REPORT 2021

The Future of Mobility

Development trends up to 2035

FORESIGHT CENTRE

An independent think tank at the Riigikogu

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Development trends up to 2035

Report

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The Foresight Centre: *Eesti elanike liikuvusprofiilid* (Mobility profiles of people in Estonia)
The Foresight Centre: *Liikuvuse arenguväljavaadete analüüs* (Analysis of the development outlook for mobility)

2021

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Foreword

There is progressively more discussion about how much mobility affects other areas of life. Of the 17 sustainable development goals defined by the United Nations, 11 are related to mobility [1]. Changes in transport policy and social changes over the past couple of decades have particularly affected how and why we move and how we use our transport systems. The number of cars registered in Estonia has almost doubled during this time for example. Many people who earlier used public transport, a bicycle or their own feet, now get around by car.

The changes in the coming decades will probably be even greater, as achieving climate neutrality in Estonia will need major changes to the way we currently understand everyday transport. Manufacturing measures the efficiency of production using the production resource load, which shows the amount of working time that a production resource spends in active use. If it is below 70%, then there is a problem. Private cars meanwhile are on average in active use only 5% of their available time, and the rest of the time they are parked. However, various resources have already been used to produce the car, the ground that it is parked on could be used for some other purpose or could be sold, and other resources will be needed in future to dispose of the car. Other challenges alongside the inefficiency of how mobility is currently organised are posed by various other negative impacts. Many living environments are affected, as are health and quality of life, the economy, and the local and global natural environments. Several countries have understood how problematic the current system of organisation is and are actively searching for solutions to improve matters.

The decisive factors in the future of mobility will be the transition or the failure to transition to sustainable transport, increasing urbanisation, and developments in transport and digital technology. The emergence of several individual trends can be predicted, but what they mean for the needs and expectations of how people move around will be decided in combination with a range of background factors.

Digital solutions and the increased availability of remote working suggests there may be less need for mobility, but to what extent? Can a nation that communicates only through digital channels be creative and competitive? Are self-driving cars a solution that will make it much less necessary to develop public transport? Will the 21st century replace the mindset of 'further and faster' with a focus on being present, where the main priority is access to services and the living environment?

We hope this research work will give food for thought on the implications of choices for mobility in the future and of possible developments.

Happy reading!

Tea Danilov
Head of the Foresight Centre

[1] https://unece.org/transport-and-sustainable-development-goals

Summary of the lines of research

Mobility and the options for mobility are tightly linked with how we live our lives

We move to go to work, to study or to make use of our leisure time. The future of mobility can be seen in the broadest sense of how and where people live their lives, or more narrowly as the day-to-day mobility choices made within the existing system.

One of the most important factors reducing the need for mobility in **how people live** is the rise of remote work and remote services. The pandemic accelerated this rise, but it is unclear how permanent the changes will be. The spread of remote working reduces the obligation to travel at fixed times in fixed directions and increases the share of travel that does not have fixed patterns.

The space where people are depends on the regional development in Estonia. The Foresight Centre produced four regional economic scenarios in 2019 describing different possible regional development outcomes in Estonia up to 2035[2]. It asked whether the future will see a Greater Tallinn, more equal growth centres across Estonia, or an Estonia of eco-communities, where the need for mobility is less than at present. Which scenario plays out will depend on external factors such as technological development and how quickly ecological values become ingrained in the economy and in lifestyles, but the choices made by the state are also important.

Mobility based on the private personal car is inefficient and wastes space

A large part of mobility happens within urban areas, where it is defined by planning practices and the quality of the urban space. Space is needed both for movement and for parking. The amount of public space is limited, and so developing infrastructure for cars reduces what is available for other forms of transport. Roads and parking spaces account for as much as 50% of the urban space in many towns. However, private cars spend around 95% of their time parked and are driven only 2.5 times a day on average in European countries [3].

Planning and use of the urban space that is centred on the car worsens the quality of the living environment and pushes people out of densely populated areas and into the suburbs. Planning that encourages different forms of mobility can, however, improve the living environment of a town and can stop, and even reverse in the longer term, the drift to the suburbs.

Mobility in Estonia features a high and rising rate of car use

The trend until now in Estonia has been for car use to increase at the expense of public transport and walking. Over 18 years the number of people going to work by public transport, on foot or by bike has fallen by 120,000. During the same period the number of cars registered has essentially doubled so that there were 598 cars per thousand residents in 2019, or a quarter fewer

[2] Foresight Centre (2019). Future of Regional Economy in Estonia. Scenarios until 2035.
[3] Driving and parking patterns of European car drivers – a mobility survey. https://setis.ec.europa.eu/sites/default/files/reports/Driving_and_parking_patterns_of_European_car_drivers-a_mobility_survey.pdf

if cars that ceased being registered are excluded, which is one of the highest figures in Europe. Car use has grown particularly rapidly in rural areas where getting to work on foot or by bike has become harder as jobs have been relocated and commutes to work have increased.

Car use has increased rapidly among the low-paid, who are at risk of mobility poverty, which arises when a large part of their budget goes on the costs of a car. A transport system centred on the car also increases mobility poverty among the elderly.

Such a system ingrains a sedentary lifestyle and a shortage of daily exercise, which is one of the main causes of premature death. The World Health Organisation (WHO) considers that integrating daily physical activity is more sustainable than sport for exercise[4], as 24 minutes of walking or cycling a day reduces the risk of premature death by 10%[5].

A third of people in Estonia move in sustainable ways, and a further 20% would be prepared to do so

The mobility profile analysis of people in Estonia shows that 33% of people move around following the principles of sustainable mobility. It would be relatively easy to change the mobility habits of around a further 20% of people. Demand-based transport in rural districts, which could in future be self-driving, would help with this, as would support for buying or renting vehicles that emit less pollution.

Public transport in towns that is clean, rapid, convenient, and easy to combine with other forms of transport would be a good alternative to owning their own car for several groups in society. Integrating the use of bicycles and trains is recommended, especially in districts bordering cities.

Demand and preferences for mobility are diversifying, and there will be no single typical road user in future

Different age groups act and move entirely differently in the urban space, and public behaviours will increasingly diversify. There is no single typical road user whose wants and needs should be the basis for setting mobility policy. Young people move in various ways and prioritise environmental sustainability, and they are less and less interested in owning and using cars.

Relying solely on technological development will not solve transport problems

Electric and hydrogen-powered cars reduce the local environmental burden and self-driving cars increase safety and convenience, but neither reduces the need for space for cars in towns and cities, and they could cause car use to increase. Micromobility broadens the transport options in densely populated areas, but needs to be regulated. Drones are energy intensive, need launch and landing sites, and require a lot of space to move safely.

[4] https://apps.who.int/iris/bitstream/handle/10665/272722/9789241514187-eng.pdf?sequence=1&isAllowed=y
[5] HEAT, World Health Organization https://www.heatwalkingcycling.org/#homepage

Mobility as a Service (MaaS) can make car use more efficient, but needs smart guidance

Mobility as a Service (MaaS) and transport solutions in the sharing economy are developing rapidly. Their success depends on how prepared people are to share transport and to make their mobility data available. In the longer term there are great prospects for self-driving cars as a part of public transport. Public transport will in future be a flexible service that is based on data, is integrated with other forms of mobility, uses vehicles of different sizes, is frequently demand-based, and optimises routes.

Achieving the goals of environmental sustainability requires large and rapid changes in how people move around

Estonia has set a target for the transport sector of total emissions of 1750 kt of CO_2 in 2035, which is 28% less than the level of 2018. This will require a rapid turn away from the current trend, as the greenhouse gas emissions of the transport sector have increased steadily each year since 2014. Car use needs to become more efficient and daily commutes need to be shorter.

Planning and infrastructure development based on expectations of increased car use become self-fulfilling prophecies

The transport and mobility strategies in Estonia are in line with contemporary principles of sustainable mobility and the framework documents of the European Union. Achieving the changes set out in them though is made harder by the framework for infrastructure development that uses baseline forecasts for mobility, mobility research methodologies and standards for roads in town that continue to be based on increasing car use and so end up encouraging it.

Promoting sustainable mobility requires compromises

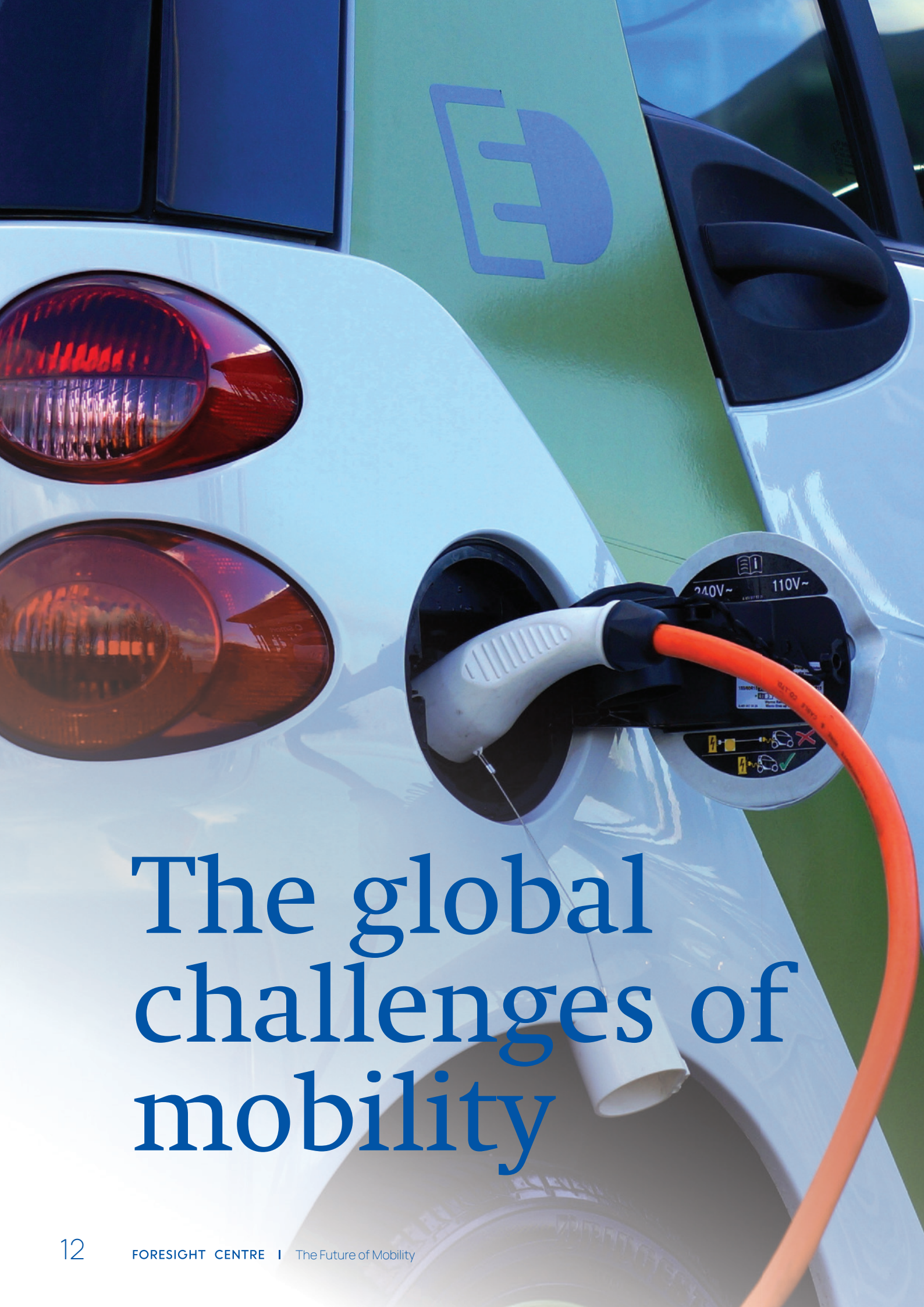
Designing mobility in towns means choosing between a high quality public space and the convenience and speed of travel by car. Movement between towns depends on the choice of developing rail transport or road transport. Public transport between towns assumes however that mobility services within towns are of good quality and flexible. Two different possible approaches for rural districts are either to provide better and more sustainable connections, or to bring jobs and services closer to reduce the need for mobility.

Taxation of transport needs to change

Taxation of transport that is based solely on fuel excise is not sustainable as electric cars spread more widely, and receipts of excise on petrol and diesel should be expected to fall by at least a fifth by 2030. VAT receipts from fuel would also fall alongside excise receipts.

Sustainable mobility will not be achieved without intervention

People make their transport choices by looking at how well transport services can meet their practical needs. They consider for example whether the transport infrastructure favours the use of cars or public transport. Mobility is not an end in itself, but is linked with different areas like environmental, health, energy, regional and education policies, and mobility policy must be pursued in line with those policies and through them.



The global challenges of mobility

The global challenges of mobility primarily come from the unsustainability of the car-centred organisation that came to dominate in the last century. It has become clear that solutions based on forecasts for increasing car use are not sustainable because of their major costs, space requirements and environmental impacts. The 20th-century approach to organising transport will in consequence be replaced by a focus on mobility and access.

Sustainable mobility has become the umbrella concept for the main challenges of mobility. This means not only prioritising environmental sustainability, but also taking a holistic approach to making the way people move more sustainable.

The main problems that are highlighted by sustainable mobility are environmental sustainability, efficiency, equality of access, and safety.

Transport based on the private personal car has a major environmental impact

Car use is the biggest polluter per passenger kilometre in the transport sector (see Figure 1). Cars with internal combustion engines produce not only carbon dioxide, but also harmful nitrogen and sulphur oxides and fine particles. Tyres and road surfaces emit dust and micro-plastic particles as they wear, and the noise produced by cars is also harmful for health. The forms of mobility with the smallest environmental impact are, as may be expected, walking, cycling and public transport, especially electric-powered public transport.

The long-term strategic vision of the European Union is to be the world's first climate-neutral economic area. The Green Deal[6] signed in 2019 sets the goal of reducing the emissions from transport by 90% by 2050, which is an extremely ambitious target. Meeting the climate goals agreed for 2030 will require major and rapid changes to transport fleets, the architecture of transport networks, levels of service in public transport, and the taxation of road use, energy use in transport, and vehicles.

