**Where will self-driving vehicles take us? Scenarios for the development of automated vehicles with Sweden as a case study**

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# INTRODUCTION

### Background

The development of Self-Driving Vehicles (SDVs) is fast, and several vehicle manufacturers have announced that they will launch fully self-driving vehicles to the market around year 2020 (“Driverless car market watch,” 2017). However, what the consequences of SDVs will be for users, society and the environment are still open questions. SDVs can become an important part of the solutions to challenges such as congestion and use of limited space in urban environments, but they can also induce more traffic and higher energy consumption (Gruel and Stanford, 2016; Litman, 2015).

SDVs are predicted to have a large impact on future life and mobility, by some even seen as a potential paradigm shift, and decisions made today will affect the future development. Therefore, understanding possibilities and challenges with SDVs for the future is important for stakeholders such as policy-makers, authorities and industry. Predicting the impacts of SDVs on society and cities is a complex task. Although simulations have shown their potential impact on fleet size and vehicle kilometres travelled under certain assumptions (Burghout et al., 2015; Fagnant and Kockelman, 2014), there still are many open questions about their role in the society (Litman, 2015; Townsend, 2014). Examples of open questions are: Where will SDVs be allowed to drive? Will it be feasible for SDVs to co-exist with manually driven vehicles? How will individuals and society accept them? Will they be used primarily as private or shared vehicles? How safe will they be? How secure will they be? How will SDVs affect acceptable commuting times and choice of travel mode?

In this study, a scenario-based approach is taken, and four plausible scenarios for the future of SDVs in Sweden are developed. These scenarios create a platform for discussions about introduction of new policy measures, new legislation, and infrastructure investments, as well as for identification of research and development gaps. The scenarios will also provide a background for the ongoing governmental investigation about future regulations for SDVs on Swedish roads (Bjelfvenstam, 2016).

The scenarios describe plausible futures, not the most wanted futures (Lindgren and Bandhold, 2009). The most wanted future differs between stakeholders, and is probably a mix of the scenarios developed in this work. Identification of the most wanted future is a topic for decision makers in both the public and private sectors. Still, the scenarios developed in this study will hopefully form a valuable platform for further discussions.

### Definitions

In this work, the term *self-driving vehicle*, or *SDV*, is used for automated road transport vehicles that can operate fully or partly without a human on-board who is responsible for the operation. The level of automation describes how “self-driving” a vehicle is. For this, the five level classification by SAE International is used in this work (SAE International, 2016). When referring to SDVs in this paper, SAE automation levels 4-5 are implicitly understood.

### Contribution

This study contributes to the understanding of impacts of SDVs on a societal level in the European context in general, and the Swedish context in particular. The study takes business, technological, policy and behavioural aspects into account, and derives four plausible scenarios for the development of SDVs in Sweden by the year 2030, with an outlook to 2050. The most important trends that affect the development are identified. Furthermore, the development of traffic volumes and fleet sizes are predicted for the different scenarios.

Previous work, where scenarios for SDVs have been developed, are based on literature reviews (Townsend, 2014), or workshops performed by smaller groups of researchers (Gruel and Stanford, 2016; Milakis et al., 2016). This current work is unique compared to previous work due to the large group of 40 experts from 23 different organizations within the transportation sector who have been actively involved in form of three full day workshops. By using this approach, it has been possible to integrate knowledge about technology, business and policy from several different perspectives into the developed scenarios. Furthermore, in contrast to most previous literature on the impacts of SDVs, this study considers impacts of SDVs at automation level 4-5 and not only at level 5.

