Report on the H2020RTR conference
#H2020RTR18

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Albert Borschette Conference Center (CCAB)
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Detailed presentations of the content presented by each project
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Towards zero fatalities

ADAS&Me

*Adaptive ADAS to support incapacitated drivers Mitigate Effectively risks through tailor made HMI under automation*

The overall objective of ADAS&Me was the development of Advanced Driver Assistance Systems (ADAS) that incorporate driver/rider state, situational/environmental context and adaptive interaction to automatically transfer control between vehicle and driver/rider thus ensure safer and more efficient road usage for all vehicle types (conventional and electric car, truck, bus, motorcycle).

The current status of achievements was pointed out: the Adaptive System Architecture (ADAS&ME) is completely developed and the development of robust detection/prediction algorithms for driver/rider state monitoring is almost finished. Also, the development of multimodal adaptive HMI and personalized driver/rider behaviour profiles, considering inter-individual differences and environment context, is completed. Moreover, final evaluation scenarios and tests are planned for the second half of 2019 (based on existing EuroNCAP test protocols from non-automated driving modes).

The development of the algorithms within ADAS&Me focuses on seven use cases:

1. Attentive Long Haul Trucking
2. Long Range Attentive Touring with Motorbike
3. Rider Faint
4. Passenger Pick Up/Drop off Automation for Buses
5. Electric Vehicle Range Anxiety
6. Driver State-Based Smooth & Safe Automation Transition (Car)
7. Non-Reacting Driver Emergency Maneuver (Car)

The presentation was concluded with a summary that stated the impact of the project for different aspects:

1. safety, mobility and environment impact
2. economic and social impact
3. legal and regulatory impact

The input data for the project was gathered from pilots (equipped vehicles, simulator and questionnaires) as well as a market analysis.

AutoMate

*Automation as accepted and trustful teamMate to enhance traffic safety and efficiency*

The top-level objectives of AutoMate were the development, evaluation and demonstration of the “TeamMate Car” concept as a major enabler of highly automated vehicles. This concept consists of viewing the driver and automation as members of one team that understand and support each other in pursuing cooperatively the goal of driving safely, efficiently and comfortably from A to B.
In particular, six sub-objectives and resulting activities were defined, which include the following topics:

- smooth distribution of tasks between the driver and the automation
- monitoring and understanding the driver
- execute driving manoeuvres
- develop solutions to assess and guarantee safety of all manual and automatically generated manoeuvres at any time
- develop optimised human-machine interaction,
- develop demonstrators to test the safety, efficiency and effectiveness of TeamMate Car

For each of the objectives, necessary activities as well as enablers were defined. The overall TeamMate concept will be demonstrated at the beginning of 2019 (3 vehicles and 1 simulator).

Moreover, the expected impact of AUTOMATE was shown:

- AUTOMATE will contribute to cutting the number of road deaths by 13% by 2022
- AUTOMATE will raise the competitiveness of European Automotive companies by boosting sales of automated vehicles that are accepted and trusted by end-users
- AUTOMATE will produce breakthrough technological solutions for HMI, advice strategies and unobtrusive measurement of driver state and intention
- AUTOMATE will positively influence development cost, efficiency and traffic flow

MAVEN
Managing Automated Vehicles Enhances Network
MAVEN mainly targets technical development of ICT infrastructure based on highly automated driving in urban areas for improving traffic efficiency and road safety, as well as a roadmap for future traffic management. The ICT infrastructure will monitor, support and orchestrate vehicle and VRU movements to guide vehicles at signalised intersections and corridors. The project included sixteen use cases, which can be assigned to the following topics:

- Cluster/platoon management.
- Longitudinal/lateral management.
- Signal optimization
- Intersection/ other road users

The presentation was concluded by stating further technical developments such as cooperative adaptive traffic light optimisation with automated vehicles and cooperative environment perception algorithms.

Also, a pilot and technical workshop plan was introduced

- 3rd - 6th of June: MAVEN demo, in conjunction with European Congress on Intelligent Transport Systems, Eindhoven/Helmond
- 9th - 12th of June: Joint Workshop with TransAID, in conjunction with IEE IV’19 (Intelligent Vehicles Symposium), Paris
VI-DAS

Vision Inspired Driver Assistance Systems

Road accidents continue to be a major public safety concern. Human error is the main cause of accidents. Intelligent driver systems that can monitor the driver’s state and behaviour show promise for the collective safety. VI-DAS will progress the design of the next generation 720° connected ADAS (scene analysis, driver status). Advances in sensors, data fusion, machine learning and user feedback provide the capability to better understand the driver, vehicle and scene context, facilitating a significant step along the road toward truly semi-autonomous vehicles. On this path, VI-DAS is focused on designing a graceful transition between manual and automated modes for L3.

