CLIMATE ANALYTICS

Transport decarbonisation in Hungary: Beyond best practices national technical report

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CLIMATE ANALYTICS

Supporting science based policy to prevent dangerous climate change enabling sustainable development

Summary

This national technical report examines the current state of public transportation in Hungary and provides policy recommendations to decarbonise the transport sector. Hungarian transport policy has prioritized road transport. Furthermore, Hungarian housing policy has caused suburbanisation and as a result led to longer commuting distances. Rising disposable incomes have increased private car ownership: 45% of households own one car, 20% have two, and 5% of households have three or more cars. Hungary is also a large market for used cars imported from wealthier EU countries, but these older cars have higher tailpipe emissions.

The report recommends policies that reduce individual willingness to drive private cars, as well as total kilometres driven. Financial measures such as tolls and taxes on car imports can adjust the price of car ownership to accurately reflect the negative externalities this practice causes. Particulate filter quality controls must also be placed on the registration of new vehicles. Most importantly, the Hungarian public must be informed about the link between car traffic and the climate crisis. By adopting these measures, Hungary can effectively transition its public transportation sector to a sustainable future.

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Introduction

Hungarian transport policy over the past several decades has been primarily focussed on developing road infrastructure to support expanded vehicle ownership and increased mobility demand. Development of the Trans European Transport Network (TEN-T) and the construction of motorways has often taken precedence over maintenance and development of the technical standard of the internal road network. The railways have been relegated to the background, and the technical state of the tracks and the rolling stock has deteriorated. The most recent EU budget period brought some improvement in this respect, with the renewal of several railway lines and the purchase of modern passenger motor trains. However, passenger services on many lines have been unnecessarily discontinued, forcing passengers to rely on buses and private cars. Other circumstances have also pushed the modal split in favour of car use. Rising incomes and personal attitudes among consumers and commuters, combined with poor inter-city public transport, have been cited as key drivers of dependence on passenger cars.

Although there are several strategies, programs, and plans concerning the development and decarbonisation of the transport sector, they are not ambitious enough to decarbonise passenger transport in Hungary. The goal of this report is to provide targeted ideas for accelerated decarbonisation of the passenger transport sector in the country. The highlighted best practices for Hungary primarily address the use of internal combustion engine (ICE) cars, which are currently the single largest source of passenger transport emissions.

Transport governance

The Hungarian government projects increasing mobility levels, and continues to develop transportation policy which prioritises road infrastructure investments. Public transportation has not been liberalised yet and service providers are still mainly state-owned, especially in intercity transport. Volánbusz, a publicly owned company, provides the majority of local services, and municipalities only provide local public transport in larger towns. Public transport is under-financed, and if at all available, schedules are not attractive enough for those who are able to use private cars. There has been some progress in the last decade, particularly in rail passenger transport in and around Budapest, with updated rolling stock for commuters and some track renovations.

The most important factors affecting passenger transport in Hungary are housing policy that has fuelled long-distance commuting, significant road infrastructure investments expanding road capacity and the inadequate supply of public transport. Tax policy is a secondary factor, which has resulted in massive imports of used cars since 2013, increasing the average age of the car fleet and lowering the average technical condition, increasing the share of car trips in the modal split, and contributing to increasing carbon emissions from passenger transport. Passenger transport emissions are additionally impacted by the fuel price freeze introduced by the Hungarian government in 2022, which kept fuel price from increasing along the prices at the global market. Although now lifted by the government and rising fuel prices may reduce fuel consumption, it is challenging to predict how the situation will develop in the future.

The following subsections described two legal documents that are of great importance for passenger transport in Hungary. Subsequently, it describes the initiatives and status of electrification in the country and concludes with some recommendations.

National Transport Infrastructure Development Strategy

The National Transport Infrastructure Development Strategy (NTS) is the main document that outlines the priorities in terms of funding transport infrastructure and the development of public transport in Hungary. The most recent version of the NTS was adopted in 2015 and constitutes the basis for spending funding from the European Structural Funds and the Connecting Europe Facility (CEF) in the period 2015-2030 (Ministry of National Development, 2014).

The NTS targets the development of more socially beneficial infrastructure and improves services that are already in operation through higher efficiency and better physical infrastructure. The NTS additionally provides support for the study of non-motorised modes of transport and demand-based planning of public transport services. (Hungary, 2015)

The NTS includes policy targets at two levels (see **Figure 1**). The first level entails social objectives such as the promotion of economic growth and social justice. Level two focuses on transport objectives, such as strengthening resource-efficient transport modes, or the promotion of active modes of transport such as walking and cycling. Walking and cycling are described as a tool to improve the social benefits of passenger transport by supporting service quality and efficiency (Hungary, 2015).

Figure 1 NTS target tree

The NTS seeks to achieve its goals by leveraging several management tools, namely long-term, predictable funding for cost-effective public services and the coordinated development of the incentive system (e.g., price controls, subsidies, or tools to influence consumer opinions).

The core of the NTS is an evaluation of infrastructure development tools or "possible interventions". Most possible interventions result from EU-supported projects during 2014-2020 budget period (Hungary, 2015). Evaluated interventions concerning passenger transport include:

- Development of non-motorised modes (walking, cycling) through infrastructure and management tools.
- Improving travel comforts and connecting transport chains in suburban transport.
- Development of bus transport in the suburbs where there is no railway.
- Implementing passenger rail vehicle and bus exchange programmes.
- Demand-based planning of public transport services.
- Low-cost development of railway services in the regional traffic of large cities.

- Low-cost transport between suburban and rural areas and railway stations.
- Development of intermodal nodes such as Park & Ride facilities.
- Improving road and railway safety, especially in Budapest.
- The development of missing elements to connect European and national cycling network.

The NTS provides a framework the government can use to select projects, but it does not provide a concrete roadmap for reforming or expanding passenger transport. In the absence of a coherent strategy, mobility policy and development are restricted to infrastructure development.

Hungarian National Energy and Climate Plan

As an EU member state, Hungary is obliged to submit its National Energy and Climate Plan (NECP) on a regular basis. The Hungarian Ministry of Innovation and Technology submitted the most recent NECP in August 2019 (Hungary Ministry of Innovation and Technology, 2019). It sets the target of a minimum 14% share of renewable energy in transport by 2030 – an increase from 6% in 2021 (Eurostat, 2023d). To meet this target the government intends to increase the share of first-generation biofuels produced from food crops and fodder plants to roughly 7%, and the share of second-generation (or advanced) biofuels produced from waste and biogas to 3.5% (Hungary Ministry of Innovation and Technology, 2019). The remaining share of the target is to be met through the increase of electricity in transport.

The Hungarian NECP uses two scenarios to project the 2030 situation: "With Additional Measures" (WAM) and "With Existing Measures" (WEM). The estimation of energy consumption under the WEM scenario indicates no reduction of energy consumption in the transport sector (Hungary Ministry of Innovation and Technology, 2019). Rather, demand is set to increase by 12% by 2030 in comparison to 2021 (**Figure 2** below) (Eurostat, 2023b).

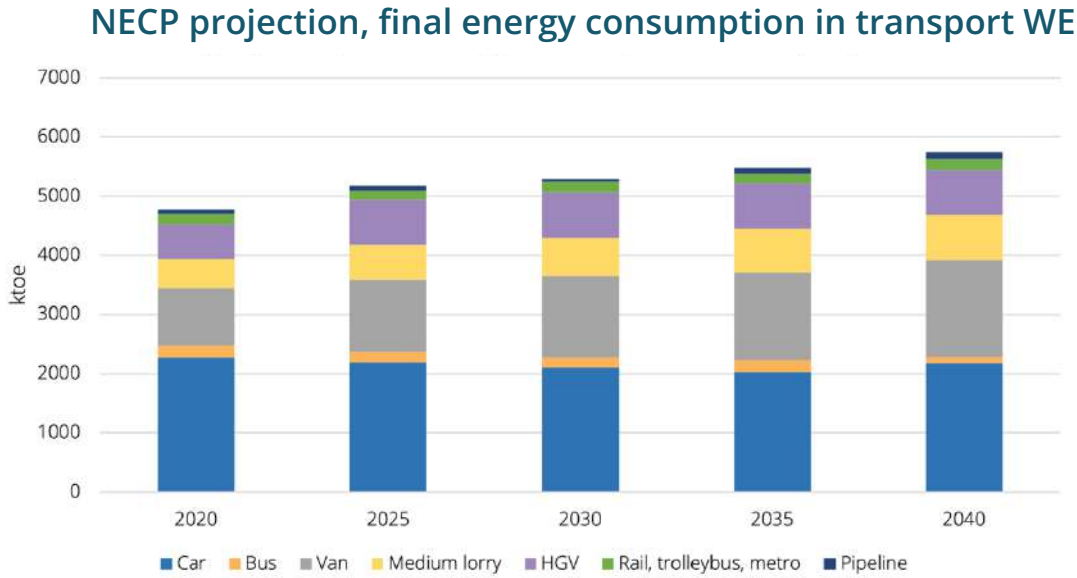

Figure 2 Energy consumption in transport, WEM

(Hungary Ministry of Innovation and Technology, 2019)

The NECP WEM scenario projects a decrease in oil consumption, substituted by electricity and gas. Oil accounted for 92% of total transport energy consumption in 2016, the model forecasts its fall to 77% in 2030 (**Figure 3**).

The scenarios project a decrease in oil consumption from 92% in 2016 to 76% in 2030 and 63% in 2040 (Hungary Ministry of Innovation and Technology, 2019). Apart from increasing the share of energy from renewables, oil should also be replaced by natural gas, the share of which is set to increase almost tenfold, from 0.89% in 2016 to 8.66% in WEM and 8% in WAM by 2030.

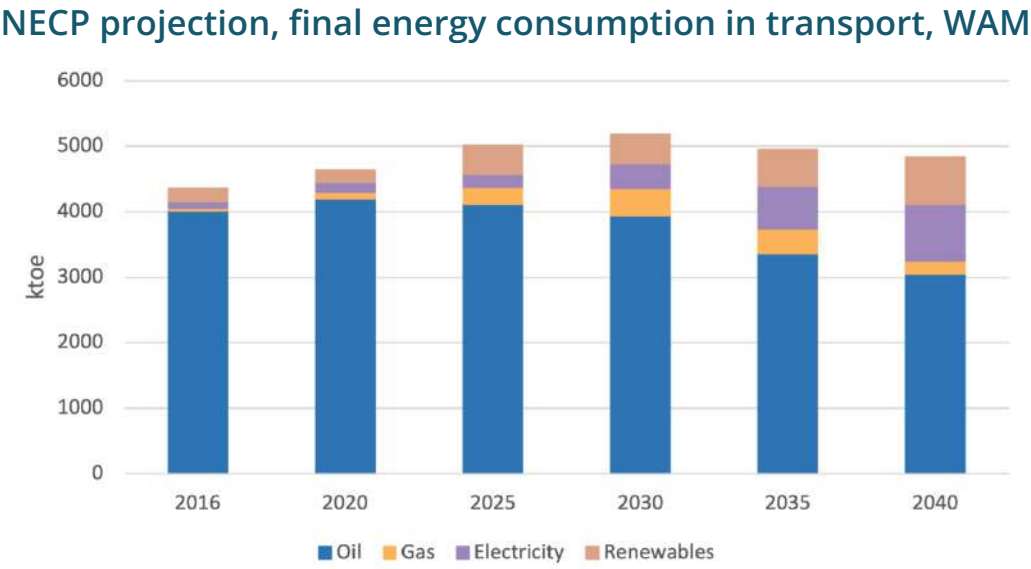

Figure 3 Final energy consumption, WAM

(Hungary Ministry of Innovation and Technology, 2019)

One of the policy initiatives clearly stated in Hungarian NECPs is the Green Bus Program, which is expected to bring around 1300 more environmentally friendly local buses into service by 2029. Initially the programme prioritised the procurement of compressed natural gas (CNG) and EURO-6 modern diesel buses beginning in 2020. In the following stages, focus will shift to procuring to electric buses (Hungary Ministry of Innovation and Technology, 2020; IEA, 2021a).

