PAV & UGHENT - RESEARCH DELIVERABLE

Planning for Autonomous Vehicles

10 & 12 June 2020

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DELIVERABLE

- **Name Deliverable 3.1**
- **Responsible ALL RESEARCH PARTNERS**
- **Timing December 2019-June 2020**
- **Content Report (or matrix) with AV uptake scenarios (+ impact) based on current literature (max. 15 pages or 30 slides), other partners can review**

- HU: technical input + scenarios based on literature
- RGU: scenarios (can be discussed in Almere)
- GU: social impact

https://www.careserviceproject.eu/new-mobility-services/

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THE ISSUE

CO2 emissions from urban mobility will increase with 26% by 2050

Demand for urban passenger transport could grow 60-70% by 2050

Population growth, economic development and continued urbanization will lead to strongly increasing demand for urban transport. This growth will more than cancel out any CO2 emissions reductions made possible by new low- and zero-carbon technologies. Projections see total motorized mobility in cities almost double (+94%) between 2015 and 2050. This growth will cause a 26% increase in CO2 emissions from urban mobility by 2050.

(Metz, 2015

HOW TO MAKE URBAN MOBILITY CLEAN AND GREEN

If urban mobility were based on shared and electric vehicles, CO_2 emissions from traffic could fall by 60%

Decarbonizing cities fast requires zero-emission cars

The electrification of motorized vehicles is a promising option for decarbonizing urban mobility. Yet the number of electric cars in cities remains marginal. To have any impact on urban CO_2 emissions in a way that helps to reach mitigation targets, their use must be scaled up very rapidly.

https://smile.adrioninterreg.eu/news/public-invitation-for-cooperation-within-the-project-sustainable-urban-mobility-in-cities-and-municipalities-in-serbia

HOW TO MAKE URBAN MOBILITY CLEAN AND GREEN

If urban mobility were based on shared and electric vehicles, CO_2 emissions from traffic could fall by 60%

Shared mobility cuts CO_2 without any new technology

Better capacity use is the key to mitigating CO_2 emissions in urban areas. Cars operate on average 50 minutes per day, with about 1.4 passengers on average. If greater ride-sharing succeeds in doubling car occupancy, today's level of mobility could be provided with less than 10% of the current number of cars. This would cut CO_2 emissions by one third without even the need for any new technology.

https://www.itf-oecd.org/shared-mobility-innovation-liveable-cities

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TRENDS INFLUENCING URBAN MOBILITY

https://www.electricvehiclesresearch.com/tag/192/autonomous-vehicles

Autonomous driving

The arrival of driverless autonomous vehicles (AVs) represents a unique opportunity for a fundamental change in urban mobility as long as public authorities and public transport companies take an active role now to integrate AVs into an effective public transport network. AVs could also lead to higher overall vehicle mileage, as people take advantage of their convenience by making more trips or even sending AVs to run errands for them.