The major aim of VIDAS was to address hand-over and hand-back between automated and manual driving with the main performance target of reducing the lack of awareness and attention by the driver, improving the driver’s and vehicle response.

VI-DAS proposes a concept that integrates various ADAS technologies based on personalised driver models. These driver models will estimate the future expected usefulness of driving actions as a combination of risk and utility.

The VI-DAS Architecture is structured in three parts:

1) Sense: Outside and inside data will be gathered by several mediums such as cameras, GNSS or sensors (beyond 720° assessment: 360° outside – 360° inside). The raw sensor data will be merged and data will be prepared for the following steps.

2) Understand, decide and check: The data will be interpreted and a risk evaluation will be conducted.

3) Assist & Act: A response will be conducted by selecting the optimal channel (HMI).

The presentation was finalised by presenting concrete unobtrusive sensing examples in order to assess the status of the driver in terms of fatigue and distraction levels such as the approach of deep learning (IBM Watson IoT Cloud platform for driver monitoring).

Furthermore, upcoming activities were presented: Tests of use cases in available platforms (simulators and vehicles). The impact regarding different topics (technological, economic, environmental, insurance and ethical as well as safety) was also pointed out.

In the near future, use cases and platforms will be revised, modules have to be developed further. In the last step, modules have to be integrated, and the demo has to be executed.

SafetyCube

Safety coUstion, Benefits and Efficiency

The primary objective of the SafetyCube project was to develop an innovative road safety Decision Support System (DSS) that will enable policy-makers and stakeholders to select and implement the most appropriate strategies, measures and cost-effective approaches to reduce casualties among all road user types and injuries of all severities in Europe and worldwide.
The SafetyCube DSS is the first integrated road safety decision support system developed in Europe. It offers for the first time scientific evidence for risks and measures covering road users, infrastructure and vehicles. Furthermore, within the DSS, a web tool calculator was developed, which allows to investigate the economic efficiency of the measures. The system can be used to identify evidences for risks, to analyse the effectiveness of countermeasures and beyond that to set policies. Consequently, the project addresses indirectly the avoidance of collisions as well as the mitigation of collision consequences, the improvement of post-crash safety and advancement in traffic safety analysis as well as cost-benefit assessment. The SafetyCube DSS aims to be a reference for road safety in Europe. Therefore, it needs to be constantly improved, updated and enhanced also in terms of future technologies. Future tasks include the operation of the current system, the update of the risk factors, measures and cost-benefit analyses and the integration of the possibility to receive, check and incorporate studies submitted by external experts and organisations.

**PROSPECT**

*PROactive Safety for Pedestrians and CyclisTs*

The objective of PROSPECT was to significantly improve the effectiveness of active Vulnerable Road Users (VRUs) safety systems compared to those currently on the market by expanding the scope of urban scenarios addressed, improving the overall system performance of autonomous emergency braking and autonomous emergency steering systems (AEB and AES) and proposing extensive validation methodologies. The emphasis within the project is on two groups with large shares of fatalities: cyclists and pedestrians. As a starting point, a study of relevant VRU scenarios was conducted in the project, taking into account an in-depth accident analysis based on European data and naturalistic urban observation. The study revealed that important accident types are not yet covered by active safety systems. Therefore, PROSPECT prototypes addressing the well-known barriers of current AEB, as for example fuzzy path prediction and slow reaction times for the actuation, were evaluated in testing and new state-of-the-art testing tools were adapted. The test methodologies were finally proposed to Euro NCAP and ISO. As a result, three demo-cars were developed, that address up to 80% of all critical cyclist accidents defined in PROSPECT, one driving simulator was built up to reproduce the use cases and realistic pedestrian as well as cyclist dummies were developed.

In conclusion, within the PROSPECT project, accident avoidance systems were developed by combining steering and/or braking (AES and AEB). As Euro NCAP will consider the research results in its active safety roadmap and European as well as non-European OEMs have shown interest to continue the work, the project made a great step towards a standardised implementation of active collision avoidance systems in future vehicles.
InDeV

_In-Depth understanding of accident causation for Vulnerable road users_

The goal of the InDeV project was to develop an integrated methodology to study the causation of accidents with VRU, as well as make enhancements in cost calculations for these accidents.

