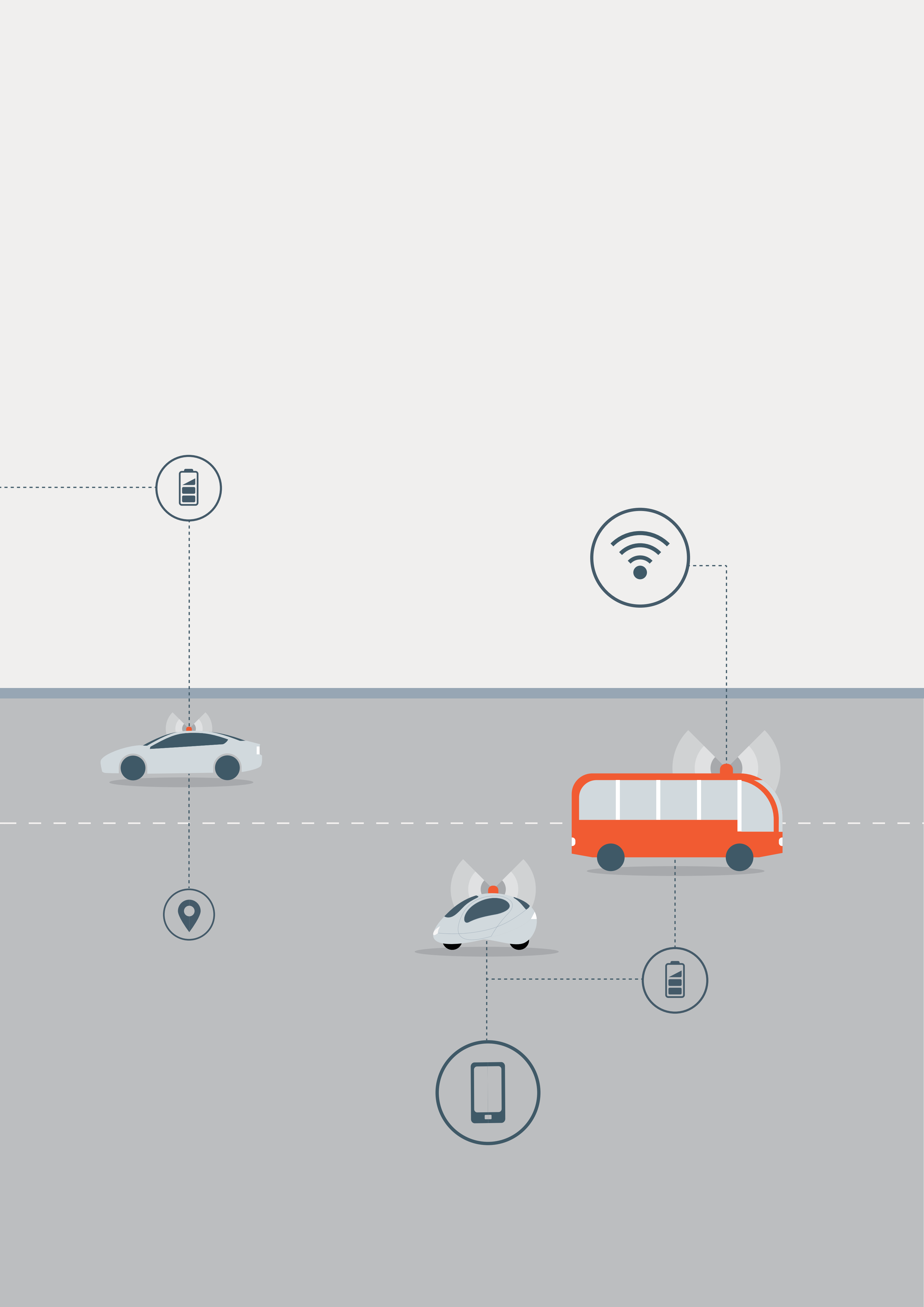
APRIL 2019
RUTER

THE OSLO STUDY – HOW AUTONOMOUS CARS MAY CHANGE TRANSPORT IN CITIES

REPORT



PREFACE

This study has been conducted between May 2018 and March 2019 by COWI and PTV on behalf of Ruter, the Oslo Region public transport company.

In this project we developed a traffic model for autonomous cars to investigate future scenarios for urban mobility in the Oslo region. The study is inspired by the Lisbon studies by the ITF-OECD.