# RELATED WORK

Most literature on SDVs treats the technical development, see for example Piao and McDonald (2008), but there are also contributions on societal and system level impacts. Among the positive effects of SDVs listed in the literature one finds increased traffic throughput leading to less congestion, improved traffic safety, reduced crash costs, possibility to rest or work while travelling, decreased need for parking places, and improved mobility for people without a driver's license (Fagnant and Kockelman, 2015; Harper et al., 2016; Litman, 2015). SDVs are also seen as a potential enabler for shared mobility services (Greenblatt and Shaheen, 2015). On the other hand, among the negative effects of SDVs are an expected increase in the consumption of transport, which would lead to an increase in total vehicle kilometres travelled (Davidson and Spinoulas, 2016), an effect that is further reinforced by empty vehicles driving on the streets, as well as by a shift from public transport to new affordable mobility services with SDVs (Gruel and Stanford, 2016). This would increase the number of vehicles on the streets and lead to increased energy consumption and congestion. Wadud et al. (2016) find that a substantial part of energy reduction can be reached already at level 4 of self-driving, while most risks of increased energy consumption and emissions appear at level 5. Litman (2015) also put forward concerns related to cyber security and privacy, as well as social equity (if SDV development is prioritized over public transport, bicycle and walk).

Miliakis et al. (2017) study potential societal impacts of SDVs and provide a literature review on the topic. The authors divide the impacts of SDVs in first, second and third level impacts. First level impacts include travel time, travel cost, road capacity, and traffic volume. Impacts on car ownership, land use and parking are classified as second order impacts, and energy efficiency, emissions, and traffic safety are examples of third level impacts. The authors show that literature predicts first level impacts to be decreased travel times, increased road capacity, and increased vehicle kilometres travelled. Furthermore, the authors conclude that research about second and third level impacts still is scarce.

### Simulation studies

One field of research studies the potential impacts of SDVs through simulations of different use cases such as autonomous shared taxis (Burghout et al., 2015; Chen and Kockelman, 2016), a shared service with different penetration levels (Burghout et al., 2015; OECD International Transport Forum, 2015), or new concepts as in Schoettle and Sivak (2015), where in-family car and ride-sharing are studied. The effects of different pricing schemes for a shared autonomous taxi service are studied in Chen and Kockelman (2016).

These simulation results provide upper or lower bounds on the potential impacts, but should not be consider as realistic estimations in a real future world since they typically do not take behavioural changes, travel demand changes, or business ecosystem changes into account. As expressed by Stocker and Shaheen (2016): "any new transportation service introduced into an ecosystem of existing travel options will have impacts on subsequent travel behaviour". Furthermore, the simulations do not take potential effects of competing suppliers into account. For example, Burghout et al. (2015) and OECD International Transport Forum (2015) both simulate only one single fleet of shared SDVs to meet the travel demand, but a plausible situation is that there will be several competing suppliers available in the same way as there are several car-sharing operators or taxi operators in many cities today.Including factors such as behavioural changes and business impacts in simulations is challenging since there are many unknown variables.

### Future scenarios for SDVs

Gruel and Stanford (2016) employ a speculative approach to identify scenarios for the impacts of SDVs based on people's behaviour and choices in a North American context. Technological, policy and business aspects are not considered at all in those scenarios. Townsend (2014) discusses how digitization and SDVs may have an impact on the US society by describing different future scenarios. The method assumes that there are four archetype future development directions: "growth" (continuous growth according to the trends present today), "collapse" (some of the critical systems fail), "constraint" (one resource is limited), and "transformation" (innovation takes place).

Most of the literature on future scenarios for and effects of SDVs treats the situation in North America. In Europe, literature in this area is primarily from the Netherlands.

In Milakis et al. (2016) scenarios for the development of SDVs in the Netherlands are developed. However, the Netherlands and Sweden are different in several important aspects, such as population density, mode choice, infrastructure and industry. Therefore, the present study, where focus is on the Swedish situation, will provide additional knowledge and insights, and a possibility to compare the results from the two countries.

# METHOD

In this section, the scenario planning method is briefly described, followed by a detailed description of the process applied in this study.

### The scenario planning method

There are several forces and trends present that will have an impact on the development of SDVs. These forces and trends are uncertain, and also counteracting, making the development of SDVs challenging to predict. Therefore, a scenario-based approach is applied. The scenarios themselves are different alternative plausible futures rather than traditional forecasts, and they are intended to span the range of possible futures (Derbyshire and Wright, 2017). Among the advantages of the scenario planning method are that it is a format that corresponds to the way our brains are working, that the method enhances unconventional thinking, and that the method reduces the complexity without over-simplifying things (Lindgren and Bandhold, 2009; Wright et al., 2013).