From a methodological perspective, accident records, self-reporting, naturalistic studies, traffic conflict studies, behavioural observations and safety inspections were used in the project to provide accident data. As a major outcome it was discovered that VRU crashes are underreported in accident data. The majority of serious injuries from VRU accidents are not recorded by the police, but covered in hospital statistics only (61%). Especially single accidents are represented in the stated numbers, as 89% of those accidents are hospital recorded only. These severe injury accidents need more attention, as hospital accident data is not obligatory taken into account in the EU yet.

In conclusion, the InDeV project has shown the importance to also take hospital data on VRU accidents into account, as the majority of accidents with severe injuries are not covered in police data. It is necessary to consider these numbers, when new protection principles shall be developed to target the most severe accidents and the corresponding causes.

XCYCLE

_Advanced measures to reduce cyclists’ fatalities and increase comfort in the interaction with motorised vehicles_

The objective of XCYCLE was to significantly improve the safety of cyclists of all age groups in their potentially dangerous interaction with passenger cars and heavy goods vehicles. XCYCLE has developed systems aimed at improving the detection of cyclists, systems informing both drivers and cyclists of hazards at junctions and effective methods of presenting information in vehicles and on-site.

A traffic safety analysis was conducted, to identify the key features of cyclist crashes and to assess the relation between the severity of bicycle crashes and factors contributing to bicycle collisions with motorised vehicle. To consider also cyclists’ and motorists’ behaviour linked to near misses and crashes, a road users’ behaviour study was conducted. For the implementation of possible safety devices, the acceptance of ITS was investigated and a set of HMI recommendations was created. In conclusion, it was possible to develop in-vehicle devices (blind spot warning), on-bike devices (collision warning system) as well as infrastructure-based systems, which offer a cost-effective solution to reduce bicycle and motorised vehicle accidents in urban areas and therefore can promote more sustainable mobility.

As a future task, the constantly evolving road and traffic environment has to be taken into account (e.g. automated vehicles) and underreported dangerous traffic situations need to be addressed. Apart from that, the implementation and large deployment of the developed innovations will be another future task.
SENIORS
Safety-ENhancing Innovations for Older Road userS
The main goal of the SENIORS project was to improve the safe mobility of the elderly and persons with overweight as car occupants and external road users (pedestrians, cyclists).
In the SENIORS project, it was found that crash and hospital data from different databases underline the need of the investigation of crashes of elderly road users, as the elderly suffer more often from higher injury severities, especially in the thorax region for car occupants and on head, thorax and lower extremities for cyclists. To improve the modelling and thus the representation in crash simulation, volunteer testing (to enhance pre/near crash kinematics) as well as tests with post-mortem human subjects were conducted to generate validation data. The findings led to age-related changes of the Human Body Model (HBM) THUMS and an update of the injury risk curves as well as the injury criteria for the THOR dummy. In addition to the development of an elderly overweight dummy, the benefits of advanced restraint systems were shown using the new injury criteria.
In terms of pedestrian safety, a revised leg form impactor (FlexPLI-UBM) and a prototype thorax injury prediction tool (TIPiT) as well as new test and assessment procedures for head, thorax and lower extremities of pedestrians and cyclists were developed. The results were used for recommendations towards legislation and Euro NCAP and can be used for an improved development and for the harmonisation of safety systems to protect highly vulnerable occupants as well as pedestrians and cyclists.
Future research needs include a number of test and assessment procedures to even better address the specific needs of older road users. The performance of passive vehicle safety systems could be further raised by information from active systems.

SAFER-LC
SAFER Level Crossing (LC) by integrating and optimising road-rail infrastructure management and design
The SAFER-LC project aims at improving safety and minimising risks at level crossings by developing a set of innovative solutions and tools. As impacts of the project, a reduction of fatalities and injuries associated to LCs (30-40%) and a reduction of related costs (30-40%) are expected.
In the first period of the project, accidents at LCs are analysed and possible scenarios are derived, to identify typical factors behind LC accidents and to summarise needs and requirements for safer LCs. Subsequently, the project consortium will focus on the human cognitive processes at LCs to generate input for the design of “self-explaining” and “forgiving” infrastructure. The target related to human factors is to develop 25 innovative solutions to improve LC safety. Another focused topic is the investigation of five technical solutions, which will be developed, tested and assessed. As results, the improvement of communication between road users and rail operators, smart detection systems and predictive maintenance solutions can be expected.
Future activities of the project include the implementation and evaluation of the solutions in simulations, controlled environments and finally real-world field tests. A cost benefit analysis as well as a recommendations list and the integration of the project results in a toolbox are still to be done as the project will run until 2020.