Prior to this project, COWI was hired by Ruter to conduct an analysis of how technology can change mobility in cities. The knowledge from this analysis was carried forward into the current project, where COWI joined forces with PTV to see concrete results of different scenarios for the future.

This is the first study of its kind in Scandinavia, and among the first worldwide. We are proud to present the results from the project, and to provide more information to the debate on future mobility. We hope the work will contribute to increase the knowledge base for policy decision and a smoother transition to tomorrow's mobility systems.

We would like to thank Ruter for giving us the opportunity to conduct this study and for the useful feedback during the project.

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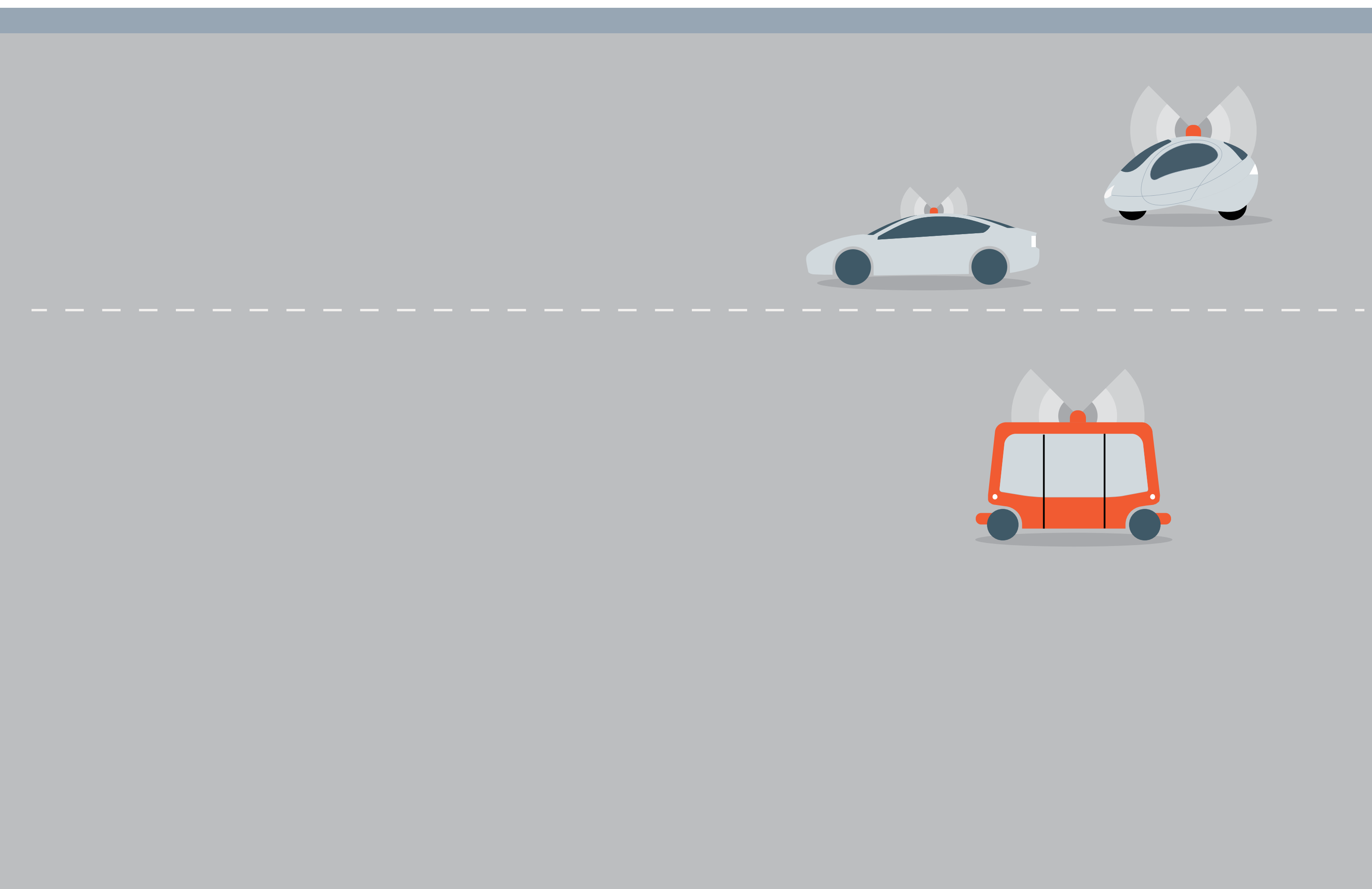
CONTENT



1 SUMMARY IN ENGLISH

BACKGROUND

The purpose of this study is to look into a future where autonomous vehicles and MaaS-based car sharing schemes have replaced private car ownership. MaaS stands for Mobility as a Service, which refers to a transportation system where users buy transportation assignments based on individual and current needs, instead of using a traditional transportation option. This report investigates some potential consequences of such a future for the Oslo region.