[6] https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_et

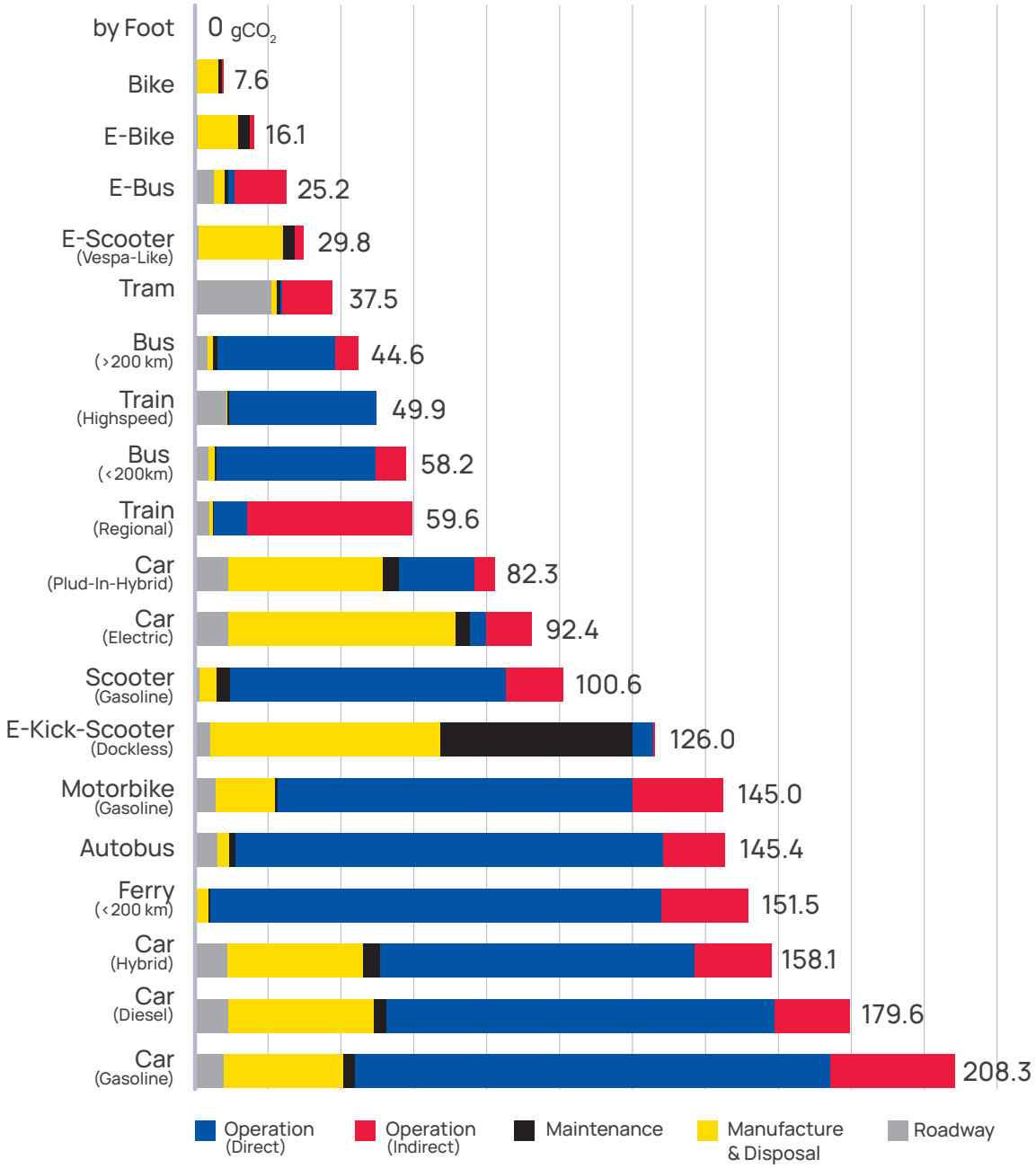


Figure 1. Average carbon dioxide emissions (g CO_2/km) for different types of transport
Sources: Schunck, K., Lufthansa Innovation Hub, Mobitool, BMVI, UBA, Handelsblatt Research

The greenhouse gas emissions of the Estonian transport sector come mainly from road transport, which produced 98% of them in 2019[7]. The Estonian transport fleet is notable for its age, which averages 16.7 years. This is markedly higher than the European average of 11.6, and second only to Lithuania at 16.8. Not only are the current vehicles old and polluting, the average greenhouse gas emissions of new vehicles registered in Estonia are among the highest in the European Union at 130.1 g CO_2 per km.[8]

[7] https://www.envir.ee/et/eesmargid-tegevused/kliima/rahvusvaheline-aruandlus/kui-palju-eestis-kasvuhoonegaase-tekib
[8] Eurostat, tabel sdg_12_30

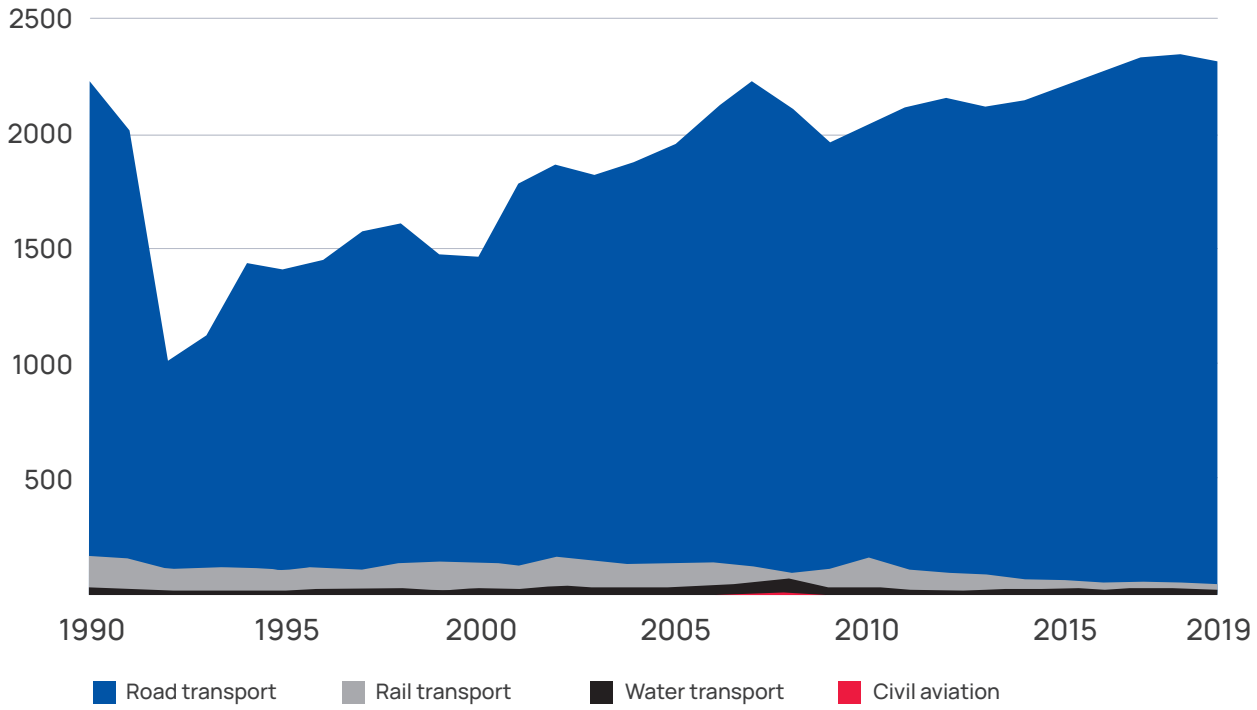


Figure 2. Greenhouse gas emissions by the Estonian transport sector by type of transport 1990–2019, kt CO_2 equivalent
Source: Ministry of the Environment

Mobility based on the private personal car wastes space and is inefficient

The problem of the space needed for car transport is shown particularly sharply in the design of the urban space. Space is needed both for movement and for parking. The amount of public space is limited, especially in towns, and so developing infrastructure for cars reduces what is available for other forms of transport. Roads and parking spaces account for as much as 50% of the urban space in many towns. However, private cars spend around 95% of their time parked and are driven only 2.5 times a day on average in European countries.[9] This means that owning a private car is not at all efficient in terms of resource use.

One of the main drawbacks to car use, and one of the clearest illustrations of the large need for space, is traffic jams, which occur when the flow of traffic is hindered, speed of movement falls or stops altogether, and delays arise. Traffic flows are generally hindered at intersections, and so additional lanes, turning lanes or multilevel intersections are built to solve the problem.

These generally push the problem of flow on to the next location, and at the same time create increasing new demand as the constant improvement in conditions for car transport persuades more and more people that the private car is a good choice for mobility. Expanding infrastructure in this way creates new demand, and so it is later seen that the earlier forecasts for increasing car use have come true. The 'predict and provide' solution means there is no way to escape traffic jams by building.

[9] Driving and parking patterns of European car drivers – a mobility survey. https://setis.ec.europa.eu/sites/default/files/reports/Driving_and_parking_patterns_of_European_car_drivers-a_mobility_survey.pdf

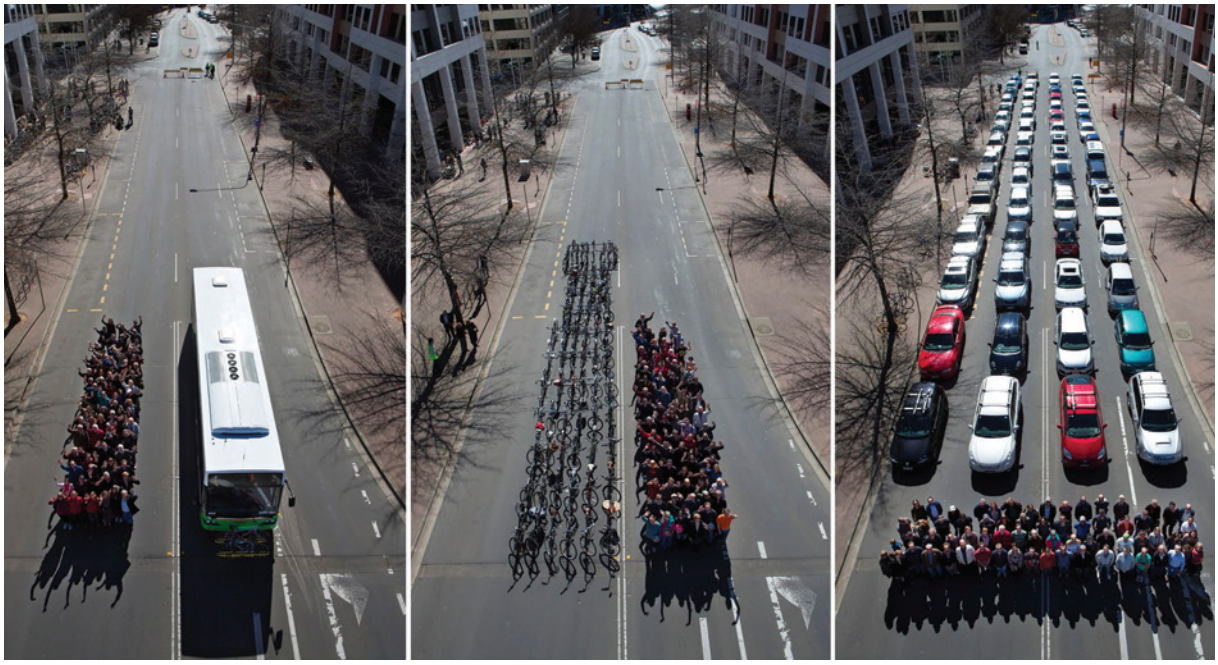


Figure 3. The amount of space needed to serve the same number of passengers with different forms of transport
Allikas: Cycling Promotion Fund

Dependency on the car increases mobility poverty in an ageing society

Options for mobility should be used to ensure equal economic and social opportunities for all members of society. Dependency on the personal car and a lack of any alternative means of mobility reduces opportunities for independent movement in an ageing society[10]. The ability to drive a car may be lost without warning, causing an immediate inability to get around.

The lack of options for mobility can cause mobility poverty, which arises when the costs of running a car account for a disproportionately large part of a family's income. Car use has particularly increased in Estonia in recent years among the parts of society on the lowest incomes. This indicates a lack of alternative choices as people are forced to spend a substantial part of their income on running a car.

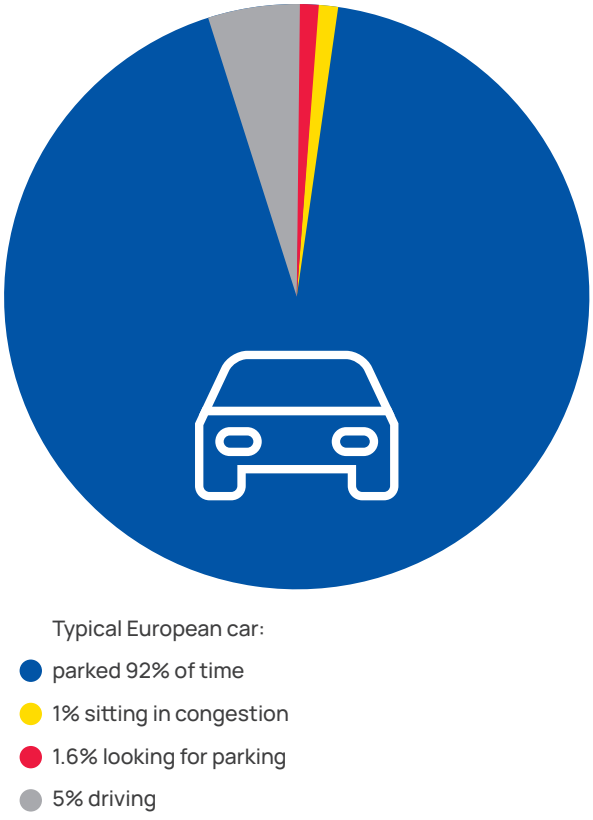


Figure 4. Car use is extremely inefficient
Source: EC Institute for Energy and Transport

[10] https://www.itf-oecd.org/reversing-car-dependency

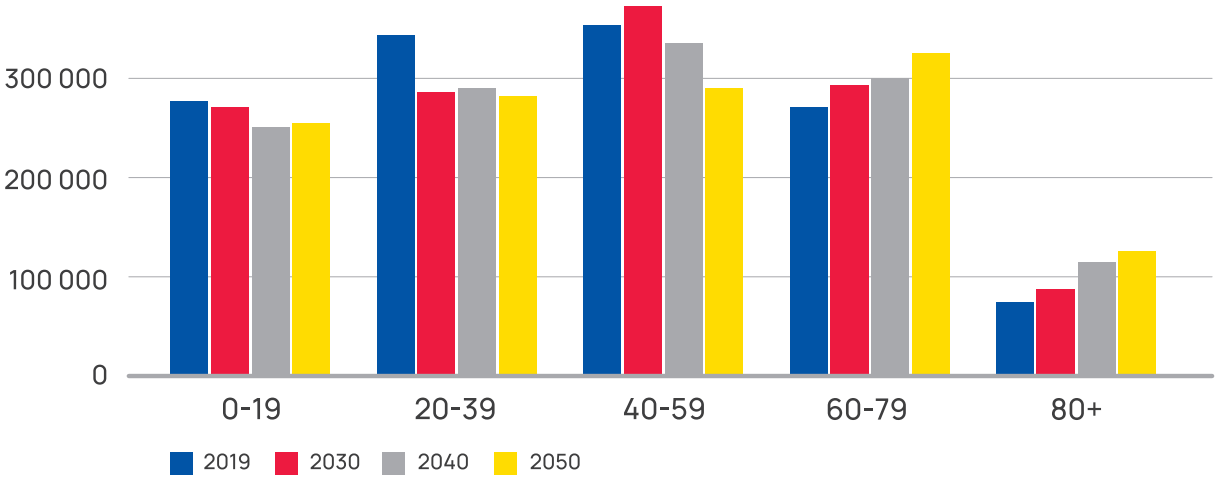


Figure 5. The population of Estonia by age groups in 2019, 2030, 2040 and 2050
Source: Statistics Estonia

Mobility poverty threatens not only the low-paid in Estonia but also the elderly, whose financial welfare will in future depend increasingly on how much they saved before retiring.

