1 Mobility: Facts and Figures

The transport sector's socioeconomic costs

Sweden is relatively large and sparsely populated. As in other European countries, urbanisation has been rapid in the last ten years, resulting in approximately 85 per cent of the population living in urban areas. Car traffic still accounts for the vast majority of travel, or around 80 per cent, but several factors indicate that the dominant role of the car in cities is changing, while public transport and biking are increasing.

15.2 Current implementation of mobility pricing

According to Swedish transport policy, pricing that takes into account the socioeconomic costs of all modes of transport should be aimed for (Gvt. bill 2005/06:160). A transport analysis with the assignment of analysing the transport sector›s socioeconomic costs, notes in its report[167] that taxes and charges should generally be differentiated according to type of vehicle and geography, and in particular make a difference between urban areas and rural areas. Goods transports with heavy goods vehicles in urban areas pay their total marginal costs to the least extent. Goods trains and goods transports by vessel are close to covering their total marginal costs. The report notes that further knowledge is required about external costs, above all for aviation and shipping. A transfer in the mode of transport of goods from road to shipping can, for example, reduce the marginal costs as carbon dioxide emissions per transported unit are drastically reduced. With the aim of encouraging such transfers, the preconditions for a Swedish Ecobonus system for shipping have recently been examined[168]. The report proposes that support could be given to projects leading to the transfer of goods and which, after a maximum support period of three years are financially sustainable.

Congestion tax

In Sweden, a congestion tax system is currently applied in Stockholm and Gothenburg[169]. The purpose of the tax is to reduce congestion, improve the environment and help to fund infrastructure investments. Since 2015, the law also applies to vehicles which are registered abroad. The charge cannot be paid at the control point – instead the taxable journeys that a vehicle makes in and out of these cities during a specific calendar month are combined in a tax decision which is paid in arrears.

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167 Transport Analysis (2016) Transportsektorns samhällsekonomiska kostnader (The socioeconomic costs of the transport sector). Report 2016:16

168 Transport Analysis (2017) Ecobonus för sjöfart – slutredovisning (Ecobonus for shipping – final report). Report 2017:11

169 www.transportstyrelsen.se

Infrastructure charge

Infrastructure charges[170] have been applied to a limited extent for a few years now in order to help with the funding of new bridges, roads and tunnels. This means that those who use the infrastructure shall help to pay for it too. Infrastructure charges are levied in various ways, both through traditionally manned stations and by means of electronic payment on certain routes. A camera-based free-flow system has been installed at certain bridges. Vehicles are identified with the help of photographic recognition and the charge is then linked directly to the vehicle and the owner. On the basis of the type of vehicle and distance driven, a charge is calculated and reported to the body responsible for road maintenance via various technologies. The basis of the calculation model is a satellite-based system which records the route taken by the vehicle.

The effect of parking charges

According to a report from the Swedish Transport Administration[171], the use of parking facilities in a specific location is steered by supply and demand, in the same way as for other goods and services. Some important factors that affect this are: price and access to parking in the area, ease of finding a parking space and availability of public transport. A survey from a suburb of Stockholm revealed a correlation between free parking and the number of people who chose to drive their own car to work; six in ten people with access to free parking regularly drive their car to work. For those who have to pay to park, the figure was just two in ten[172]. A follow-up of the parking plan for central Stockholm shows that parking fees have a significant impact. However, it is unclear how a fee system should best be organised to achieve the desired effects[173].

15.3 Societal and political debate

Scenarios for reduction of emissions from the transport sector

A new climate law has been adopted in Sweden (2016/17:MJU24) with the aim that Sweden should be climate neutral by no later than 2045, and that emissions from domestic transport shall be reduced by 70 per cent by 2030, compared to 2010. The Swedish Transport Administration has shown, in a number of scenarios, how these goals can be achieved[174]. A combination of measures and policy levers are required in the next few years which can stimulate technical development and influence methods of transport. Dramatically improved energy efficiency and electrification of, primarily, cars and lorries are required but also investments in public transport, cycle and pedestrian paths and improvements in the efficiency of goods transports. Transport systems need to be developed to become less transport intensive, logistics need to be made more efficient and better opportunities to transport goods by rail and water need to be created. An important aspect in the analyses is how global demand and the price of fossil-based and bio-based fuels develop. According to the Swedish Transport Administration, there is

170 www.transportstyrelsen.se

171 Parking in heavily-populated, attractive towns: Time for a new approach, The Swedish Transport Administration, 2013

172 Background materials from conference (2011), collaboration for an efficient transport system in the Stockholm region (SATSA).

173 Background document "Appendix 3 – background materials on parking" www.stockholm.se

174 The Swedish Transport Administration (2016), Measures to reduce the transport sector›s emissions of greenhouse gases – a Government assignment", 2016:111.

an increasing gap between the forecast emissions and the climate objectives – a gap which needs to be addressed with new measures and policy levers[175].

The Government intends to propose what is known as a «compulsory reduction» in combination with tax amendments which could lead to a transition from fossil to renewable fuels. The aim is to make distributors increase the distribution of biofuels and find other alternatives to reduce greenhouse gas emissions. At the same time, a number of changes to fuel taxes have to be taken into account with regard to the content of biofuels[176].

Another way to reduce carbon dioxide emissions is the bonus-malus system for new cars, according to which environmentally sound vehicles with low carbon dioxide emissions (<60 grams carbon dioxide/km) receive a bonus at the time of purchase, while vehicles with high carbon dioxide emissions (>95 grams carbon dioxide/km) are levied at a higher tax-rate for the first three years. Vehicles that will be affected by the new system are new passenger cars, light goods vehicles and light buses. The bonus-malus system may be viewed as a supplement to the more general governance through fuel taxes. The Government proposes to introduce the system for new cars from 1 July 2018[177].

Environmental zones have been introduced in a number of larger Swedish towns. The reason has primarily been protection of human health in view of the frequently high levels of particles, nitrogen dioxide and other air pollution that occur in town centres. Until now, requirements have only been imposed on heavy vehicles, but the Swedish Transport Agency has recently examined how passenger cars, light goods vehicles and light buses can be included in the provisions on environmental zones[178].

15.4 Other approaches to future mobility

Digitisation and self-driving vehicles

Government bill 2016/17:21 presents proposals regarding the focus of investments in transport infrastructure for the period 2018–2029. It is noted that digitisation and the development of new technologies will affect both travel patterns and transport. Examples that are mentioned include the development of new technologies for connected infrastructure and more or less self-driving vehicles. Changes are required in capacity utilisation in connection with several connected and collaborating vehicles – the need for parking spaces will also be affected. The Government bill points out that it is important to promote the development of digital innovations. The focus needs to be placed on offering tailor-made mobility solutions for a person or product, known as servicification.

Project on automated vehicles

Sweden participates, together with seven other countries[179], in a project called CoEXist, with the purpose of preparing towns and bodies responsible for road maintenance for the introduction of self-driving vehicles. The automation of the transport system will involve major changes and the ambition is to create preconditions that enable conventional vehicles to share the road network with an increasing pro-

175 The Swedish Transport Administration (2017), "Reduced emissions despite heavier traffic and record car sales", Memorandum 14 February 2017.

176 www.regeringen.se 17 March, 2017

177 http://www.regeringen.se/pressmeddelanden/2017/03/ett-bonusmalus-system-for-nya-bilar/

178 The Swedish Transport Agency, inquiry assignment, 13 January 2017.

179 15 parties from Sweden, Belgium, France, Holland, Italy, Germany and the UK will participate in the CoEXist project. http://cordis.europa.eu/project/rcn/210134_en.html

portion of automated vehicles in a well-functioning way. The three-year project which started this year will include cooperation with four European towns: Gothenburg (Sweden), Helmond (The Netherlands), Milton Keynes (UK) and Stuttgart (Germany) and will tackle identified problems such as efficiency, collaboration and traffic-related security aspects.