There are a number of different approaches to scenario planning (Bradfield et al., 2005). In this study, the Intuitive Logics (IL) approach is used. In IL the aim is to identify four scenarios that are plausible and represent different descriptions of the future, and at the same time are internally consistent. There are variations in the IL method (Derbyshire and Wright, 2017; Foster, 1993; Vanston et al., 1977), but the standard method contains the following steps: (1) identify the issue of concern, (2) identify predetermined elements - in this report called *the certain development* (a set of future trends that are predicted to have a very high probability to come true) and *the critical uncertainties* (trends that may or may not come true, and whether they do or do not come true will have a great impact on the issue of concern), (3) recompose and cluster the critical uncertainties into clusters of *strategic uncertainties*, (4) identify two ‘extreme’ but plausible sets of outcomes for each strategic uncertainty, (5) cluster the strategic uncertainties, and (6) select the two clusters with greatest impact and uncertainty as the *scenario dimensions*. The scenario dimensions are then used to form a scenario matrix with four scenarios, and for each scenario an explanation based on causal logic is written to describe how the scenario will unfold from the present to the future.

### The scenario development process

The work to identify the scenarios in this project has been performed by an expert group and an analysis team. The analysis team consisted of the three authors of this report and two future strategists. The expert group has involved 40 persons from 23 transport organizations, including authorities, municipalities, lawyers, city planners, researchers, public transport operators, taxi and other mobility providers, and vehicle manufacturers. The scenario development process is shown in Figure 1. The expert group met for three full day workshops with one month in between. The experts where selected to represent a wide variety of organizations, as well as based on their expertise in the field.



Figure 1: The scenario development process. Steps performed by the expert group are shown in black and steps performed by the analysis team in blue.

The process to develop the scenarios included the IL steps described in the previous section, and was complemented with scenario descriptions and predictions of the consequences for SDVs in each of the scenarios (see also Figure 1):

1. Identification of issue of concern (IL1 – analysis team): The future development of SDVs in Sweden was identified as the issue of concern.
2. Trend analysis (IL2 – expert group): Identification of trends that have an impact on the development of SDVs. Trends were classified according to their relative impact on the development of SDVs (high-low) and their relative uncertainty (certain-uncertain).
3. Certain development and preliminary scenario dimensions (IL3 to 6 – analysis team): Formation of certain development and strategic uncertainties.
4. Scenario workshop (IL6 - expert group): Verification of preliminary scenario dimensions.
5. Preliminary scenario descriptions (IL6 - analysis team): First drafts of scenario descriptions are derived by the analysis team.
6. Scenario review and consequence analysis (IL6 - expert group): Revision of the consistency in the scenario descriptions and predictions of consequences on the development of SDVs.
7. Final scenario descriptions (IL6 – analysis team).

### Consequence analysis

To estimate the development of SDVs in the four scenarios, the expert group was asked to analyse the consequences for, and predict the development of, SDVs in the different scenarios in three ways: (1) predict the years for emergence, growth and saturation of SDVs at level 4 and 5 for each scenario, (2) predict the total fleet size and the share of SDVs at level 4 and 5 for each scenario for the years 2030 and 2050 respectively, and (3) predict the total volume of vehicle kilometres driven and the share of kilometres produced by SDVs at level 4 and 5. During the consequence analysis, the experts were asked to first make individual estimations. The experts were then divided into groups of four to five persons, and were asked to agree on a group estimation.

# RESULTS

### The certain development - where Sweden is going

The certain development, as identified by the expert group, is described in Table 1. The trends listed in Table 1 are not intended to be general or complete, but contains a selection of trends that are considered particularly important for the development of SDVs in Sweden.