The number of road deaths and injuries is falling more slowly

The number of road traffic deaths has fallen in the past decade, but the rate of fall is slowing. An average of 51 people per million die in traffic each year in Europe[11]. It is estimated that for each death there are a further five people who suffer life-changing serious injuries. The costs of road traffic accidents are estimated at around 280 billion euros a year, or around 2% of the GDP of the European Union.

The Strategic Road Safety Action Plan of the European Commission has set the the ambitious Vision Zero target for road safety, which takes the ethical position that there should be no deaths or serious injuries from road transport. Vision Zero highlights the importance of planning the mobility environment so that human error in infrastructure planning or in traffic should not cause death or serious injury.

An important part in reducing the number of road deaths and injuries is played by safer cars and infrastructure and by better use of protective equipment. Lowering speed limits in towns and residential areas, and also on the open road, is seen as an effective way of reducing the number of road deaths further. Lower speeds and a smaller difference between the speeds of cars and heavy vehicles will also help improve road safety. A speed limit of 30 km/h has been introduced in built-up areas in the Netherlands, and also in Brussels in Belgium.

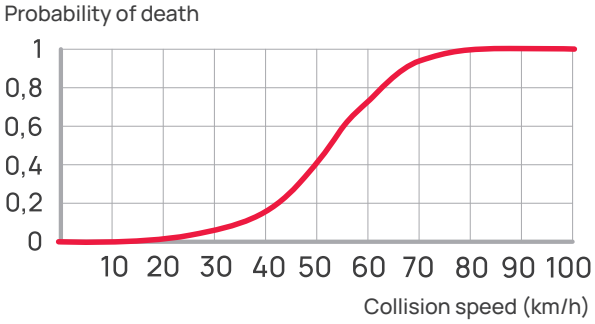


Figure 6. The probability of a pedestrian surviving a crash at 80 km/h is close to zero
Source: Safety European Road Observatory (2006)

[11] Eurostat, 2020.

Development trends in mobility

Demand and preferences for mobility are diversifying, and there is no single typical road user

Different age groups act and move entirely differently in the urban space, and public behaviours will increasingly diversify. Generally people have made two movements a day, going to work and coming home, but in future the number of movements per day may rise and they may become more distributed throughout the day. There is no single typical road user whose wants and needs should be the basis for setting mobility policy. In consequence the 8:80 principal that both eight-year-olds and eighty-year-olds should be able to move independently around town is being increasingly applied in town planning.

Young people move in various different ways and prioritise environmental sustainability. Throughout the world they are less and less interested in owning and using cars. There are various reasons for this from changes in attitude to new opportunities for transport. This also affects their choice of where to live and work and their lifestyle choices. People in their later years are also losing interest in having a driving licence, which is shown by statistics in the extremely car-centric USA as well as in Estonia. It has been suggested though that people have simply delayed getting a driving licence to a later point in their lives, as they are also having families later.

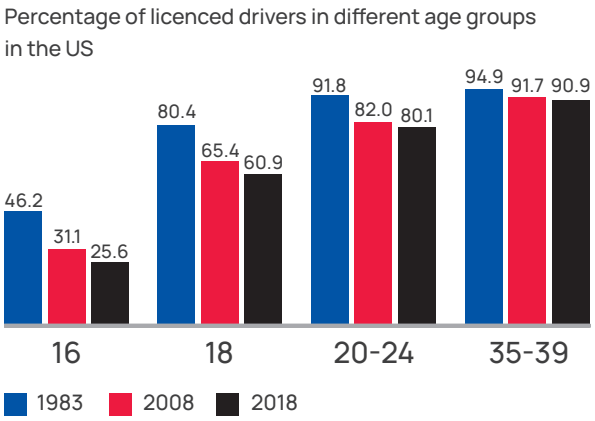


Figure 7. People in the US, especially the young, are becoming less interested in learning to drive
Source: Federal Highway Administration

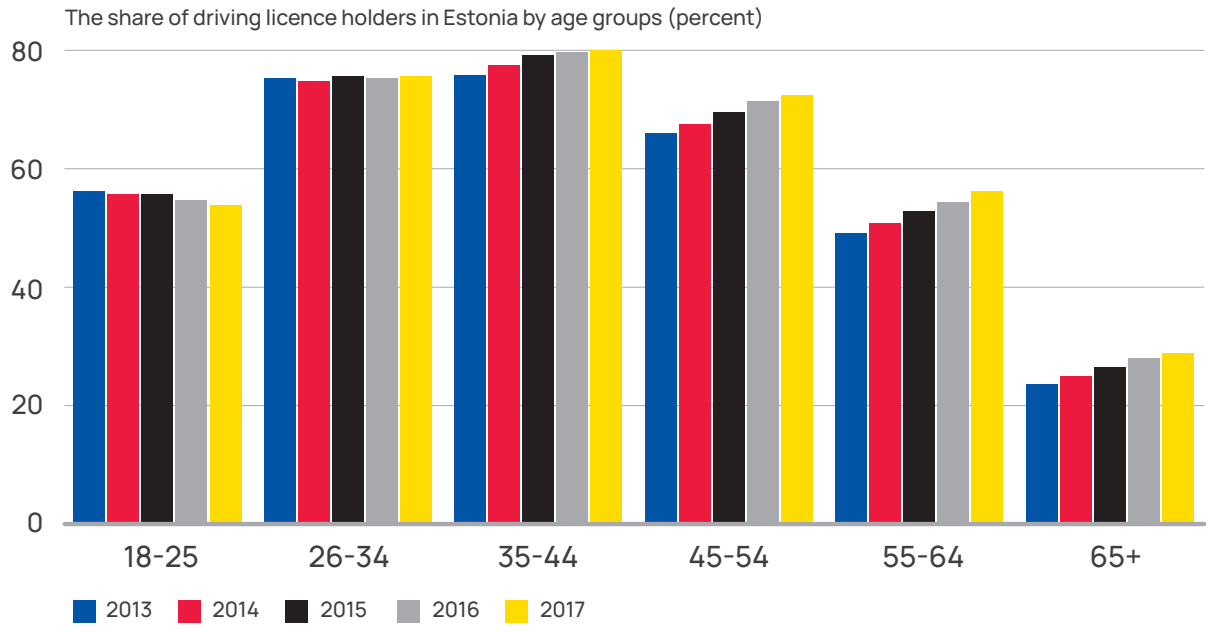


Figure 8. Having a driving licence is becoming less common among the young in Estonia and more common in older age groups
Source: Data from the Estonian Transport Administration and Statistics Estonia

Options for mobility in cities have expanded in recent years, especially for younger road users, through new micro-mobility solutions like scooters, which have become very popular all over the world in the form of electric scooters and similar vehicles, both for private use and as a sharing service. The pandemic has amplified the trend towards such lighter vehicles even further. This has caused a lot of problems though, as towns were not ready for such vehicles and they have often had to use parts of the urban space that were intended for pedestrians and were already crowded. Analysis has shown that micro-mobility needs to be regulated better to solve the problems of parking for electric scooters, use of the streets and dangerous speeds, and also to set single quality standards for vehicles and to ensure fair competition and pricing of micro-mobility services.

Micro-mobility is not a good solution for older people, but society is ageing and older people are moving around more than ever. Society is ageing very unevenly across Estonia, as it is happening much faster in rural areas and more slowly in the towns. If the current trends continue with the birthrate stabilising and average life expectancy extending, the population of Estonia will continue ageing quickly until the end of the 2050s, after which the share of the population that is over 65, currently 20%, will stabilise at around 28%[12].

Demand for mobility is made more varied by the spread of remote working, which reduces the obligation to travel at fixed times in fixed directions and increases the share of travel that does not have fixed patterns. This makes the current transport solutions that are intended to serve large and regular flows of passengers less efficient. The increase in working remotely means that travelling for work becomes less necessary and the quality of the living environment becomes more important. The option of working remotely is connected though to how prepared people are to accept a distant job. It has been found that each additional eight-hour remote working day is related to an increase of 3.5% in length of the commute[13].

An increasing part of trade and services is moving from the physical environment to the virtual one, which reduces the need to travel. At the same time this substantially increases the importance of goods transporters and courier services. Optimising parcel transport and reducing the emissions from it has become a much bigger challenge in consequence.

[12] Population and cohesive society development plan 2030.

[13] de Vos, D., Meijers, E., & van Ham, M. (2018). Working from home and the willingness to accept a longer commute. The Annals of Regional Science, 61(2), 375–398. https://doi.org/10.1007/s00168-018-0873-6

Countries are competing to attract talent that works remotely and is not tied to one place

It is becoming increasingly desirable to work in different countries. More than three quarters of millennials want to work abroad during their career. The nature of work is changing as there are more freelancers and people working on short-term or gig contracts. Working in one country and one job for a very long time is in consequence becoming less common. If work can be done remotely, the workers can seek a good living environment anywhere in the world instead of being obliged to live close to their place of work.

The global talent mobility platform Topia and the Estonian start-up firm Teleport that it has acquired illustrate how cities around the world are working increasingly to have an attractive living environment for talent and to attract it and the income it brings. Competition in this is only increasing and the question of how to build a town so that it is attractive for smart workers is becoming increasingly important.

The preferences of the users of Teleport, who number more than 200,000, can be used to identify what talented workers consider important when choosing between cities around the world. The most important factor is a clean environment, with low costs in second place and low crime in third. Social values are also considered very important, as tolerance is placed fourth for importance. Generalising from these results shows that costs are important for mobile talent in choosing a city to live in, but the quality of life is even more important. The city needs to be green and friendly.

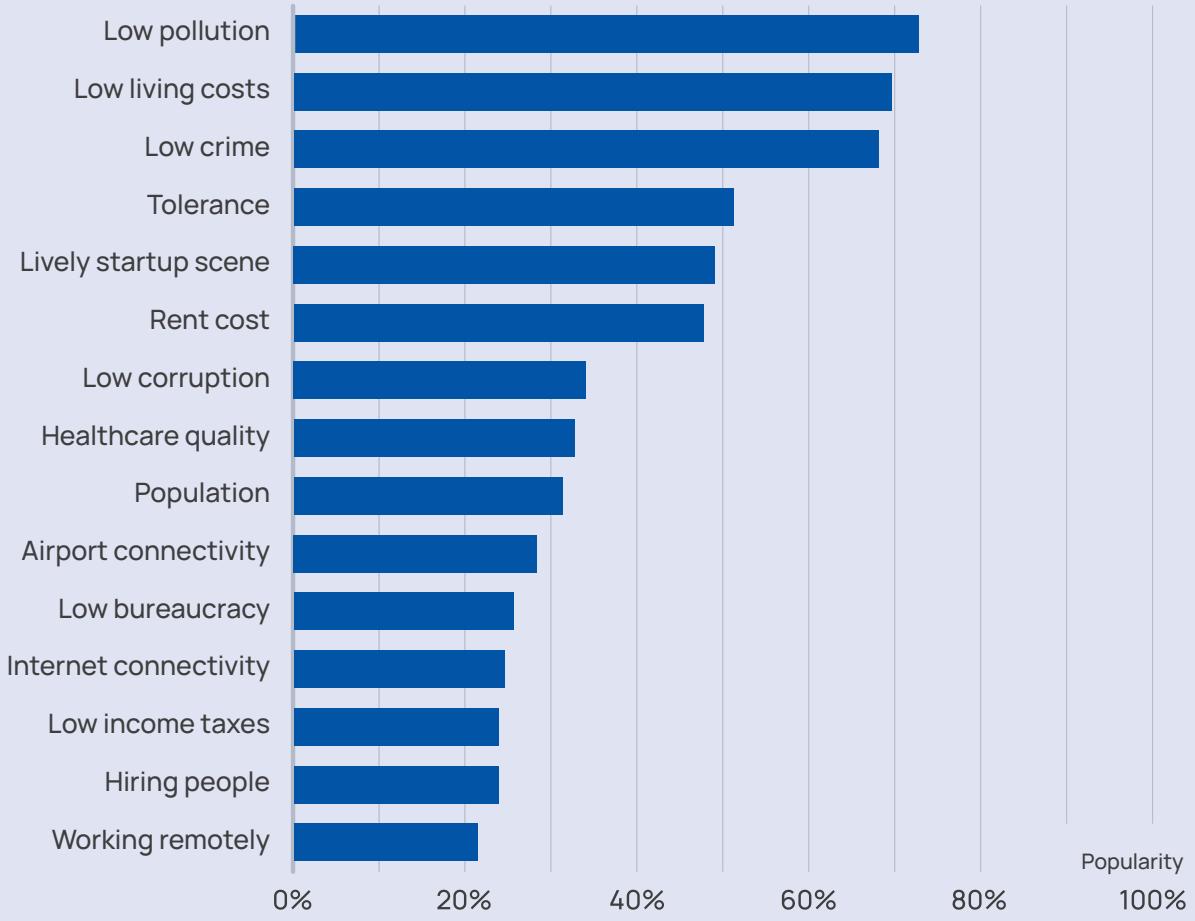


Figure 9. Footloose talent looks for a clean and comfortable living environment
Source: Topia

Mobility as a service will make car use more efficient

Mobility is more and more seen as a service that is provided and consumed rather than as a personal transport product. Different forms of transport need to be combined to optimise traffic flows and this means that moving from one form of transport to another needs to be simple and convenient. MaaS (Mobility as a Service) is a concept aimed at making mobility simpler and more efficient, integrating all the elements of mobility into a single service. The traveller sets a start and end point for their journey and a digital platform proposes various different ways of making the journey, combining public transport, taxis, shared vehicles and other options into a single package that can be provided for a single fee. The transfer from one form of transport to another happens seamlessly, so that when the traveller steps off the bus at the bus stop for example, there is a car waiting that has been ordered for them and others travelling to the same destination, with a driver who has already been told by the platform where to go.

MaaS could make vehicle usage much more efficient and offer an alternative to owning a private car. The spread of MaaS solutions is being boosted by new platforms and services in the sharing economy. Sharing services for travel, cars and bicycles are spreading rapidly and are making it less necessary to own a means of transport. They remain more expensive than owning a private car, and so they have so far been used to give people a further option alongside owning their own vehicle. Exchanging and collecting the data given to various providers of mobility services is a further challenge for MaaS, as is adhering to data protection requirements while doing so. A broader challenge lies in the differences between regulations in different countries that make it harder and more time-consuming to scale up services.

The world's first broadly operational MaaS solution was launched in Helsinki in Finland, where an all-inclusive service allowing unlimited travel was priced at around 500 euros a month. Estonia has MaaS XT[14], a development project within the Accelerate Estonia programme, that is being used to create a ride-sharing platform.