Mobility as a service

Mobility as a service (MaaS) means that a traveller can solve his or her travel needs from door to door via a cohesive service. The journey may include different modes of transport, but the traveller will pay for a single service according to an advance agreement, for example, in the form of a subscription. The purpose of MaaS is to reduce congestion and the negative environmental impact of transport, to improve utilisation of resources and to improve health. MaaS is one of the Swedish Government›s priority areas within the framework of the partnership programme Next generation travel and transport.

The first actual test of a MaaS service with paying customers was conducted in Gothenburg in 2013–14. Within the framework of the Go:Smart project, the travel service UbiGo was developed and tested in close cooperation with the business and public sectors and with academia. Almost 200 individuals from just over 80 households became paying customers to the UbiGo service over a period of six months. The service combined public transport, car-pooling, car hire, taxi and bike-pooling – all in one app and on one invoice with 24-hour support and bonus points for sustainable choices. The overall outcome of the trial was positive among participants. They appreciated the "transportation smorgasbord" concept i.e. the different travel needs were included in one package. Participants asked for even greater flexibility in terms of more transport providers to be included in the offer. The main barriers to further dissemination of MaaS were found within and between providing companies and organisations. The evaluation of the project came to the conclusion that present laws and regulations have to be addressed to overcome the institutional barriers[180].

180 Karlsson MA et al. Developing the 'Service' in Mobility as a Service: experiences from a field trial of an innovative travel brokerage Travel service for the future (2016). Transportation Research Procedia 14 3265 – 3273

16. SWITZERLAND

Christina Tobler

16.1 Mobility: Facts and Figures

Travel Behavior

In 2015, the average Swiss resident covered a daily distance of almost 37 kilometers and travelled for 90 minutes every day. The majority of this distance (65%) was covered by passenger car, 24% of the way was travelled by public transportation[181].The total distances covered on Swiss roads and railways added up to 130 billion person-kilometers[182]. Since 1970, the transport performance of motorised private transport and public transport has roughly doubled.

Costs and funding of transport

The cost for road transportation in 2013 (including public transportation) amounted to CHF 74.5 billion, of which 74% accounted for passenger transport and 26% for goods transport (see Table 1). In addition to expenditure on transport and transport infrastructure, these figures also include the cost of accidents and costs for transport-related damage to the environment and health. Most of these generated costs (89%) were covered by the user groups (such as car drivers, bus passengers or freight payers). However, CHF 6.3 billion of external costs (accidents, environmental or health costs) had to be funded by the public sector[183].

Compared to road transportation, the total costs of rail transport were seven times lower with CHF 10.3 billion (see Table 1). Users (passengers and freight payers) covered 47%, the public sector funded 44% of the costs[184].

Table 1. Costs of transportation in Switzerland, 2013

Costs in CHF billion	Road transportation	Rail transporation
– Passenger transport	47.3	8.4
– Public transportation	3.6	
– Goods transport	19.3	1.9
Total	74.5	10.3

In the same year, the total income from motorized road transportation accounted to CHF 8.8 billion. More than half of this sum stemmed from the petroleum tax, 25% was collected through cantonal mo-

181 https://www.bfs.admin.ch/bfs/en/home/statistics/mobility-transport/passenger-transport/travel-behaviour.html

182 https://www.bfs.admin.ch/bfs/en/home/statistics/mobility-transport/passenger-transport.html

183 https://www.bfs.admin.ch/bfs/de/home/statistiken/mobilitaet-verkehr/kosten-finanzierung.assetdetail.1023800.html

184 Ibid.

tor-vehicle taxes and only small fractions came from general taxes, a motorway vignette, heavy-vehicle charges and parking fees[185].

16.2 Current implementation of mobility pricing

Currently, there is no mobility pricing scheme established in Switzerland. There are some taxes and charges for road vehicles and a price reduction scheme for people using public transportation after peak morning hours:

- Each registered vehicle is annually taxed and there is a mandatory annual charge of CHF 40 for using the national motorways. It is applicable to the drivers of all vehicles and is evidenced by a "vignette" or tax disc affixed to the windscreen. The annual charge is considered as a user tax and can be likened to a toll for the use of the Swiss motorways network. Furthermore, there is a petroleum tax and a federal charge on heavy vehicles (either performance-related – depending on the total weight, on the level of emissions and the number of kilometers driven – or in the form of a lump sum).
- To encourage people to travel after peak morning hours, the Swiss Federal Railways (SBB) offer a 9 o'clock travelpass at a reduced price, which is valid from 9 a.m. onwards on Mondays to Fridays. With the pass, one can use any train, postbus, boat or urban transport service and travel almost everywhere in Switzerland.

To ease congestion on Swiss roads and crowded trains during rush hours, the Swiss government decided in 2016 to review the legal basis in order to pave the way for pilot projects using mobility pricing[186]. Under this system, drivers would pay according to the distance they travel on main roads. A system of differentiated ticket prices for public transport could also be introduced.

The transport ministry was mandated to examine legal amendments to launch trials in cooperation with cantons and communes in different parts of the country over the next decade. For the introduction of mobility pricing in Switzerland, the following principles were established[187]:

- «Pay as you use»: Performance-related prices for products and services instead of indirect taxes, levies and uniform tariffs. Consumers of mobility should have an incentive to act cost-effectively.
- Overall, the price of mobility should not be increased, but structured differently.
- Mobility must remain affordable for everyone.
- Mobility pricing includes rail transport as well as road traffic transport.
- Mobility pricing is based on a modular design. This allows for a gradual introduction as well as for a parallel existence of the old and new system.
- Data protection is an important issue and has to be legally regulated.
- Mobility pricing should be transparent and easy to understand for users.

16.3 Societal and political debate

Last year, the Federal Council published a report on mobility pricing. The proposal was sent to political parties, organizations and cantons for consultation. Most cantons viewed mobility pricing as a useful instrument to increase the capacity of rail and roads as well as to break traffic spikes[188].

185 https://www.bfs.admin.ch/bfs/de/home/statistiken/mobilitaet-verkehr/kosten-finanzierung.assetdetail.1024450.html

186 https://www.admin.ch/gov/de/start/dokumentation/medienmitteilungen.msg-id-62452.html

187 https://www.uvek.admin.ch/uvek/de/home/verkehr/mobility-pricing.html?_organization=801&_startDate=08.01.2014&_pageIndex=0

188 https://www.admin.ch/gov/de/start/dokumentation/medienmitteilungen/bundesrat.msg-id-62452.html

However, critics fear the system could make commuting costlier while the possibilities to work flexible hours remain limited. The Swiss People's Party for instance argues that mobility pricing rips commuters off and creates a two-class mobility system. The aim of influencing mobility demand is viewed as state paternalism and instead of mobility pricing, only an immediate expansion of the rail and road networks could solve capacity problems, according to the party[189].
Overall, most politicians demand further measures to curb rush hour traffic, such as flexible working hours, part-time employment models, home office or carpooling. Adjusting the schedules of schools and universities to avoid students travelling in peak hours is also discussed.

16.4 Experiences and outlook

As there currently is no mobility pricing scheme established in Switzerland, experience is lacking so far. In 2016, transport minister Doris Leuthard suggested mobility pricing could replace the current system of taxes on petrol and diesel or the annual fee for the use of Switzerland's motorways gradually until 2030.

However, except for the canton of Zug, no canton or region has been willing to conduct pilot tests. Several cantons have mainly been interested in introducing road pricing in cities, which would contradict the federal aim of including rail and roads as well as cities and agglomerations in an overall mobility pricing approach[190].

Therefore, on July 5th of this year, the Federal Council has decided to forego pilot tests at the moment and has mandated the Federal Department of the Environment, Transport, Energy and Communications (DETEC) to conduct an impact study in the canton of Zug, involving theoretical modeling. The study should examine how performance-related transport charges might affect traffic, the general public, the industry and environment. Results are expected by summer 2019, at which point it is conceivable that mobility pricing will be tested in practice with volunteers[191].