SAFE STRIP

SAFE and green Sensor Technologies for self-explaining and forgiving Road Interactive apPlications

The SAFE STRIP project investigates a disruptive technology solution that will enable Cooperative Intelligent Transport System (C-ITS) applications through existing road infrastructure, including novel I2X and V2X communication, as well as Variable Speed Limit/Variable Message Sign (VSL/VMS) functions. The introduced system targets self-explaining and forgiving roads and will reduce operational and maintenance costs by full recyclability. As another benefit, the system will provide added value services, as e.g. real-time predictive road maintenance functions.

The SAFE STRIP project develops road strip modules with integrated micro/nano sensors and communication as well as energy harvesting functions. The low-cost strips can be integrated in the road surface and are made out of acrylic cold plastic, as this was proven the best material option by the consortium. The strip will enable communication with equipped vehicles as well as with non-equipped vehicles and provide an integrated detection system even for pedestrians. This is expected to allow for the reduction of fatal highway accidents by approximately 5% and the reduction of fatal accidents at specific traffic scenarios (merging or intersections) by about 15% - 30%. The project partners are currently implementing the system and completing HMI testing to start with the final road set-up soon.

The system developed so far can be extended in future research to other modes, further C-ITS applications and the use in other conceptual contexts (e.g. pavement integration). It can be used to enforce traffic rules and enables communication for preventive safety, both at vehicle and infrastructure level.

SAFE-10-T

SAFEty of transport infrastructure on the TEN-T network

The SAFE-10-T project develops novel tools and methodologies to support more reliable decision making regarding the management of transport infrastructure, including bridges, tunnels and earthworks, to increase safety and to maximise network capacity along the TEN-T road network. As a key technology to reach these targets, novel machine-learning applications are developed within the project.

A decision support tool is under development, which is based on a global safety network, in which not only data concerning geological factors and infrastructure assessment, but also effects of unplanned disruption of infrastructure are taken into account. The safety network will be supported by a big data platform, where the data is filtered and assigned to the specific case. The whole system will be complemented with a currently developed machine learning
application to e.g. enable automated change detection in infrastructure due to fatigue or damage. As a demo project a bridge in the port of Rotterdam is currently under assessment. The output of the project is first of all a more reliable decision-making tool for transport infrastructure management, leading to improved safety as well as network capacity, an increase in resilience and sustainable budget spending. It can also lead to reduced CO₂ emissions due to improved traffic planning and will act supportively for climate change adaption planning.

**SimuSafe**

*Simulator of behavioural aspects for Safer transport*

SimuSafe develops road user behaviour models based on data collection. The road user models will be used in effective multi-user and multi-agent road user simulations. Finally, the results can be used to develop new standards, safety devices and novel training modules. Currently, the project is in the first of three phases. To develop the road user models, naturalistic road tests are under evaluation and simulator tests are in the preparatory phase. So far, initial versions of four models and simulators (car, powered two-wheeler (PTW), bicycle and pedestrian) are developed, but still need further optimisation iterations. The expected future impact of the project is to use simulators as a more valid tool for road safety studies. The results can be used for standardisation in road safety as well as for the development of new safety devices. To raise the awareness of road users concerning unsafe behaviour, simulators can be used e.g. in driving schools, as well. The developed simulators will need a constant further improvement when it comes to the implementation of future traffic scenarios. The main expected impact of the project is safer behaviour of road users, even though concrete numbers regarding the reduction of road fatalities cannot be stated yet, as the project is just running since one and a half year.

**MeBeSafe**

*Measures for Behaving Safely in traffic*

The MeBeSafe project focuses on human factors in transport and tackles human errors as one of the main causes for accidents. The project will implement nudging measures for road infrastructure (e.g. adaptive in-road displays), in-vehicle advanced driver assistance systems and remote applications, like coaching. To cover the in-vehicle nudging solution, a driver alert (offer to take a break) is developed, which is currently prepared for a real-time application in a vehicle fleet. As an example, for an infrastructural solution, a system was developed to reduce drivers’ speeds by light signals. The system’s viability has been proven in experimental simulator tests, and the system will be applied on a public road near Eindhoven in March 2019.