Table 1: Highly probable trends with relevance for the development of SDVs

|  |  |
| --- | --- |
| **Area** | **Trend** |
| Technology | A continued fast development, including development of high-capacity communication technology such as 5G, more precise geo-positioning technology, and high level of connectivity. |
| City Life | Continued urbanization leading to increased competition for space in the city, and decreased number of parking places. Regional enlargement leading to longer work trips and increased demand for mobility. |
| Life Style and Demography | Increased search for a smooth life. Quality-of-life and how time is used will be important, but there will be an increased difference in what different people interpret as ‘high-quality time’. There is a trend that younger people take driving licenses later in life, but at the same time older people are more mobile and drive more. Furthermore, there is a trend of increased flexibility in work life, where people can work from home or other places. |
| Business | It will be profitable for enterprises to be sustainable. New business models related to mobility and transportation will be invented and tested, but it is difficult to predict which of them will be competitive in the future and who will be the main actors. |
| Policy and Governance | The Ministry of Enterprise will support the development of industry and business related to SDVs and aim for making Sweden a test bed for innovative mobility solutions. Furthermore, there will be (at some level) a harmonization of communication and data integrity within EU. |
| Transport and Mobility | Vehicles will in general reach higher levels of automation (even if they do not reach automation level 4 or 5). There is also a trend towards replacing costly labour hours with automation. New types of vehicles will also appear, including development of small busses or pods that will complement high-capacity public transport. |

### Strategic uncertainties

The trends identified by the expert group that were classified to have an uncertain outcome1 and at the same time important for the development of SDVs, were formulated into strategic uncertainties, where each trend has two possible outcomes, see Table 2.

Table 2: Strategic uncertainties identified by the expert group

|  |  |  |
| --- | --- | --- |
| **Trend**  | **Outcome A** | **Outcome B** |
| De-urbanization | SDVs make longer travel distances more attractive | SDVs do not change travel distances |
| Acceptance of sharing | Sharing not accepted | Increased acceptance of sharing |
| Integrity | People have high integrity and are reluctant to share data | People are OK with sharing data |
| Growth of shared transport services | Significant and fast increase of mobility as a service (MaaS) | Slower and less influential increase in MaaS |
| Private car ownership | Private car ownership decreases drastically | Continued interest in having access to one’s own car |
| Trust in authorities | The mistrust towards authorities increases. Instead people trust commercial organizations  | People begin to trust authorities again |
| Acceptance of SDVs | People in general accept SDVs, are curious and want to try it out | People are reluctant towards SDVs and find the benefits of SDVs to be minor |
| Media focus | Media focuses on problems and accidents | Media focuses on potentials and benefits |
| Cyber and data security | High system reliability is achieved | Hackers tend to always be one step ahead |

The analysis team analysed and restructured the strategic uncertainties and chose two dimensions to span the scenario matrix: *consumer behaviour* and *urban policy and planning*. These dimensions were formulated as:

* *Consumer behaviour* Whether people buy in on the sharing economy, including sharing of space, things and data, as well as consumption of services rather than ownership or this will not happen, and to what extent this is reflected in the solutions that will reach market attention.
* *Urban policy and planning* Whether the ambitious goals that policy makers and authorities have to change society are followed by proactive handling and new solutions and ways of organizing things, or whether implementation is deemed to be done within today's national and international structures. A consequence of the second outcome with respect to this dimension is that commercial actors will be given the opportunity to lead the development.

### The scenarios

The selected scenario dimensions create the scenario matrix that gives four scenarios shown in Figure 2, together with a bullet point summary of each scenario.



Figure 2: The scenario matrix.

The scenarios are described in more detail in the following sections, using fictitious stories, written from the perspective of the year 2030.

#### 4.3.1 Same, same, but different

A lot has happened since the mid 10’s. The combination of increasingly visible climate changes and utilization of the possibilities provided by digitalization has changed Sweden during these last fifteen years. It is clear now, that one of the most important changes was that both private and public sectors managed to implement their high ambitions. Digitalization has contributed to a radical change in how society is organized and many services that support everyday life decisions are now available. There is however one trend that we saw in the mid 10’s that didn’t bloom: the Swedes, like Europeans in general, didn’t buy in on the sharing services regardless of whether it comes to sharing data, transport or things. Integrity and ownership turned out to be more important for people than trend spotters believed fifteen years ago. Therefore, consumer patterns have remained the same, while production methods have changed to become far more sustainable.

