



levitate

LEVITATE

# Policy Recommendations Brochure

Deliverable 2.7  
of the project Levitate

## List of acronyms:

Automated Urban Shuttle Service (AUSS)  
Autonomous Vehicle (AV)  
Automated Ride Sharing (ARS)  
Connected and Automated Vehicle (CAV)  
Cooperative, Connected, and Automated Mobility (CCAM)  
Dedicated Lanes (DL)  
Green Light Optimal Speed Advisory (GLOSA)  
Policy Support Tool (PST)  
Road Use Pricing (RUP)  
Vehicle Kilometres Travelled (VKT)

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# Project Partners



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Detailed references and the full source material for this brochure can be found in D 8.4 'Policy Recommendations for Connected, Cooperative, and Automated Mobility' and can be downloaded from the project website listed in the executive summary.

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## 1. Executive Summary

The primary aim of this document is to present a summary of the key findings in the Cooperative, Connected, and Automated Mobility (CCAM) field based on the research, methodology, impact assessment framework and outputs of the LEVITATE project.

LEVITATE was a European Commission supported Horizon 2020 project which ran for 42 months and ended in May 2022.

This document is based upon a comprehensive policy recommendation deliverable (D 8.4) and provides an overview of the structure of the project, key findings, relevant issues to consider in future policymaking and policy recommendations created within the project.

The main output of the project, the Policy Support Tool (PST), which can be used to guide and assess CCAM deployment scenarios and goals is also presented, and can be found at: <https://www.ccam-impacts.eu/>.

The policy recommendations are primarily aimed towards city authorities and local governments contributing to policy advancements to meet established environmental, societal and economic goals.

The complete policy recommendations can be found in D 8.4 'Policy Recommendations for Connected, Cooperative, and Automated Mobility', available on the downloads page of the LEVITATE website: <https://levitate-project.eu/>.

## 2. Background: The need for modern mobility tools

Connected, cooperative, and automated mobility (CCAM) systems are not currently in widespread use. As a result, there is a lack of data and knowledge about the impacts and interactions with the overall transport system.

Connected and Automated Vehicle (CAV) pilot projects, testing and deployment are becoming more common around the world. Scenario testing, assessing deployment impacts and gathering data towards the development of technical and

design standards is becoming increasingly important to safely implement these technologies in reaching cities' ambitious environmental, social and economic goals.

To anticipate the introduction of expanded CAV deployment and CCAM services and technologies over the next decade, there is a need to measure impacts on existing systems and forecast future scenarios.