Future activities include the field evaluation of the developed systems, where the impact of the systems will be proven. The main target is the avoidance of risky situations to appear, which leads to reduced accidents and therefore a reduced number of fatalities and severe injuries in road traffic.
InterACT

*Designing cooperative InterACTion of automated vehicles with other road users in mixed traffic environments*

The InterAct project designs the cooperative interaction of automated vehicles with other traffic participants in mixed traffic environments and therefore will improve not only the acceptance of automated vehicles (AVs), but also make a first approach on future pedestrian safety.

Based on psychological models and intention recognition as well as behavioural predictions, new systems were developed (external HMI) to enable interaction of vehicles and other road users. The software components to successfully integrate and enable the novel interaction systems are still under development. A next step in the still running project will be to integrate a methodology for assessing the quality of interaction.

The major impact of the project will be improved user acceptance of AVs. It can also have a broad impact on behaviour in traffic, which can lead to improved traffic safety and better traffic flow. To implement highly automated vehicles in the current traffic environment, the results can also be used for validation procedures and therefore lead to a safer implementation of the new technologies.

TrustVehicle

*Improved Trustworthiness and weather independence of conditional automated Vehicles in mixed traffic scenarios*

TrustVehicle aims at advancing level three automated driving functions in normal operation and in critical situations (active safety) in mixed traffic scenarios and even under harsh environmental conditions. The project follows a user-centric approach and will provide solutions that will significantly increase reliability and trustworthiness of automated vehicles hence, contribute to end-user acceptance.

As starting base of the project, critical scenarios were systematically identified. In these investigations, young male drivers as well as elderly pedestrians were found to be the main target groups in suburban and urban areas. Four critical use cases were defined in which automated driving functions need to be investigated comprehensively by simulations, validation and finally testing. Currently, the project is conducting a driver simulator study in different scenarios. For the second half of the project duration, the development of an assessment algorithm based on measurements from the driving simulator study, a second simulator study and the finalisation of the developed HMI concepts is planned. The final step to come in the end of the project will be the build-up of demonstrator vehicles for real-world testing.

As the project is just half way through, the main results will be achieved in the upcoming project periods. Nevertheless, so far, a catalogue of safety-critical scenarios as well as assessment criteria for current automated driving functions were created. The expected impact of the project includes the reduction of accidents caused by human errors by improving current automated driving functions and the prediction of failures and safety critical...
situations. Another main outcome of the project is interdisciplinary knowledge building, combining technology and psychology and highlighting gender issues in disaggregated data collection and analysis.

**BRAVE**

*BRidging gaps for the adoption of Automated VEHicles*

The main objective of the BRAVE project is to improve the safety and market adoption of automated vehicles by raising acceptance not only by immediate users, but by all road users and relevant stakeholders.

To reach the objectives, a multidisciplinary approach is followed in the project, studying requirements and expectations of drivers and other stakeholders regarding the use of automated vehicles. The approach includes both on-road testing as well as studies in controlled and simulated environments, using virtual reality and dynamic simulators. From the conducted studies, conclusions regarding HMI concepts were derived. Additionally, young adult views on automated driving systems were studied, as these were identified as a focus group. From the generated research results, novel ideas of HMI were generated, which are currently still in a concept stage though.

Further project steps include continued dynamic driving simulator and test track testing. A survey on user and stakeholder acceptance will be done and HMI concepts developed as well as integrated. The project will increase the trust as well as acceptance of AVs using improved HMI concepts and information on user views.
Improving quality of life in urban areas

**EBSF_2**

*European Bus System of the Future 2*

The EBSF_2 project focused on six research areas to enhance the efficiency and reliability of urban bus transport. Among these six areas, the Project’s demonstrators (12) have successfully tested innovations for energy-efficient on-board auxiliaries, predictive maintenance, IT standard protocols for interoperability of fleet management systems.