Overall, mobility pricing is a very controversial topic in Switzerland. It is expected that the introduction of pilot trials would result in a referendum, which would ultimately lead to a vote of principle on mobility pricing. Therefore, the future of mobility pricing in Switzerland is rather unclear at this moment.

16.5 Other approaches to future mobility

Automated driving:

Automated vehicles have the potential to change Switzerland's transport landscape in the next 15 to 25 years. Therefore, the Swiss government is preparing for future automated driving by enabling pilot tests, launching research projects and creating legal bases.

Pilot tests:

In June 2016, DETEC issued a temporary permit for PostAuto Schweiz AG to conduct tests with driverless vehicles. The project involves the transport of passengers by two minibuses on a designated stretch of road in the center of Sion. Within the first three test months, the two SmartShuttles have driven more than 1'000 kilometers and transported around 7'000 passengers on more than 800 trips through Sion's old town. Tests are scheduled to end in October 2017[192].

Another pilot project will be launched this summer and involves two driverless shuttle buses in the city of Zug. The two vehicles will operate along a stretch between the railway station and a technol-

189 https://www.svp.ch/aktuell/editorials/gegen-die-einfuehrung-einer-zweiklassenmobilitaet/

190 https://www.admin.ch/gov/de/start/dokumentation/medienmitteilungen.msg-id-67431.html

191 Ibid.

192 https://www.postauto.ch/en/news/smartshuttle-testing-sion-resumes

ogy center and, in contrast to the test in Sion, will be integrated into the local transport network. The test will run until the end of 2018.

Research:

Within the framework of road research, the Federal Roads Office (FEDRO) has launched an "automated driving" research package, by means of which the federal government aims to close existing gaps in knowledge and enable research institutions to closely examine this future-oriented topic[193].

Creation of legal bases:

The use of automated vehicles makes it necessary to create a legal framework within the road traffic legislation. For this purpose, FEDRO has drawn up a concept regarding the road traffic rules that need to be adapted and issues relating to the homologation of vehicles and licensing drivers. The necessary amendments to the involved legislation are currently being prepared[194].

Mobility as a service

In an effort to prepare for future mobility, SBB launched several market trials[195]:

- The comprehensive road and rail package «SBB Green Class»: For CHF 12'200, one hundred trial customers receive a year-long mobility package covering the entire travel chain. The package includes a first class annual GA train pass, annual subscriptions to the PubliBike cycle and the Mobility carsharing scheme as well as the use of an eco-friendly BMW electric car for one year.
- The «Green Class SBB E-Bike» annual pass combines (for CHF 8'980 for first and 6'750 for second class travellers) an annual GA rail pass with the use of an electric bike and a one year membership of a car-share scheme. The trial is open to 300 people.

Both year-long pilots will be monitored by researchers from ETH Zurich, who will track participants' use of the various transport methods. SBB is expecting the results to provide important insights into clients' needs and expectations in terms of door-to-door mobility.

193 "Automated driving – consequences and impacts on transport policy". Report by the Federal Council in response to Leutenegger Oberholzer postulate 14.4169 concerning automated mobility, Bern, 21 December 2016.

194 Ibid.

195 https://www.sbb-greenclass.ch/intro.php

17. UNITED STATES

Naba Barkakati

17.1 Mobility: Facts and Figures

United States has a highly mobile society that relies on a vast, multimodal transportation network with nearly 4.2 million miles of roads, more than 19,000 public and private use airports, about 140,000 miles of freight and passenger railroads, and 25,000 miles of navigable waterways. This transportation system accommodates the mobility demands of more than 321 million U.S. residents and 75 million foreign visitors. In 2014 there was roughly 5.4 trillion person-miles of travel in the United States, of which nearly 70 percent was in cars or other personal vehicles, about 23 percent by air, and the rest by rail and bus public transportation[196]. Much of the travel by average U.S. residents occurs at the local level and such travel often involves repetitive daily trips. In 2009, the latest year for which survey data is available[197], U.S. households averaged about 9.6 trips per day, with the average trip slightly under 10 miles in length. Total annual travel per household was about 33,000 miles, or 13,200 miles per person.

The average U.S. household has a yearly transportation budget of about $9,500 of which about 93 percent is spent on purchasing, operating, and maintaining private vehicles; and the remaining 7 percent goes towards public transportation. Vehicle owners pay gasoline taxes and other user fees that go towards highway construction, but taxes paid by all taxpayers pay for close to half the cost of building and maintaining highways.

The reliance on private vehicles as the most popular mobility option in the United States comes at a heavy price. The aging transportation infrastructure does not have the capacity to effectively handle the mobility demands and causes travel delays due to congestion. The combined hours of delay experienced by all commuters across the United States in 2014 reached 6.9 billion hours. Urban highway congestion cost the economy $160 billion in 2014, of which 17.5 percent, or $28 billion, was due to the effects of congestion on truck movements.

17.2 Current implementation of mobility pricing

In the United States, tolls, congestion pricing, and user fees have been implemented at the state level to help solve congestion and mobility problems and provide new revenues for improving the transportation infrastructure. Congestion pricing is implemented through electronic tolls (charged by the trip and distance travelled) that vary by the time of the day and involves charging a higher price to use the system during peak periods or on congested routes. Doing so provides incentive for users to shift to less congested times or make other adjustments. Those who value the service enough pay the additional price; those who value it to a lesser degree shift their use accordingly. In 1995, Orange County, California implemented the world's first congestion pricing using electronic variable tolling on State Route 91 Freeway. Since that first U.S. congestion pricing project opened in 1995, there were 41 pricing projects in operation or under construction in 2012. About 400 miles of priced highway lanes including

196 U.S. Department of Transportation, Bureau of Transportation Statistics, Transportation Statistics Annual Report 2016 (Washington, DC: 2016). https://www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/TSAR_2016r.pdf

197 U.S. Department of Transportation,Federal Highway Administration, Summary of Travel Trends: 2009 National Household Travel Survey (Washington, DC: 2011). http://nhts.ornl.gov/2009/pub/stt.pdf

nearly 150 miles on the New Jersey Turnpike were in operation with tolls varying from 25 cents to $14. All pricing projects in operation are either High Occupancy Toll (HOT) lanes, which charge solo drivers to use newly constructed lanes or carpool lanes, or peak-period pricing projects, which charge a lower toll on already tolled roads, bridges and tunnels during off peak periods. For example, such HOT lanes have been implemented in the I-495 corridor in Northern Virginia, the I-394 express lanes in Minnesota, and the I-15 High Occupancy Vehicle (HOV) lanes in San Diego, California.

In addition to California, some of the other early adopters of congestion pricing have been Florida, Texas, and Minnesota. By now many other states have set-side lanes or entire stretches of highways that employ congestion pricing. For example, the Intercounty Connector (MD-200) is Maryland›s first all-electronic toll road where tolls are collected at highway speed as motorists drive under tolling structures. Tolls vary to help manage traffic volumes with a higher toll charged during peak hours and a lower toll charged during off-peak and overnight hours.

Tolls and congestion pricing apply to private vehicles and freight transportation. Congestion pricing is also used in public transportation in some regions. For example, Washington DC Metro charges higher fares during morning and afternoon rush hours.

17.3 Societal and political debate

Economists generally believe that charging automobile, truck, vessel, and aircraft operators surcharges or tolls during congested periods can enhance economic efficiency by making them take into account the external costs they impose on others in deciding when, where, and how to travel. Transportation planners agree that congestion pricing is a good way to significantly reduce urban traffic congestion. However, most drivers do not want to pay for roads that are currently free, and most elected officials –aware that drivers are voters – don't support congestion pricing.

In addition to political opposition, incorporating pricing into the U.S. transportation systems involves overcoming several implementation challenges. U.S. Department of Transportation (DOT) has to approve all congestion pricing projects on roadways that receive federal funds and provides grants for project studies, implementation, and evaluation. DOT provides helpful guidance to transportation projects on road pricing[198].