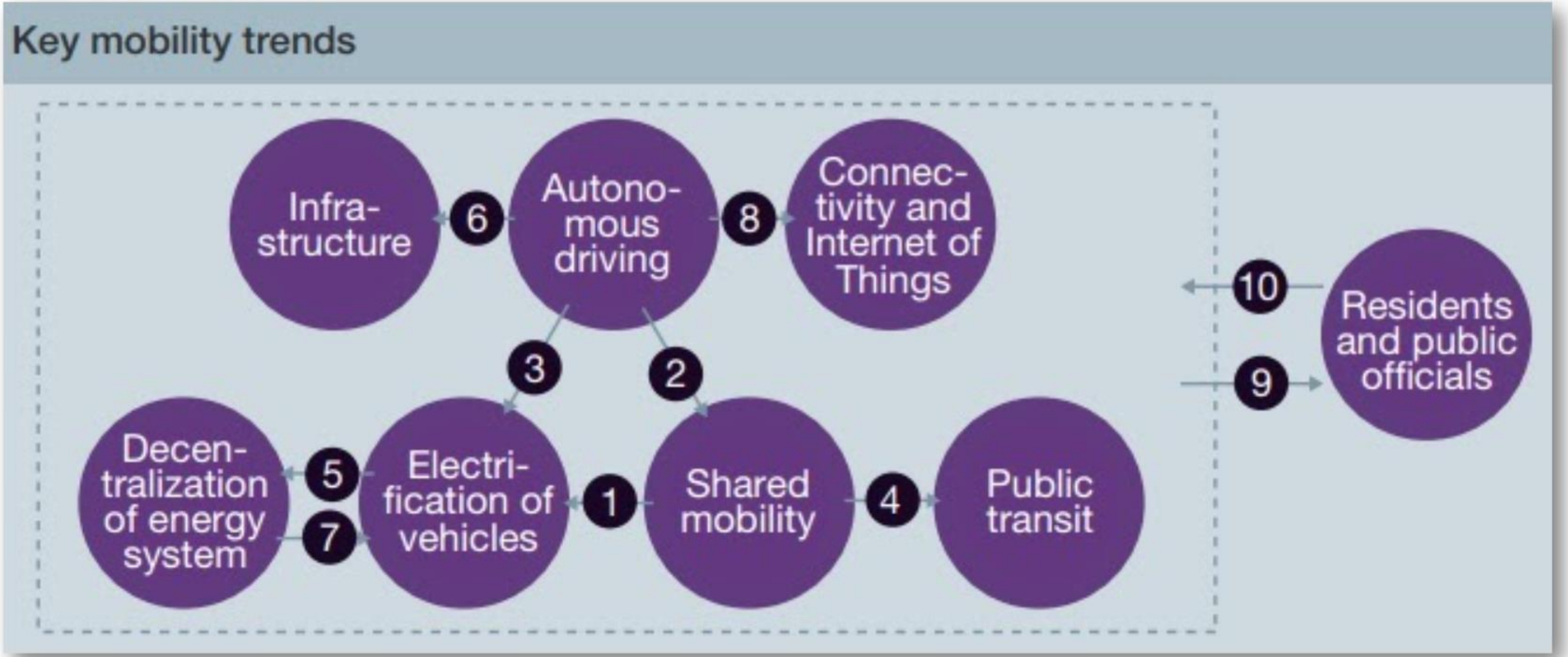
DEFINING CONNECTED AND AUTONOMOUS VEHICLES

The vehicle segments included for the social scenarios are cars, shuttles and buses, with autonomy level 3 or more. AVs and CAVs (connected and autonomous vehicles) are defined as follows:

•**Autonomous Vehicles** (AVs) (also known as automated, self-driving or driverless vehicles): Vehicles with increasing levels of automation will use information from on-board sensors and systems so they can understand their global position and local environment and enable them to operate with little or no human input for some or the whole journey.

Connected Autonomous Vehicles (CAVs) (also known as Cooperative Intelligent Transport Systems [C-ITS]): CAVs refer to vehicles with increasing levels of connectivity which allows them to communicate with their surrounding environment (including the infrastructure and other vehicles). This could provide information to the driver about road, traffic, and weather conditions, and on routing options and enable a wide range of connectivity services.

Some emerging mobility trends will have reinforcing effects on one other



(Bouton et al., 2017)

REINFORCING EFFECTS FROM MOBILITY TRENDS

- An uptake in **shared** mobility will accelerate **electrification**, as higher utilization favors the economics of electric vehicles

- **Self-driving** functionality could lead to a competitive proposition for **shared** mobility. Self-driving vehicles, both private and shared, are likely to increase mobility consumption, in which case **electric** vehicles offer a lower total cost of ownership

- An uptake in **shared** mobility will affect public transit. **Electricity** demand will surge while demand for fuel goes down; electric-vehicle production at scale could accelerate the drop in battery prices

- **Self-driving** and **electric** vehicles will require different charging and parking infrastructure, likely freeing up **real estate** in city centre's (e.g. street and garage parking) and making suburbs more **accessible**

- Increasing penetration of renewable energy could accelerate the financial and environmental attractiveness of **electric** vehicles

- **Self-driving** vehicles might accelerate the uptake of mobility **applications**. Mobility trends could impact residents in ways such as shifts in **work** formats (e.g. taxi employees vs. self-employed ride-hailing drivers), **real-estate** values, and **cost** and **time** spent in transit