<table>
<thead>
<tr>
<th>Project contribution</th>
<th>ERTRAC - Urban Mobility Roadmap</th>
</tr>
</thead>
<tbody>
<tr>
<td>The EBSF_2 solutions are key to support the deployment of e-mobility in European cities (series buses, retrofitting programs)</td>
<td>Clean fuels and vehicles</td>
</tr>
<tr>
<td>Energy efficient solutions for e-buses are under optimization to be implemented in series buses (VOLVO, IRIZAR, EVOBUS…)</td>
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</tr>
<tr>
<td>eBUS Design Charter promotes the adoption of new design ambitions for future tenders</td>
<td>Integrating urban mobility within overall European transport chains</td>
</tr>
<tr>
<td>Modular architecture approach based on standards (TS13149, SIRI) and ITXPT specifications</td>
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</table>
| Standardised IT architecture paves the way for:  
  - full interoperability of IT systems in a multi-supplier environment  
  - co-existence with IT systems already installed | |
Several PTO and PTA publish tenders requiring compliance with ITxPT specifications.

A certification process (label) for IT modules

**ELIPTIC**

*Electrification of public transport in cities*

The ELIPTIC project deals with electrification of public transport in cities, a hot topic in all European cities. A municipality, City of Bremen, a rare case in transport research projects, coordinated the project. There are not only the technical research results of the research but as well the political campaign “factor 100” that will give the ELIPTIC project special and long-lasting impacts. The project probably is the only transport research project that has a beer coaster as deliverable!

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**Project contribution**

<table>
<thead>
<tr>
<th>ERTRAN - Urban Mobility Roadmap</th>
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<tbody>
<tr>
<td>Safe integration into existing electric PT infrastructure</td>
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<tr>
<td>Energy efficient electric Public Transport systems</td>
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<tr>
<td>Multi-purpose use of electric PT infrastructure</td>
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</table>
CIPTEC

Collective Innovation for Public Transport in European Cities

The CIPTEC project focused on the overall objective of making public transport more attractive, as a mean to reduce congestion and relevant impacts. The project performed a market and customer trend analysis, mapped an evaluated based on existing innovation and services, co-creation of new innovative solutions for public transport. Main results from the project is the TOOLBOX, strategy plan and policy recommendations for public transport operators and authorities.

Utilising collective innovation activities (co-creation and crowdsourcing) for making Public Transport more attractive. In brief according to the pictogram below:

<table>
<thead>
<tr>
<th>Project contribution</th>
<th>ERTRAC - Urban Mobility Roadmap</th>
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<tbody>
<tr>
<td>• Market and societal trends influencing PT</td>
<td>Integrating urban mobility within overall European transport chains</td>
</tr>
<tr>
<td>• Identification of existing innovations &amp; ranking</td>
<td></td>
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<tr>
<td>• Utilisation of Collective Intelligence (co-creation / crowdsourcing)</td>
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<tr>
<td>• Advanced Marketing Research</td>
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<tr>
<td>• Social Entrepreneurs involvement</td>
<td></td>
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<tr>
<td>• CIPTEC Toolbox</td>
<td></td>
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<tr>
<td>• Policy Suggestions</td>
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</table>
SKILLFUL

Skills and competences development of future transportation professionals at all levels

The project addressed the job change in the transport sector to prepare education and competence development challenges;

• Need for continuous education, training and qualification.
• The economic downturn has had a huge impact on job development.
• The industrial production dropped back to the levels of the 1990s.
• This is the need for EU countries for change, development and evolution.

The presentation gave an overview of the foresight activities undertaken in term of skills and competences needed in the coming years in the transport sector. The presentation showed the new curricula to be established in order to get the right skills and competences in due time. The presentation highlighted finally the pilots for new curricula to form European masters in transport in the coming years.

The SKILLFUL project contributes to this need by designing appropriate training /education modules for key actors in the transport sector, in order to fulfil their emerging and foresighted required competences and skills.

The project resulted in the development of the following training schemes;

• Transport infrastructure operators’ training schemes (7 courses).
• Young scientists’ seminars (1 course).
• Lifelong training schemes for low to middle-skilled segments of transport professionals (10 courses).
• Interdisciplinary thematic courses on key technologies, services and trends (10 courses).
• Towards a pan-European Transport

TRACE

Opening the cycling and walking tracking potential

TRACE looked at movement tracking services to better plan and promote walking and cycling in cities, and developed tracking tools that fuelled the take-up of walking and cycling measures.

The project targeted established measures to promote cycling and walking to the workplace, to school, for shopping purposes or simply for leisure. More particularly, TRACE assessed the potential of ICT-based tracking services to optimise the planning and implementation of such measures and enhance their attractiveness and potential impact. Issues such as data privacy, cost, interoperability, financial/tax incentives, infrastructure planning and service concepts were also addressed. The tools were tested in eight pilot sites: Breda (NL), Agueda (PT), Southend on Sea Borough (UK), Bologna (IT), Esch (LU), Belgrade (RS), Plovdiv (BG) and Belgium, and evaluated in terms of impacts, success factors and benefits, while preparing for their full commercial exploitation.