[14] https://accelerateestonia.ee/et/projekt/digitaalsed-liikuvusteenused/

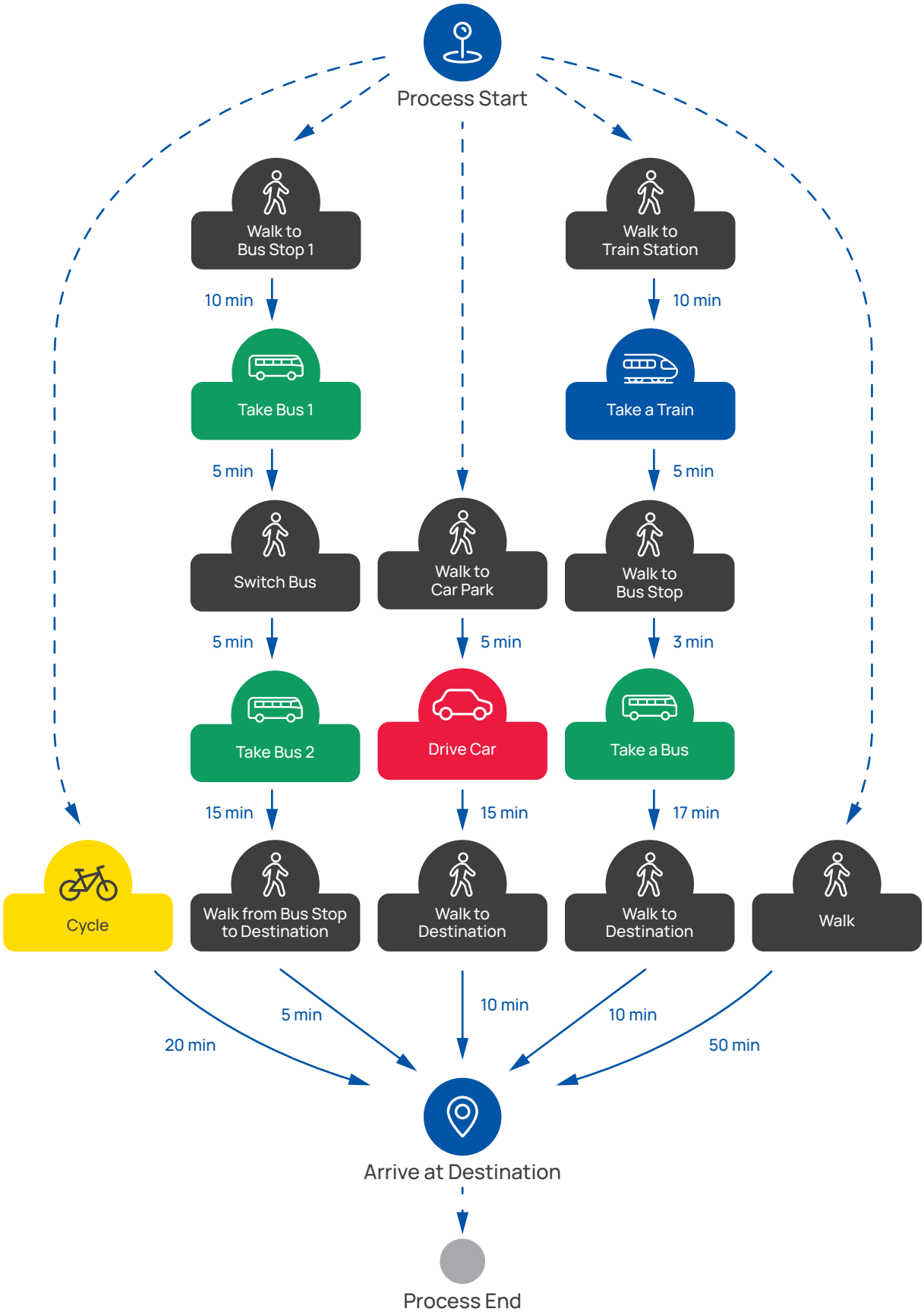


Figure 10. Transport options offered under mobility as a service (MaaS)
Source: Mobility-as-a-Service.Blog

Self-driving cars will make demand-based mobility services more competitive, but could also increase car use

Self-driving cars will make traffic safer and cars easier to use. Their introduction could give a substantial boost to MaaS solutions and the spread of demand-based mobility services. As the cost of the driver is the most expensive part of vehicle sharing services, self-driving cars could sharply reduce the cost of such services.

How self-driving cars affect the efficiency of a transport system and the environment depends on what role they start to play in the mobility system. If self-driving cars start to be used as personal vehicles, car travel will become accessible to a broader range of people including children, the disabled and others. This would be a positive development socially and for equal rights, but it would also mean an increase in travel by car. If self-driving vehicles were to replace public transport for some people on top of this, their broader spread could further increase car use, traffic jams in cities, and the environmental impact of transport.

Self-driving cars will only have a positive impact in reducing traffic levels if the demand-based solutions they use are connected to public transport to provide a last-mile solution[15, 16].

The introduction of a fleet of autonomous vehicles for various MaaS solutions will need self-driving systems to be developed and the prices of the technology required for them to fall. Autonomous travel needs hardware such as sensors and processing platforms and other components such as artificial intelligence software and high-resolution maps. The broader use of self-driving vehicles needs sensors and cameras to be developed to the point where they can function well in difficult traffic and weather conditions. The stock of vehicles currently on the road and the average lifetime of a car of 14 years suggest that self-driving cars will not be in widespread use in technologically advanced countries before 2030. The difficult weather and road conditions mean that this will happen quite a lot later in Estonia.

Electric vehicles will become more common and fuel excise receipts will fall

Internal combustion motors will soon be replaced by new technologies. The rise in sales of electric vehicles has been helped by generous subsidies, rapidly falling prices for batteries, tighter emissions standards, increasing attention from manufacturers, and growing interest among purchasers. Electric vehicles that use hydrogen as a fuel are also developing rapidly.

It is estimated that by the middle of the current decade the total cost of owning a car with an electric motor could be similar to that of a car with an internal combustion engine[17]. For vehicles that are used more intensively such as taxis this will happen even earlier. Electric cars are expensive to buy but cheap to run, so they are relatively cost efficient when driven a lot. Further development of the sharing economy will in consequence support the electrification of vehicles.

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[15] Microsimulation of Demand and Supply of Autonomous Mobility On Demand https://dspace.mit.edu/handle/1721.1/110178
[16] How Autonomous Cars May Change Transport in Cities? https://www.cowi.com/insights/how-autonomous-cars-may-change-transport-in-cities
[17] McKinsey, 2019 https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/making-electric-vehicles-profitable

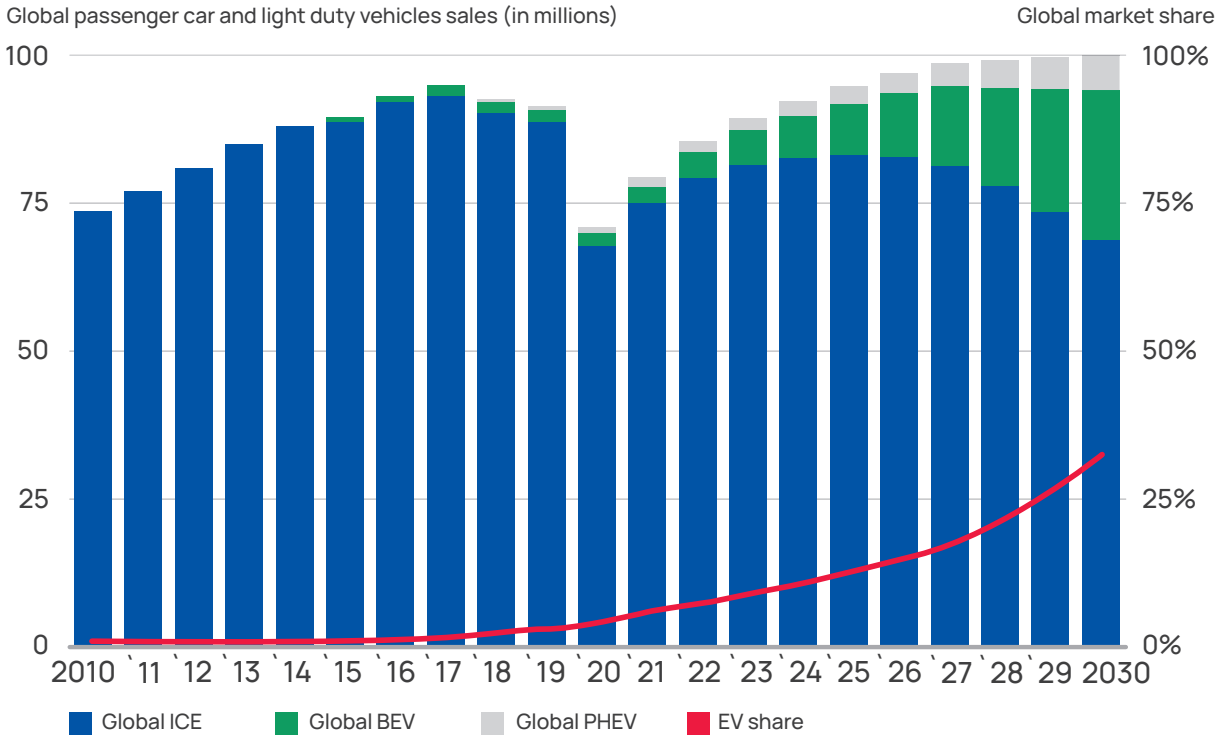

Figure 11. The share of cars that are electric rises to 30% by 2030
Source: Deloitte

How quickly electric cars are adopted more widely depends on the attitudes and behaviours of consumers, on regulations, and on the development work done by car manufacturers. Prices are becoming steadily more competitive while the mileage per charge of electric vehicles has increased and charging times have come down. National support packages for the recovery from the pandemic have focused a lot of attention on developing charging infrastructure, which could accelerate the change of attitudes in favour of electric vehicles. The strategic programmes of several car producers like BMW and Daimler foresee electric vehicles providing 50% of sales volumes by 2030. Volvo has set a target of reaching that level as early as 2025. The VW Group is planning to bring 70 new electric vehicles to market by 2030 and is expecting that they will provide at least 40% of all its vehicle sales.

The arrival of electric vehicles solves first of all the question of local emissions. If electricity comes from a renewable source, then it also partly addresses the question of global emissions. The large amount of space needed for travel by car and all that goes with it is a major problem though, and electric drivetrains cannot solve this. Neither can they solve the problems of the costs of energy, production and resources, of noise, as tyres are the main source of noise at speeds above 30 km/h, of road safety, or of the fine particles caused by the wear of tyres and road surfaces. Wear of car tyres is the main source of micro-plastics in the Baltic Sea for example.

The wider adoption of electric vehicles will need the taxation of transport to be changed as well, especially in Estonia, where there are no regis-

tration or annual taxes based on the emissions of cars or on their fuel use. Taxation based purely on fuel excise is not sustainable with a shrinking tax base. It is forecast that there could be around 85,000 electric cars in Estonia by 2030, and that by 2040 half of all cars could be electric[18]. A rough estimate suggests that excise receipts from petrol and diesel could fall by more than a fifth by 2030, or 97 million euros at current prices. The loss in fuel excise by 2040 under these forecasts would be as much as 185 million euros at current prices[19]. VAT receipts from fuel will also fall alongside excise receipts. If electric vehicles are introduced faster than expected, the tax base will shrink at a faster rate. This means the current logic of taxation of transport could not be continued if electric vehicles become more common. The smaller receipts from fuel excise as electric cars become more common could be offset by taxes on registration and annual taxation, but taxing all private vehicles by mileage would be even more effective.

Data and algorithms will help optimise mobility services

New data sources and the internet of things (IoT) allow a deeper understanding than before of how people move and their needs for mobility and of how the related mobility services and environment should be designed. The main source of data that is currently used regularly for decision-making in Estonia is vehicle traffic frequencies within towns and outside them. No town in Estonia is currently using big data on mobility systematically. Mobile positioning data could for example be used for analysing the spatial movement and location of people with relatively high accuracy.

Various key parameters beyond those covering car traffic could be used for planning movement and space. The quality of the mobility environment could be mapped for example by looking into the trajectories of pedestrians and cyclists or by involving the public through platforms to plan services. In practice this means a lot more analysis and consideration of it. Evidently analysis and planning of any sort is a great deal cheaper than construction work, even without the long-term impact on the total development of mobility.

Basing the organisation of services on data holds great promise for making public transport and demand-based services more efficient. A good example is the integration of the municipal transport network in Tartu, which used mobile positioning data, data on passenger journeys made, a database of the home addresses of schoolchildren, and other data sources. After the upgraded network was opened in summer 2019, the use of public transport and ticket sales have grown steadily by 15-20%. The budget for the service needed to increase by only 5%.

Planning that compacts the urban space will shorten daily journeys

Denser urban populations and better planning should reduce the need for transport. One contemporary goal in planning is the **15 minute town**, which is when most of the everyday necessities can be reached within a 15 minute walk or bike ride.

[18] Estonian Environmental Research Centre.

[19] Based on estimates by the Estonian Environmental Research Centre for the energy intensity of road transport and the speed of introduction of electric vehicles.

It has been said in consequence that while the 20th century was a century of movement, the 21st century will be the century of staying in place. A dense urban space means that less energy is consumed for transport[20]. Reducing energy intensity will become increasingly important for environmental sustainability in the future. Parking policy is increasingly important in the planning of mobility and the urban space. Cutting parking spaces and the use of car parks will improve the quality of life in towns and encourage the use of different forms of transport. Copenhagen has been systematically reducing the number of parking spaces in the city centre since the 1960s, while Paris will lose 70,000 parking spaces or half of the total in 2021, and Stockholm has got rid of its car parks. Parking policy is an indivisible part of mobility policy.

Figure 12. Cutting car parks positively benefited Houston in the USA – before (left) and after (right)
Source: www.theldnet.com

[20] Lefèvre, B. (2009). Urban Transport Energy Consumption: Determinants and Strategies for its Reduction.

Mobility scenarios from other countries

Although each country and each region has its own individual population, arrangement of towns and villages, attitudes of different people, and previous history, the problems of mobility are quite similar everywhere. This means that studying the development scenarios of other countries can highlight key questions that should be considered in designing the future of mobility.

The mobility scenarios in other countries prioritise technological development and changes in how people live their lives.

The Netherlands: convenient and fast mobility or a peaceful living environment, security and low environmental impact?

The development scenarios for urban regions and mobility in the Netherlands up to 2049 are based on possible changes in the values held by the public. A safe and peaceful life or environmentally sustainable values could dethrone the priorities of good access and rapid mobility, while the increasing options in cyberspace could make physical movement less necessary. The scenarios have been grouped into four different developments named Bubble City, State of Green, Market Place, and Our Neighbourhood.