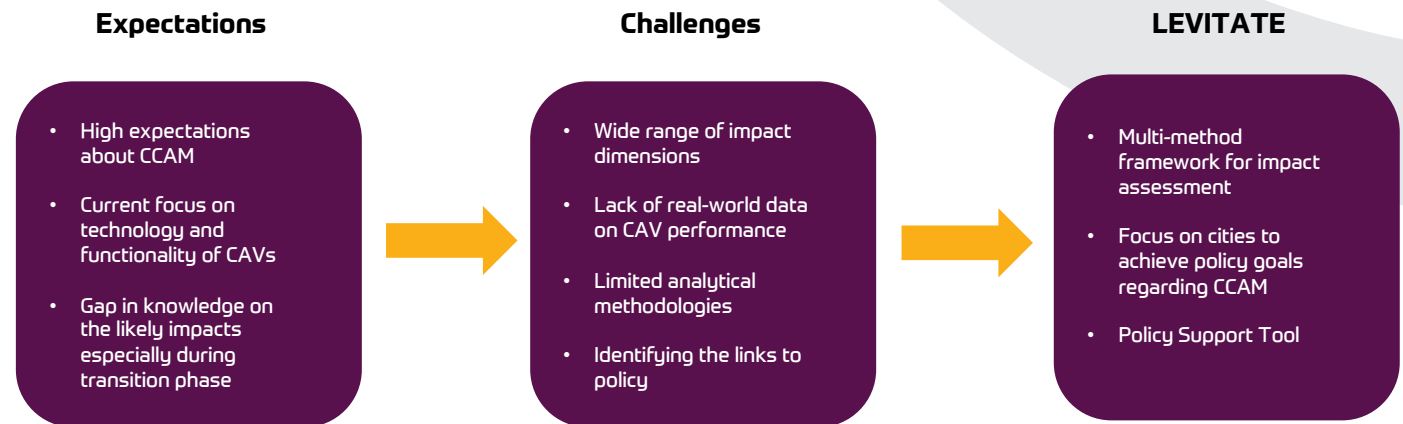


Figure 1: Motivation and scope of the LEVITATE project

### 3. What is LEVITATE?

Societal **Level** Impacts of Connected and **A**utomated Vehicles (LEVITATE) is a European Commission supported Horizon 2020 project implemented between December 2018 and May 2022. The LEVITATE project was led by Loughborough University and aimed to prepare policymakers to manage the introduction of automated transport systems and maximize their benefits. The project had four key objectives:

1. Establish a multi-disciplinary methodology to assess the short, medium, and long-term impacts of CCAM on mobility, safety, environment, society and other impact areas.
2. Develop a range of baseline conditions and forecasting and backcasting scenarios relating to the deployment of mobility technologies to serve as the basis for impact assessments. These included automated urban shuttles, passenger cars and freight services.
3. Apply the methods and forecast the impact of CCAM for a range of use cases, operational designs, environments and an extensive range of mobility indicators. A series of case studies were conducted to validate the methodologies and to demonstrate the system.
4. Incorporate the established methods and parameters into the main output of the project, an open web-based Policy Support Tool (PST), to enable users to forecast the impacts of CCAM on urban areas and apply backcasting to guide policymaking in reaching the desired objectives.



### 3.1 Impact assessment framework

To address the above objectives, a framework was developed to gather relevant data, agree upon a system to measure impacts and include a cost-benefit analysis method to calculate the benefits and limitations of various scenarios in CCAM decision making.

Methods to assess and predict the impacts of connected and automated driving were developed in the following stages:

1. Identification and classification of impacts
2. Description and measurement
3. Development of methods of backcasting and forecasting
4. Estimation of the societal impacts of many CCAM services and technologies
5. Evaluation of comparability and amenability to monetary valuation
6. Method for analysing the costs and benefits
7. Methods for generating options and scenarios to introduce policy at the city level

The layered figure on the right visualises the impacts analysed within the LEVITATE project, consolidated into categories of impact. The inner layer represents the **direct impacts**, which are changes noticed by each road user on each trip. The middle layer represents the **systemic impacts**. These are system-wide within the transport system. Finally, the outer layer displays the **wider impacts**, which occur outside of the transport system.