Other potential concerns include income equity (whether low-income drivers are disproportionately affected by congestion pricing) and geographic equity (whether one geographic area is more negatively affected than another, such as when traffic diversion occurs). These impacts are important to assess as they address the public and elected officials' concerns about the effects of pricing on travelers and communities.

Equity concerns may become more acute where sponsors are using pricing not only to manage congestion, but also to raise revenue to build new projects. Raising revenue can be at odds with managing congestion (e.g., increasing passenger throughput) if higher tolls can produce more revenue from fewer paying vehicles. Options to address equity issues include using a portion of toll revenues to finance public transit service.

The current U.S. Administration's 2018 budget submission[199] includes a proposal to fund programs that could incentivize innovative approaches to congestion mitigation and mentions congestion

198 U.S. Department of Transportation, Federal Highway Administration, Road Pricing Overview https://www.fhwa.dot.gov/ipd/revenue/road_pricing/

199 The White House, Fact Sheet 2018 Budget: Infrastructure Initiative (Washington, DC: 2017) https://www.whitehouse.gov/sites/whitehouse.gov/files/omb/budget/fy2018/fact_sheets/2018%20Budget%20Fact%20Sheet_Infrastructure%20Initiative.pdf

pricing as an option. The Administration also suggests reducing current restrictions on tolling on interstate highways. However the trucking industry opposes tolls and in rural areas, the volume of traffic may not be sufficient to generate enough revenue from tolls to pay for basic upkeep of highways.

17.4 Experiences and outlook

Results from 14 U.S. congestion pricing projects that have current and complete evaluations generally show that pricing can help reduce congestion[200]. A 2015 report[201] on a program to demonstrate congestion reduction in Los Angeles, California through the implementation of pricing activities showed that the impacts on congestion on the I-10 and I-110 express lanes were generally positive and 86 percent of users rated their overall experience with variable toll lanes as good to excellent.

Results from two projects in California that used two forms of congestion pricing – a fixed monthly fee and a dynamic per-trip-based fee – showed that both were successful. Both forms of pricing proved to be capable of generating significant changes in travel behavior. In Orange County, California, the express lanes typically move at 60–65 mph (97–105 km/h) while congestion on the free lanes causes speeds as low as 15–20 mph (24–32 km/h). As a result, during a typical Friday afternoon rush hour, the express lanes have twice as much vehicle throughput as the free lanes.

Studies in Florida's Lee County showed that a significant number of residents did change their driving behavior in response to variable tolls, even though the difference in toll prices between peak and non-peak travel was as low as $0.25. Congestion Pricing in Florida continues to be successful in offering their residents a monetary reason to change their driving behavior. Similar improvements in traffic flows have been seen in congestion pricing schemes implemented in Minnesota and Texas.

17.5 Other approaches to future mobility

In the United States, future mobility is expected to be shaped by technologies that initially connect vehicles to each other and the infrastructure, which then evolves into deployment of fully autonomous vehicles, predicted to be commercialized within 5–20 years[202]. Additionally, with the rising popularity of on-demand mobility using shared rides via smartphone apps offered by the likes of Uber and Lyft, it is expected that no one would own a private car in the future. Much of these future mobility technologies already exist. For example, vehicle-to-vehicle (V2V) technologies have already progressed to the point of real world testing, and if broadly deployed, they are expected to offer significant safety benefits[203]. Still in development and testing are vehicle-to-infrastructure (V2I) technologies that would enable roadside devices to communicate with vehicles and warn drivers of safety issues[204].

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200 U.S. Government Accountability Office, *Road Pricing Can Help Reduce Congestion, but Equity Concerns May Grow,* GAO-12-119 (Washington, DC: 2012). http://www.gao.gov/products/GAO-12-119

201 U.S. Department of Transportation, Federal Highway Administration, *Los Angeles Congestion Reduction Demonstration ExpressLanes Program: National Evaluation Report* (Washington, DC: 2015). https://ntl.bts.gov/lib/55000/55600/55669/FHWA-JPO-14-126-1.pdf

202 U.S. Government Accountability Office, *Internet of Things: Status and implications of an increasingly connected world,* GAO-17-75. (Washington, DC: 2017) http://www.gao.gov/products/GAO-17-75

203 U.S. Government Accountability Office, *Vehicle-to-Vehicle Technologies Expected to Offer Safety Benefits, but a Variety of Deployment Challenges Exist,* GAO-14-13. (Washington, DC 2013) https://www.gao.gov/products/GAO-14-13

204 U.S. Government Accountability Office, *Vehicle-to-Infrastructure Technologies Expected to Offer Benefits, but Deployment Challenges Exist,* GAO-15-775. http://www.gao.gov/products/GAO-15-775

The automobile manufacturers, including newer entrants such as Tesla and some technology companies such as Google and Apple, are testing and refining autonomous vehicle technologies, which can control steering, acceleration, and braking without a driver's input. Most automobile manufacturers have already started to introduce semi-autonomous sensor-based technologies capable of reducing a vehicle's speed through adaptive cruise control or even stopping a vehicle through automatic braking when a collision is imminent. As of May 2017, Google self-driving car project, now called Waymo, has already logged 3 million miles on public roads, with the final million miles driven in just seven months.

In anticipation of a future with self-driving cars, many states have already enacted legislation permitting the operation of autonomous vehicles under certain conditions. U.S. DOT has also published a federal policy for highly automated vehicles,[205] which includes performance standards for self-driving cars and offers guidelines on how states can regulate autonomous vehicles.

205 U.S. Department of Transportation, *Federal Automated Vehicles Policy – September 2016*. https://www.transportation.gov/AV/federal-automated-vehicles-policy-september-2016

18. Mobility pricing in Europe and beyond: Summary Synthesis

Christina Tobler

The EPTA report 2017 provides an overview of mobility pricing in 16 countries and regions in Europe, Japan, the United States and Russia. This final chapter presents a summary synthesis of the main findings in the country reports focusing on the current implementation of mobility pricing, the societal and political debate as well as the experiences made. The chapter concludes with some policy recommendations and an outlook on the EPTA conference 2017 "Shaping the future on mobility".

18.1 Current implementation of mobility pricing

According to the editorial guidelines, the term mobility pricing describes charges for the use of any transport infrastructure or services on all transport modes with the objective of influencing travel demand and mobility behavior. Mobility pricing aims to manage transportation demand in order to reduce peak hour travel, congestion, air pollution or greenhouse gas emissions.

According to this definition, prices charged for roads or other transport infrastructures must clearly aim to steer mobility behavior and not solely serve to cover construction and maintenance costs.

Among the members of the EPTA network, the majority of countries have established some form of road pricing (such as road tolls). However, only a few have implemented a mobility pricing scheme, which systematically tries to influence transportation demand in order to reduce congestion (particularly during rush hour) and environmental damage (such as pollution). A few countries have implemented no such scheme. An overview of the countries and their pricing schemes is presented in the table below. The following three sections shortly describe the different policies of the EPTA network countries.

Mobility pricing	Road pricing	No mobility pricing
Japan	Austria	Finland
Norway	Catalunya (Spain)	Mexico
Poland	France	Netherlands
Sweden	Germany	Switzerland
United States	Greece	
	Russian Federation	

Countries with mobility pricing schemes

The mobility pricing schemes in Japan, Norway, Poland, Sweden and the United States meet the definition given above, with charges implemented to influence mobility behavior. All of these policies aim to generally avoid congested roads in inner cities by redirecting the traffic to interregional roads. A few of them also increase charges depending on peak periods (such as the United States) or levels of air pollution (such as Norway).

The first urban toll ring in Europe was created in 1986 in Bergen, *Norway*, with the cities of Oslo and Trondheim following shortly after. The toll rings were built in order to deal with heavily congested roads. Currently there are 11 urban toll rings and about 60 different road tolling projects. Four urban areas have implemented congestion pricing aiming to limit traffic during rush hours, and spread out the traffic more evenly throughout the day. Starting in winter 2017, Bergen will implement a 5-fold increase of tolls during days of heavy air pollution. Since 1990, electric vehicles are strongly incentivized in Norway, which includes reduced toll charges for them.