Bubble City

- society is fragmented
- urban network nodes are more important than city centres
- digital is more important than physical
- technology has a permanent beta status

State of Green

- major public sector intervention for environmental goals
- environmental arguments and vehicle sharing are the top priority
- the urban space is densely packed and movement is on foot or by bike
- technology serves green aspirations

Market Place

- values focused on success
- major social and economic contrasts
- people travel a lot using all types of transport
- technological development is focused on increasing efficiency

Our Neighbourhood

- everyday life is centred around the neighbourhood
- physical activity and local production are standard
- there are large differences between neighbourhoods
- coordinating at a level beyond the local is difficult

Figure 13. Mobility scenarios from the Netherlands
Source: BL Netherlands Environmental Assessment Agency (2020), Rehearsing the future

Bubble City assumes that events in urban areas are driven primarily by the market and by people and civil society taking the initiative, while the public sector does not actively design the space or mobility. Different age groups act in completely different ways in the urban space and the different bubbles do not communicate with one another. A large part of what people do happens in cyberspace, and so actual physical movement becomes less important. Behaviour patterns are not stable within the space, but change rapidly and are not concentrated in one centre but rather in many different hubs or nodes. People identify less strongly with specific locations. The physical movement that is necessary usually happens on criss-crossing routes, and so there is no great use for transport solutions that are built to serve large flows of passengers moving at fixed times in fixed directions.

State of Green assumes a strong guiding role for the public sector in directing life and the economy to be more environmentally sustainable. A system of planetary points is introduced to measure the environmental harm of goods and services, and each person is given an equal number of points that they can use to consume goods and services but that they cannot exceed. Use of private cars drops drastically, and the train is the most popular means of transport. New houses can only be built at transport intersections, preferably close to railway stations. Technology is used and developed only to the extent that it can help preserve the environment.

Market Place assumes values focused on success, with constant growth in movement and rapid technological development. The government decides that it is not possible to predict what transport developments it should invest in, and orders its mobility development system from the private sector. Google wins the tender and can use its database on mobility to connect larger roads with a smart communication system and create the infrastructure needed to introduce self-driving vehicles. Greater convenience means that traffic increases on those roads, and in consequence the price of real estate around those roads becomes a hot topic. People on lower incomes can no longer afford to use certain roads or to live near to them. Car use increases rapidly.

Our Neighbourhood assumes that the centre of gravity of human life moves back towards smaller settlements, neighbourhoods and town districts. This is encouraged by an ageing society, increasing wealth and the spread of remote working, as work and the way of life it dictates become a less important part of people's lives. Local communities have an interest in an environment that is good for walking, jogging and Nordic walking. The city starts to appear more as a grouping of villages. Fast and frequent transport connections are not a priority. Peace and security are more important than the need to connect rapidly with the outside world. New road building that would disturb the local life is to be rejected at all costs.

The United Kingdom: the invisible hand of the free market or public digital services and strict environmental requirements?

In 2019, the UK Government Office for Science published future mobility scenarios up to 2040 that started from the currently unanswered questions of

- how much physical movement can be replaced by online alternatives in the future;
- how successfully the rules can be agreed for the data collection and exchange that is needed for innovations in mobility as a service (MaaS); and

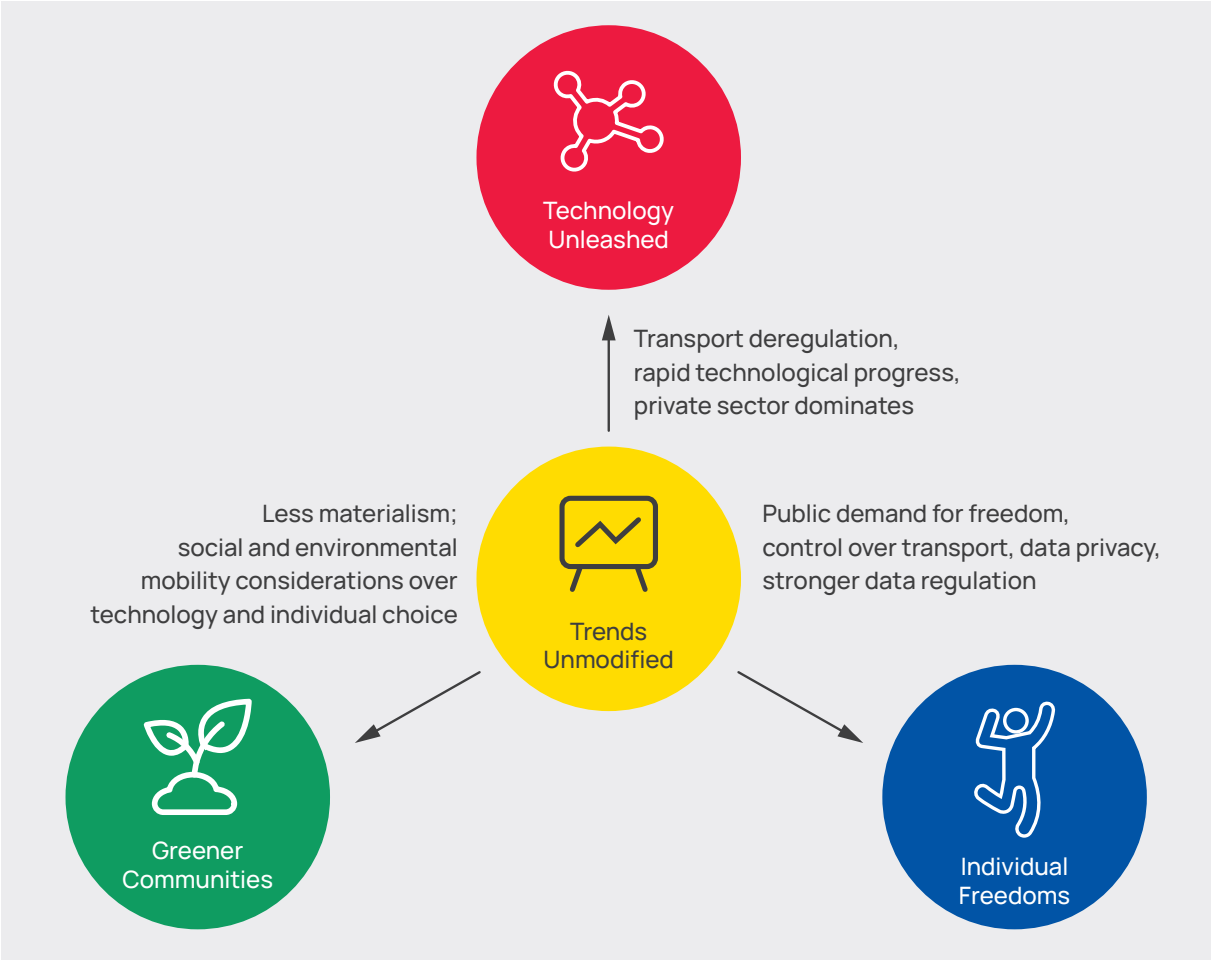

Figure 14. Mobility scenarios from Great Britain
Source: UK Government Office for Science (2019), The Future of Mobility

- how prepared people will be to share transport in the future.

In the Trends Unmodified scenario, there is no effective solution for data exchange, and the tools like MaaS and self-driving cars that could ease the current problems are not introduced. Traffic problems and social stratification worsen.

In the Technology Unleashed scenario, where the government does not actively guide or regulate mobility, cars that run on alternative fuels and are largely self-driving enter widespread use but are not accessible to the poorest layers of society. Private cars dominate mobility and traffic jams worsen, while poorer people have few affordable alternatives and so have limited access to jobs that are far away.

The Individual Freedoms scenario focuses on the importance of mobility data and shows that if society does not trust information sharing and blocks solutions based on it, new and potentially efficient services and technologies cannot be developed.

The Greener Community sees a determined transition to more environmentally sustainable transport solutions such as effective multimodal MaaS systems that are adapted for the needs of different age groups, while road traffic is taxed and there are subsidies for rail transport, bicycles and pedestrians, and for remote working. Cars other than self-driving vehicles for the disabled are banned from town centres.

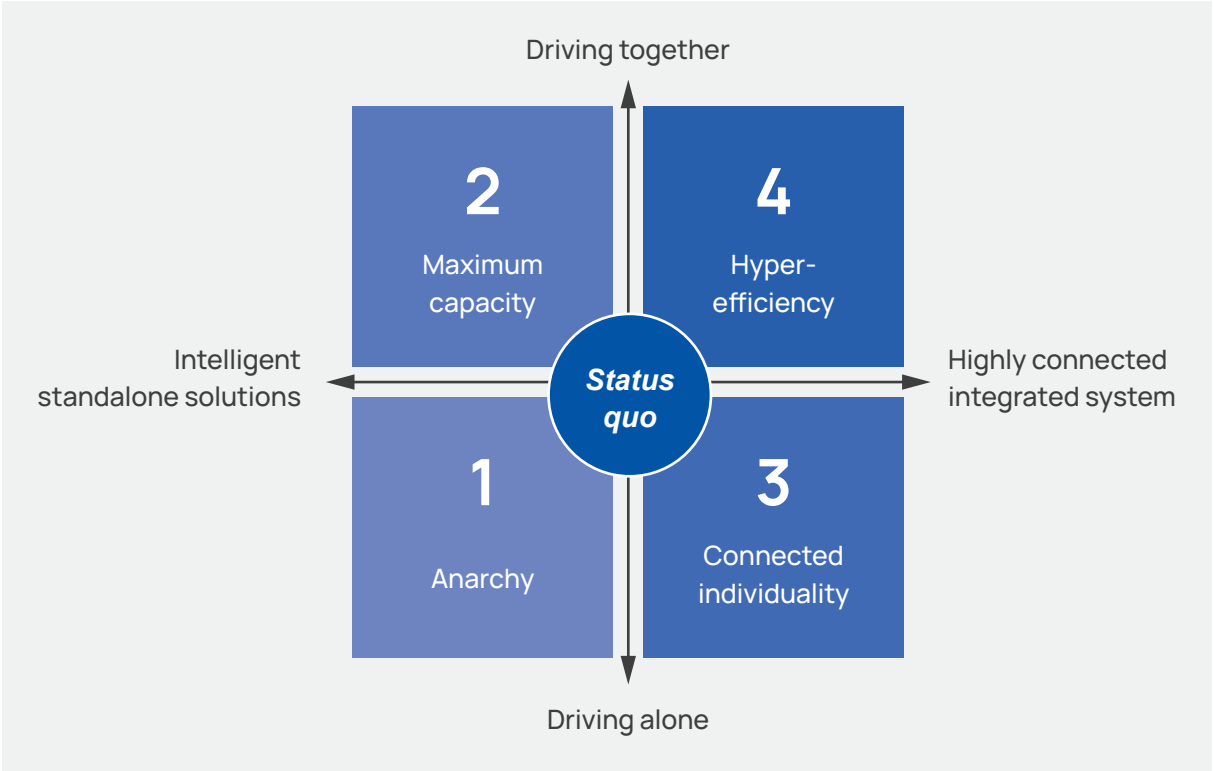

Figure 15. German scenarios for the future of urban mobility
Source: Roland Berger (2018), Urban Mobility 2030

Germany: a private car and personal services or a shared vehicle and an integrated system?

The Roland Berger consultancy produced four scenarios for the future of urban mobility for Germany. The report started from the understanding that future solutions will be based on various types of electric self-driving vehicles such as trains, buses, cars and electric bicycles, but the different potential trajectories will be driven by

- whether it is possible to move from solutions focused on individual vehicles and individual travel to an integrated system and

- whether the future is dominated by private car use either for individuals or for families, or by vehicle sharing and travelling with strangers.

The most problematic scenario is Anarchy, where people continue to travel individually as much as possible and there is no multimodal transport system connected in real-time. This scenario sees the current problems amplified.

A trend towards travelling together without the transition to an integrated system in the scenario Maximum Capacity would mean work on further developing the traditional public transport system, particularly rail transport.

The Connected Individuality scenario, in which travel in an integrated transport system is mainly in private vehicles that may be privately owned or temporarily rented, has advantages, especially given the impact of the pandemic. A large share of vehicles are either self-driving or partly automated so that they can use the services designed to optimise traffic flows in an integrated system.

This scenario does not reduce the current traffic burden or energy consumption.

The Hyper Efficiency scenario is a digitally coordinated multimodal system, where trains are combined with pre-ordered minibuses or robot taxis or electric bicycles for example, and where each person makes their journey together with others in public transport.

The primary decisive factor in the move towards the ideal scenario is how ready people are to travel less in individual vehicles and instead to travel together with others in public vehicles. Self-driving cars that are more convenient than before and taxi services provided by them that are cheaper than before could lead people even further away from public transport.

Oslo: a personal self-driving car or on-demand self-driving services?

The analysis by the consultancy COWI of how self-driving cars could change city transport produced three scenarios for the city of Oslo. The central choice is how self-driving cars could be used in future, whether as private cars as is currently the habit, or as vehicles providing mobility services in a MaaS system.

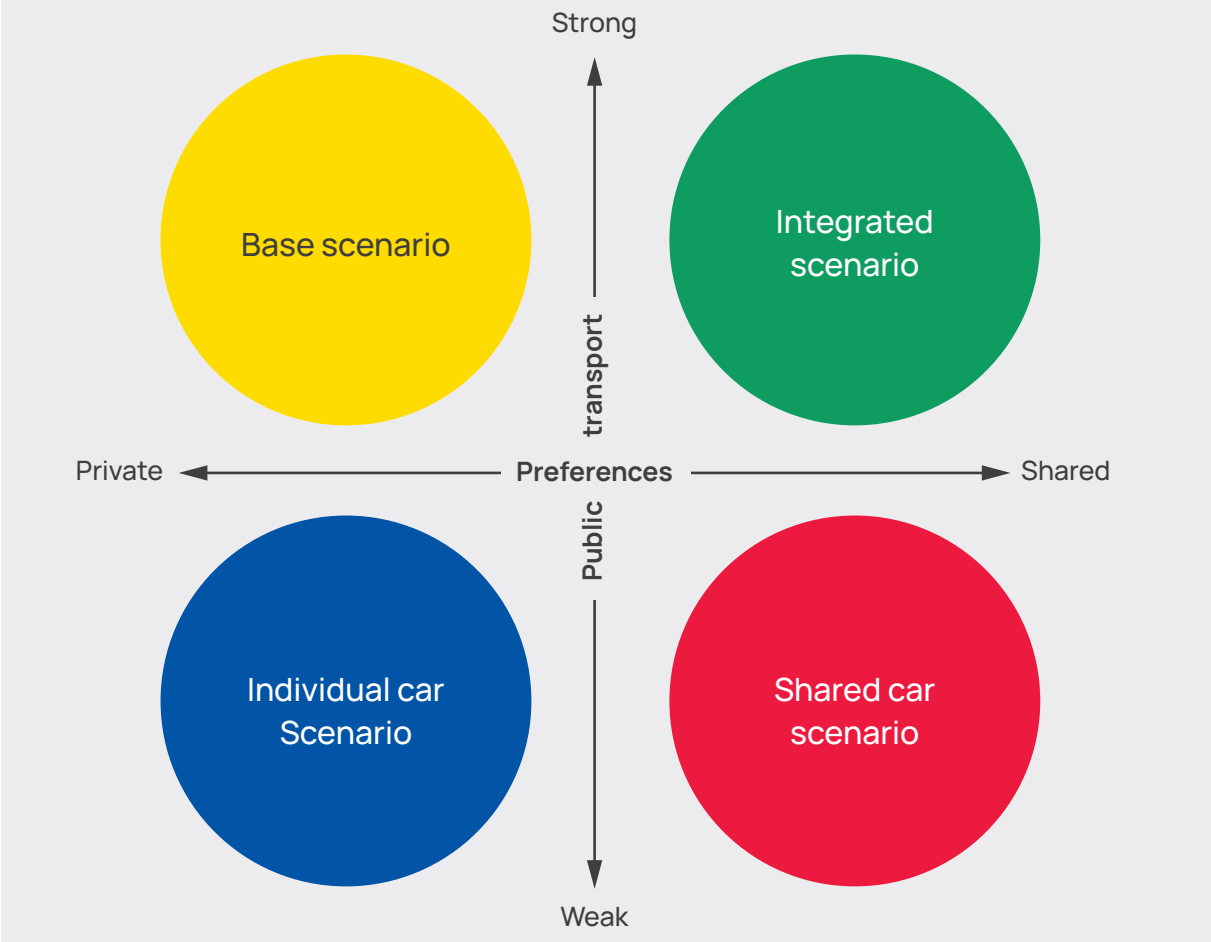

Figure 16. Mobility scenarios from Oslo
Source: COWI (2019)

The Individual Car Scenario has more people using cars, including children and the disabled among others. Time can be used more efficiently, as time spent in a car can be used for some purpose other than driving. More convenient car use causes the suburbs to grow, traffic to become denser and traffic jams to become more common, while new and bigger roads are built at the same time and emissions from car transport increase.