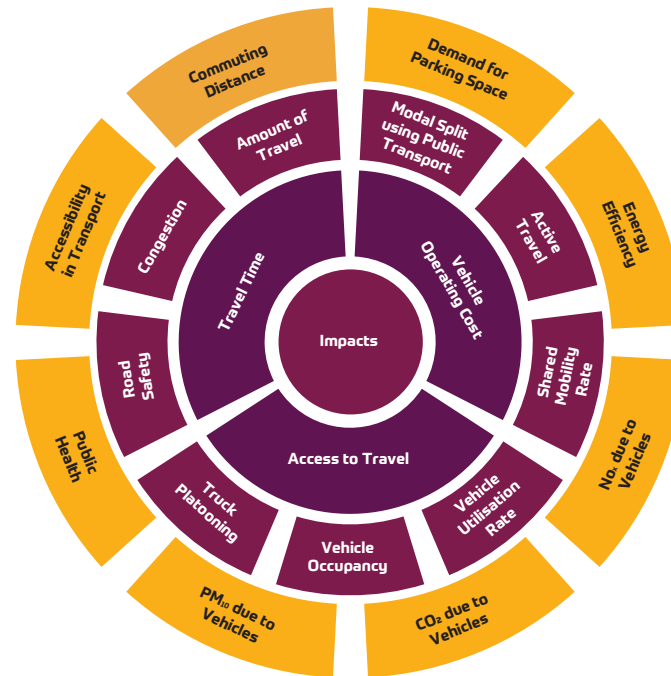


Figure 2: Impacts Dimensions of CCAM studied within LEVITATE;  
Direct (inner circle), systemic (middle circle), and Wider Impacts (outer circle)

## 3.2 Policy analysis scenarios

A range of policy interventions to support or mitigate CCAM impacts were identified through stakeholder reference group workshops, scientific literature and roadmaps.

The following policy interventions (sub-use cases) were defined for three categories of transport modes:

Passenger Transport	Urban Transport	Freight and Logistics
Road use pricing (RUP)		Automated urban delivery
Provision of dedicated lanes (DL) on urban highways		Automated consolidation
Parking price policies	Point-to-Point Automated Urban Shuttle Service (AUSS)	Hub-to-Hub automated transport
Parking space regulations	On-demand AUSS	Platooning on urban highway bridges
Automated ride sharing (ARS)		
Green light optimal speed advisory (GLOSA)		

Table 1: Policy interventions – transport categories

The LEVITATE project evolved through a wide review of available literature and stakeholder involvement in determining the most significant CCAM services, relevant impacts and use cases. This led to the establishment of LEVITATE's methodologies and scenario building (forecasting and back-casting). This created the framework to develop the Policy Support Tool and provide the project's policy recommendations.

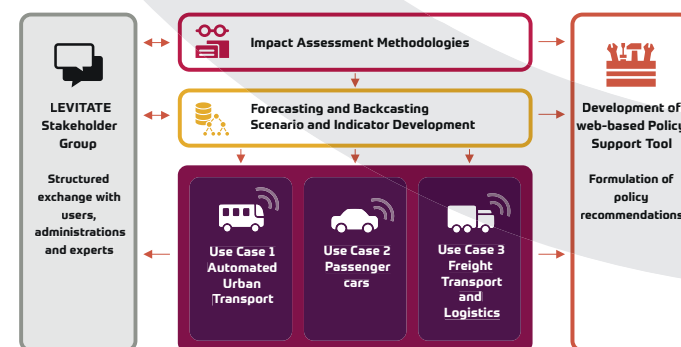


Figure 3: Overview of project components and workflow

### 3.3 Policy Support Tool (PST)

The impact assessment framework and policy interventions (use cases) were implemented into forecasting and backcasting tools to form the foundation of the primary output of the project, the LEVITATE Policy Support Tool (PST). The tool can be found at: <https://www.ccam-impacts.eu/>.

#### The PST offers:

- A forecasting tool to quantitatively estimate the impact of CCAM policies on urban spaces.
- A cost-benefit tool to enable users to analyse economic impacts.
- A backcasting tool which allows users to identify combinations of interventions to reach future policy goals.
- A knowledge library with LEVITATE's central documents, key results and policy recommendations.



FORECASTING



BACKCASTING



KNOWLEDGE

Image 1: LEVITATE Policy Support Tool (PST)

# 4. Policy recommendations

The LEVITATE project has shown the benefits of conducting detailed impact forecasts based on a broad spectrum of modelling methods. The different CCAM scenarios, potential policy options and interdependencies show a complex pattern of effects. The effects of CCAM on cities and society at large can be estimated using the project's Policy Support Tool to forecast and backcast scenarios. It is up to policy makers to define a regulatory framework supporting future goals of the respective Smart City Strategies, SUMP, climate strategies and mobility planning to avoid adverse effects.

The following policy recommendations are the result of findings from the LEVITATE project and are viewed as helpful guidelines to consider when aligning mobility strategies with CCAM implementation.