In *Sweden*, a congestion tax system is currently in place in Stockholm and Gothenburg. The purpose of the tax is to reduce congestion, improve the environment and help to fund infrastructure investments.

The main mobility pricing instrument in *Poland* is an electronic toll collection system, which covers sections of motorways, expressways and selected national roads. Electronic readers on selected road sections connect to a device in the vehicles and charge the toll, dependent on road category, type of vehicle and emission standard. The system is mandatory for heavy vehicles; light vehicles (such as passenger cars) may use the system voluntarily or pay manually. The road tolls are important for managing the traffic flow on the national road network, i.e. concentrating interregional traffic on express roads, at the same time reducing local traffic on those roads.

In the *United States*, tolls, congestion pricing, and user fees have been implemented at the state level to help solve congestion and mobility problems and provide new revenues for improving the transportation infrastructure. Congestion pricing is implemented through electronic tolls (charged by trip and distance travelled) that vary according to the time of the day and involves charging a higher price for the use of the system during peak periods or on congested routes. Doing so provides incentives for users to shift to less congested times or make other adjustments. Tolls vary to help manage traffic volumes with a higher toll charged during peak hours and a lower toll charged during off-peak and overnight hours. Tolls and congestion pricing apply to private vehicles and freight transportation.

There have also been a few attempts in *Japan* to reduce travel demand by increasing the burden on travelers through higher fares on public transportation during peak traffic hours or tolls on public roads. In the cases where mobility pricing schemes have been implemented, it is generally with the intent of inducing users to travel in areas or during hours that are less congested by offering a lower cost. Two of the cases of traffic demand management in Japan were the implementation of environmental road pricing schemes by Kawasaki City in the Tokyo area and in Amagasaki City in the Osaka area. Both of these schemes were intended to provide an incentive for trucks and other large vehicles to avoid traveling on roads that pass through the inner-city by reducing the tolls on roads and expressways that cross less-populated areas near the shoreline. Part of the reason such schemes were implemented is related to lawsuits over pollution from automobiles.

Also in *Japan*, a measure to ease rush-hour congestion on commuter trains is the implementation of off-peak multiple-trip tickets, which are offered by many railway companies operating in the Tokyo and Osaka areas. Less expensive than regular multiple trip tickets, they can only be used during off-peak hours on weekdays as well as all day on weekends and holidays.

Countries with other forms of road pricing

In Austria, Catalunya (Spain), France, Greece and the Russian Federation, some forms of road pricing scheme have been implemented. Most of the countries charge trucks and heavy vehicles for the use of road infrastructures (such as Austria, France and the Russian Federation). Some of them also introduced vignettes and tolls for individual travellers.

In *Austria*, road pricing for individual travellers on motorways goes by way of a vignette. For individual travellers as well as for trucks, extra tolls are levied on specific links (especially in Alpine areas such as the Brenner pass) for environmental reasons and/or in order to recover the infrastructure costs.

In *France*, it is mandatory to modulate the toll rates for heavyweights according to their level of greenhouse gas emission. It is also possible – but not compulsory – to modulate them according to traffic congestion. An ecotax on road freight was extremely controversial and finally abolished.

Germany plans to introduce an infrastructure charge for the use of German federal motorways and federal highways for owners of passenger cars and motor homes registered in and outside Germany alike. The price of the annual vignette for passenger cars will be calculated based on their engine displacement and environmental performance (emission standard).

In Greece and Catalunya, there is no consistent or harmonious road pricing system in use. In *Greece*, all major national highways have tolls; some are operated by the public sector and some by private companies. The tolls can be found on random spots along the highways and the charges depend neither on distance nor time. In *Catalunya*, there are free roads and direct toll roads, where users pay a charge based on their use of the road (distance travelled between joining the road and leaving it at the toll).

Countries without mobility pricing scheme

In Finland, the Netherlands, Switzerland and Mexico, there is currently no mobility pricing scheme implemented. A few of these countries, however, aim to introduce mobility pricing but have not succeeded yet.

In the *Netherlands*, for instance, dynamic road pricing has been debated for thirty years but not yet implemented in any form. The governmental Study Group on Sustainable Growth considers «pay as you drive»-schemes, and specifically congestion pricing measures, a desirable intervention.[206] Some others, however, see implementing dynamic road pricing in the Netherlands as «political suicide».

Mobility pricing is also a very controversial topic in *Switzerland*. In 2016 the government suggested mobility pricing could gradually replace the current system of taxes until 2030. However, it is expected that the introduction of pilot trials would result in a referendum. Therefore, the future of mobility pricing in Switzerland is rather unclear at the moment.

18.2 Societal and political debate

As suggested above, mobility pricing can be a very controversial issue. Accordingly, the national reports of the EPTA members show that the topic is highly politicized and subject of heated debates. In Norway, for instance, the first urban toll ring created in 1986 spurred massive protests, and even death threats against the planners. Since then, tolling has remained a politically heated topic.

Economists generally believe that charging automobile, truck, vessel, and aircraft operators surcharges or tolls during congested periods can enhance economic efficiency inducing them to take the external costs imposed on others into account and to adjust when, where, and how they travel accordingly. Transportation planners agree that congestion pricing is a good way to significantly reduce urban traffic congestion. However, most drivers do not want to pay for roads that are currently free, and most elected officials – aware that drivers are voters – do not support congestion pricing.

Resistance from stakeholders

In the political discussion, right-wing and economy-oriented parties in particular seem to oppose mobility pricing, as has been reported by Norway and Switzerland. The general public appear to be resistant

206 Studiegroep Duurzame Groei. (2016). 'Rapport werkgroep bereikbaarheid'. https://www.rijksoverheid.nl/documenten/rapporten/2016/07/06/rapport-werkgroep-bereikbaarheid

as well, at least at first: In Oslo and the neighbouring county Akershus, 70 percent of the respondents were opposed to the urban toll ring before it opened in 1990. In 2016 56 percent of the respondents were in favour of the toll ring.

In several countries, there has also been strong resistance by the transport sector, such as the truck industry or taxi drivers. In Bergen, Norway, the increases in road tolls led several hundred truck drivers to participate in a go-slow protest against road tolling. Truck drivers in Poland, too, protested against the replacement of the previous vignette system with an electronic toll system by parking their trucks for one hour on road shoulders. In France, the introduction of an ecotax on road freight even lead to the destruction of many detection devices.

Other stakeholders groups opposing mobility pricing were local merchants fearing a drop in customer numbers, handicraft businesses and SMEs, especially in the agrifood sector.

Financial concerns

A concern frequently expressed is that mobility pricing are too costly for car drivers and commuters. In Switzerland, critics argued that mobility pricing threatens to rip off commuters and to create a two-class mobility system. Similarly, in Austria and the United States, there were concerns that low-income drivers were disproportionately affected by congestion pricing and therefore, only the more affluent members of society would be able to afford car ownership and usage in the future.

Equity concerns may become more acute where sponsors are using pricing not only to manage congestion, but also to raise revenue to build new projects. Raising revenue can be at odds with managing congestion (e. g. increasing passenger throughput) if higher tolls can produce more revenue from fewer paying vehicles.

In order to address these fears, the Swiss government decided that mobility pricing must be exclusively used as an instrument to solve capacity problems and not to finance transport infrastructure. Thus, the overall price of mobility should not be increased, but structured differently. Similarly, the car toll in Germany is to be accompanied by car tax cuts, so that no car driver in Germany is subjected to additional financial loads. However, there have also been warnings that financial advantages are not only not to be expected, but there may even be losses, due to the high administrative cost from toll collection.

Privacy concerns

The Norwegian Board of Technology released a briefing on GPS-based road pricing in 2010[207], which spurred a debate on data privacy. Since then, all major transport organizations as well as the Institute of Transport Economics have proposed GPS-based road pricing as an equitable and effective way of charging for road use. A survey in the Netherlands held among members of the Royal Dutch Touring Club showed that most people feared they had no guarantees their privacy would be sufficiently protected.