By June 2023, all EU member states must submit drafts of an updated version of the NECPs followed by a final version a year later. The Hungarian government should take this opportunity to update its NECP and implement more ambitious targets for transportation electrification and emissions reductions.

Transport electrification

The 1998 Act I regulates traffic, and was expanded and updated over time to include electromobility as the field developed (Farkas Csamangó, 2020). It defines electromobility services, as well as licensing, reporting obligations and regulations for consumers, dealers, and charging point operators.

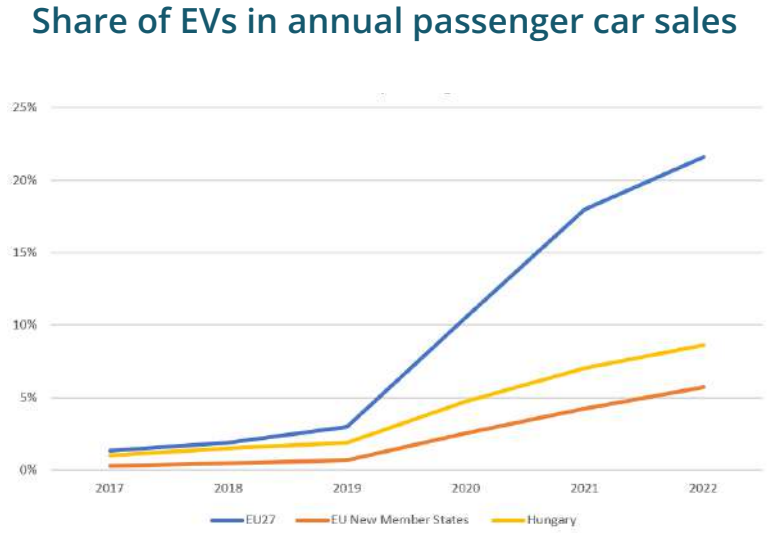

Figure 4 Share of EVs, Hungary
(Fitch Solutions, 2023)

Hungary has increased support for EVs in recent years, providing financial incentives and subsidies to consumers. In 2016, the government announced its initial support program, which included HUF 2.3 billion (EUR 6.2 million) in funding (IEA, 2017a, 2017b). Since then, the state has contributed approximately HUF 12 billion (EUR 32 billion) towards the purchase of electric cars, with the last program having ended in 2022. Additionally, the government is expected to support the construction of the charging stations. Currently, electrically chargeable cars are exempt from motor vehicle taxes, company car taxes, and registration taxes (Ibid.).

All these measures have resulted in an increase in the share of electric vehicles among newly sold passenger cars in Hungary, from around 1% in 2017 to 8.6% in 2022 (Fitch Solutions, 2023). While this share was slightly higher than in other countries that entered the EU since 2004, Hungary's share of EV sales remains significantly lower than in the EU overall, which reached almost 22% in 2022 (Bello, 2023). In addition, of the EVs and hybrids sold, the share of battery-only vehicles in electrically chargeable vehicles sold in Hungary dropped from 63% in 2017 to 49% in 2022 (Fitch Solutions, 2023).

Hungary has a national policy framework in place for the construction of alternative fuel infrastructure (European Commission, 2023). The national policy framework specifies target values for the construction of the public charging point network the most ambitious of which is 45,000 charging points by 2030.

Electrification is further supported by the Integrated Mobility Operational Program Plus for the 2021-2027 period, which invests EU Funds in the electrification of passenger transport, focusing on building and developing low emission urban transport infrastructure, low emission public transport vehicles, and electric railways infrastructure (Hungary, 2021).

Electrification of railways

In 2021 Hungary had 3,221 km of electrified railway out of roughly 8,000 km total, or about 42%, well below the EU average of roughly 57% (Hungary Central Statistical Office, 2023b; Statista, 2022). The government has not prioritised railway electrification and diesel trains are still the norm, however advances in hydrogen fuel cell trains may mean that total electrification may not be necessary to achieve low- to zero-emissions rail transport (van Leijen, 2022).

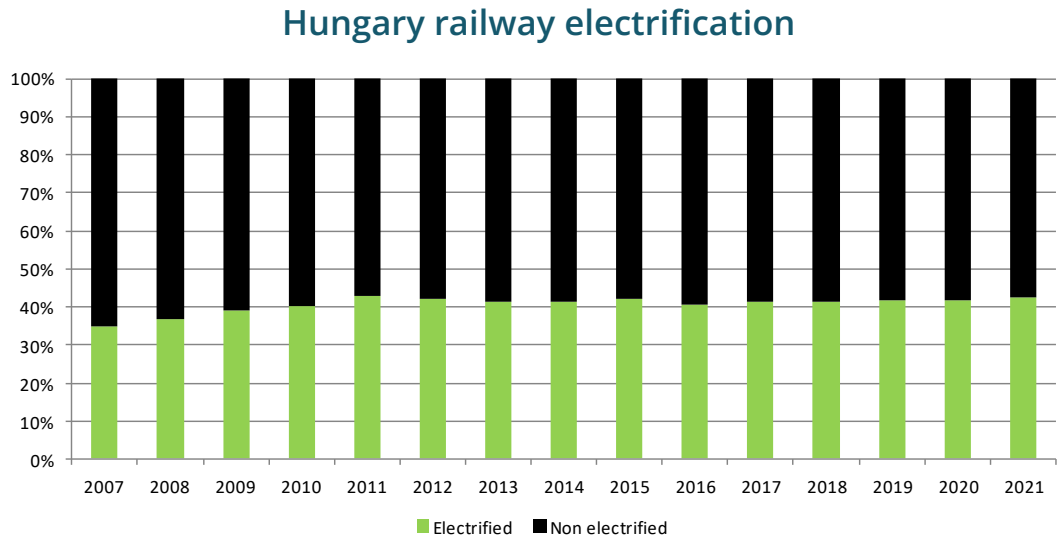

Figure 5 Rate of railway electrification in Hungary

(Hungary Central Statistical Office, 2022; Statista, 2022)

Conclusions

Electrification of road-based public transport, especially buses, is a key starting point and is both, relatively easy and cost-effective. Investing in fixed-track passenger transport, on the other hand, should be pursued cautiously, due to the reliance on autonomous and connected cars between 2030 and 2040 (Goulding Carroll, 2023). Instead of replacing private cars with electric ones, it seems reasonable to support future-oriented services, such as public carpooling, carpooling, and directional taxis, as well as tailored public transportation on demand.

Biofuels account for the largest share of renewable energy consumption in the transport sector in Hungary. Although the number of electric vehicles has increased recently, they play a minor role in 'clean' transport. According to the NECP, the share of

biodiesel and bioethanol in fuels would increase to 8.2% (to 6.1% in petrol) by 2020 (Hungary Ministry of Innovation and Technology, 2019). The Hungarian government intends to encourage both the use and domestic production of advanced, second-generation biofuels (Ibid.). However, since 2020, the usage of biofuels in the European Union changed slightly due to the change in the eligibility of first-generation biofuels for inclusion in the Member States' renewable energy mix (Goulding Carroll, 2023). Hungary recorded a sharp fall in 2021, dropping, from a 11.6% share to 6.2%. The objective is to increase the consumption of so-called second-generation biofuels. In the meantime, Europe and Hungary are experiencing a contradictory trend, a rise in the production and consumption of Hydrotreated Vegetable Oil (HOV) biodiesel produced from used cooking oil (UCO) (European Commission, 2022).

Hungarian modal split and passenger transport emissions in numbers[1]

Total passenger activity in Hungary has been rising steadily over the past two decades, despite dipping during the pandemic - from 84 billion passenger kilometres (pkm) in 2000 to 95 billion pkm in 2021 – an 18% increase overall. During the same time total emissions from passenger transport increased from 7.3 $MtCO_2$ in 2000 to 9.6 $MtCO_2$ in 2021. Per capita emissions from passenger transport in Hungary have increased by 39% from 712 $kgCO_2$ per capita in 2000 to 986 $kgCO_2$ per capita in 2021. Cars contribute the greatest share of emissions, with international aviation distant second.

Passenger transport emissions 2000, 2010, 2021 ($kgCO_2$ per capita)

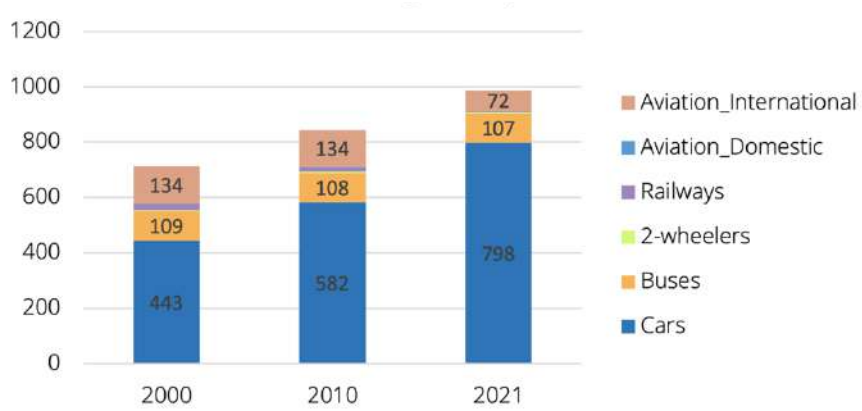

Figure 6 Hungary passenger transport emissions

With an average of almost 7,000 pkm travelled per capita by car in Hungary in 2021, this mode of transport accounted for the largest share in passenger activity, increasing from a 62% share in 2000 to just over 80% in 2021. While slightly cleaner now than in 2000, passenger cars in Hungary are also much emptier: their occupancy rate decreased from 2.35 persons per vehicle in 2000 to 2.09 persons per vehicle in 2021. There are also more cars on the road in Hungary: increasing from less than 2.4 million in 2000 to 4 million in 2021. At the same time, population in Hungary decreased by 4.8%. As a result, the level of motorization increased from 232 cars per 1000 citizens in 2000 to 415 cars per1000 citizens in 2021.