Experts differ on how the future of mobility will be and how soon it will come. But there is a consensus that technological development, autonomous vehicles and new MaaS concepts will challenge current transportation norms, infrastructure and urban development.

This study is inspired by similar studies in other cities, especially the studies from Lisbon. We have carried out calculations for different futuristic scenarios for the Oslo region by using a transport model developed to analyse consequences of autonomous cars and MaaS systems. Similar to the Lisbon study, we have based the calculations on the current transportation demand. With this knowledge of the trips in Oslo and Akershus, we have simulated a future with a full implementation of autonomous vehicles in a shared fleet, with and without ridesharing. Thus, allowing us to assess isolated effects of future transport systems and transportation concepts.

The scenarios are designed to capture the outer boundaries, or extremities, of a future where all cars are fully automated. Further analysis on more realistic scenarios are needed to give adequate tools for future planning. This study, for example, doesn't include a scenario where autonomous vehicles feed mass transit as a first and last mile service, which may be something we will see in the future. The study looks at road capacity challenges but does not include calculations of changes in travel time due to changes in traffic levels.

THE SCENARIOS

Six different scenarios were modelled in this study; four main scenarios and two sub scenarios that are variations of the main scenarios. Only the four main scenarios are discussed in this summary. The scenarios differ in how we will travel with the new MaaS concept. Will we travel alone, or will we share trips with strangers? The scenarios also distinguish themselves by which groups will adopt the new MaaS solutions. Will only car drivers adopt new concepts, or will bus and tram riders also shift towards MaaS solutions? And if so, will they shift to services similar to car users or to something more similar to traditional public transport.

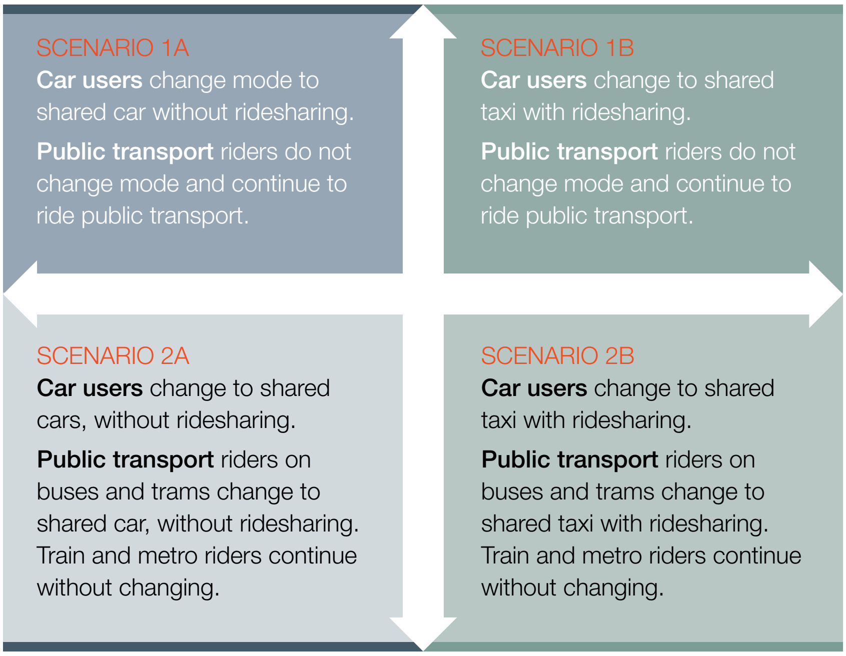


FIGURE 1-1 Scenario cross

The four main scenarios of the study are summarised in the scenario cross in Figure 1-1. The horizontal axis shows level of ride sharing. The vertical axis shows the market strength of public transport. In scenario 1a and 1b today's public transport users will continue to use public transport while private car users switch to a MaaS option. In 2a and 2b, all buses and trams will be replaced by a fleet of autonomous vehicles providing on demand door-to-door service. In both a-scenarios vehicles will be shared, but there will be no ride sharing. In the b-scenarios all transport will allow ride sharing.