Doubts about efficiency

In Germany and Catalunya, there is criticism that the tolls are not used for mobility management or environmental pricing. The German Federal Environmental Agency criticizes that the system is not based on the length of trips but is a kind of "flat rate" for people who drive very often and will therefore have no ecological impact.

The introduction of toll roads could also lead to geographic inequity, when one area is more negatively affected than another, such as when traffic diversion occurs. If conventional roads run parallel to toll roads, this could also lead to an inefficient use of the network. In Catalunya, for instance, the

207 https://teknologiradet.no/wp-content/uploads/sites/19/2013/08/SF-GPS-basert-veiprising-2010.pdf

current toll system leads to accidents and congestion on the free conventional roads running parallel to the toll roads. These inefficiencies take the shape of loss of time and accidents and have been quantified by several studies as running into the millions.

Suggested alternatives to mobility pricing

One of the leading arguments pro road tolls is acquiring resources in order to decrease emissions and enhance sustainability. However, researchers claim that road tolls have a marginal impact on enhancing sustainability and that land use planning and infrastructure are the most effective means for a radical decline of traffic emissions[208].

In Switzerland, critics fear mobility pricing could make commuting costlier while the possibilities to work flexible hours remain limited. The argument was raised that, instead of mobility pricing, an immediate expansion of the rail and road networks should solve capacity problems. Furthermore, Swiss politicians demand further measures to curb rush hour traffic, such as flexible working hours, part-time employment models, home office or carpooling. Adjusting the schedules of schools and universities to avoid students travelling in peak hours is also discussed.

18.3 Experiences made with mobility pricing

According to the definition given in this report, mobility pricing should change mobility demand and behaviour, thereby reducing peak hour travel, congestion, air pollution or greenhouse gas emissions. The experiences of the EPTA members presented in this section can give an general indication on the feasibility of these goals.

Some of the expected positive effects of mobility pricing (such as reduced congestion and traffic volume) were reported in Norway, Japan and the United States. In Poland, the introduction of an electronic toll system even lead to a renewal of the transport fleet, which benefitted the environment, road safety and the Polish economy as a whole.

Reduced congestion and traffic volume

After being implemented, congestion pricing in Norway contributed to reduced traffic during rush hours: 10 percent in Trondheim, 3 percent in Kristiansand and 14 percent in Bergen.

Results from 14 U.S. congestion pricing projects also show that pricing can help reduce congestion[209]. A 2015 report[210] on a program to demonstrate congestion reduction in Los Angeles, California through the implementation of pricing activities illustrated that the impact on congestion on the I-10 and I-110 express lanes were generally positive and 86 percent of users rated their overall experience with variable toll lanes as good to excellent. Two projects in California that used two forms of congestion pricing – a fixed monthly fee and a dynamic per-trip-based fee – showed that both were successful and proved to be capable of generating significant changes in travel behavior. In Orange County, California, the express lanes typically move at 60-65 mph (97–105 km/h) while congestion on the free

208 Tuominen A., Tapio P., Varho V., Järvi T. & Banister D. (2014) Pluralistic backcasting: Integrating multiple visions with policy packages for transport climate policy. Futures 60 (2014) 41–58, Elsevier Ltd, dx.doi.org/10.1016/j.futures.2014.04.0140016-3287

209 U.S. Government Accountability Office, *Road Pricing Can Help Reduce Congestion, but Equity Concerns May Grow,* GAO-12-119 (Washington, DC: 2012). http://www.gao.gov/products/GAO-12-119

210 U.S. Department of Transportation, Federal Highway Administration, *Los Angeles Congestion Reduction Demonstration ExpressLanes Program: National Evaluation Report* (Washington, DC: 2015). https://ntl.bts.gov/lib/55000/55600/55669/FHWA-JPO-14-126-1.pdf

lanes results in speeds as low as 15–20 mph (24–32 km/h). As a result, during a typical Friday afternoon rush hour, the express lanes have twice as much vehicle throughput as the free lanes.

In Japan, research conducted over a 10-year period showed that the pricing schemes had a quantifiable effect, the volume of truck and other large-vehicle traffic diverted to routes through less-populated areas being between 10 and 15% in either Kawasaki and in Amagasaki.[211] Environmental road pricing on urban expressways had a quantifiable effect when the overall volume of traffic in the area was fixed. It did not, however, restrain traffic and was ineffective when the total volume of traffic in a designated area increased. Some critics insist that pricing schemes putting a higher burden on travellers might be necessary to control traffic volume effectively.

Changes of mobility behavior

In Norway, the national share of public transport grew from 10 percent to 14 percent from 2005 to 2014. In Oslo, it increased from 21 percent to 25 percent in the same period.

Studies in Florida's Lee County (USA) showed that a significant number of residents did change their driving behavior in response to variable tolls, even though the difference in toll prices between peak and non-peak travel was as low as $0.25. Congestion Pricing in Florida continues to be successful in offering residents a monetary reason to change their driving behavior. Similar improvements in traffic flows have been seen in congestion pricing schemes implemented in Minnesota and Texas.

Other effects

In Norway, the urban toll rings have had little effect on the traffic volumes, but they were a successful means of financing infrastructure projects faster. However, since the share of electric vehicles sold per year has rapidly increased from close to 0 percent to 35 percent[212], the financial incentives result in less revenue for financing transport projects and road construction.

The introduction of electronic toll system in Poland, including the introduction of different rates for heavy vehicles according to their EURO exhaust emission class, contributed to a more rational use of the transport fleet and its renewal, which helped to directly reduce the negative environmental impact of transport. The national transport fleet is currently among the youngest in Europe, which translates into the competiveness of national road transport companies. The national road transport companies have become an important part of the Polish economy, improving the competiveness of the companies they serve, as well as impacting the entire EU economy. Furthermore, the introduction of the toll system is one of the factors indirectly contributing to improving the safety on the Polish national road network (the number of road accidents and their consequences have been declining steadily in recent years).

18.4 Policy recommendations

Mobility pricing could be a suitable instrument to manage traffic demand and address capacity bottlenecks. It could also help to reduce pollution and meet environmental goals. There is, however, some resistance to be expected, as the heated political and societal debates in the member countries point out. For the implementation of a mobility pricing scheme the following recommendations could be drawn from the report:

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211 Yoshitaka Takahashi, "Environmental Road Pricing: Environmental Measures for Urban Expressways," The Journal of the Institute of Electrical Engineers of Japan, vol. 136 no. 11, 2016.11, pp. 748–750. (in Japanese)

212 *English reference:* https://www.ft.com/content/84e54440-3bc4-11e7-821a-6027b8a20f23

• Defining the goals of mobility pricing
Should mobility pricing be introduced to protect and improve the environment? Should congestion and traffic volume be reduced? Is the main aim the financing of infrastructure and maintenance? Different objects of mobility pricing could be at odds with each other. For instance, the aim of raising revenue might collide with environmental goals or congestion management. Clearly defining the purpose of mobility pricing could therefore help to avoid a conflict of objectives.

• Consistent and harmonious mobility pricing schemes
A heterogeneous mix of free roads and toll roads could lead to a traffic diversion and an inefficient use of the transport infrastructure. This could result in higher traffic volumes, congestion and accidents on free roads, which would, consequently, undermine the goals of mobility pricing.

• Address concerns
Resistance from stakeholders is to be expected, e.g. from politicians, the transport sector and residents. Particularly financial concerns may be raised and need to be dealt with. Participative processes might be a helpful method to create productive discussions and to address these concerns.

• Ensure data protection
Data security and privacy are important issues worrying the public. Thus, technical solutions and legal regulations are needed to ensure data protection.

• Consider accompanying measures
Reaching the goals set for mobility pricing might be facilitated by including additional measures, such as policies on land-use and urban planning. Encouraging flexible working hours, home office or carpooling are other examples that might enhance the effect of mobility pricing.