- City authorities can shape their mobility agenda to capture financial, **social**, and environmental benefits through forward-thinking policy

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SCENARIO VARIABLES

Variables	Types	Specific
Space	•Urban •Suburban •Rural	
Time	•1 week •X months •X years	
AV	•Car •Shuttle •Bus	•Car - human factors •Shuttle & bus - shared
Acceptance	•Acceptability •Acceptance • Satisfaction	•Before •During + afterwards • During
Individuals	•Users > Social group •Public (active/passive) •Stakeholders/experts	Social group: •Young adults •(Elderly) Other: •Commuters •Tourists •Vulnerable road users

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SCENARIO 1

Variables:

- Pilot in a suburban environment with shuttles for x months to years (~ Hannover)

Who?

- Social: Young adults (~ students, technical **university**? more men)
- Public (~ commuter, ! high income)

- Before: It is expected that the acceptability will be high for both groups since people who live (work?) in an urban environment (not necessarily the case), with a higher degree, with a higher income, who are tech-savvy, who are younger, and male will be more in favour of AVs.

- During: Acceptance will probably be high. The users are more used to experiments in the context of the university. It is highly likely that both groups will be “early adopters”. Sharing the shuttle will be less of an issue because the people have something in common and there are a lot of young people.

- Afterwards: The further acceptance will depend on the service of the shuttle.

SCENARIO 2

Variables:
- Pilot in an urban environment with a bus for a special **event** (~ Almere)

Who? Tourists
- Public (~ citizens… PT users)

- Before: The acceptability will be hard to measure. It is better to narrow down the scope to citizens or PT users. Acceptability of citizens will partly depend on the involvement in the implementation process. Public transport users tend to be more in favour of AVs.

- During: The acceptance will probably be high since the destination is part of a leisure activity in which the travel time is less narrow than a mandatory activity. The bus can also be viewed as part of the leisure activity which makes the bus a location in itself. Willingness to share is probably more critical and will probably depend on the configuration of the seats. An acceptance survey (think) can also be complemented by a satisfaction survey (feel).

- Afterwards: ? (Will this be extend in the future apart from this event)

SCENARIO 3

Variables:

- Pilot in a suburban environment with a **car** for x months (~ Varberg)

Who?

- Car-drivers
- Vulnerable road users (pedestrians and cyclists)'

- Before: The acceptability will be hard to measure. It is better to narrow down the scope to citizens or test drivers which will be a limited number. Acceptability will depend on the sample. However, it is expected that the acceptability will in general be higher since this group is willing to take part in this pilot. The acceptability of the pedestrians and cyclists will be more mixed, probably also with a slightly more positive view for the same reasons.

- During: Acceptance improves often due to experience which is also expected for this pilot. The acceptance of vulnerable road users will depend on the functioning of the automated car (e.g., emergency braking).

- Afterwards: …

SCENARIO 4

Variables:

- Pilot in a rural environment with a shuttle as intermodal service to a mandatory/leisure activity for x months to years (~ Inverness)

Who?

- Tourists (profile? older/younger, men/women, …)
- Public (~ commuters ? profile)

- Before: Acceptability can be measured, it is expected to be relatively positive for tourists as well as commuters. The shuttle is seen as a complement for people with reduced mobility (PRM) due to various reasons.

- During: It is expected that the acceptance will also be relatively high. The critical view upon sharing will depend on the objective of the shuttle (for PRM, everybody, …)

- Afterwards: …

ENVISIONING THE FUTURE(S) OF URBAN MOBILITY

- **More infrastructure improvements.** The most valuable upgrades will be those that make it easier for people to get around using modes of transportation, such as **shared** mobility services and **mass transit**, that do not worsen traffic congestion, air pollution, or other pressing problems. Without better infrastructure, though, the benefits of integrated mobility could be curtailed.

- **The expansion of cost-effective forms of transport.** High-capacity public transport and shared mobility services will probably do the most to satisfy rising demand for mobility. It has been estimated that by 2030, shared light vehicles could account for a third of vehicle-miles traveled in an average-size city.