Cars on the road in Hungary are also getting older – the average age of cars in 2000 was 11.7 years, increasing to 14.8 years by 2021 (Budapest Business Journal, 2022; Hungary Central Statistical Office, 2023a). At the same time, fuel changed – in 2010 the rate of diesel cars was 21% and in 2019 it was 31.5%. Generally, most of the diesel cars put on the road were not new but older imported second-hand cars.

[1] The data provided in this section have been calculated using the Transport Emissions Disaggregation Tool (TEDiT). Climate Analytics (2023). Transport Emissions Disaggregation Tool. Retrieved from http://tools.climateanalytics.org/tedit/

The increase in the activity levels of passenger cars has been facilitated by development of the motorway network. The length of the motorway and e-roads was 448 km in 2000, 1274 km in 2008 and 1860 km in 2021 (Eurostat, 2023c). Although the main justification for building motorways is increased mobility, the result is more likely to be people travelling further, moving out of cities and commuting for work and school. Since motorways allow for much faster driving, which also results in higher emissions per vkm, this resulted in higher CO_2/vkm intensity. Emissions intensity from passenger cars dropped consistently between 2000 and 2013 before ticking slightly upwards from 188 gCO_2/vkm in 2013 to 240 gCO_2/vkm in 2021.

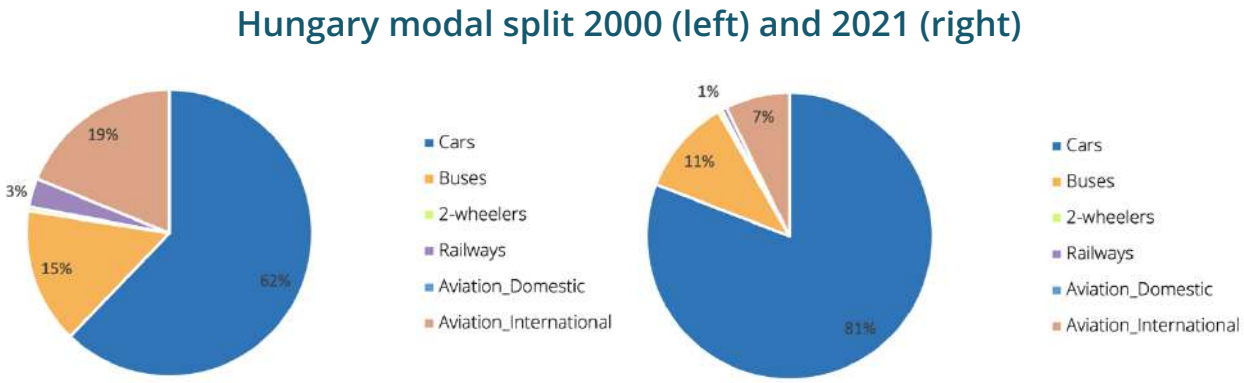

Figure 7 Hungary modal split

Motorcycle activity increased from 28 pkm per capita in 2000 to 56 pkm per capita by 2021. As a share of overall passenger transport emissions, motorcycles remain below 1%. However, different sources provide significantly varying data for this mode of transport.

Buses are the second largest form of transport in terms of pkm per capita and the third largest source of emissions in the passenger transport sector. Passenger kilometres fluctuated over time, decreasing from around 1,800 pkm per capita in 2000 to around 1600 pkm per capita in 2010, and then rising to a pre-pandemic high of over 1,900 pkm in 2018 per capita. Due to the pandemic, in 2021 bus travel fell to roughly 1,250 pkm per capita. As a share of overall passenger transport emissions, buses decreased from 15% to roughly 11% between 2000 and 2021. The emissions intensity from buses declined from 1,630 gCO_2/vkm in 2000 to 1,560 gCO_2/vkm in 2021.

Activity for railways decreased from close to 1000 pkm per capita in 2000 to just below 800 pkm per capita in 2019. Due to the pandemic, the activity for this mode of transport fell to less than 500 pkm per capita and increased slowly to almost 560 pkm per capita in 2021. The share of railways in modal split decreased from 11% to just under 6% in 2021. These changes reflect the fact that there have been significant cancellations in regional rail services during this period in Hungary. While improvement in commuter lines in and around Budapest led to higher passenger numbers, the impact of line closures could not be fully offset as of 2021.

The contribution of railways to overall emissions decreased as well during this time, from 3.2% in 2000 to less than 1% in 2021 This decrease was mainly driven by a decline

in emissions intensity from 3,450 gCO_2/vkm to 924 gCO_2/vkm over the past two decades. This decline is due to the partial renewal of the rolling stock and the entry into service of a high number of electric trains.

Subway and tram activity levels increased from 251 pkm/capita in 2000 to 297 pkm per capita in 2021.

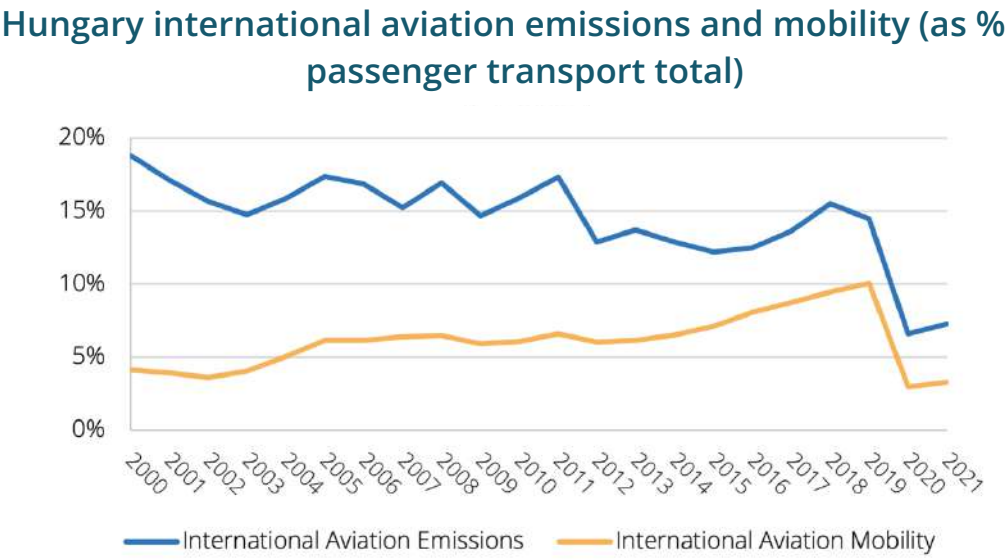

Figure 8 Hungary international aviation emissions and mobility over time

The distance travelled by international planes decreased between 2000 and 2021, from roughly 340 pkm per capita to 320 pkm per capita, although 2021 levels were significantly below pre-pandemic levels. Load factor increased significantly over this time period as well, from 78 pkm/vkm in 2000 to roughly 140 pkm/vkm in 2021. Emissions intensity decreased only slightly, down to 30,420 gCO_2/vkm in 2021 from 30,900 gCO_2/vkm in 2000. Overall contribution to passenger transport emissions also decreased, from roughly 18% in 2000 to just over 7% in 2021.

Cycling and walking in Hungary remain a fairly small percentage of the overall mobility, with average activity per capita at 83 and an estimated 220 pkm respectively in 2021.

The main drivers of emissions from passenger transport

Emissions from the passenger transport sector in Hungary, as well as the mobility levels, increased much faster than in the EU on average. This has been caused by a number of drivers, particularly rising income levels, personal attitudes, unsustainable spatial planning practices, and weak and sometimes contradictory transport policies.

Rising income

A significant increase in the average income in Hungary allowed more people in the country to purchase a car, especially second-hand ones from abroad (Eurostat, 2023a). While single-car households are still common, rising disposable incomes have led to an increase in two- or three-car households. Households with multiple cars additionally decrease load factor, resulting in emptier cars thus increasing the emissions per kilometre travelled by car. According to a survey by Robert Bosch Ltd. Hungary, 79% of households own a car. Around 45% of households have one car, 20 % have two cars, and 5% have three or more cars (Robert Bosch Ltd., personal communication, 2023).

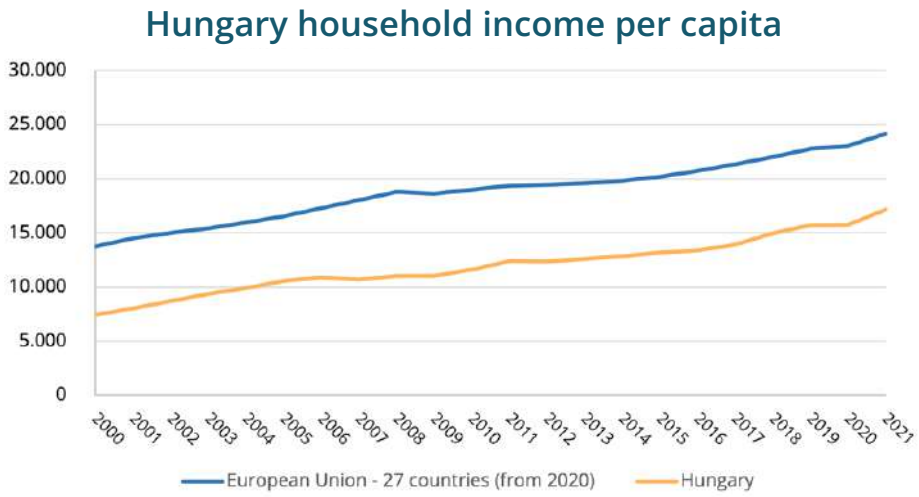

Figure 9 Adjusted gross disposable income of households per capita

(Eurostat, 2022)

Interestingly, the 2020 survey, "Environmental impacts of motorisation trends and car use patterns in Hungary" (Forsense Institute, 2020) shows that car use does not increase with financial position, especially in towns.

Increasing age of cars

The average vehicle age in Hungary is more than 14 years. As cars age and used cars imports increase, the average vehicle age is expected to grow. While policymakers are

aware of the issue, they have not connected the registration fee to the car's emissions or require exhaust system updates for older imported cars.

Personal attitudes

While car ownership increases, a high proportion of people in Budapest do not own a car, indicating a negative correlation between car ownership and income as well as the quality and density of public transport in Hungary. On the other side, car-sharing has been growing in popularity in Budapest, perhaps marking a change in attitude among citizens – with more people opting out of car ownership as a matter of preference rather than financial constraints. Agglomeration car-pooling is at attractive approach to mitigate commuting traffic. In 2013, the CAAG ordered a survey about car-pooling in the agglomeration of Budapest. Around 30% of respondents were willing to take a ride with a stranger (PolicySolutions, 2012). Additionally, the increasing number of passengers on the renovated railway lines, especially in the Budapest agglomeration, shows that affordable, comfortable, safe, and reliable public transport can be attractive to some people.