The evaluation of the project shows that the pilots’ implementations were successful (high numbers participated to the campaigns, with good results). There are clear indications that
tracking can affect mobility behaviour. The collected data helped municipalities and practitioners to plan better for active travel modes. The campaigns benefited from small incentives, and budget should be foreseen in future campaigns supported by tracking to cover this. Some technical bugs appeared.

The collected data are of high value to the stakeholders and can be used to facilitate the communication between schools/companies and the city about sustainable mobility needs. Within TRACE, most campaigns provided in-depth, interactive information on the walking routes which were previously done by hand (routes drawn by the parents on paper maps). Information on the modality split was also acquired and contributed to the overall mobility patterns in the city. Many stakeholders are looking for data and citizens are prepared to use tracking apps if they believe that they will get better cycling and walking infrastructure in return. Local authorities should continue using tracking tools for these purposes. The TRACE project integrated successfully campaigns with tracking tools.

The project recommended that joint actions are needed to promote walking and cycling, as well as improved and increased data collection for walking and cycling. This data can be incorporated in the data collection and analysis in the SUMP.

The TRACE project relates to several Integrated Urban Mobility Roadmap elements:

- Decarbonisation/New assessment methods to evaluate the impacts of innovative policy measures on decarbonisation and pollutant emissions
- City dynamics/Promote ‘active’ and safe mobility
- Active and light travel modes/Needs assessment with regards to active and light travel modes across target groups – understanding modal choice behaviour
- Active and light travel modes/Integrating (safety aspects) of active and light travel modes in SUMPs

**FLOW**

*Furthering Less Congestion by creating Opportunities for more Walking and cycling*

FLOW has developed tools to put walking and cycling on an equal footing with motorised modes from a transport planning perspective by developing a user-friendly methodology, involving traffic modelling, to assess the effectiveness of walking and cycling measures in addressing urban road congestion. The project has enhanced the theoretical link between non-motorised transport measures and their effect on congestion.

FLOW has calibrated, customised and tested its tools in five FLOW cities (Budapest, Dublin, Gdynia, Lisbon, Munich). The project developed a portfolio of measures supporting the take-up of walking and cycling measures that reduce congestion and improve urban mobility.

The first tool, the FLOW multimodal transport analysis calculation methods were developed to improve the ability of existing analysis techniques to assess the transport benefits and impacts of walking and cycling measures. While existing techniques are generally acceptable for evaluating the transport impacts of walking and cycling measures, they only provide mode-specific results. This makes it difficult to compare the potential impact of measures for different modes (e.g. whether it is better to add a bike lane or a car lane in a given situation).
The second tool, the FLOW Impact Assessment Tool was developed to ensure that transport decision making considers more than just transport system performance (i.e. congestion levels). The tool specifically considers the environmental, societal and economic benefits and impacts of a proposed transport improvement measure – in addition to mobility benefits and impacts.

The FLOW Impact Assessment Tool is a spreadsheet-based tool that can be used to evaluate the benefits and impacts of a proposed transport measure by comparing data from before and after implementation. Users enter data from transport models and economic, societal and environmental projections, and the spreadsheet calculates the benefits and impacts of the proposed measure (e.g., construction of a new cycle lane). The spreadsheet uses factors based on country-specific and EU-wide default values that can be modified by users as necessary and appropriate to account for local conditions.

Despite impressive technical improvements of models over the decades, their theoretical basis and algorithms do not fully consider walking and cycling because they inherited the assumptions of a time when technical limitations were much more restrictive and when political objectives favoured car-centric planning. FLOW contributed to improvements in modelling in two ways:

- **Macroscopic modelling** – Path-level attributes in stochastic assignment of bicycles, a modelling platform for combining two legs of a journey using different transport modes (here, shared bikes and public transport) and an enhanced representation of mobility sharing in public transport assignment

- **Microscopic modelling** – Enhanced modelling of conflict zones between cars and pedestrians, behaviour parameters, new mobility patterns, the interaction between bikes and pedestrians and shared space.