(Viegas & Martinez, 2017)

ENVISIONING THE FUTURE(S) OF URBAN MOBILITY

Little uptake of AVs. Public and shared mobility services will likely favor vehicles **driven by people**, because labor costs are low, sustaining employment remains a priority for policy makers, and AVs might be stymied by bad roads and heavy traffic.

https://www.urban-hub.com/smart_mobility/how-shared-mobility-can-mean-less-traffic-cleaner-air-and-better-public-transit/

A shift toward EVs. This would be enabled by advances in decentralized renewable-power generation (for example, rooftop solar) and motivated by concerns about air pollution. It has been projected that approximately 40% of vehicles in developing, dense cities will be electric by 2030. These developments could create challenges for utilities, however, given the aging power grids in many dense, developing cities.

(Viegas & Martinez, 2017)

WHAT ARE THE BENEFITS OF AVs?

- The scenarios for convenience and quality-of-life improvements are limitless. The elderly and PRM would have independence. If your kids were at summer camp and forgot their bathing suits and toothbrushes, the car could bring them the missing items.
- But the real promise of autonomous cars is the potential for dramatically lowering CO_2 emissions. Experts identified three trends that, if adopted concurrently, would unleash the full potential of autonomous cars: vehicle automation, vehicle electrification, and ridesharing. By 2050, these “three revolutions in urban transportation” could:

- Reduce traffic congestion (30% fewer vehicles on the road)
- Cut transportation costs by 40% (in terms of vehicles, fuel, and infrastructure)
- Improve walkability and livability
- Free up parking lots for other uses (schools, parks, community centers)
- Reduce urban CO_2 emissions by 80% worldwide

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Potential energy and emission savings by CAVs and AVs

Potential energy and emission saving improvements through CAVs & high AV penetration rates		Potential outputs
Energy-saving driving practices (i.e. eco-driving)	→	**Energy efficient driving**
Changes in the design of vehicles, such as lighter vehicles	→	**Energy efficient vehicles**
Optimisation of the transportation system, in particular platooning, synchronised driving and optimised routing	→	**Smoother Traffic flow**
Reduced need to search for parking space	→	**Reduced energy consumption**
Reduced need for street lighting at night	→	**Energy efficient Infrastructures**

(Cavoli et al., 2017)

BENEFITS LINKED TO AVS

- AVs are expected to improve the convenience and comfort of driving by allowing drivers to engage in non-driving tasks, such as working or being entertained, and by reducing the stress of driving

- However certain studies and surveys suggest that drivers might not want to engage in non-driving tasks, in particular working, or might not be able to due to motion sickness issues. This puts into question the claims that AVs are likely to improve productivity at social levels

- Even though AVs have the potential to reduce driving stress, certain reports indicate that platooning might increase the driver's stress levels

Potential benefits and issues linked to AVs in-car experience

Potential benefits :

Improved convenience and comfort

Reduced travel stress

Ability to engage in certain non driving tasks

Potential issues:

New road safety risks

User not being able to engage in certain non-driving tasks due to issues such as motion sickness

Platooning could increase drivers' stress levels

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(Litman, 2015)

ACCESSIBILITY AND EQUITY

• **Equity**

- Some question the extent to which those with accessibility restrictions will be able to afford the use of AVs and whether the introduction of AVs could affect equity negatively
- On the one hand, some argue that the initial high price of AVs could limit the technology to the wealthy
- Others argue that in the context of shared mobility a broad range of users could benefit from the technology

FURTHER RESEARCH

Further research is needed to investigate the likely interactions between certain groups of the population, such as older people, and AVs. Similarly, possible social acceptance issues amongst these potential users need to be further studied.

- Will elderly people, disabled and non-drivers, such as underage children, have the capacity to use these vehicles? Will they want to/feel comfortable in using a vehicle without a driver? To what extent do AVs have the potential to improve the life of non-drivers, in particular the elderly and the disabled?

Further research is also needed to better understand the potential social inequity issues the uptake of AVs might generate.

- Will the uptake of AVs widen inequity? Or, on the contrary, will it improve accessibility for all through shared mobility?

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