It wasn’t only the unwillingness to change behaviour that stopped the sharing economy. Hacker attacks in the national health care data system led to that people no longer trust the state to provide sufficient data security levels. This has also led to a new market for bots that take care of a person’s individual data on the internet.

During the 20’s, several city centres in Sweden banned private car traffic, and cafés and restaurants took over the streets. New policies have raised the costs for having private cars in cities radically. Congestion charging levels are now based not only on time of day, but also on which street is used, the size of the car, number of passengers and local emissions. This has slowed down urbanization and led to that many people work from home or from local co-working spaces. Commuting is done by public transport, electric bicycles or one of the new light electric vehicles that were introduced during the 20’s.

To reduce CO2 emissions, fees and taxes have made flying very expensive. Instead car, bus and rail travel has increased. Platooning services that virtually connect buses and cars to vehicle trains, which decrease fuel and energy costs, have increased. It is also possible for private car users to connect to bus trains, so that the driver can use the time for sleeping and working - a service that has become affordable due to subsidies. Advanced traffic control systems and digital infrastructure have paved the way for more advanced driver systems. In addition, self-driving shuttle busses that connect remote parking areas with public transport or business areas are now common.

#### 4.3.2 Sharing is the new black

After some years of unrest in the world during the second half of the 10’s, society development started for real in the beginning of the 20’s. A key factor was the broad political commitment in Sweden after the election in 2022. The election 2022 was a major success for the new “Green Future Party”, that together with established parties managed to implement a whole set of new solutions, called the “10 Actions List for Future Sweden”. Political scientists find this list to be the most important political action during the last century, since the organizational structure of and culture within authorities have changed completely.

New solutions for public transport and city planning were not only supported by public actors, but were also driven by them. Sweden has now a progressive legislative support for self-driving vehicles, and a city planning that enables the technology, for example by preparing physical and digital infrastructure and by dedicating lanes and roads to self-driving vehicles. This has led to Sweden being a test site for large global enterprises to try out new technology. Most Swedes use automated solutions in their every-day lives. New rules require vehicles to be fossil free, connected, and share data to the public cloud.

The public sector adopted the block chain technology early, which has led to a high public trust in general. There have been attempts from hackers to get hold of the data but coordinated efforts within EU have helped authorities to protect themselves. This made it possible to release the 2nd generation congestion charging system in 2027, based on GPS technology that automatically log all vehicle movements, and there is a per-minute fee for using the streets. A new public transport concept has been developed as a partnership between public sector and selected mobility suppliers. Door-to-door trip using a single ticket is the philosophy. During the last years of the 10’s it was called “Mobility as a Service”, but today no one calls it anything else than just D2D (door to door). D2D has drastically changed public transport.

The development of SDVs has been supported both by the shared D2D solutions, where the technology costs are divided by several users. Mobility has drastically increased for a large share of the population compared to 2017, including people without a driving licence, disabled and elderly.

#### 4.3.3 Follow the path

The high ambitions of a sustainable and fossil free Sweden in the end of the 10’s have partly failed. Effects of climate change are for sure visible, but the Swedes (and Europeans in general) weren’t prepared to change behaviour fundamentally. Privately-owned or leased cars, shopping malls and a dream of winter holidays in Thailand are still important in our lives. E-commerce has grown, but still the physical experience of shopping is important and often integrated with e.g. a visit to a restaurant or cinema. New services have not been adopted at the rate that was expected by innovators during the mid 10’s. A first sign of this was when Car2Go closed down in Stockholm in 2016. The Swedish government has struggled to find functioning alliances between parties, which has led to new technology being used to improve existing solutions, rather than finding new solutions. It was not lack of ambitions or will – rather the opposite – but the authorities simply didn’t manage to look beyond the most urgent challenges.