The Usemobility project conducted a survey in 2012, illustrating 20 percent satisfaction for those who switched from cars to public transport, 62 percent did not feel a change, but 18 percent specifically was dissatisfied with public transport (European Commission, CORDIS, 2013). The comparison of passengers' opinions about rail passenger transport in general and the Budapest-Esztergom line, which was renewed at the time, shows the feasibilities of the railway service, which could be improved to make it more attractive to people.

Survey also queried passengers who recently switched from cars on the Budapest-Esztergom railway line about multimodality. Only 35% travelled by train, while 43% used other modes of transportation to reach their destinations; demonstrating that, in the presence of appropriate service, a significant number of people are willing to travel by public transport and use their car only for the last kilometre.

Further, the Cycling Club conducts a survey every two years with the Median polling company and found that for 2022 around 63% of the Hungarian population does not travel primarily by car (Hungarian Cyclists Club, 2022). Instead, 13% walk, 16% ride bicycles, and 30% use public transport to their destinations. Around 59% of individuals own a bicycle.

Focus on the development of roads

For many years, Hungary's policymakers have prioritised building motorways over developing a high-quality internal road network.
Budapest is the centre of a star-shaped motorway network, which theoretically eases traffic flow between the city centre and surrounding suburban areas, supporting higher suburbanisation levels. The growth of the suburban areas outside the city has increased

the demand for car ownership and traffic as residents commute into the cities for work or school. About 30% of Budapest's pupils and students commute from the suburbs.

Looking ahead, a more balanced road development policy and a dedicated rental housing program could have resulted in lower commuting rates and more efficient population density. High occupancy rates and a tight rental market facilitate move away from the city to suburbs, locking residents into long and carbon-intensive commutes.

Weak and contradictory transport policies

Hungarian transport policy lacks a transparent and consistently implemented strategy, hindering expediency, and threatening Hungary's commitment to emissions reductions. Policies are generally not created with the idea of decreasing transport demand. While the declared objective is to increase the capacity of road and rail networks, there is no consistent investment into projects that complement each other in a coherent way.

Ramping up the capacity of urban roads for many years was considered the principal measure to fight traffic congestion. The Budapest City Council has begun to show the beginnings of a paradigm shift, favouring plans to support bicycles and other micromobility options over vehicles (Tóth, 2022). This is however hindered by the fact that the budget of the municipalities in Hungary formally depends on decisions of the Parliament but practically on the Prime Minister. The current Prime Minister, Viktor Orban, does not treat the Budapest municipality fairly and in proportion to its economic weight. As a result the City Council does not get enough resources from the national budget in order to achieve its transport goals (Hungarian Anti-Corruption Association, 2021).

In addition, the city government of Budapest is limited in the taxes it can levy. Meanwhile, the federal government makes investments without the consent of the Budapest municipality and residents, even against their will, shunting already limited fiscal resources away from sustainable transport plans and policy. An example of this where the federal government's plans for an unnecessary bridge over the Danube, even though the city had alternate plans for more efficient infrastructure development.

In the Hungarian political system, development of transport policy tends to be based on attitudes of several planners and policymakers who are often working in their own political self-interest. Their preferred projects usually take precedence over rational development goals.

Outdated technologies

There are huge opportunities for increased integration of technologies in passenger transport, but in Hungary they are introduced much more slowly than in other developed parts of the world. The best example of this is public transport ticketing – electronic ticket system projects in Budapest have failed three times so far. With some exceptions, in urban public transport only single-trip tickets are sold. In this case,

Budapest which introduced a Mobility as a Service (MaaS) app, Budapest Go, is ahead of other cities (BKK, 2023). However, the system is not passenger-friendly, but rather "cheat-proof". Another example is the slow implementation of the European Train Control System (ETCS) which could increase the frequency of train trips using the same rail tracks (Thales Group, 2020).

Good practices and policy recommendations

Recognising that passenger cars are the greatest source of passenger transport emissions in Hungary, good practice recommendations are targeted towards reducing kilometres driven and individual willingness to drive as opposed to using other forms of transport. These policies are paired with those targeted at reducing the emissions of cars on the road, in an effort to further reduce passenger car emissions. Road tolls seek to make drivers bear the full cost of their decision to drive, and push travellers to other forms of transport.

Introducing a taxation system to curb the import of used cars, could persuade people choose more up-to-date vehicles and reduce emissions. The implementation of Low Emission Zones serves the same aim and helps to reduce pollution in cities.

Additionally, steady, low-speed road traffic with a speed that is appropriate to the conditions results in much lower emissions than hectic, speeding and braking. A general speed limit of 30 kilometres per hour in residential areas is recommended to calm traffic and reduce tailpipe emissions. Car-sharing is a good service in cities to wean people off owning their own cars and shift their travel habits towards multimodality. Connected and autonomous driving, which could become commonplace in the coming decades, creates an opportunity if it appears not as an individual property, but as a community property. That is why it is good if, through car-sharing, as many people as possible understand that it is possible to live and travel without owning a car.

Road charging

Financing road infrastructure maintenance is a challenge in Hungary. Costs are unfairly distributed across society and car owners and users do not pay the total costs of car traffic, e.g., the road wear, or the treatment of those who have become ill from exhaust fumes. Currently car users pay an excise duty on fuel, but as EVs continue to replace traditional cars, this payment may decrease and car users will pay an even smaller share of the total costs. Introducing a blanket road toll may address this issue and work to internalise eternal costs.

The road toll is one of the most effective market instruments to shift people from private cars to less polluting modes of travel. Prices can be fine-tuned to a specific area and the cost of driving can be manipulated in places to adjust traffic to road capacity, reducing congestion and making traffic flow more evenly.

Policy description

Customs duties and local taxes had been levied on travellers and hauliers in Hungary for a long time. In Budapest, there was also a bridge toll, which required users to pay the toll regardless of whether they crossed it by vehicle or on foot.

Initially developed in the 1960s, Hungary's highway system was semi-privatised in the 1990s and private entities were allowed to levy tolls in order to build and maintain highways. Fees were initially proportional to the distance travelled, but in 2000 the Hungarian government and highway operators decided to replace it with a time-based payment. At this point the modern vignette system was introduced, and a vignette on the windscreen is required to drive on highways. Vignettes are now sold and managed through an electronic system on both the national and regional levels. (Hungary Vignette, 2023). The right to use the road can be purchased for a specific period, one day, ten days or a year.

While the flat rate time-based toll does take steps to internalise the full cost of travelling by car, it is somewhat inflexible, applying the same rate to those who only travel a few kilometres and those who travel hundreds in the same period of time. Technological advances in navigation and satellite systems now common in personal vehicles mean that it may be possible to re-introduce a distance-based toll for personal vehicles. Distance-based fees already apply to vehicles above 3.5 tonnes, automatically levied as distances are tracked by satellite navigation devices already in the vehicles. A system like this could be applied to vehicles under 3.5 tonnes, internalising a greater proportion of the total cost of driving, thus contributing to reducing traffic and emissions.

In Hungary a series of tariff maps should be developed, clearly identifying infrastructure tolls, congestion tolls, and a map of speed limits. In this system each vehicle would have a base fee per kilometre, likely depending on weight, number of axes, fuel type, and tailpipe emissions. The tariff maps give the multipliers for each kilometre and tolls would be calculated electronically, with an application for users to see both the map and fees. There are several efficient enforcement tools as well, including cameras already installed on highways and first-class roads, and regular traffic policing on other roads.

Responding to current challenges

It is without a doubt challenging to abolish a customary right, which has developed over 100 years, whereby the government and local authorities maintain the road network from taxes. The direct taxes and charges, e.g. the excise duty, feed the misconception that motorists pay for the costs of maintaining transport infrastructure and the externalities of traffic-related accidents, air pollution-related illnesses and their treatment, lost working time, and premature deaths (Lukács et al., 2011). The fact that even the costs of infrastructure maintenance are not covered is shown by the condition of roads. What people driving on public roads pay in various ways - for example, car tax, registration tax, excise tax - does not even cover the maintenance of the roads, let alone

the damage caused by noise and air pollution, the treatment of diseases or the damage caused to buildings. In addition, with the rapid spread of electric cars, the treasury's income from the excise tax runs out. All these problems could be solved by a properly adjusted toll.

Implementation

Implementation needs to shift both social and legal paradigms. The Hungarian public needs to be made aware that the way the road network is currently funded is environmentally and financially unsustainable. The full cost of driving needs to be made common knowledge and the public should be educated on how much driving combustion cars actually costs. Additionally, while the existing infrastructure requires more funding, it cannot be fully covered from the state budget due to more urgent priorities, including development of low-carbon infrastructure.

From a legal point of view, changes must be made to Act I of 1988 on road traffic, Act LXVII of 2013 on road tolls for the use of highways, motorways and trunk roads in proportion to the distance travelled, the Act CLXXXIX of 2011 on Local Governments and other additional laws and regulations.

Gaining social acceptance and support

There is a lack of mass public communication in Hungary about the close link between car traffic and the impending climate catastrophe. It is necessary to demonstrate how unfair it is to use the money paid by all taxpayers to maintain a road network that is used significantly more heavily by those who travel by car than by those who travel by bicycle, train, or bus. The 'user pays' and 'polluter pays' principles must also be applied to road transport. The necessity of implementing these principles needs to be communicated by the government and the cities clearly and effectively.

Technical implementation

The best course of action would be to impose the road toll on every road in the country, both on the road networks connecting settlements and on those within them. However, in practice a good place to start is by instituting a daily vehicle entrance fee in Budapest. There is already some groundwork in place for this – the implementation of a London-type congestion fee was a condition of EU support for the Metro line 4 project. The Budapest entrance fee could be a new Budapest vignette which is treated by the National Toll Payment Services Ltd (NÚSZ Zrt.) as the highway vignette. This Budapest vignette can be implemented over the course of a few months, piggybacking off of the current vignette system. The next phase could be to set up an electronic system for charging and collecting road tolls per kilometre and to integrate its use into the Budapest Go application. The transfer of motorists from the vignette system to the kilometre-based system could be gradual, through a steady increase in the daily vignette charge, for example increasing the fare annually by the rate of inflation plus 10%.

Road charging co-benefits

In Hungary, speeding is a permanent and growing problem of traffic. However, the GNSS-based Electronic Toll Collection system can detect and punish speeding.
The tariff could penalise ICE and reward the use of zero-emission cars, to encourage ICE car owners to drive less and new car buyers to choose the latter type. Embedding the road toll into Mobility as a Service will take car ownership on the same platform as public transport and car sharing. As this unfolds, an increasing number of people will realise that they do not need to own a car and give it up.

Conclusions

The significant increase of activity levels of passenger cars has created externalities that endanger people's health and quality of life. The need to reduce these externalities, finance transport infrastructure securely and match mobility needs to road network capacity can only be achieved by internalising the external costs of car ownership.

The development and integration of technology makes this possible, but the transition requires committed political actors and a change in people's attitudes. The car users must be made to understand that rolling on the tarmac, and air and noise pollution on the road come at a cost and that this cost must be paid directly, as well as the car, its maintenance, and the energy needed to move it.