In the Shared Car Scenario, people no longer produce personal transport themselves, but purchase it as a service. There is a wide choice of services and vehicles and a choice between different price classes, so that travelling together with other passengers is cheaper than travelling alone for example. Self-driving cars can provide services for around one third of the cost of a vehicle with a driver, making mobility services significantly more accessible to poorer groups in society.

In the Integrated Scenario all cars are partially digitally connected to the public transport system, which combines self-driving cars and large public transport vehicles like buses and trains. The CO_2 emissions of city transport fall by 40-60%, and 90% of cars are removed from the urban space without anyone suffering any negative impact. Traffic levels fall substantially and there is no need to build new roads, while the urban space can be used for other purposes.

The central defining factors in the mobility scenarios of different countries:

- **Development of values**: a safe and peaceful life or environmentally sustainable values could dethrone the priorities of good access and rapid mobility
- **The gap between cyberspace and the physical space**: the increasing options in cyberspace could make physical movement less necessary
- **Issues of data mobility and control**: failure to exchange data securely hampers the introduction of innovative mobility services (MaaS)
- **People's readiness to share vehicles with strangers**: rising living standards may leave people feeling uncomfortable or insecure about sharing
- **An integrated transport system**: whether it is possible to move from solutions focused on individual vehicles and individual travel to an integrated system
- **Use of self-driving cars**: whether such cars are used primarily as private cars or as vehicles providing mobility services in an MaaS system


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The trend until now in Estonia has been for car use to increase at the expense of public transport and walking. Bicycles have only a marginal share in the pattern of mobility. The number of vehicles registered rose from 333 per thousand residents in 2000 to 598 per thousand residents in 2019. Although around a quarter of them have had their registration suspended and do not circulate in traffic, Estonia has still climbed within quite a short time to become one of the most car-centred countries in the European Union.

Car use has grown particularly rapidly in rural areas, where getting to work on foot or by bike has become less common as jobs have been relocated and commutes have increased. Car use has grown more slowly in urban areas, but half of the journeys made by urban residents to work are still made by car even so.

The share of people going to work by car has risen particularly quickly in the past five years among workers earning less than the average income. This is offset by a small decline in recent years in people on wages above the average using their car to go to work. Access to jobs depends on being able to use a personal car, and families with two or more cars are at risk of falling into mobility poverty, which is when a disproportionately large part of a family's budget goes on running a car. The elderly are also at risk of mobility poverty. Research on family budgets shows an increase of 69% in the average total spending by family members in 2012-2019, while transport costs rose by 101%, with the costs of buying and repairing vehicles rising by 195%. The total costs of car use in Estonia are around 2.4 billion euros a year, with commuting between home and work alone

The trend until now in Estonia has been for car use to increase at the expense of public transport and walking.

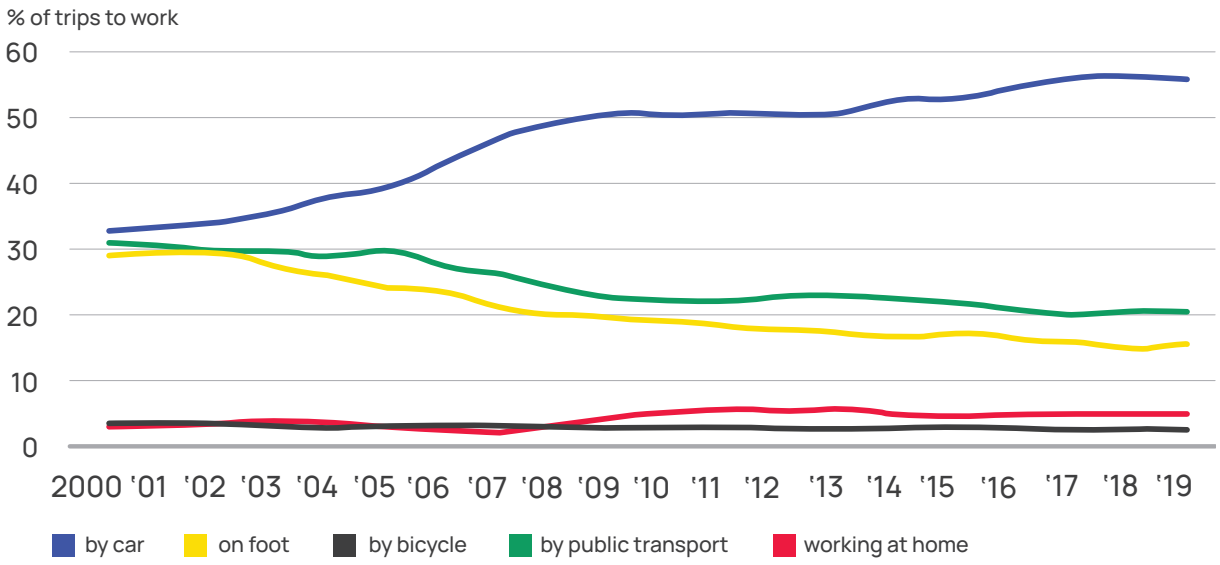


Figure 17. Main means of transport for commuting for people employed in Estonia, %
Source: Statistics Estonia

[21] Eurostat, table road_eqs_carhab

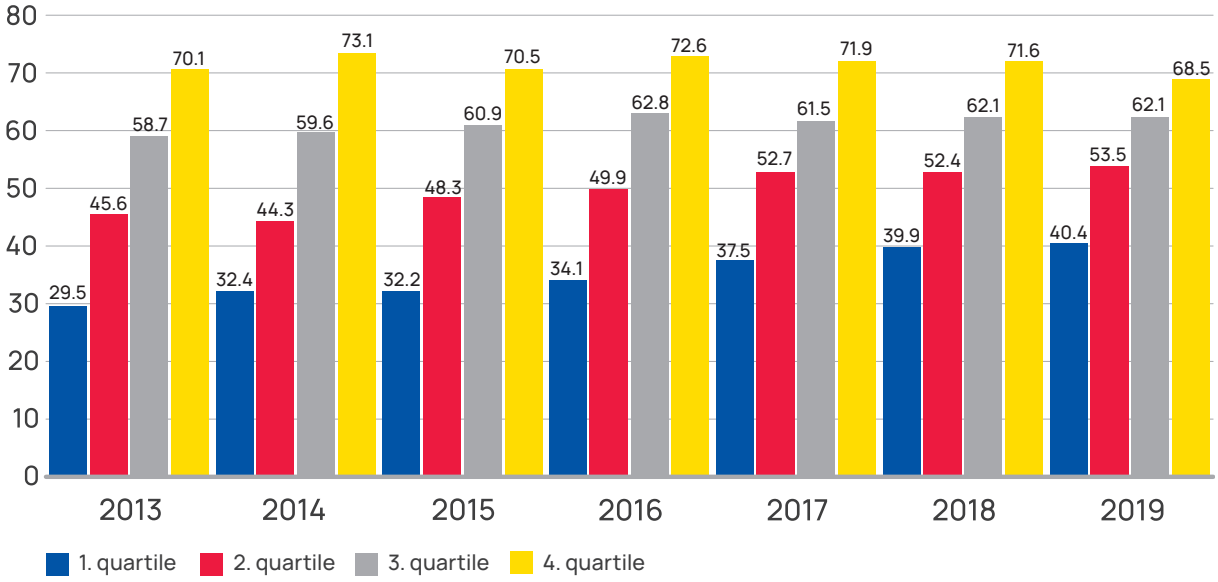


Figure 18. Share of employees in Estonia travelling to work by car by wage quartiles, %
Source: Statistics Estonia

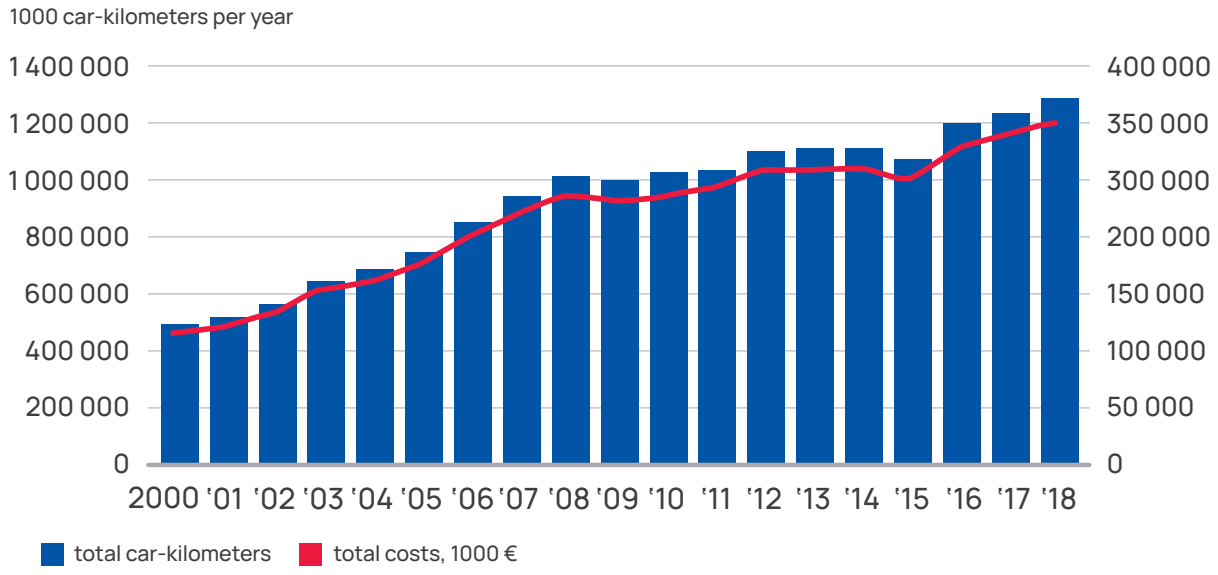


Figure 19. Mileages and total costs of those commuting by car
Source: Statistics Estonia

costing around 400 million euros a year. The targets for increased use of public transport set in the development programme for transport for 2014-2020 have not been met. Instead of rising to reach the target of 25%, the share of people going to work by public transport fell from 22.6% in 2014 to 20.6% in 2019.

A positive trend is the rise in recent years in the number of passengers travelling on regional bus routes and trains. The number of people using public regional bus routes in 2018-2019 rose because of free and subsidised tickets and because services became more frequent. Part of the rise in passenger numbers came because some lo-

cal routes were reclassified as regional routes. Use of public transport by schoolchildren and those aged over 63 has particularly increased. The rise in passenger numbers as a whole has been similar for free and subsidised regional public transport. Demand has affected supply as the number of regional buses has risen to the same degree as the number of passengers.

The introduction of new trains and a new level of service in 2013 doubled the number of people travelling by train (see Figure 20). This demonstrates that there are users to be found for public transport that is of sufficient quality and properly funded. The success of rail transport did not however affect very much the increase in the total number of users of public transport.

Despite the continuing rise in the number of workers living in urban areas, which has increased by 9% since 2013, the number of passengers on city transport, including the free city transport in Tallinn, was practically unchanged in 2014-2019 in Estonia as a whole (see Figure 21).

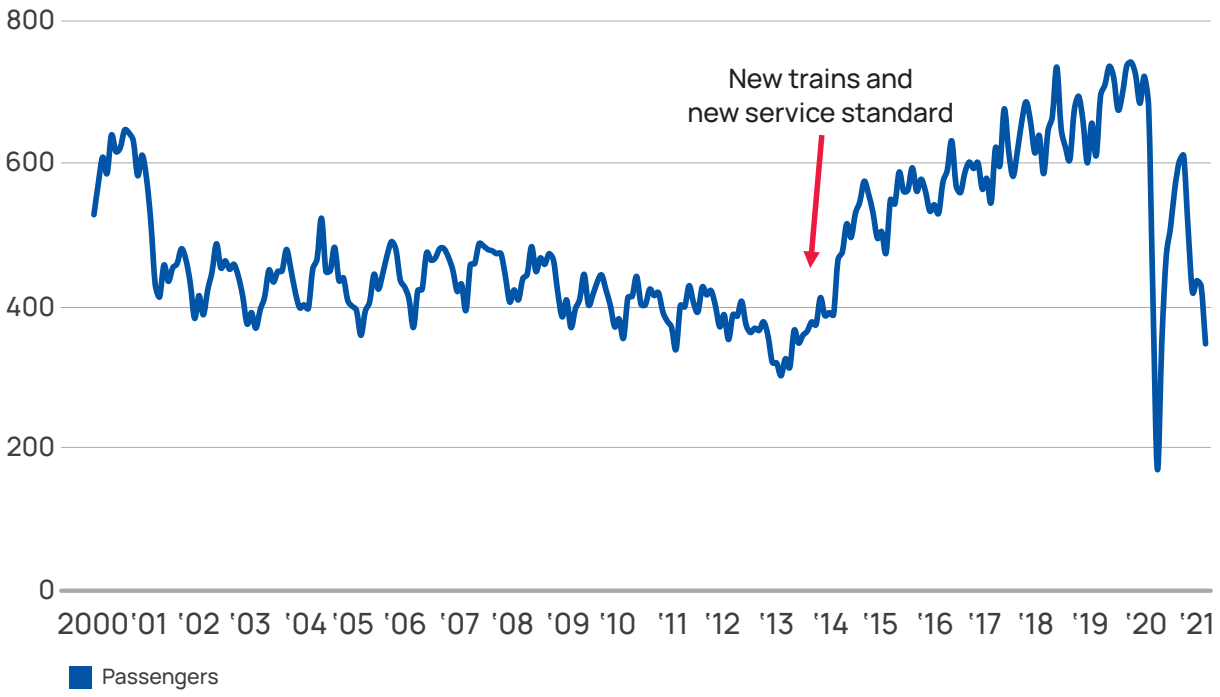


Figure 20. Train journeys, thousand passengers per month
Source: Statistics Estonia, Table TS1421[21]