There has been a vast development in technology. Voice control functions flawless, and advanced navigation services, drones and VR-technology belong to everyday life. The Swedes live a comfortable life, assisted by advanced technical solutions, but without much sharing of data between persons and organizations. Attempts to create standards for data exchange have been stopped by hackers. The lack of standards and the focus on cyber security have slowed down the development of SDVs. The traditional car manufacturers have taken the lead in the development and outperformed the small, innovative suppliers that tried to enter the market during the early 20’s.

China is today the world’s leading nation in innovation, and has several cities where SDVs at level 5 operate. In Sweden and Europe, self-driving is focused on advanced driver assistance systems, and cars can for example be self-driving in situations of congestion or on highways. Private car ownership (or private leasing) gives a lower fleet turn-over rate and slows down the penetration of the new technology.

#### 4.3.4 What you need is what you get

Digitalization has led to a rich world of new services that makes everyday life smooth, and the curious and progressive majority of the Swedes don’t only like them, they love them. The change from ownership to sharing that could be seen as early signals in the late 10’s, has totally exploded in the last years. Companies that managed to collect unique data from their customers and transform it into new solutions have become successful. Personal data is the most important asset. Public actors intended to take the lead in the development, but they were too slow compared to commercial actors. Supported by the Ministry of Enterprise and Innovation, the approach became to create legislation that opened up for commercial actors, to let them drive the development. The evolution started with many start-ups and smaller companies, providing pooling and sharing services, e-commerce and mobility services. Consolidation and company takeovers integrated those into the large enterprises. Large commercial organizations have taken over services that previously were offered by the public sector. For example, Google has not only taken over traffic information, but also built new roads to support its own transport service “Seamless”, a service that has its roots in their consolidation with Uber and Volvo Cars.

A Swedish success story is Ericsson’s and Volvo’s joint investments to create an IT infrastructure for cloud services for SDVs. A solution now considered the most safe and robust solution on the market. E-commerce has grown, and got support from the new trend of automated shopping. The systems do not only recommend clothes and products, they also send the products directly home to the customer, without any involvement of the customer. This type of “bot-chosen” clothes, based on personal data, immediately became high status. Everything is shared: cars, trips, tools, and dogs. IKEA recently released the new service DELA where customers share and exchange sofas. It has become a boom for providers of solution services, for example LinkedIn Workplace, a service offer to employers that provides “an effective and creative work production”. The service is based on an analysis of the employee’s current work load, the need for physical meetings between persons, and the employee’s private life and preferences, and recommends whether the person should work from home or go to work - and if so, an optimized transport is arranged.

Public transport is still operated by the traditional types of buses and trains as during the 10’s, and becomes less and less attractive in comparison to new shared services such as Google Seamless and Facebook Connect that have been introduced in the large cities. Rumours say that Google Seamless soon will offer to take over the operation of Gothenburg’s whole public transport system at a very competitive price. There is a big difference in the mobility solutions provided in the larger cities compared to the rural areas. The rural areas are not intentionally left behind, but the main customer base and profitability are in the urban areas. The development and deployment of SDVs at level 4 and 5 are driven by commercial forces, and the change goes fast.

### The Development of SDVs

In this section, the expert group’s predictions of the development of SDVs in the four different scenarios are presented. In all predictions, 2016 is used as base level, and the experts where asked not to take population increase into account. The predictions of the total fleet size and size of SDV fleet (at level 4 and 5) for 2030 are shown in Figure 3. First the experts made individual estimations of fleet size. They were then divided into groups of four to five experts that agreed on a common prediction. Figure 3 shows the average and standard deviation of group estimations. As shown in the figure, the breakthrough of the sharing economy is expected to have most impact on the share of SDVs. Furthermore, fleet size is expected to be highest in the scenarios *Same, same, but different* and *Follow the path*.

Figure 3: Fleet size in 2030 in the different scenarios, for all vehicles (blue bars) and for SDVs (red bars), as predicted by the experts. Index 100 corresponds to the 2016 base level. The figure shows average and standard deviation of the experts’ group estimations.