Reducing used car imports

According to the TEDiT tool (2023), Hungary's average car emissions in 2021 were 240 gCO_2/vkm. This is relatively high, and the ageing of the Hungarian car fleet is a contributing factor. At the end of 2021, the mean age of cars was more than 15 years, and the number of vehicles older than 16 years reached just under 50% by the end of 2021. Owners of older cars may be less concerned with maintenance, and in Hungary this means that outdated and neglected vehicles are on the road (Motor1, 2022). In addition, older cars produce more tailpipe emissions (Archer, 2017; Transport & Environment, 2016). The import of used cars from Western Europe is a key hurdle to reducing vehicle emissions in Hungary. Rejuvenating the fleet and preventing it from ageing further is considered an effective approach to mitigating carbon emissions from passenger transportation (Climate Analytics, 2023).

The main cause of ageing is the massive flow of used cars from the more developed members of the EU to the former socialist countries, including Hungary. The 7th point of the Climate and Nature Action Plan declares: "We will not be Europe's dumping ground for polluting cars, imports of polluting cars will be severely restricted." (IEA, 2021b). In line with this declaration, the Hungarian government has attempted to address this before, setting the registration tax to increase with the car's age, but the Court of Justice of the European Union (CJEU) articulated that this is contrary to the principle of free movement of goods (ECLI:EU:C:2006:652, 2006).

The registration tax calculation criteria have been changed, and despite the government's repeated promises over the past 16 years to address the issue, there has been little productive action in this area. Registration tax currently decreases depending on vehicle production year, but is relatively inexpensive to still justify the import of older models.

Policy Description

In order to capitalise on government and public willingness to phase out old cars and cut down on the import of old vehicles, the registration tax should be reformed to further dissuade the registration of older vehicles. Currently, all passenger cars and motorcycles with Hungarian licence plates are subject to the registration tax, which is levied as the vehicle is put into service. The tax is levied by the customs authorities and is set at a flat rate depending on the engine size and fuel, the environmental classification, and the production year of the vehicle. Under current law, the differentiation between environmental classifications does not effectively offset the steep decline in fee level associated with production year, meaning older cars can still be imported and registered for a relatively low fee.

ACEA's regular summary of car taxation systems in European countries shows that other EU countries have found solutions to this problem, providing clear models for Hungary to utilise (Kotzapasis, 2022). Environmental protection should be favoured more than age-related depreciation hence the registration tax calculation approach must be adjusted (Grabiel, 2018).

Current challenges

Supply chain disruptions caused by the COVID-19 pandemic have temporarily made used cars more expensive in developed member states. However, this is a temporary phenomenon, and the dumping of used cars is expected to bounce back in the coming years. This trend is expected to increase as the number of electric vehicles increases, the market for outdated combustion cars that can only be sold abroad will expand. The emergence of low- and zero-emission zones, while welcome, has made the situation particularly severe due to the lack of effective policies in the importing countries to mitigate this challenge.

The ageing and the technical conditions of the car fleet are not in the scope of the Hungarian climate and transport policy. This lack of interest is highly concerning given that the Association of Vehicle Importers regularly draws attention to the risk associated with importing an excessive number of used cars in its reports (MGE, 2023). The issue is additionally highly publicised, with the frequent appearance of "wrecked car imports" in the press.

Additionally, the post-COVID-19 rebound and the Russian aggression against Ukraine has resulted in very expensive imported crude oil and fuel. The price cap of fuel was the

worst answer to the problem. Ottó Grád, secretary of the Hungarian Petroleum Association, noted that "In the first half of 2022, the same trend continued as in the first three months after the introduction of the price cap last year, i.e. no decrease in consumer spending. In total, almost 33% more fuel was consumed by MÁSZ member companies than in the first half of 2021 (BHL, 2022).

Implementation

It is necessary to restructure the registration tax so that vehicles with higher environmental ratings, as well as complying with the new EU standards, are more readily available on the market than before. Registration tax reductions based on vehicle production year have lessened the impact of EU standards-based fees, and should additionally be overhauled. Moreover, the registration fee might be differentiated according to emissions, indicating that until the target proportion of newly registered electric vehicles is reached, vehicles not emitting CO_2 would not be charged.

The European Union does not regulate registration taxes, although the free movement of goods must take place according to EU rules. Consequently, registration taxes should not be a direct barrier to the import of used cars. Nonetheless, altering the car registration fee might lead to reducing average car emissions in Hungary.

Particulate filter quality control

Currently, inspection of exhaust particle filters is required for a vehicle to be registered and granted a Hungarian license plate. Regulation 5/1990 (IV. 12.) of the Ministry of Transport, Communications, and Construction on the technical examination of road vehicles stipulates that the state of the exhaust system and the composition of the exhaust gas must be examined. A verification, indicating that the vehicle has not travelled more than 160,000 kilometres, is required to ensure the particle filter is operating properly.

In order to address particulate and CO_2 emissions, Hungary should move forward with the plan to implement further remote control of exhaust fumes. Initially proposed in 2014 by the Rural Development Ministry, the government planned to implement random roadside emissions inspections as well as introducing Remote Emission Technologies (Sándor, 2014). Further inspections will help address after-market modifications, as well as any age-related increases in emissions, which are particularly prevalent in older imported models.

Stakeholders

A strong emissions-oriented adaptation of the registration tax can be linked to the 2030 carbon reduction targets. The most important stakeholders behind the changes are the importers of new cars, as well as national political actors including parliament and the Ministry of Economy and Transport. The professional organisation, Hungarian Car

Importers Association (MGE) has already begun discussion in this space and continues to lobby to reform the registration tax.

Conclusions

Banning imports of used cars is a decades-long debt to Hungarian transport policy. The main reason might be the inability of transport policy to abandon the paradigm inherited from the twentieth century, the dream of unlimited mobility, and, within it, the dream of unlimited car mobility. Now, however, after Russia's aggression against Ukraine, there is a new sense of saving resources, of reducing vulnerability caused by oil imports. The inevitable paradigm shift to a resource-saving, climate-friendly, smart mobility concept is worthwhile with relatively cheap interventions, such as restricting imports of older, used cars. By amending legislation, changing the way registration tax is calculated, and requiring functioning particulate filters, policymakers can reduce public willingness to import older vehicles.

Car sharing

The higher the cost of buying, maintaining, and storing an asset, the more economical it is to rent it than to own it. In densely populated areas, car sharing eliminates the need to purchase a car in order to travel, run errands, or do any number of other tasks. Car sharing can serve the same mobility needs for a community with fewer cars. As a result, parking spaces are freed up for other uses, and individuals save the time and money required to maintain a personal vehicle. Moreover, those who rent a car, rather than owning one tend to drive much less (Ramos, Bergstad, & Nässén, 2020). Estimates show a shared car can replace up to 20 private cars in densely populated urban areas (Jochem et al., 2020). While car sharing services using combustion vehicles do offer emissions reductions potentials, the best services in terms of carbon emissions are those powered exclusively by zero-emission electric cars, such as GreenGo in Budapest.

Car sharing has increased in popularity over the past several years, and car sharing companies exist in over 30 countries (Zhou et al., 2020). It has already had some impact on car ownership and use patterns among users, with surveys showing behavioural changes towards reduced personal car use as early as 2008 (Martin & Shaheen, 2011). In the Netherlands, car share members drive 15-20% fewer kilometres after joining the sharing system (Nijland & van Meerkerk, 2017). Car sharing users are often likely to travel primarily by active modes of transport (walking or biking) or by public transport, utilising a shared car for more tricky travel such as transporting bulky goods or going to areas that are underserved by public transport (Ramos, Bergstad, Chicco, et al., 2020).

Car sharing in brief

Car sharing service providers argue that car sharing is defined by its environmental and social purpose, rather than business and financial objectives (Car Sharing Association,

2022). Car sharing is a service designed for local users in support of community travel and environmental goals. Its mission, vision, and values lead to actions aimed at decreasing individual car ownership, reducing vehicle miles travelled, improving urban land use and development, providing affordable access to vehicles for all constituencies – including those less able to afford car ownership - as well as motivating residents to use active transport modes, as for example walk or public transportation, and decreasing dependence on fossil fuels while reducing the emission of greenhouse gases.

Car sharing is a membership-based service available to all qualified drivers in a community. No separate written agreement is required each time a member reserves and uses a vehicle. All car-sharing organisations offer members access to a dispersed network of shared vehicles 24-hours, 7 days a week at unattended self-service locations. Car usage is provided without restriction at affordable hourly and/or 'per mile or kilometre' rates that include fuels, insurance and maintenance. Primarily designed for a shorter time and shorter distance trips as an extension of the transportation network, car sharing provides a public service designed to enhance mobility options. Car sharing organisations help members save money over the cost of individual car ownership by encouraging members to drive less often, plan trips better, use other modes of transportation more, and drive fuel-efficient vehicles when a car is needed.

Car sharing does not aim to compete with other public transportation options – such as walking, cycling, or taking the bus, train or taxi – but encourages the use of these services as a socially and environmentally responsible alternative to private vehicle ownership and single vehicle occupancy. Car-sharing organisations have the greatest impact when integrating with communities and partnering with local governments, transit authorities, and other partners involved in providing transportation (including other car-sharing organisations) in order to maximise choices, making car-sharing more convenient than car ownership.

The simple use of shared vehicles is based on technological innovations and relies on the use of cars loaded with electronics. A nearby vehicle can be geolocated to borrow by registered app on a mobile phone. The car can be locked or unlocked using the mobile phone nearby. At the end of the trip, payment is made by direct debit from the pre-registered bank card. When it is time to return the vehicle, the driver simply must make sure that it is within the geographical zone permitted and close it, at which point the vehicle becomes available for a new user.

In Europe there are two types of car-sharing:

- Stationary car-sharing, also known as station-based car-sharing, where cars are distributed across a city or town in permanent parking spaces, often at rental hubs. The vehicles have to be booked in advance and drivers usually contribute to the acquisition and maintenance costs by paying an admission fee and/or monthly contribution. Customers typically have to specify the exact period of use, their desired car, and go to a static rental station to pick up the car.

- Free-floating car sharing is a service for sharing vehicles without fixed stations. The idea is simple: to make transportation options publicly available all over a city, without a central base. One can find and may leave the car anywhere in a public parking place.

Implementation

While car sharing services are typically private enterprises, it is up to the state and municipalities to create a regulatory environment in which these businesses can thrive and car sharing can become popular. In Hungary, the existing legal environment allows to provide car-sharing services. This opportunity is used by three service providers Budapest: GreenGo, Mol Limo, and ShareNow.

National legislation should be strengthened with further regulation on the number of vehicles allowed to be used for car sharing. Additionally, in line with the need to phase out the purchase of new combustion cars by 2035, a regulation should be put in place nation-wide obliging car sharing companies to convert their fleet to electric vehicles.