## 4.1 General policy recommendations

**CCAM policy measures should be identified with consideration of the impact dimensions.**

- Wider societal impacts of CCAM such as public health, parking space, road safety, etc. must be evaluated and included in CCAM policy discussions. LEVITATE has shown that future CCAM services and technologies may have both positive and negative societal impacts. To give an example, last-mile shuttles and automated ridesharing services could increase public transport modal splits. However, they could also reduce active travel and therefore have negative consequences on public health. Policies to sustain or improve the modal split of bike and walking should also be implemented.

**The way CCAM services and technologies are implemented can be essential for managing potential adverse impacts.**

- Cities have the capacity to manage how CCAM services will be implemented and control CAV access to the road network. LEVITATE's Policy Support Tool and impact assessment framework can help cities find suitable sets of policy interventions and guidelines to mitigate potential drawbacks of CCAM while profiting from its potentials.

**The transition phase to full fleet penetration is critical and cities must manage potential adverse impacts during that period.**

- During the transition phase, LEVITATE's findings forecast uncertain or inconsistent balances of positive and negative impacts where a mixed fleet of AVs and human-driven vehicles co-exist. Early generations of automated vehicles are anticipated to be less capable than human drivers, negatively impacting mobility indicators like travel time and congestion.
- In the early phase of CAV deployment, a low market penetration rate can be challenging in regard to improving road safety. Crash rates only reduce very gradually initially and may increase at first. However, increased penetration levels of CAVs lead to decreasing crash rates. Policy makers can influence the road safety impacts of CAVs, for example, by regulating the accessibility conditions of public roads.
- As the process evolves, positive impacts on road safety are estimated once human-driven vehicles are replaced and second-generation automated vehicles make up at least 60% of the city's vehicle fleet. Greater penetration levels of CAVs in urban areas, with the right policy interventions, are estimated to have positive impacts on the environment, society, safety, economy and mobility.

## 4.2. Specific policy recommendations

The following represents the specific policy recommendations resulting from the findings of the LEVITATE project. These should be considered as guidelines along with CCAM implementation and deployment strategies. The specific policy recommendations are arranged according to transport mode.

### 4.2.1 Policy recommendations for passenger cars

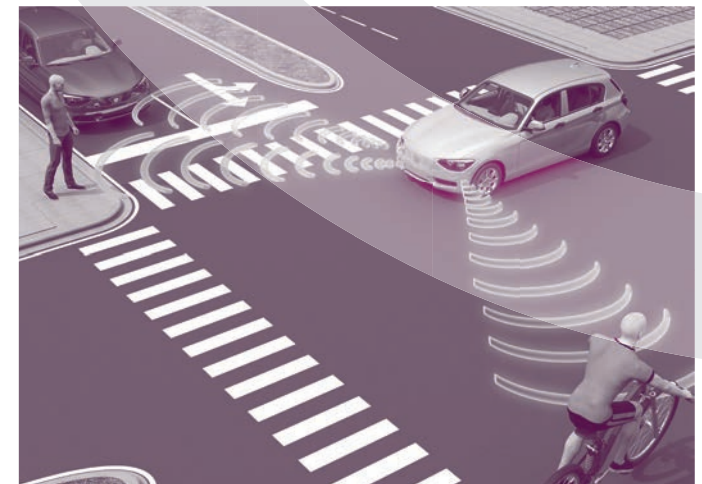
The LEVITATE project considered the impacts of road use pricing and GLOSA with passenger car models. The following presents a summary of the findings in this area from the project.