The scenarios assume that users will act coherently as a group based on their modal choice when choosing their new transportation method. Either all public transportation riders will continue to use traditional public transport as today, or all public transportation riders who use buses and trams will shift to MaaS solutions. Train and metro users will not change their behaviour in any of the scenarios. In scenarios with only trains and metros, the remaining public transportation modes will be replaced by the new MaaS offers.

MAIN RESULTS

We have looked at effects on vehicle kilometres, fleet size and the level of service. A few of the key findings are presented in this summary. The results are compared with a base scenario, calculated with a traditional transport model.

Network impact (Vehicle kilometres)

BEST CASE:
Traffic reduction of **14 %** to **31 %**

WORST CASE:
Traffic volumes doubles, resulting in a complete traffic breakdown

The traffic volume, measured in vehicle kilometres driven, will, in the most positive scenario, be reduced by 14 %. This is scenario 1b, where public transport users continue to use public transport, and private car users start to share rides with others. The results are shown in Table 1-1. The potential traffic volume reduction is lower in this study compared to previous studies for Lisbon and Helsinki. This can partially be explained by the lower population density in the Oslo region. Furthermore, this study operates with a high service level for the MaaS system. This implies short waiting times and no long detours, resulting in lower effectiveness of the ridesharing system. If longer detours were allowed, each car would be able to accommodate more passengers. We have done sensitivity analyses to see the effects of allowing longer detours. They show that traffic volumes can be reduced by up to 31 % (compared to the 14 % in the main analyses), because of additional possibilities for ride sharing in scenario 1b.

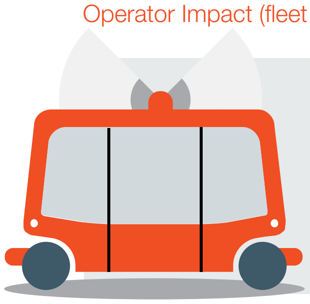
TABLE 1-1 Changes in vehicle kilometres compared with the base scenario

1A	1B	2A	2B	
FROM PRIVATE CAR TO CAR SHARING	FROM PRIVATE CAR TO SHARED TAXI	FROM PRIVATE CAR, BUS AND TRAM TO CAR SHARING	FROM PRIVATE CAR, BUS AND TRAM TO SHARED TAXI	
+26%	-14%	+97%	+31%	CHANGE IN VEHICLE KM

Public transport riders may find the MaaS concept more attractive than their current mode of transport. In the scenario where both, car and public transport riders, change to a MaaS system based on individual driving (without ridesharing), the traffic doubles compared to the base scenario. Despite autonomous vehicles being able to use the road capacity more efficiently than human drivers, the current infrastructure would not manage to deal with such an increase. In the scenario where public transport riders change to MaaS systems with ridesharing, an increase of almost 1/3 compared with the base scenario is estimated. This would pose as a significant challenge for the road capacity and would be in conflict with the city's climate goals.

A scenario with autonomous vehicles feeding mass transit is not analysed in this study. A scenario of this kind could lead to a substantial reduction in vehicle kilometres by making public transport more attractive.

Operator Impact (fleet size)



Number of cars can be reduced by **84 %** to **93 %** in all scenarios

All scenarios show a significant reduction in the numbers of cars needed. In the scenario where all current car users switch to autonomous cars with ride sharing, 7 % of the current car fleet would be necessary to meet the transportation demand in the morning rush hours. Thus, making 93 % of the cars redundant. In the scenarios where all tram and bus riders switch to car sharing, only 16 % of the current vehicle fleet would be necessary. In addition, all busses and trams would be removed from the roads.

These two scenarios represent the best- and worst-case scenarios in the study. The number of cars needed lies between 7 % and 16 % of the current vehicle fleet, which means that the number of private cars on the roads in the morning rush could be reduced by between 84 % and 93 %. This illustrates that a radical reduction in the number of cars is feasible. Previous studies on regions of similar size as the Oslo region support this result.

Customer impact

In a future without private car ownership, we all travel either with public transport, a shared car fleet, by foot or by bicycle. Those who travel with a shared autonomous car may have to wait before a vehicle can pick them up and the vehicle may take a detour to pick up other passengers en route.