In cities, current regulations allow local residents that live in paid parking zones to park near their homes at a reduced rate. This discount should also be given to car-sharing companies, as their cars are also used by local residents, and mostly people who do not have a car to claim the discount. Car owners may object to the designation of parking spaces exclusively for car-sharing, and municipalities are often reluctant to take such action, however the problem can be addressed with proper communication. The municipality can further support the use of car-sharing services by reserving some public parking spaces in central or very busy areas to park only shared cars.

The car-sharing companies are engaged in communication activities, but this is not enough. The state, local authorities, and NGOs also need to raise awareness by promoting car-sharing, and every opportunity should be taken to highlight its benefits.

Co-benefits

Transport needs to be transformed into a sharing economy, and thanks to the development of communication tools, we can widen the circle and think about multimodal passenger transport, not bicycles only. In this new paradigm, the traveller can optimally combine active modes (walking, biking) of transport with both public transport and car use. In fact, if someone takes a car, they only own it - perhaps not entirely, or only partly, if travelling with others - for the duration of the journey. They won't even have to drive if the vehicle is driverless. But the passengers can also share a scooter and a bicycle. In summary: car-sharing becomes part of transport service, Mobility as a Service.

Area bans and low emission zones

Although measures can be taken to reduce car emissions, true transformation away from using personal cars as a primary mode of transportation is the strongest way of reducing emissions from passenger transport in urban areas. Instating area bans and low emission zones (LEZs) could further accelerate the shift away from personal cars and towards public and active transport, facilitating significant emissions reductions in urban areas.

There are several ways to protect an area from vehicle traffic, including by introducing:

- access charges
- car-free zone, or car-free blocks
- a low emission zone
- a zero-emission zone
- an area closed to through traffic, and
- a speed-restricted area.

The aim of any land protection measure is to restrict motor vehicle traffic in general or to a specific type of vehicle. The most drastic solution is a complete closure of the area to everyday traffic, except for emergencies, delivery vehicles, and vehicles for mobility impaired citizens. That restriction can result in near-zero emissions from passenger traffic within the area.

There are several examples of even stricter car-free blocks and zones, with some pedestrian-only streets already in place in Budapest. For example, in Vauban, a district of Freiburg in Baden-Württemberg, Germany, exclusively pedestrians, public transportation, or micromobility vehicles (scooters, bicycles) are permitted to enter (Stadt Freiburg, 2022).

LEZs are an effective policy, and many cities around Europe have instituted them in some form (CLARS, 2022). According to a recent report by the Clean Cities Campaign, there are already around 320 LEZs in place in European cities, and more than 500 are expected by 2025, with 35 Zero Emission Zones (ZEZs) planned (Clean Cities Campaign, 2022). For instance, Spain mandates LEZ designation in all cities with more than 50,000 residents.

To designate the zone, the authorities establish which Euro emission criteria must be met by cars in order for them to be admitted into the zone. According to the EU Euro x/X legislation, the vehicles in Hungary are categorised in their registration certificates according to different environmental classes. The restriction may be strict or permissive, where only vehicles above a certain Euro classification can enter the area under strict regulations, but under permissive regulations, a lower (older) classification vehicle may enter subject to paying a charge. In the most stringent version, a zero-emission zone only allows zero-emission cars, e.g. battery electric or hydrogen powered to enter.

Implementation

Hungarian legislation allows municipalities to restrict vehicle traffic in certain zones, and political debate around designating low-emission zones has been held for many years. Debate has evolved over time, with the Ministry of National Development publishing a study on LEZ guidelines as early as 2013 (KTI Transport Research Institute Nonprofit Ltd. & Centre for Environmental and Sustainability Research, 2013). The study defined an LEZ and its boundaries in accordance with the Uniform Rules on Road Traffic Management (KRESZ). While now partially obsolete due to the fact that the environmental category of cars is no longer indicated on the plate, it remains a fundamental document for creating LEZs in Hungary.

Hungary's transport code is somewhat contradictory in this case, where Article 14(1)(z/3) says that LEZs and area bans may be indicated by clear signage at the beginning and end of the zone that indicates which license plate stickers are not allowed entry. However, as of January 2016, license plate validation stickers were removed from the vehicle registration system. There is already a legal work-around to changes in the licensing system, and Article 20/A of the transport code indicates that there is more flexibility in the signage of an LEZ. Since stickers have been phased out, LEZ signage can additionally specify the environmental category of the permitted cars (e.g. "Euro 4-6" and "Euro IV-VI") and be legally compliant. Additionally, the KRESZ does permit direct labelling of prohibited vehicles according to their classification.

Beyond initial implementation, the maintenance of LEZs is crucial. Successful implementation over time relies on the regular review of car categories that are permitted to enter. Additionally, regulations should be revealed years in advance, similarly to Euro emission standards, so that motorists can adapt over time. Regular review of permitted vehicle types and early announcements of upcoming developments allows the city to stay up-to-date as vehicles change and the regulatory environment at the regional or national level changes.

A simple way to enable this, given the removal of stickers from license plates, is to establish a clearly visible environmental classification sticker system for vehicle windscreens. In various European countries, there are pieces of legislation requiring labels to be placed on the windscreen indicating a car's environmental classification. The nationwide application of uniform labels will make it easier for local authorities to carry out checks and establish clear communication to citizens about which cars are allowed.

This can be done in a couple of ways. The quickest would be for the state to issue a decree, regulating the appearance of the sticker and the process for obtaining it. In the case of imported vehicles this could easily be paired with the particle filter inspection. Alternatively, larger cities could join forces and establish a uniform decree regulating the prerequisite for access to the LEZ. Those who frequently enter a zone in an old car but who don't reside in the city may purchase a special sticker with prices proportional to the level of air pollution caused by their car and time validity.

LEZ implementation has occurred already within Hungary, and there are several restricted zones in Budapest. For instance, obtaining permission in advance is required to drive into Buda Castle. These locations are listed in the third annex of the Decree of the Municipal Assembly No.30/2010 (4.VI.). The entry or entry and parking permits are subject to a fee and the rates in paragraph 25 of the regulation may be amended so that the charge is determined proportionately to the vehicle's official air pollution level. For example, a vehicle complying with the latest Euro 6/VI standard could be subject to the current basic entry fee when it enters protected zones. Higher emission vehicles could pay a surcharge.

Stakeholders

Despite being the key actors in LEZ development, municipal leaders are reluctant to embark on the process of designating LEZs, particularly zero-emission zones, at the risk of possible critics from the public and the press. In other words, the government must act if it considers low and zero-emission zones to be an important and effective means of reducing carbon dioxide emissions from passenger transport. The Clean Air Action Group has often urged the mayors of major extended urban areas to consider the possibility, but nothing concrete has occurred. Despite the possible creation of LEZs being stated in several municipalities' Sustainable Urban Transport Plans, decisive action is yet to be seen.

Other key stakeholders in the area are of course the residents that would live within an LEZ. Car owners are particularly important stakeholders in this area and can be treated similarly to the residents of the parking zones recommended earlier. When the LEZ designation is announced, or slightly earlier, the municipality may issue a special access permit to previously registered cars of residents. A reasonable fee should be charged for the permit.

Non-vehicle owning residents and those predisposed to be friendly towards environmental protection can be important allies in this area as they are not financially impacted and will benefit from decreased pollution and traffic. In order to designate the LEZ, it is essential to obtain their cooperation. In Hungarian cities, potential supporters can be reached through local newspapers, regional television channels and programmes, and social media. It is possible to garner the support that politicians require over a relatively short period through a well-constructed and highly visible campaign.

Co-benefits and conclusions

In addition to reducing tailpipe emissions in urban areas, LEZs can additionally help fight the ageing car fleet and the import of old, highly polluting cars to Hungary by making it either expensive or impossible to drive in certain areas.[2]

LEZs additionally have proven impacts on public health. Air pollution has dangerous impacts on public health, and can lead to both short-term and long-term, chronic conditions. Exposure to air pollution can affect nearly every aspect of a person's health, and children, the elderly, and those with pre-existing conditions are highly susceptible to negative health impacts (European Environment Agency, 2023). Tailpipe emissions from vehicles are a huge health factor, and estimates show that 75% of the public health costs associated with road air pollution are linked to diesel cars (Transport & Environment, 2019). LEZs have been shown to not only be effective emissions reductions measures, but highly effective public health policy (Ibid.).

Speed limits

The European Environment Agency (EEA) has called for tighter speed limits as a means of reducing fuel consumption and air pollution from transport (Directorate-General for Mobility and Transport, 2022). According to a simulation, reducing the speed limit on motorways from 120 km/h to 110 km/h could lead to fuel savings of 12-18% for combustion cars in traffic, assuming smooth driving and cruise control were available. Additionally, both fuel consumption and CO_2 emissions decrease with speed up to a certain speed. In contrast, consumption increases when driving at a steady speed below the optimum speed for fuel consumption (EEA, 2022). The data from the EEA simulation in **Figure 15** (below) shows in a striking graph how fuel consumption varies from 1.4 to 2.0 litres for Euro 4 petrol and diesel cars at 100 km/h.

[2] See also: Márton Vargha: Clean Air Action Group's Transport Theme Officer Sticker against the import of junk cars 2021.07.19.

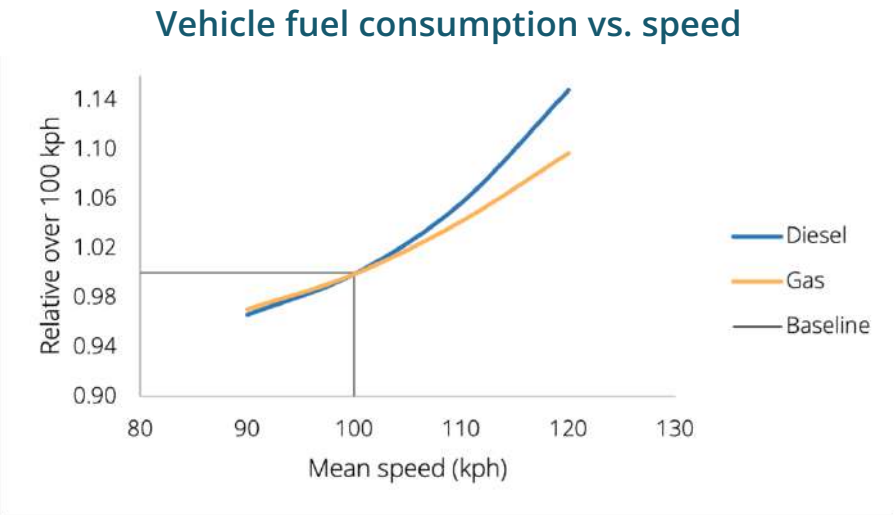

Figure 10 Combustion fuel consumption vs. speed

(EMISIA - ETC/ACM) Note: emissions expressed relative to average emissions at 100 km/h, for which the value '1' is assigned.