**Pricing schemes on CCAM could have positive and negative societal impacts. The use of various policies and tools, and their implementation strategies, are essential.**

- Parking pricing schemes for CCAM services can be used to optimise personal CAV parking behaviours by minimising empty drive-around or, alternately, avoiding extended parking. This could reduce congestion and travel times across the network. Depending on the implementation strategy there can be various positive implications of parking price policies, such as vehicle occupancy, vehicle operating cost, access to travel, active travel, public health, and accessibility in transport. However, the impact outcome is highly dependent on the implementation scheme.
- Road use pricing (RUP): Desired effects of RUP extend outwards from the zones of implementation in a uniform manner, declining with distance (spreading outwards). The use of pricing tools can benefit and encourage active travel and the use of public transport, which is otherwise predicted to decline with increased automation. This paves the way towards more liveable urban areas. Road use pricing is expected to improve energy efficiency, increase vehicle occupancy rates and lower parking space demand. It could also lead to increased vehicle operating costs and less equal accessibility to transport.

**Green Light Optimal Speed Advisory (GLOSA) system implementation can potentially bring mobility and environmental benefits. Implications need to be carefully assessed, especially when human-driven vehicles comprise the largest proportion of traffic.**

- GLOSA systems, tested only on automated vehicles, have been found to have positive impacts on traffic efficiency. However, for application on human-driven vehicles, various human related aspects (e.g. compliance rate, response delay) are important to consider for the potential implications.



#### 4.2.2 Policy recommendations for automated urban (public) transport

The introduction of automated urban shuttles, both point-to-point and on-demand, is estimated to lead to benefits including improved access to travel, public health and energy efficiency. The following recommendations could help tap into the benefits of automated urban transport systems.

**To govern these new systems, public authorities will need to steer the process of innovation, set up standards, guidelines and strategic agendas, cooperate with many new partners and assume new governance roles. Authorities will also need to clearly communicate with stakeholders and users to explain the new systems and avoid idealised expectations.**

**As CAVs could potentially attract more road users to shift to private automated cars, local governments should enhance the overall public transport network by providing point-to-point and on-demand automated urban shuttles. This includes providing automated urban shuttle services in regions not served by traditional public transport, usually outside the city center, or by providing automated shuttles connecting different existing public transport stations.**

**Policies for introducing shared automated mobility services should consider minimising the empty vehicle-kilometres travelled (VKT) and maximise the willingness to share.**

- LEVITATE results indicate that introducing automated ride sharing services could lead to negative impacts on mobility, such as increased congestion and travel times. However, these could be mitigated or reduced if users are willing to share trips in these vehicles.
- To tap into the positive impacts (accessibility, energy efficiency, vehicle operating costs, etc.), policies on automated ride hailing services should focus on minimising empty VKT (e.g., 'empty km pricing') of vehicles and introducing incentives to use shared vehicles.

**Automated urban shuttles will attract people who are using active modes (walking, bike). This is especially true in the suburbs, where a part of shorter trips will likely be replaced by last-mile shuttles. Public authorities should take this potential negative impact into account when implementing automated shuttles.**



#### 4.2.3 Policy recommendations for automated freight transport

Even without policy measures, automation in freight transport will likely gain popularity once the technology is mature and the operating costs become cheaper. Nevertheless, policy-makers should steer the automation of freight transport to maximize the benefits.

**Automation alone will most likely lead to an increase in freight mileage (because of smaller and cheaper freight vehicles). Corresponding policy measures in favor of freight consolidation should be considered to mitigate this trend.**

- Consolidation requires homogenous and shared data among operators, which is perhaps the most difficult challenge due to the competition between service providers and freight operators. National governments or municipalities can act as a neutral, credible party to collect and use this data.

**During the transition phase, truck platooning (consolidating multiple trucks together into a convoy through connected and automated driving systems) may increase the dynamic load on certain parts of the infrastructure. Especially critical areas such as bridges should be under consistent observation. Structural strengthening or access control should be considered.**


The LEVITATE impact assessment methods are directly applicable to future trials of CCAM services and broader societal impacts are a key consideration. The methods can be readily applied to evaluate new technologies using a common framework and extended to additional cities and regions.





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