[21] Eurostat, table road_eqs_carhab

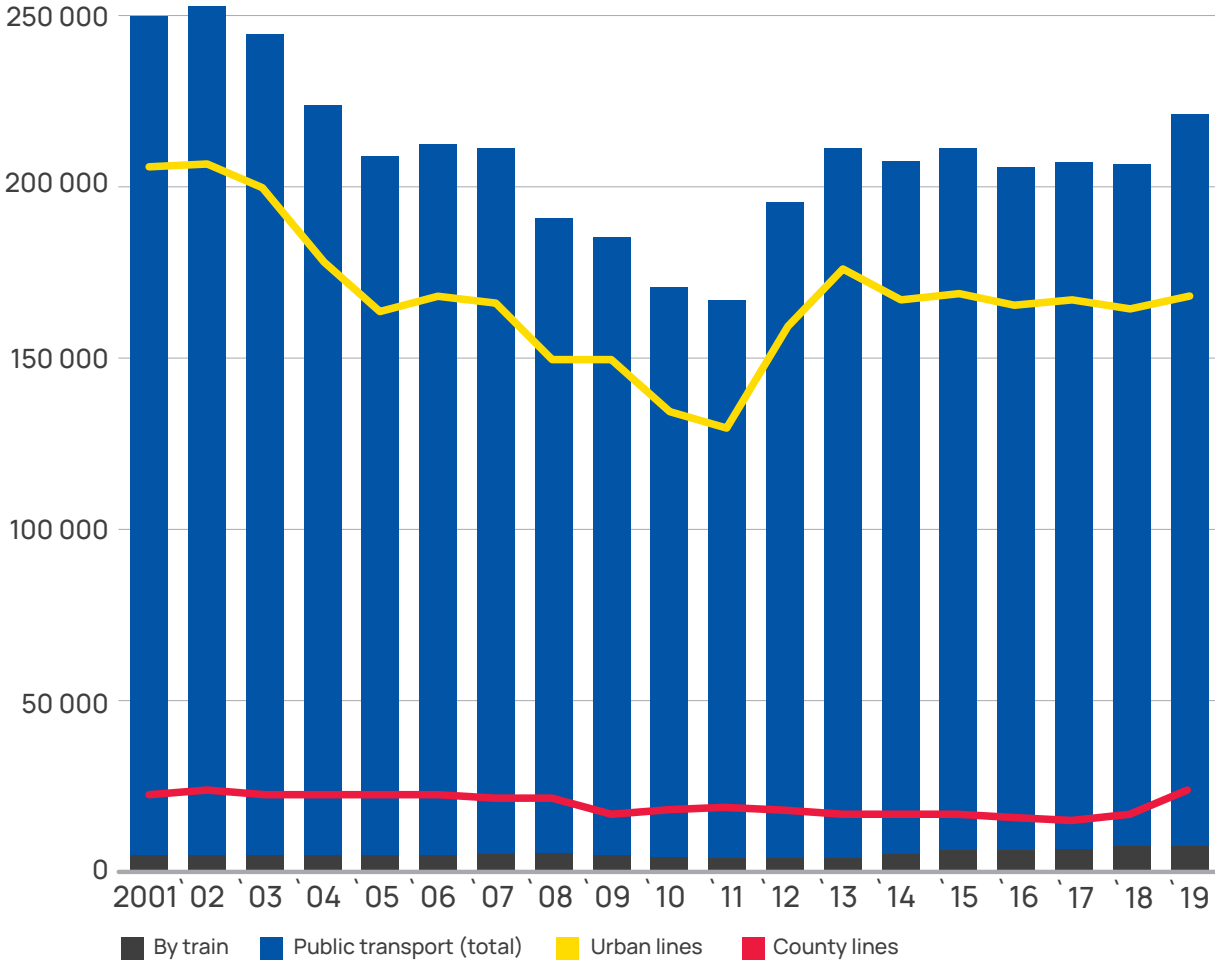


Figure 21. Number of passengers on public transport in Estonia 2001-2019, thousand passengers
Source: Statistics Estonia

Exercise from daily movement is more effective than sport for health

The WHO considers that integrating daily physical activity is more sustainable than sport for exercise. The increase in sedentary lifestyles is one of the main causes of premature death. Excess weight is an increasing problem for residents of Estonia of working age, as 20% of Estonian residents aged 16–64 are obese, and a further 32.4% are overweight (see Figure 22). The HEAT model developed by the WHO shows that 24 minutes of walking or cycling a day reduces the risk of premature death by 10%. For Estonia this would mean that if 10,000 people went to work on foot, by bicycle or by public transport, seven premature deaths a year would be saved, generating socio-economic income of about 10 million euros a year. The importance of everyday movement has been particularly highlighted by the movement restrictions of the Covid-19 pandemic, when the negative impact of inactivity on mental and physical health has been clearly illustrated.

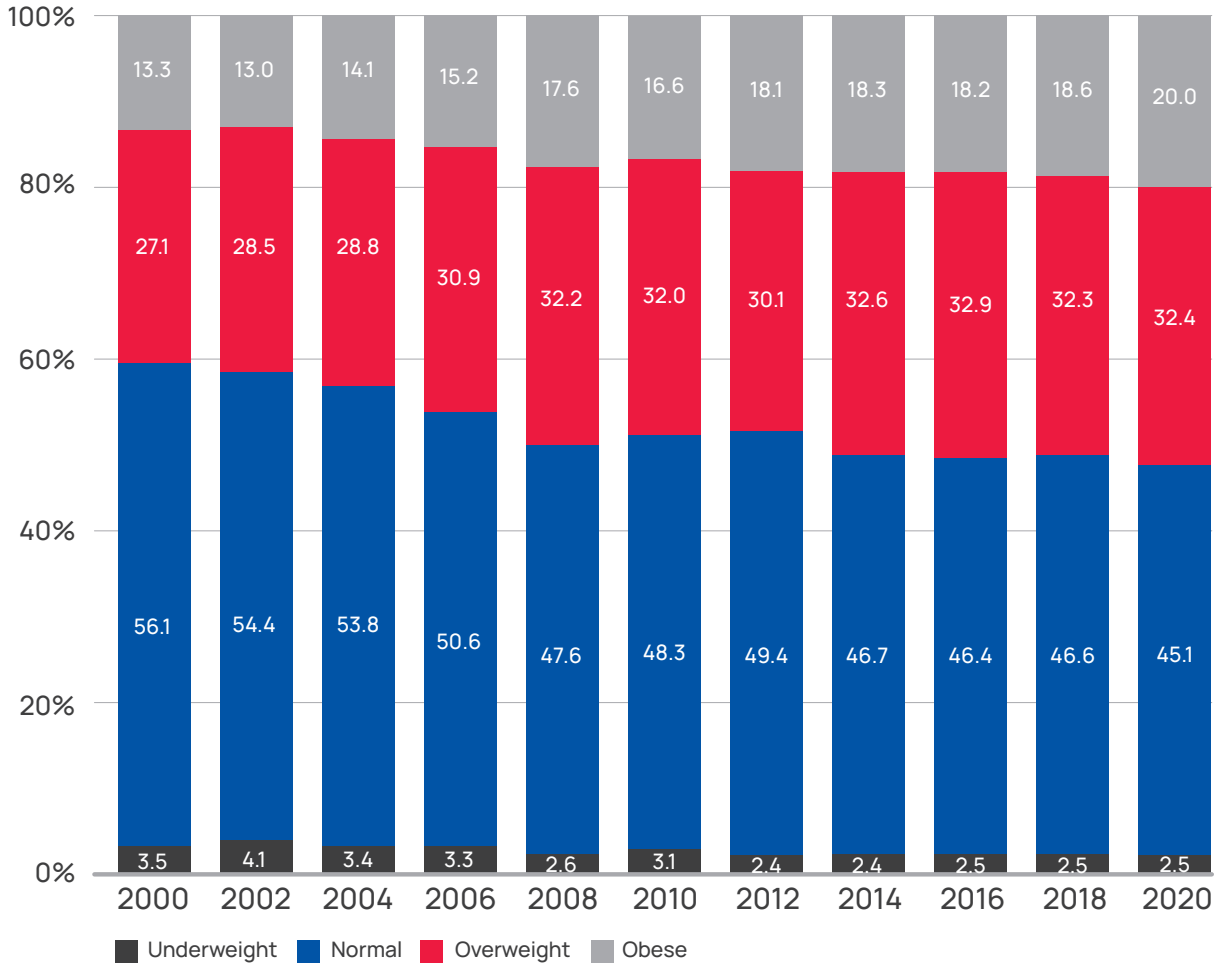


Figure 22. The share of people who are overweight is increasing
Source: Statistics Estonia

Forecasts work as self-fulfilling prophesies

There are three main strategic documents that guide the development and future of mobility in Estonia at the national level:

- The Estonia 2035 strategy produced by the State Chancellery
- The development programme 2021-2025 for transport and mobility produced by the Ministry of Economic Affairs and Communications
- The road safety programme 2016–2025

The strategic documents generally favour a move towards sustainable mobility and are in line with global developments in the field. The strategic goals and policies are to be realised through action plans that depend on the existing framework. These are the norms, standards, regulations and guidelines used for infrastructure construction, the most important of which is the traffic survey guide and baseline forecast from 2020, where car use is forecast from previous trends. It shows car use as increasing from around 400 cars per thousand residents currently to 600 per thousand by 2040. The key standard is the urban streets standard EVS 843 (2016), which starts from the priorities and needs of car traffic and pays little consideration to other functions of streets in their functional and spatial context.

Planning based on forecasts for increased car use becomes a self-fulfilling prophecy, as new options for travel by car make car use more attractive for ever more people:

- mobility is measured as the flow of vehicles, or traffic, not as the number of people moving with a starting point, a destination and a purpose;
- traffic flows are measured to find the peak of demand in rush hours, from which growth in demand is forecast;
- the road capacity needed is produced following planning norms and standards that prioritise road traffic and produce solutions from projected traffic needs;
- infrastructure investment is supported by analysis, including cost-benefit analysis, where the greatest weight is given to saving time for car users;
- the capacity needed is built and the car users that were planned for find travel convenient, and so demand is created;
- the whole planning cycle ends by showing that the forecasts of the past have been fulfilled, and so the methodology is justified and should be maintained.

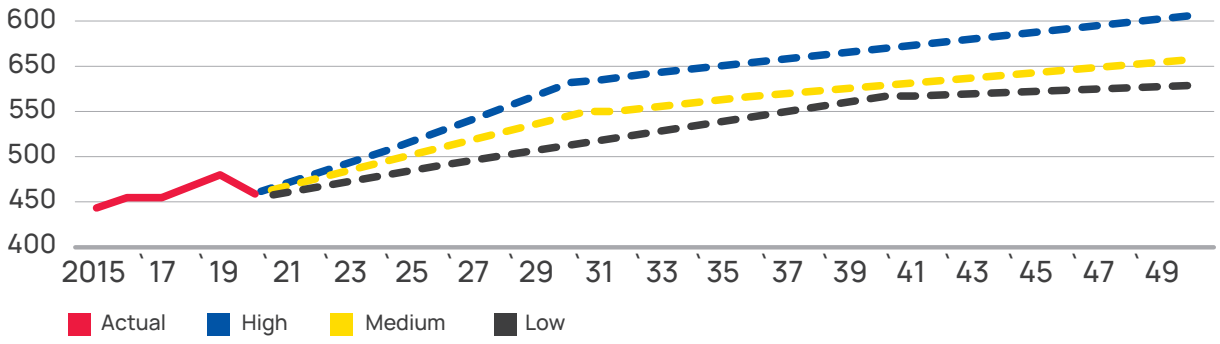


Figure 23. Number of cars per thousand residents of Estonia and the forecast for it
Source: Liiklusuuringu juhend ja baasprognoos [Traffic survey guide and baseline forecast] (2020), Tallinn University of Technology

Successful examples of data-driven mobility planning

• **The upgrading of the Tartu city transport network**

The city of Tartu decided in 2017 to upgrade its entire network of bus routes and introduce a new fleet of buses powered entirely by gas. It did this by developing a vision that assigned levels of service to different regions, used modern data sources and analysis, and bought in expert design for individual city networks from the external consultants WSP Finland. The existing 29 routes were replaced by 14 running 50% more frequently and covering the same spatial area with faster connections. After the lines were launched in summer 2019, the use of public transport and ticket sales have grown steadily by 15-20%, while the budget for the service needed to increase by only 5%.

• **Tartu Smart Bike Share**

The Smart Bike Share in Tartu was opened at the same time as the new network of bus routes. The network of bicycle rental points was designed as a spatial whole to provide supply in the places with greatest potential for use, with particular attention focused on integration with the public transport network and the most commonly used bus stops. Eighteen months later, in March 2021, the use of rented bicycles had exceeded expectations.

Figure 24. Statistics on Tartu Smart Bike Share as at the start of May 2021
Source: ratas.tartu.ee

Estonia has eye-catching start-ups providing mobility services

Estonia has very successful and advanced start-ups providing mobility solutions. Estonia is a good place for trying out new solutions, not only because it is small and open, but because the variable weather and infrastructure here allow products and services to be put to the test. This allows people in Estonia to get involved in innovation. Bolt, which started as a ride-sharing service, has become a unicorn and has expanded into home deliveries and micro-mobility solutions, operating in more than 30 countries. Estonia is home to bicycle manufacturer Ampler, smart network operator for bicycles Comodule, and rental service provider for electric scooters Tuul. Ridango is successfully developing a holistic ticket sales system.

Cleveron has worked on developing new solutions for postal and courier services for a long time and makes parcel machines, and is working on robot cars for parcel delivery. Starship Technology is also developing robot parcel delivery. Parcelsea is marketing new smart postboxes that anybody can use for deliveries of food or parcels at home or at work. Vok Bikes produces four wheeled electric bicycles for couriers that extend their range and make them more efficient.

The mobility patterns and attitudes of residents of Estonia

The decisions people make about how they move around may have different time limits and horizons. Mobility in the broadest and longest-term sense is related to lifestyle patterns of where and how people live and work, how they spend their leisure time, and what size of family they want to have. Different lifestyle patterns define the level of intensity of mobility and the structure of it that people expect for the future. This is not just mobility for work or to access vital services, but for everything else as well, such as holidays, leisure time, hobbies and relationships.

The Foresight Centre has considered these outlooks in more detail in its monitoring of Estonia's regional economy[22], finding different development paths for where people may be located and what they may be doing economically in 2035. If Estonia's future concentrates economic development in the larger population centres, especially Greater Tallinn, with current lifestyles and weak environmental ambition, car dependency may increase and the frequency of public transport and the level of service in regional districts may remain low. A transport policy that encourages the emergence of regional growth centres would help develop connections between regions and between the growth centres and the rest of the world. If Estonia's future is a more local way of life with a more ecological and social approach, a rapid turn towards sustainable mobility through local mobility, electrified railways and micro-mobility solutions would be appropriate.