The results of the simulation can be compared with **Figure 16**, below, which shows the relationship between speed and fuel consumption for petrol cars up to 1.4 litres (Samaras, 2012):

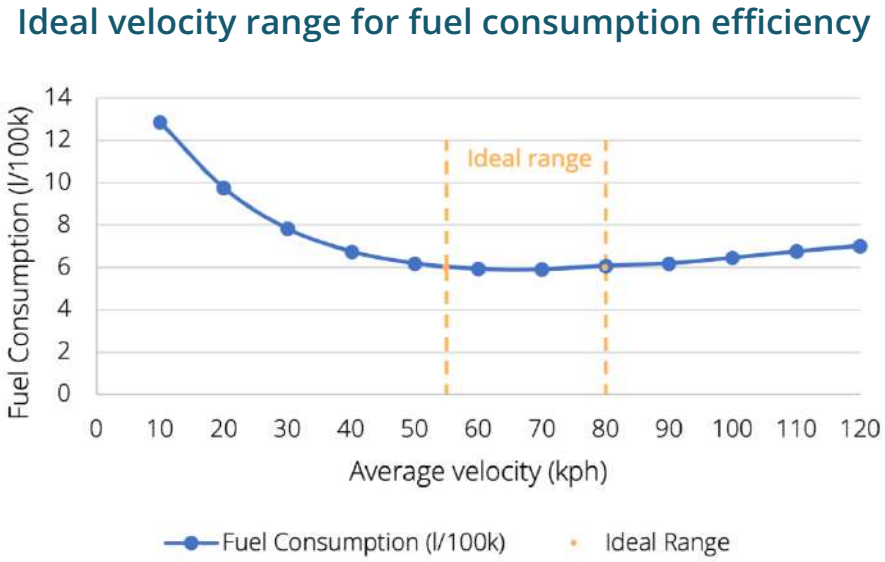

Figure 11 Fuel consumption vs. average velocity

(Samaras, 2012)

In an urban environment, lower average speeds of 30 km/h instead of the acceleration-braking-acceleration pattern common at higher speeds (eg. 50 km/h), can lead to a reduction in average fuel consumption and hence carbon dioxide emissions (Han et al., 2019).

There are two types of permanent road speed limits; general rules and speed limits for specific sections of roads that are signed. For Hungary, general speed limits on certain

types of roads should be tightened. This will significantly reduce carbon dioxide emissions from car traffic while improving safety and lowering the number and severity of accidents. **Table 1** shows the suggested and current speed limits for road passenger transport vehicles.

Table 1 Suggested passenger transport vehicle speed limits in Hungary, km/h

	Motorways	Main roads	Roads outside built-up areas	Traffic by-ways around residential areas	Residential areas	Calmed residential areas
Vehicles < 3500kg	100 (130)	100 (110)	90 (90)	50 (not designated)	30 (50)	20 (30)
Buses	100 (100)	70 (70)	70 (70)	50 (not designated)	30 (50)	20 (30)

Suggested limit (current limit)

Responding to current challenges

In 2020, roughly one half of oil imports to Hungary went towards the transport sector, accounting for emissions of over 3.5 $MtCO_2e$ (IEA, 2022b). The ongoing energy crisis has highlighted how critical phasing out fossil fuels is and all available strategies must be employed to reduce Hungary's oil imports. Decreasing speed limits and strengthening enforcement of the phase-out of Russian oil is required. Accordingly, the International Energy Agency's analysis highlighted the need for governments and citizens in advanced economies and beyond to reduce the speed limits on highways by at least 10 km/h as a practical measure to achieve significant reductions in oil demand in response to the emerging global energy crisis brought on by Russia's invasion of Ukraine (IEA, 2022a).

Stakeholders

Key stakeholders in this area include the national government and actors such as Parliament and the transport ministry who can put regulation in place, local governments and actors who will actually enforce speed limits, and citizens who drive. Communicating two facts is the key to gaining public support for tightening speed limits: safety and consumption reduction. By clearly articulating the connection between speed and the severity of accidents, human reaction times, and stopping distances, as well as emphasising the relevance of speed in news reports of catastrophic accidents, safety can be leveraged to persuade people of the importance of speed as a factor. Additionally, instability in the oil market, ongoing sanctions on Russian oil, and increasing public concern around the impacts of climate change all can be leveraged to engage stakeholders on reducing speed limits.

Public support for decreasing the speed limit is not significant, with many drivers believing driving at higher speeds or over the limit either will not be recorded or cause an accident. In addition, they are oblivious to the effect of others' speed on their own safety. Nevertheless, it is feasible to persuade NGOs, urban planners, and health and road safety experts to support the notion of speed limiting.

Implementation

Speeding is quite common in Hungary, including in urban areas. Current control and enforcement mechanisms used in Hungary are not an effective deterrent. Introducing point-to-point (P2P) measurement more broadly across the country could help enforce lower speed limits more effectively. Estimates looking at implementation of new, lower speed limits and P2P enforcement in Naples found that drivers gradually adapted to the new system and average speeds decreased, with compliance to speed limits increasing (Montella et al., 2015).

In urban areas, redesigning streets is an effective method of enforcing a 30 km/h speed limit. Speeding is encouraged by wide streets, where drivers perceive extra space. Drivers are compelled to drive slowly if the road is narrower or include curves, or if cars are parked on both sides (Banerjee & Welle, 2016). Several road shaping techniques have the potential to slow down traffic, and urban planning in Hungarian cities should take this into account.

Co-benefits

From a climate change mitigation viewpoint, the reduction of fuel consumption is the main benefit of decreasing speed limits. There are additionally significant road safety benefits to reduced speed limits. In Hungary, hundreds of people die in road accidents, the majority of which were preventable, and some of which include speed as a critical factor. In Hungary, in 2021, a total of 14,233 road accidents involving personal injury occurred on domestic roads, 3.3% more than a year earlier. The number of people killed and injured in accidents increased by 5.3%, from 18,176 to 19,143. The number of fatal accidents rose from 423 to 467 (+10%) and the number of fatalities from 460 to 544 (+18%) (Hungary Central Statistical Office, 2022). This indicates that traditional tools may be becoming ineffective against inattentive driving and relative speeding. A generally lower speed can at least reduce the severity of accidents that occur and improve road safety.

Conclusions

Hungary needs to fully move into the 21st century. The technical development of Intelligent Transportation Systems (ITS) is expected to completely reshape mobility in the coming decades. Larger countries like the USA and China are beginning to develop this system in their national road networks and on the streets of their big cities. Research is looking towards developing a transport system for 2050, and Hungary must move to develop a transport system built on sustainable mobility to achieve its climate targets by that time. Even if we can't say exactly what mobility will look like in 2050, there is enough research and knowledge already accumulated in the world to build a vision of good, sustainable, carbon-free mobility, and to tell policymakers, researchers, and other stakeholders what to avoid and how.

Our vision is of personal mobility, served at first by active modes. Citizens should be empowered to walk and ride bikes for their daily needs, People will travel longer distances on a well-established public transport network with shared zero-emission cars, buses, trams, and trains. We must speed up the use of ITSs, quickly developing new initiatives, the app of MÁV Start and the Budapest Go introduced by BKK. We must support and promote shared mobility, and we must start reducing the need to travel by car, by pricing the distance we travel. Everyone should be charged for using transport infrastructure and services.

References

Archer, G. (2017, September 5). A real-world fuel consumption test protocol developed by Groupe PSA, T&E, FNE and Bureau Veritas provides accurate information for drivers. Transport & Environment. https://www.transportenvironment.org/discover/real-world-fuel-consumption-test-protocol-developed-groupe-psa-te-fne-and-bureau-veritas/

Banerjee, S. R., & Welle, B. (2016). Bigger Isn't Always Better: Narrow Traffic Lanes Make Cities Safer. https://www.wri.org/insights/bigger-isnt-always-better-narrow-traffic-lanes-make-cities-safer

Bello, C. (2023). Sales of electric cars in the EU broke records in 2022. Which country in Europe is leading the way? Euronews. https://www.euronews.com/next/2023/02/20/sales-of-electric-cars-in-the-eu-broke-records-in-2022-which-country-in-europe-is-leading

BHL. (2022, July 13). Megszaladt az üzemanyageladás, frissíteni kellene az ársapkatörvényt. Világgazdaság. https://www.vg.hu/energia-vgplus/2022/07/harmadaval-ugrott-meg-az-uzemanyageladas

BKK. (2023). BudapestGO Public transport app in Budapest. https://bkk.hu/en/tickets-and-passes/budapestgo/

Budapest Business Journal. (2022). Average Age of Cars in Hungary Surpasses 15 Years. BBJ.Hu. https://bbj.hu/business/industry/automotive/average-age-of-cars-in-hungary-surpasses-15-years

Car Sharing Association. (2022). What is car sharing? Carsharing Association. https://carsharing.org/what-is-car-sharing/

CLARS. (2022). Impact of Low Emission Zones. Urban Access Regulations Europe. https://urbanaccessregulations.eu/low-emission-zones-main/impact-of-low-emission-zones#Berln

Clean Cities Campaign. (2022). CleanCities. Clean Cities Campaign. https://cleancitiescampaign.org/

Climate Analytics. (2023). Transport Emission Disaggregation tool (TEDiT). TEDiT. https://tools.climateanalytics.org/tedit/

Directorate-General for Mobility and Transport. (2022). Safe speed. Mobility & Transport – Road Safety. https://road-safety.transport.ec.europa.eu/eu-road-safety-policy/priorities/safe-road-use/safe-speed_en

EEA. (2022). Do lower speed limits on motorways reduce fuel consumption and pollutant emissions? [Page]. Eionet. https://www.eea.europa.eu/themes/transport/speed-limits-fuel-consumption-and

European Commission. (2022). 2022 Country Report – Hungary (Commission Staff Working Document SWD(2022) 614 final). European Commission. https://commission.europa.eu/system/files/2022-05/2022-european-semester-country-report-hungary_en_0.pdf

European Commission. (2023). European Alternative Fuels Observatory. https://alternative-fuels-observatory.ec.europa.eu/

European Commission, CORDIS. (2013). Final Report Summary—USEMOBILITY (Understanding social behaviour for eco-friendly multimodal mobility). https://cordis.europa.eu/project/id/265392/reporting

European Environment Agency. (2023, May 25). How air pollution affects our health. https://www.eea.europa.eu/en/topics/in-depth/air-pollution/eow-it-affects-our-health

Eurostat. (2023a). Adjusted gross disposable income of households per capita. https://ec.europa.eu/eurostat/databrowser/view/sdg_10_20/default/table?lang=en

Eurostat. (2023b). Final energy consumption in road transport by type of fuel. https://ec.europa.eu/eurostat/databrowser/view/ten00127/default/table?lang=en

Eurostat. (2023c). Length of motorway and e-roads. Eurostat. https://ec.europa.eu/eurostat/databrowser/view/ROAD_IF_MOTORWA__custom_4982809/default/table?lang=en