18.5 Shaping the future of mobility

The present EPTA report should make a contribution to the controversial debate about mobility pricing and give an overview of the perspective and experiences of different countries in Europe and beyond.

The EPTA conference 2017, taking place November 8, 2017 at the Swiss Museum of Transport in Lucerne will broaden the topic and take a look at possible future developments. The issue of how future mobility is approached in the different EPTA member countries was also addressed in the last sections of the national reports. With nine out of sixteen countries, a vast majority mentioned that automated and connected road vehicles (or "robot cars") play an important role in future mobility. Other common themes were car sharing (reported six times), electric vehicles (five times) and Mobility as a Service (three times). Consequently, the conference bearing the title "Shaping the future of mobility" will be structured as follows:

Session 1: Visions of Future Mobility in Europe
Session 2: Sharing Mobility & Mobility as a Service
Session 3: Autonomous driving & Electric vehicles
Session 4: Mobility Pricing & Conclusions

The conference aims to present scientific contributions from the fields of economics, technology assessment, innovation and sociology to parliamentarians from various countries in order to foster insights into the policy implications of an issue we are all greatly affected by: the future of mobility

19. Appendix 1: Abstracts

19.1 Future mobility – the view of the Swiss Federal Roads Office

Keynote by Jürg Röthlisberger, Director of the Swiss Federal Roads Office (FEDRO)

The volume of traffic on our roads is increasing rapidly. The network infrastructure needs to be expanded, but this measure on its own will not enable us to master the existing traffic volume. We will therefore have to find ways to use the road network more efficiently and intelligently.

On the motorway and national roads network, the use of emergency lanes and the implementation of other traffic management measures are envisaged in the short to medium term. But the readiness on the part of road users to share their vehicle with others or use vehicle sharing options can also ease the burden on the network.

In the longer term, mobility pricing is a suitable instrument for easing congestion during peak periods and thus ensuring a more balanced utilisation of the infrastructure. The introduction of fully and partially automated vehicles could also facilitate the achievement of this objective.

The Federal Department of the Environment, Transport, Energy and Communications (DETEC), and in particular its unit responsible for road transport, FEDRO, are playing an active role in this development. For example, FEDRO has already licensed trials with automated buses in Sion and Marly, and related activities are currently in progress aimed at adapting road traffic legislation to the changing circumstances. In this way, FEDRO is creating the necessary background conditions for the use of new technologies. It also plans to upgrade the motorway infrastructure at the appropriate time in order to enable the necessary networking between vehicles and infrastructure.

This will foster the development and use of new technologies. FEDRO is also supporting the use of more efficient vehicles on Switzerland's roads, for example in the area of development and promotion of electric vehicles.

19.2 Smart mobility in the Netherlands

Magda Smink, Rathenau Institute, Netherlands

Dutch smart mobility policy aims to achieve a transition to a safer, and more efficient, accessible, and sustainable mobility model. There are high expectations from the phased implementation of connected autonomous vehicles and flexible mobility services, including car sharing. However, some experts argue that dynamic road pricing schemes will still be necessary to achieve the above public goals. For the last three decades, however, road pricing has been a very controversial topic and neither societal nor political support has been found for this policy option. This history shows that for a successful mobility transition, privacy is an important societal question to address, as are security, safety and liability.

19.3 The UK perspective on mobility

Sarah Foxen and Jack Miller, Parliamentary Office of Science and Technology, United Kingdom

Past experience shows that transport can be one of the most challenging areas for policymakers, who face sub-optimal infrastructure lock-in and difficult political choices. This presentation gives an overview of the current mobility policy landscape in the UK, contextualizing and exploring the following recent strategic developments:
The Transport Investment Strategy: *Moving Britain Ahead*, published by the UK Department for Transport. The strategy makes the case for continued investment in the UK's transport infrastructure and presents the strategic priorities and propositions which centre around or are interlinked with: the creation of a more reliable, less congested network; growing a more productive, balanced economy; enhancing global competitiveness; and supporting the building of new housing.
In June 2017 the UK Government announced plans for an Automated and Electric Vehicles Bill. Elsewhere, in September 2017, Parliament's Business, Energy and Industrial Strategy Committee announced its inquiry into electric vehicles: *developing the market and infrastructure*. This recent focus around electric vehicles follows on from earlier work of the Parliamentary Office of Science and Technology who, in 2013, published a briefing on autonomous road vehicles.
Finally, in July 2017, The Government Office for Science announced a one-year foresight project to explore the Future of *Mobility*. The aim of this project is to gather scientific evidence and knowledge of future techniques to inform policymakers.

19.4 Sharing and intermodal mobility options: from niches towards more sustainable mobility regimes?

Jens Schippl, ITAS, KIT, Germany

This presentation contributes to the discussion whether digitalization may lead to urban mobility regimes which are strongly dominated by "sustainable" practices of car-sharing and multi- or intermodality. It is widely acknowledged that cleaner technologies such as electric mobility are necessary but not sufficient for sustainable transitions of urban transport systems. A reduction in the usage of private cars is also needed, which means changes in the way we travel. Since several years it can be observed that a broad range of relatively new services such as different forms of car-sharing, ride-sharing and similar schemes emerge, strongly supported or enabled by digitalization. These services are often considered as highly promising niche application that will trigger a transition towards strongly inter- and multimodal urban transport regimes.

Transition research has repeatedly highlighted the co-evolutionary nature of transition processes. Technical developments, societal trends and changes in the institutional settings of a sociotechnical system mutual influence each other – and may lead to new "configurations that work". Technology assessment has to take these complex processes of mutual feedback into account in order to be able to inform decision makers a.) about potential development pathways and their impacts b.) about the sustainability of these pathways and c.) about policy options to take influence on the course and character of these pathways.

The presentation introduces an approach to take institutional dynamics more explicitly into account in prospective analysis. It is argued that urban mobility systems are usually populated by different, sometimes competing institutional logics. Whether future urban transport will be shaped by intermodality and sharing schemes, or by an even stronger dominance of private car usage, may strongly depend on how institutional settings will develop and co-evolve with new technological options. Both directions appear to be still possible and – in spite of digitalization – there seems to be a need for strong governance to ensure more sustainable urban mobility and more livable cities.

19.5 Future outlook in Sweden: Mobility as a service

Bo Nyström, Research Service of the Riksdag, Sweden

The Swedish debate about sustainable transport currently dominates by the issue of electrification of the transport sector. Mobility as a service[213] (MaaS), however gradually gets more attention, on the national, regional and local level. The first example of a more advanced MaaS service in Sweden was a trial with paying customers conducted in Gothenburg in 2013-14. The so called Go:Smart project developed the UbiGo travel service. The service combined public transport, car-pooling, car hire, taxi and bike pooling – all in a smartphone app. Altogether 83 households and 195 individuals became UbiGo customers for a period of 6 months. The final evaluation of the trial showed that the participants became less positive towards private car and more positive towards alternative modes of transport.

There are a number of local initiatives. The car-sharing project in the Tolg community in southern Sweden has for instance started to offer the WiseTravel platform to companies, integrating different transportation modes like bikes, public transport and car sharing. Many municipalities and regions have also established sustainability goals for transportation.

On the national level, the Swedish cooperation "Samtrafiken", owned by 38 private and regional transport companies, is coordinating different transportation solutions. A new service will soon be launched in the region Västra Götaland, providing integrated transportation solutions. According to the Swedish National Mobility Program, similar services are planned for the Stockholm and Skåne regions in 2018 and 2019.

The Swedish government has established a group for MaaS-cooperation between relevant national agencies and the Swedish Innovation Agency, Vinnova, is funding a number of projects, established by the national action plan for combined mobility, KOMPIS.

213 Mobility as a service (MaaS) means that a traveller can solve his or her travel needs from door to door via a cohesive service. The journey may include different modes of transport, but the traveller will pay for a single service according to an advance agreement, for example, in the form of a subscription.