The need for mobility in the narrowest sense arises because people live in one place but the places they need for everyday activities are at different locations, which are reached at a cost in time and money that must be affordable. Various practical, social, psychological and other factors guide everyday mobility choices. The first set of practical factors covers how well transport services meet

A third of people in Estonia follow the principles of sustainable mobility.

people's practical needs, such as whether the transport infrastructure encourages travel by car or by public transport. Psychological factors include emotional responses like how much people enjoy driving a car or walking. Social factors include how much mobility choices are affected by other people, through peer pressure for example, or social standards and habits, and the status symbol of owning a vehicle. The final set of factors come from life-cycle events and income[23].

Figure 25. Factors affecting mobility decisions
Source: Salomon and Ben-Akiva 1983, adapted

[22] Foresight Centre (2019). Future of Regional Economy in Estonia. Scenarios until 2035.

[23] UK Government Office for Science (2019), A Future of Mobility: A time of unprecedented change in the transport system.

Once mobility habits are already set, they can predict future movement patterns quite accurately[24]. This has been found to be particularly so when the normal means of mobility is the car[25]. The mobility choices people make are to some extent forced. Habits may be changed simply by changing the place of residence or work, if people have not already decided their new mobility habits and they remain open to changes[26]. In addition to planning infrastructure and the public space, giving people information or sharing experiences with them can influence them to change their transport behaviour, and the impact of social factors must not be overlooked.

Mobility profiles for Estonia were made for this monitoring work from the mobility patterns and attitudes towards mobility of the population of Estonia. A people-centred approach allows an authentic experience of the choices people make for mobility and offers ideas for how to achieve the goals of sustainable mobility.

Mobility profiles of the Estonian population built on attitudes and personal factors have not been made before. The mobility profiles were built using data found in the annual Kompass 2020 social trends research produced by Kantar Emor. The surveys were run between 5 March and 20 May 2020, and the data for 2020 came from 1719 respondents. People were grouped into single mobility profiles by their social demographic characteristics like gender, age, home language and household composition; their place of residence at the regional level and as type of settlement and housing; and their most typical ways of moving and behaving given their status.

The profiles show that around 33% of people in Estonia already follow the principles of sustainable mobility. It should be relatively straightforward to reorientate the profiles of Andrei, Katrin and Eino, which account for 21% of people. Reorienting the mobility behaviour of Tiiu and Kuldar, who are 12% of the population, would be hardest.

[24] Chen, C., Chao, W. (2011). Habitual or reasoned? Using the theory of planned behavior, technology acceptance model, and habit to examine switching intentions toward public transit. Transportation Research Part F-traffic Psychology and Behaviour - TRANSP RES PT F-TRAFFIC PSYCH. 14. 128-137.

[25] Şimşekoğlu, Ö., Nordfjærn, T., Rundmo, T (2015). "The role of attitudes, transport priorities, and car use habit for travel mode use and intentions to use public transportation in an urban Norwegian public," Transport Policy, Elsevier, vol. 42(C), pages 113-120.

[26] Walker, I., Thomas, G., Verplanken, B. (2014). Old Habits Die Hard: Travel Habit Formation and Decay During an Office Relocation. Environment and Behavior. 47.

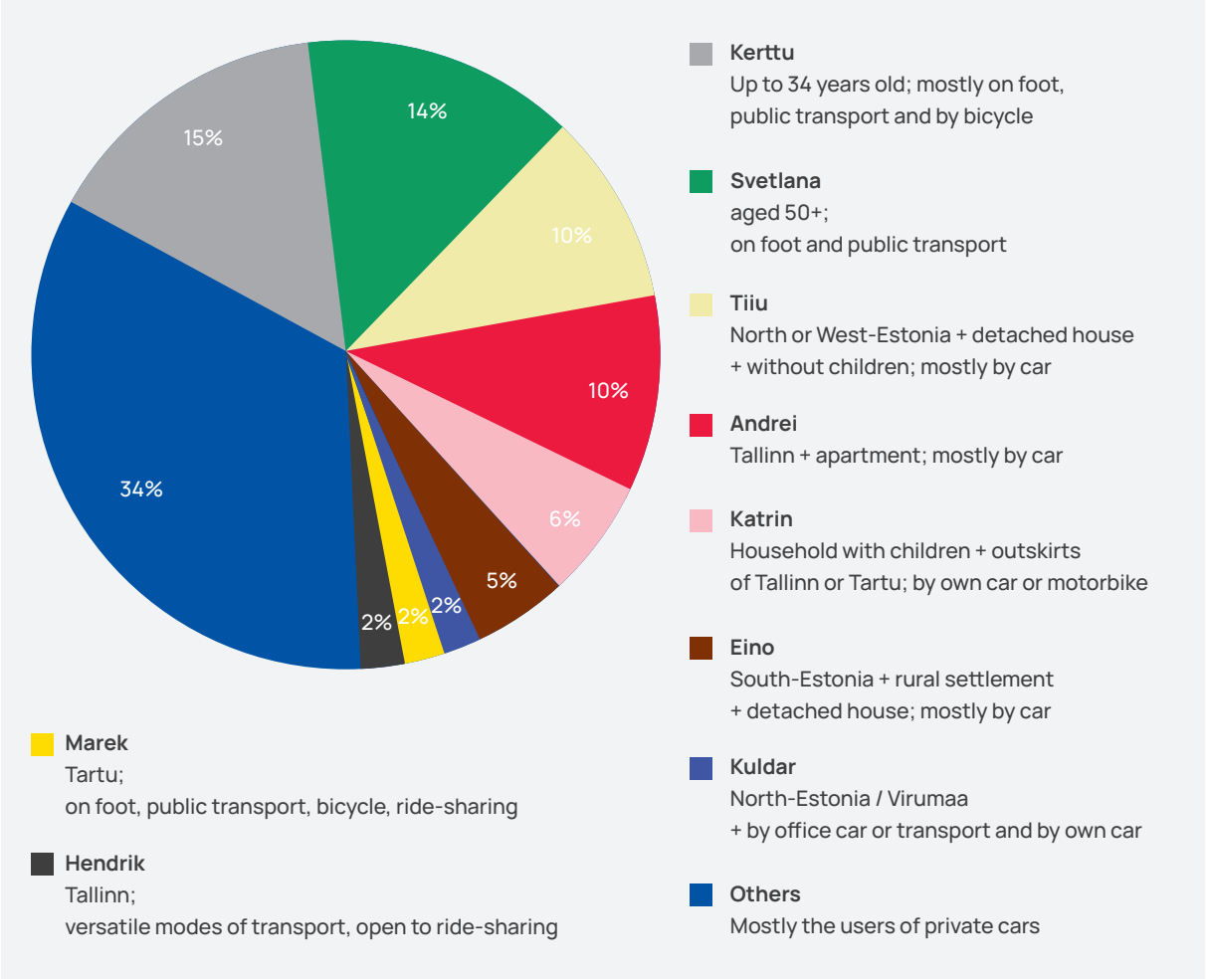


Figure 26. Mobility profiles
Source: Ojala et al. 2020

Kerttu is around 15% of the population. She mostly lives in the larger towns like Tallinn or Tartu and has a family and children. Kerttu is more environmentally conscious than the average and is worried about the pollution and congestion that cars cause, and tries to follow environmentally sustainable principles in her own mobility choices. Kerttu walks or uses public transport, regional and local public transport, the train, long distance buses, ride-sharing services, a bicycle, or car sharing. Over the next five years she could see herself using a scooter or electric scooter, a bicycle, an electric car, Bolt and Uber, self-driving cars, public transport, or self-balancing personal transporters. Kerttu is convinced that many people of her age and younger who live in towns no longer want or need to own a personal car. Owning a car was earlier a clear status symbol, but the focus nowadays is more on the environment. Kerttu rides a bicycle a lot and would do so more if the town was better designed for cyclists and the

existing cycle tracks were better planned, for example without lamp posts in the middle of the track, and then she would also feel more confident about teaching her daughter to ride. To get out of town she would be happiest to use a train that she could put her bike on, but that would need trains to have more bike spaces or even a separate carriage just for cyclists.

Svetlana is 14% of the population. This is a profile of women aged 50 to 74, who often live alone in a large town like Tallinn. In most cases Svetlana is not Estonian and has an income of 500-1000 euros per family member. Tradition and her beliefs are important for her. Svetlana considers a healthy lifestyle to be important, including walking, but the distances in Tallinn are too great and so Svetlana mostly uses public transport and is generally satisfied with it as it takes her to the main places she needs to be. Public transport can be a problem if Svetlana wants to go to the furthest parts of town that it does not cover well, as there are few departures within the hour or insufficient stops. As Svetlana is an independent woman and her habits have become fixed with age, she will continue to travel mostly by public transport in the future.

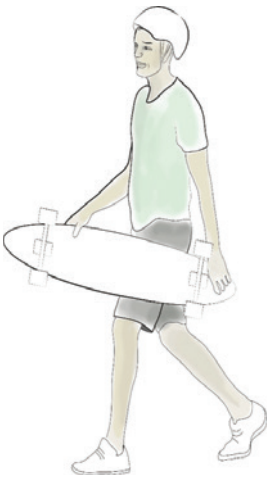
Andrei is 10% of the population. He lives in an apartment in Tallinn and is aged 35-55 and is usually a professional with higher education, who mainly travels by car. His main priority in choosing a car is low running costs, and so he is open to alternative fuels like electricity, gas or hybrid power. Andrei is interested in alternative forms of transport and is open to changing his mobility in the future. He is currently firmly attached to his personal car or his work car, as it is convenient and flexible to use. He is prejudiced against public transport and considers it to be unclean. Andrei does not believe that orders, bans, taxes or limits, for example congestion zones or bans on diesel cars in the city centre, would make him change his behaviour. Andrei believes he would be more persuaded to change if it was inconvenient to get by car to where he wants to go, if there was nowhere to park or parking was expensive for example, and if there was a quick, clean and convenient alternative.

Tiiu is 10% of the population and she lives in a rural part of northern or western Estonia and is generally Estonian and aged over 50. Tiiu likes to keep busy at home and in the garden and she prefers Estonian products when doing her shopping. She mainly travels using her personal car. The reason she uses the car is not that she does not like public transport, but simply that she does not consider public transport to be a good alternative for her, as she lives in a sparsely populated rural area. This could change if the buses ran frequently enough and flexibly so that she could go where she needs when she needs without having to waste a lot of time waiting and changing buses. Tiiu thinks that orders, bans, car taxes and limits would not make her use her car less.

Katrin, who is 6% of the population, lives in a rural part of northern Estonia or the Tartu region. She is 35-49 years old and has a job. There are at least three people in her family and one of them is usually a child aged under 16. She mostly gets around by car, and she mostly drives it herself. As Katrin's family live close to the town and there are younger children in it who need to be driven to school, it would not be very convenient for her to use a different form of transport at the moment. Katrin thinks that once the children are independent she could consider using alternative forms of transport such as the train or the bus if the timetables and stops suit her. Sharing a ride with neighbours does not work and tends rather to create pointless tensions. It should also be noted that Katrin is an experienced driver for whom convenience outweighs the costs of running a car, and who would undoubtedly find it hard to let go of her ingrained habits. Katrin would be quite happy to use an electric car in the future, but in that case the prices of electric cars would have to be reasonable, ideally with a state subsidy.

Eino is 5% of the population and is mostly found in southern Estonia or rural parts of the Tartu region as an older person with an income below the average. Eino prefers to use his own car and over the next five years he sees himself using a car with an internal combustion engine or one powered by gas. As Eino lives in a small place in the country that does not have transport connections, he considers the car to be his only reasonable means of transport. Although the places he goes to regularly are only five or six kilometres away, age and poor health mean that a bicycle is no use for him or his wife. Eino further notes the poor condition of the country roads. As a more environmentally friendly means of transport, Eino would choose an electric car. State subsidies could help some rural families buy an electric car, but Eino understands that this would not make any sense for him given his income.

Marek and **Hendrik** are together 4% of the population and are ambassadors for new transport solutions. Marek mainly uses his bicycle to get around, and believes that there could be more cycle tracks and segregated routes for cyclists. He would primarily be persuaded to use his car even less than he does by a shortage of parking spaces and the high cost of parking, and generally by a rise in fuel costs. Hendrik uses various means of transport and is open to different sharing services. He often walks or takes the tram. Hendrik says that he would use a bicycle, but he has no space to keep one in his apartment. He would be happy to rent a car to travel around Estonia or for longer journeys within the city. He currently does not see any reason to own a car, but he thinks it would be unavoidable if he had a child.



Kuldar is 2% the population, and is generally a middle-aged man living in a small town. He uses his personal car or the car provided by work to get around. If he had more money, Kuldar would by a gas-powered or electric car and an electric scooter. He is open to making a greener choice of car, but the main obstacle to this is financial. Public transport does not serve his needs particularly well, and he does not like to be dependent on bus timetables.

Profiles describing people's mobility choices provide lifelike explanations and examples, and demonstrate that promoting more sustainable mobility requires informed policies and consideration of different target groups. Everyday mobility can be affected by how the transport system is organised and what modes of transport are favoured by transport infrastructure and the services that are provided.

- The largest part of mobility occurs **in and around towns**, and there are more opportunities for resetting mobility patterns there than elsewhere. There are also more opportunities for introducing new transport technology in towns, where it will also have more effect. The main problem is the use of the public space, which is heavily weighted in favour of car users. The streets have a wide range of social and societal functions. Maintaining a car-centred transport system makes winners out of those who can allow themselves to use a car, and losers out of those who cannot, such as the disabled, children, the elderly, or the economically vulnerable. The mobility profile analysis shows that at least a fifth of those in urban areas who currently use only a car would be prepared to alternate their everyday car use with other forms of transport if these were fast, convenient and clean. The profiles of residents of the larger towns show that parking policy could be a very effective tool for making people change their mobility choices. Investing in parking and storage facilities for bicycles alongside the development of the network of cycle tracks could prove successful.

- Public transport does not provide an alternative to the personal car for those living in **sparsely populated rural districts** because it runs infrequently and to few places. Modernising public transport and connecting it with user-focused mobility as a service (MaaS) holds great potential. Steadily improving mobility data, such as mobile positioning data, create a good ground for developing urban transport networks further. Modern public transport is a flexible service, and the principles and contracts for ordering it can be adapted effectively using data. In the longer term there are great prospects for self-driving cars as a part of public transport in rural areas. Given the established habits of older members of society, it may in the years ahead be appropriate to provide targeted subsidies for buying or renting less polluting vehicles alongside improvements to public transport.

- Movement **between towns** needs a choice to be made between developing rail transport and developing road transport. Public transport between towns however needs mobility services within towns to be of good quality and flexible. Mobility profiles combining different modes of transport illustrate the new challenges that will emerge from the development of multi-modality, such as how the use of bicycles and trains can be combined, especially for moving to suburban areas.

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