Eurostat. (2023d). Share of energy from renewable sources. https://ec.europa.eu/eurostat/databrowser/view/NRG_IND_REN__custom_4615617/bookmark/table?lang=en&bookmarkId=6f052c1a-b3ed-4cd1-8162-26d5dd4637cd

Farkas Csamangó, E. (2020). Az elektromobilitás jogszabályi környezete Magyarországon. Journal of Agricultural and Environmental Law = Agrár- És Környezetjog, 15(28), 181–201. https://doi.org/10.21029/JAEL.2020.28.181

Fitch Solutions. (2023). Hungary Market Analysis. Fitch Solutions. https://www.fitchsolutions.com/region/hungary

Forsense Institute. (2020). A motorizációs trendek és autóhasználati szokások környezeti hatásai Magyarországon [Environmental impacts of motorisation trends and car use patterns in Hungary]. Forsense Institute. https://www.forsense.hu/a-motorizacios-trendek-es-autohasznalati-szokasok-kornyezeti-hatasai-magyarorszagon/

Goulding Carroll, S. (2023, February 14). EU sees brutal drop in renewable energy used in transport. Euractiv. https://www.euractiv.com/section/agriculture-food/news/eu-sees-brutal-drop-in-renewable-energy-used-in-transport/

Grabiel, T. (2018). Options for Eastern European countries to restrict the influx of second-hand diesel vehicles. Défense Terre; Transport & Environment. https://www.transportenvironment.org/wp-content/uploads/2021/07/Legal%20Analysis%20-%20Measures%20on%20Second-Hand%20Diesel%20Vehicles.pdf

Han, J., Vahidi, A., & Sciarretta, A. (2019). Fundamentals of energy efficient driving for combustion engine and electric vehicles: An optimal control perspective. Automatica, 103, 558–572. https://doi.org/10.1016/j.automatica.2019.02.031

Hungarian Anti-Corruption Association. (2021). Request to the European Commission against the Hungarian government's discriminatory and unfair municipal subsidies. https://kelleszegyesulet.hu/docs/Europai_Bizottsagnak_onkormanyzatok_diszkriminacio.pdf

Hungarian Cyclists Club. (2022). This is how Hungary cycles in 2022. Medián, Hungarian Cyclists Club. https://drive.google.com/file/d/12tkT4O3fIeuuJt7U_4IkFnxcYVbHvGqV/view

Nemzeti Közlekedési Infrastruktúra-fejlesztési Stratégia, (2015). https://2015-2019.kormany.hu/download/3/a8/10000/Nemzeti%20K%C3%B6zleked%C3%A9si%20Infrastrukt%C3%BAra-fejleszt%C3%A9si%20Strat%C3%A9gia.pdf

Government Decree No. 186/2019, (2019). http://www.kozlonyok.hu/nkonline/index.php?pageindex=kozltart&ev=2019&szam=130

Hungary. (2021). Integrált Közlekedésfejlesztési Operatív Program Plusz (IKOP Plusz). https://www.palyazat.gov.hu/integralt_kozlekedesfejlesztesi_operativ_program_plusz

Hungary Central Statistical Office. (2022). Transportation 2021. Situation 2021. https://ksh.hu/s/helyzetkep-2021/#/kiadvany/szallitas/a-szemelyseruleses-kozuti-kozlekedesi-balesetek-szama-kimenetel-szerint

Hungary Central Statistical Office. (2023a). 24.1.1.26. Average age of the passenger car stock by make. https://www.ksh.hu/stadat_files/sza/hu/sza0026.html

Hungary Central Statistical Office. (2023b). Bevezető – Fenntartható fejlődés indikátorai. https://ksh.hu/s/kiadvanyok/fenntarthato-fejlodes-indikatorai-2022/ffi

Hungary Ministry of Innovation and Technology. (2019). National Energy and Climate Plan. Hungary. https://energy.ec.europa.eu/topics/energy-strategy/national-energy-and-climate-plans-necps_en

Hungary Ministry of Innovation and Technology. (2020). Klíma- És Természetvédelmi Akcióterv. https://docplayer.hu/182810204-Klima-es-termeszetvedelmi-akcioterv.html

Hungary Vignette. (2023). Motorway vignette Hungary—Highway sticker purchase 2023. https://www.hungary-vignette.eu/

IEA. (2022a). A 10-point Plan to Cut Oil Use. International Energy Agency. https://www.iea.org/news/emergency-measures-can-quickly-cut-global-oil-demand-by-2-7-million-barrels-a-day-reducing-the-risk-of-a-damaging-supply-crunch

IEA. (2017a). Ownership tax benefits. IEA. https://www.iea.org/policies/6704-ownership-tax-benefits

IEA. (2017b). Registration tax benefits. IEA. https://www.iea.org/policies/6769-registration-tax-benefits

IEA. (2021a). Climate and Nature Protection Action Plan—Green Bus Program. IEA. https://www.iea.org/policies/13933-climate-and-nature-protection-action-plan-green-bus-program

IEA. (2021b, July). Climate and nature-protection action plan. IEA. https://www.iea.org/policies/11625-climate-and-nature-protection-action-plan

IEA. (2022b). Hungary Oil Security Policy. https://www.iea.org/articles/hungary-oil-security-policy

Ákos Nádasdi (C-290/05) v Vám- és Pénzügyőrség Észak-Alföldi Regionális Parancsnoksága and Ilona Németh (C-333/05) v Vám- és Pénzügyőrség Dél-Alföldi Regionális Parancsnoksága, Colneric, N. ___ (Court of Justice of the European Union (First Chamber) 2006). https://curia.europa.eu/juris/document/document.jsf;jsessionid=06DCF62AC43F3ACAF099B730BA378683?text=&docid=65603&pageIndex=0&doclang=en&mode=lst&dir=&occ=first&part=1&cid=227889

Jochem, P., Frankenhauser, D., Ewald, L., Ensslen, A., & Fromm, H. (2020). Does free-floating carsharing reduce private vehicle ownership? The case of SHARE NOW in European cities. Transportation Research Part A: Policy and Practice, 141, 373–395. https://doi.org/10.1016/j.tra.2020.09.016
Kotzapasis, P. (2022). ACEA Tax Guide 2022. ACEA. https://www.acea.auto/files/ACEA_Tax_Guide_2022.pdf
KTI Transport Research Institute Nonprofit Ltd., & Centre for Environmental and Sustainability Research. (2013). Útmutató alacsony emissziós zónák létrehozásához [Guideance for the creation of low emission zones]. Hungary Ministry of National Development. https://pm10.kormany.hu/download/2/ae/80000/KTI_LEZ_UTMUTATO_2013.pdf
Lukács, A., Lakos, G., Békefi, M., Horvath, Z., Kövesdi, I., Pál, J., Kiss, K., Pavics, L., Szabó, Z., & Vörös, A. (2011). The social balance of road and rail transport in Hungary. CAAG, Levegö Munkacsoport. https://www.levego.hu/sites/default/files/social_balance_transport_hungary_20110131.pdf
Martin, E., & Shaheen, S. (2011). The impact of carsharing on household vehicle ownership. Access, 38, 22–27.
MGE. (2023). Hungarian Vehicle Importers Association. http://www.mge.hu/
Ministry of National Development. (2014). National Transport Strategy: Guidance for the strategic development of the transport system. https://2010-2014.kormany.hu/en/ministry-of-national-development/news/national-transport-strategy-guidance-for-the-strategic-development-of-the-transport-system
Montella, A., Imbriani, L. L., Marzano, V., & Mauriello, F. (2015). Effects on speed and safety of point-to-point speed enforcement systems: Evaluation on the urban motorway A56 Tangenziale di Napoli. Accident; Analysis and Prevention, 75, 164–178. https://doi.org/10.1016/j.aap.2014.11.022
Motor1. (2022, March). Tovább nőtt a magyar autók átlagéletkora [The average age of Hungarian cars continues to grow]. Motor1.com. https://hu.motor1.com/news/571711/auto-eletkor-magyarorszag/
Nijland, H., & van Meerkerk, J. (2017). Mobility and environmental impacts of car sharing in the Netherlands. Environmental Innovation and Societal Transitions, 23, 84–91. https://doi.org/10.1016/j.eist.2017.02.001
PolicySolutions. (2012). Közvélemény-kutatás egy lehetséges telekocsi-szolgáltatásról. https://www.levego.hu/sites/default/files/telekocsi_kutatas.pdf
Ramos, É. M. S., Bergstad, C. J., Chicco, A., & Diana, M. (2020). Mobility styles and car sharing use in Europe: Attitudes, behaviours, motives and sustainability. European Transport Research Review, 12(1), 13. https://doi.org/10.1186/s12544-020-0402-4
Ramos, É. M. S., Bergstad, C. J., & Nässén, J. (2020). Understanding daily car use: Driving habits, motives, attitudes, and norms across trip purposes. Transportation Research Part F: Traffic Psychology and Behaviour, 68, 306–315. https://doi.org/10.1016/j.trf.2019.11.013
Robert Bosch Ltd. (2023). Car ownership survey data [Letter to Márton Vargha].
Samaras, C. (2012, May 20). Optimal Car Average Speed For Minimum Fuel Consumption. My Engineering World. https://myengineeringworld.net/2012/05/optimal-speed-for-minimum-fuel.html
Sándor, F. (2014, January). On case number: PTKF/107/2/2014. https://www.parlament.hu/irom39/13513/13513-0001.pdf
Stadt Freiburg. (2022). Vauban. Freiburg im Breigsau. https://www.freiburg.de/pb/208732.html
Statista. (2022). Electrified rail network in Europe, by country. Statista. https://www.statista.com/statistics/451522/share-of-the-rail-network-which-is-electrified-in-europe/
Thales Group. (2020, December 18). First Thales ETCS Level 2 project successfully put into operation in Hungary. Thales Group. https://www.thalesgroup.com/en/austria/news/first-thales-etcs-level-2-project-successfully-put-operation-hungary
Tóth, K. (2022). Budapest bike revolution – Morals on the connection between the city and cycling. Issuu. https://issuu.com/iparmuveszetimuzeum/docs/bringologia_oldalak_en/s/10676410
Transport & Environment. (2019). Low-Emission Zones are a success—But they must now move to zero-emission mobility. https://www.transportenvironment.org/wp-content/uploads/2021/07/2019_09_Briefing_LEZ-ZEZ_final.pdf
Transport & Environment. (2016, April 5). First real-world car CO2 results show gap of up to 56%. Transport & Environment. https://www.transportenvironment.org/discover/first-real-world-car-co2-results-show-gap-56/

van Leijen, M. (2022, September 30). Hungarian railway companies turn to diesel in despair of electricity price. RailFreight.Com. https://www.railfreight.com/railfreight/2022/09/30/hungarian-railway-companies-turn-to-diesel-in-despair-of-electricity-price/

Zhou, F., Zheng, Z., Whitehead, J., Perrons, R., Washington, S., & Page, L. (2020). Examining the impact of car-sharing on private vehicle ownership. Transportation Research Part A: Policy and Practice, 138, 322–341. https://doi.org/10.1016/j.tra.2020.06.003


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