The predicted volumes of vehicle kilometres travelled (VKT) for the different scenarios are shown in Figure 4, which shows average and standard deviation of the expert’s individual estimations. The experts predict VKT to be lowest for *Sharing is the new black* and *What you need is what you get*, where the sharing economy has had a breakthrough. The share of level 4/5 SDVs is also highest in these scenarios. In the scenario *Sharing is the new black* the expert group estimated the VKT to decrease in relation to 2016. It was challenging for the expert group to predict the effects of the sharing economy on VKT, which is shown by the larger standard deviations for *Sharing is the new black* and *What you need is what you get*.

Figure 4: VKT in 2030 in the different scenarios, for all vehicles (blue bars) and for SDVs (red bars), as predicted by the experts. Index 100 corresponds to the 2016 base level. The figure shows average and standard deviation of individual estimations.

The expert group was also asked to draw S-curves (Christensen, 1992; Foster, 1985) for the SDV development in each of the scenarios, and explicitly state years for the start, the region of maximum rate of progress, and the time where saturation is reached for each scenario. The expert group was also asked to predict the share of SDV of level 4 and 5 at market saturation in each of the scenarios. The predictions were made individually, and the average results are shown in Table 3.

Table 3: Expert group predictions on S-curves for SDV development

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Scenario** | **Start point** | **Maximum progress rate** | **Limit** | **Saturation level (mean ± std)** |
| Same, same, but different | 2030 | 2040 | 2056 | 59 ± 34 % |
| Sharing is the new black | 2028 | 2034 | 2050 | 89 ± 9 % |
| Follow the path | 2033 | 2039 | 2058 | 48 ± 38 % |
| What you need is what you get | 2027 | 2033 | 2050 | 83 ± 19 % |

The S-curves for the scenarios *Sharing is the new black* and *What you need is what you get* are similar, which indicates that the expert group expects the development of SDV functionality to be similar in those scenarios. The development is predicted to be slower in the scenario *Same, same, but different*, and slowest in *Follow the path*. The level of saturation is not expected to be 100 % in any of the scenarios. The standard deviations of the predictions of saturation level are substantially higher for the scenarios *Same, same, but different* and *Follow the path*, showing that the experts disagreed to a higher extent on the expected development in these scenarios.

The predictions in this paper implicitly take aspects as behavioural and business model changes into account, aspects that are typically difficult to model explicitly and therefore are left outside simulation studies. However, a comparison with the simulation study by OECD shows that the predictions in the present study agree with respect to direction of development but tend to underestimate VKT in relation to that report (OECD International Transport Forum, 2015).

# CONCLUSIONS AND FUTURE WORK

In this report four plausible future scenarios for the development of SDVs in Sweden up to the year 2030 have been presented. The scenarios are based on the input from 40 experts from more than 20 different organizations within the transport and mobility sector in Sweden. To derive the four scenarios, both the highly probable future development of the society and mobility pattern, called “the certain development”, as well as four scenarios for future development have been identified. The four scenarios are described both in text, as fictitious stories, and with estimations of the impact on VKT and fleet size.

One main conclusion that can be drawn from this study is that societal and transportation policy making and planning will have a large impact on the consequences of SDVs in society and on the environment. It is clear that actions and decisions made by policy makers today will have a strong impact on which role SDVs will play in our future society and cities. Therefore, it is highly important for policy makers, planners and other decision makers to explore their possible decisions and the expected outcomes of them.

It is challenging but important to understand the long-term impacts of SDVs, and how they depend on decisions made today. In this report, four plausible scenarios have been developed and described, but there is still a need for detailed analysis and simulations of the development of SDVs and analysis of consequences on indicators such as traffic flow, social equity, accessibility, security and safety is needed. There is also a need for a deeper understanding of the consequences of business models and behavioural changes. This paper, similar to previous literature on the impact of SDVs, has been focused on person transportation and people’s daily travel. To get the full picture about the impact of SDVs, it is also important to consider freight transportation.

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**NOTES**

1 In this study, it is assumed that the general political situation in the world has not changed disruptively by 2030, and wild cards, e.g. that EU falls apart or that free trade decreases radically, are not considered.