An average private car trip in the base scenario takes 12 minutes and is 12 kilometres long. Whereas an average trip with a bus or tram is 13 kilometres but takes 32 minutes.

In the scenario where private car users share cars without ride sharing (1a), the travel distance does not change. In the scenario where they also share rides (1b), the average distance increases. This is because the car may have to take a detour to pick up other passengers. The average detour in this case amounts to approximately one kilometre. For both scenarios the travel time increases. With car sharing, the waiting time and the time for boarding and deboarding causes an increase in travel time of of around six minutes on average. In the scenario with ride sharing, the travel time is increased by an average of around 8 minutes, compared to the base scenario.

In scenarios 2a and 2b, where current public transport users switch to a MaaS option, we obtain approximately the same results on average travel time and distance, as for 1a and 1b respectively. However, for the public transport users, there would be a significant reduction in travel time, from 32 minutes to 21 minutes on average.

Changes in travel time caused by a possible change in traffic congestion are not considered in the scenario results. Hence, the increased congestion due to a higher volume of car traffic, when public transport users switch to MaaS, will have a negative impact on travel time. The opposite may occur in scenario 1b, as the travel time may be lowered along with the reduction in vehicle kilometres caused by ride sharing.

Need for new infrastructure

MaaS systems will impose new requirements to the infrastructure. They will also have the potential to free up areas that are now used for parking. Curb side parking can be removed entirely from the inner city, providing opportunities for better urban development. Furthermore, an absence of parking requirements will benefit city development projects. At the same time, a MaaS system will also require some space and infrastructure. So-called PUDOs, which are zones for picking up and dropping off passengers, will need to be in place. Since there will be very high activity at the PUDOs in busy areas in the city centre, they will require space and infrastructure in order to work efficiently.

POLITICAL SIGNIFICANCE

This study shows that shared transportation with a high level of service will not be sufficient to reach the traffic reduction targets in the Oslo region and will challenge road capacity. Hence, we cannot solely rely on autonomous vehicles in a MaaS concept to cater for all of our transportation needs. Traditional public transport combined with cycling and walking will be key elements in solving future urban mobility. Autonomous vehicles can help reaching the target, when integrated in a larger mobility system, but can worsen the situation if they are used as cars are today. Attractive public transport with integrated train, metro and bus services in combination with sufficient facilities for walking and cycling will assist in relieving the road network capacity. Integrating MaaS solutions into the public transport network will be a vital part of making public transport more attractive and competitive, especially in areas with low public transport coverage. The solution of tomorrow's mobility challenges lies within the combination of mass transit and integrated MaaS systems.

Oslo has ambitious environmental targets and has been appointed European Green Capital of 2019. In sustainable development, mobility plays an important role. Oslo has set a target of reducing car use by one third by 2030. Our study shows that there are uncertainties related to the effect of implementing autonomous cars on traffic. Without ridesharing, traffic would increase. Traffic would also increase, if MaaS became more attractive than traditional public transport. With ridesharing and a high share of public transport riders, the MaaS system can help to achieve the climate change adaption target. Although, this study shows that the traffic reduction potential is less than estimated in previous studies from other cities. In the most optimistic scenario a reduction of 14 % traffic is possible. Population growth will offset the reduction and in the coming years and lead to a traffic growth. This study assumes a very high level of service. When relaxing this precondition, by allowing longer waiting times before a vehicle shows up or permitting longer detours, the effect on traffic will be substantially better. The integration of MaaS systems into existing public transport is likely to lead to even better results concerning traffic reduction.

MODEL ASSUMPTIONS

We assume an optimal car fleet allocation to meet the transportation demand. In real life, there may be multiple competing MaaS providers that are not coordinated, resulting in the emergence of a suboptimal situation. This would likely lead to an increase in traffic compared to our optimal simulation results. Some other model assumptions are:

- Only trips starting and ending in Oslo and Akershus are included.
- Calculations are based on the transportation demand forecast for 2020 (the base scenario). The demand is estimated for peak hours from 6 a.m. to 10 am. on a weekday.
- Only car and public transport trips are calculated. Cyclists and pedestrians are assumed not to change their travel modes.
- Public transport riders who travel by train, both regional and local train and metro, will keep using these modes in all scenarios.