19.6 Self-driving Cars: TA Questions along their way from a promise to a solution

Torsten Fleischer, ITAS@KIT, Germany

Self-driving cars, or automated driving (AD) as the underlying technology is called in expert circles, now seem to be feasible in the course of technical change. In connection with related social performance promises, they also appear to be economically and politically attractive. In a short period of time, AD has developed into a top topic in industry, politics, science and the media.

Research and development at automated driving are currently focusing on technical feasibility as well as HMI. In both the expert discussions and the public debate, a wide variety of positions regarding vehicle and service concepts, the respective technical maturity levels, entrepreneurial implementation strategies, time to market or the required regulatory environment can be found.

In view of this, questions on the social conditions under which such techniques would have to be (or should be) designed or could be introduced, as well as on the possible social consequences of their widespread use, are raised comparatively rarely. However, given the role that mobility systems with the corresponding infrastructures play for quality of life and economic development in modern societies and noticing that self-driving cars promise to transform (or, depending on the perspective, threaten to transform) them, these questions are at least as important as technological-economic arguments for innovation and diffusion processes around AD. The paper will identify and discuss some of the non-technical challenges that AD will face today and in the future and attempts to outline some important questions for technology assessment.

19.7 Autonomous Cars: Private Chauffeurs or Collective Transport?

Tore Tennøe, Teknologirådet, Norway

Deemed impossible only few years ago, the technology for autonomous driving has made a leap and is now poised to transform the city transport system. The question is what kind of transformation – and for whom?

Two alternative paths for autonomous cars are emerging. The first focuses on the technology and how it can improve today's transport: Driving may become safer and available for everyone, and time in the car more productive or relaxing. Coupled with electrification, autonomous driving may also approach zero marginal cost. This could mean a private chauffeur for everyone, bringing city dwellers door-to-door, for the price of taking the bus. However, this will increase the demand for transportation, meaning congestion or need for more infrastructure. In this vein, Elon Musk has suggested a 3D web of tunnels under Los Angeles.

The second vision focuses on a shift from ownership to mobility, and implies alternative use of urban space. Sharing economy concepts and Mobility-as-a-Service enable platforms on which autonomous vehicles can be integrated with public transport. A recent simulation indicates that a fleet of shared taxis and minibuses may remove all congestion and eliminate 95 percent of parking spaces in a city like Lisbon. Freeing up space opens up for discussions about alternative use of land – for bikes, parks or more housing.

Regulators in Norway and several other European countries have already made first steps in allowing for testing and deployment of autonomous cars on public roads. However, a real transformation of the transport system will depend on regulating spaces as well as vehicles. Mobility pricing, zoning, elimination of parking lots and market (de)regulation are some of the tools that policymakers have at hand.

19.8 Autonomous electric vehicles and public finance

Stefanie Peer, Wirtschaftsuniversität Wien, Austria

Vehicle and fuel taxation generate revenues upward of 5% of national budgets in most OECD countries. The pending introduction of autonomous (electric) vehicles is predicted to have significant impacts on (among others) travel demand, fuel consumption and car ownership structures, and as a consequence also on tax revenues. Alternative modes of taxation that can accommodate for these upcoming technologies will become necessary. In the process of designing these taxation schemes, the avoidance of costly lock-in effects is crucial. More targeted taxes that lead to an internalization of external effects (congestion, pollution, noise, use of public space, etc.) will increase efficiency and are likely to foster public acceptability. Such taxes that are in line with 'user pays' and 'polluter pays' principles are increasingly feasible due to the digitalization of mobility systems and other innovations such as GPS tracking of vehicles.

19.9 Electric motorization of the future

Huguette Tiégna, OPECST, France

The ban on sale of petrol and diesel cars from 2040, made public by the French Government, is part of an international effort to strengthen constraints on particulate and CO_2 emissions. Other countries have announced similar or even more stringent targets. The effort required to reach the aim is huge, but several technical avenues are emerging: a massive increase in investment in R&D on electric vehicles, in order to lighten batteries and boost their autonomy, hybrid or mild hybrid (low-voltage) vehicles, hydrogen fuel cells, etc.

At the same time, research on combustion engines and fuels continues to advance. The changeover from the demand for cars to the need for mobility, with more shared vehicles, will also facilitate the transition process. More detailed scenarios, involving car and automotive components manufacturers, as well as new players, still have to be developed to reach the target. The OPECST could make a useful contribution to this forward-looking approach.

20. Appendix 2: Contributors

Country/Region	EPTA-Member	Authors of country report
Austria	ITA INSTITUT FÜR TECHNIKFOLGEN ABSCHÄTZUNG Institute of Technology Assessment (ITA) of the Austrian Academy of Sciences oeaw.ac.at/ita/en	Stefanie Peer & Tanja Sinozic
Catalunya (Spain)	CAPCIT Consell Assessor del Parlament sobre Ciència i Tecnologia Advisory Board of the Parliament of Catalonia for Science and Technology (CAPCIT), Catalan Regional Parliament parlament.cat/capcit	CAPCIT, with the collaboration of the Government of Catalonia
EU	STOA Scientific and Technological Options Assessment (STOA), European Parliament stoa.europarl.europa.eu	Christian Kurrer
Finland	EDUSKUNTA RIKSDAGEN Committee for the Future, Finnish Parliament eduskun-ta.fi/EN/lakiensaataminen/valiokunnat/tulevaisuus-valiokunta/Pages/default.aspx	Olli Hietanen
France	SÉNAT UN SITE AU SERVICE DES CITOYENS · ASSEMBLÉE NATIONALE Office Parlementaire d'Evaluation des Choix Scientifiques et Technologiques – Parliamentary Office for Evaluation of Scientific and Technolo-gical Options (OPECST), French Parliament senat.fr/opecst/english.html	OPECST

Country/Region	EPTA-Member	Authors of country report
Germany	Office of Technology Assessment at the German Bundestag (TAB) tab-beim-bundestag.de/en/	Torsten Fleischer, Maike Puhe, Max Reichenbach and Jens Schippl. Research assistance: Lemana Babovic
Greece	Greek Parliament hellenicparliament.gr/en/Koinovouleftikes-Epitropes/CommiteeDetailView?CommitteeId=983767d2-0b12-48c6-910d-ad74b8d0ca6e&period=26c28f97-f651-4937-85dc-a52600fb148e	Costas Papadimitriou
Japan	Science and Technology Research Office, Research and Legislative Reference Bureau, National Diet Library of Japan http://www.ndl.go.jp/en/diet/service/works.html	Yasuyo Takamine
Mexico	Foro consultivo cientifoco y tecnologico, AC http://www.foroconsultivo.org.mx/	Brenda Ávila, José Franco & Víctor Hugo Guadarrama
Netherlands	Rathenau Institute of the Royal Netherlands Academy of Sciences rathenau.org	Marijn Biesiot, Melanie Peters, Magda Smink & Rinie van Est
Norway	Teknologirådet – Norwegian Board of Technology (NBT) teknologiradet.no/english/	Joakim Valevatn

Country/Region	EPTA-Member	Authors of country report
Poland	Bureau of Research (BAS), Polish Parliament bas.sejm.gov.pl/	Mirosław Sobolewski
Russian Federation	Analytical Department of the Council of Federations council.gov.ru/en/about/	Victor Krivov & Timur Semenov
Sweden	Evaluation and Research Secretariat (ERS), Swedish Riksdag riksdagen.se/en/Committees/The-parliamentary-committees-at-work/Research-and-the-future/	Helene Limén & Bo Nyström
Switzerland	Stiftung für Technologiefolgen-Abschätzung Fondation pour l'évaluation des choix technologiques Fondazione per la valutazione delle scelte tecnologiche Foundation for Technology Assessment Foundation for Technology Assessment Switzerland (TA-SWISS) ta-swiss.ch/en	Christina Tobler
USA	Center for Science, Technology, and Engineer-ing (CSTE) of the U.S. Government Accountabil-ity Office (GAO) gao.gov/technology_assessment	Naba Barkakati

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