**Cities-4-People**

*New approaches for community-driven sustainable mobility innovations at neighbourhood and urban district level*

Cities-4-People presented their approach revolving around sustainable and people-oriented transport as a solution to the many challenges linked to mobility and faced by urban and peri-urban areas today. Aiming to implement mobility solutions developed by the people for the people, Cities-4-People taps into participatory practices of social innovation and neighbourhood governance and builds on three main pillars: citizens’ participation, community empowerment, and sustainable urban planning.

Cities-4-People unfolds in five European areas: the Oxfordshire County, Hamburg District of Altona, Üsküdar in Istanbul, Budapest and Trikala. In these areas, Mobility Communities are set up involving citizens, city authorities, mobility providers and innovation experts. By developing and providing a framework of support services and tools, Cities-4-People empowers these communities to actively contribute to shaping their local mobility innovation ecosystems in line with a People-Oriented Transport and Mobility (POTM) approach.
POTM encompasses a blend of new digital and social technologies under an inclusive and multidisciplinary approach in order to bring out solutions that have a low ecological footprint, a sharing mentality and the potential to solve real urban and peri-urban mobility issues.

**Metamorphosis**

*Transformation of neighbourhoods in a child-friendly way to increase the quality of life for all citizens.*

Metamorphosis transforms neighbourhoods into more liveable and shared spaces. The project starts from the premise that when a neighbourhood has many children in its public spaces (Gehl, 2013), this is a major indicator that it is well designed as a people-oriented and sustainable neighbourhood.

This approach is tested in seven European Partner cities, i.e., Alba Iulia (RO), Graz (AT), Meran (IT), Munich (DE), Southampton (UK), Tilburg (NL), and Zurich (CH). The project applies an innovative and participatory approach, which encompasses the direct involvement of children as crucial players in each phase of the project – from planning through implementation, evaluation, and dissemination.

During each phase of Metamorphosis children’s perspectives, suggestions, and ideas are highly valued as essential contribution to create more children-friendly cities. Several tactical urbanism examples have been implemented so far.

**MUV**

*Mobility Urban Values*

The project leverages behavioural change in local communities using an innovative approach to improve urban mobility: changing citizens’ habits through a game that mixes digital and physical experiences.

Rather than focus on costly and rapidly ageing urban infrastructures, MUV promotes a shift towards more sustainable and healthy mobility choices by engaging in a positive way local communities, local businesses, policymakers and Open Data enthusiasts. MUV solutions are tested in 5 diverse urban neighbourhoods spread across Europe: Amsterdam (NL), Barcelona (ES), Fundao (PT), Ghent (BE), Helsinki (FI), Palermo (IT).

Mobility and environmental data gathered via the mobile app and the monitoring stations will allow policy makers to enhance planning processes and civic hackers to build new services able to improve cities’ quality of life in a more effective way.

The three neighbourhood projects relate to the following research topics mentioned in the UM research roadmap:

- City dynamics/Understanding people's needs and expectations
- City dynamics/Exploring the potential role of neighbourhood-based solutions and services
- Land use and transport interactions – neighbourhood level
EMPOWER
EMPOWERING a reduction in use of conventionally fueled vehicles using Positive Policy Measures

EMPOWER has developed an app that rewards change. The project researches how positive incentives can encourage citizens to reconsider their travel choices and reduce the extent to which they travel using conventionally fuelled vehicles. Rewarding change also means rewarding a shift to travelling in off-peak hours, car sharing, and schemes to help people avoid travelling altogether.

There is already evidence that the use of a range of incentives can have a strong influence on travel choices. For incentives to be effective, past research has also shown that incentives should be personalised. This implies they should be tailored towards the preferences, personal goals and needs for each person at a specific time. The personalisation of incentives is also needed in order to address the needs of specific vulnerable groups of travellers. Smart devices (phones and tablets) will allow two-way information flow between the travelling public and transport authorities or providers, including the ability to offer tailored incentives relevant to the individual’s travel patterns.

For this type of scheme to be successful, it is important to consider who governs the different types of data, the sustainable provision of incentives and new collaborations between transport authorities, transport suppliers and third parties. As a result, the project is also researching viable business models and how best to evaluate the success of such schemes.

The EMPOWER project relates to several Integrated Urban Mobility Roadmap elements:

- Decarbonisation/New assessment methods to evaluate the impacts of innovative policy measures on decarbonisation and pollutant emissions
- City dynamics/Promote ‘active’ and safe mobility
- Active and light travel modes/Needs assessment with regards to active and light travel modes across target groups – understanding modal choice behaviour
- Active and light travel modes/Integrating (safety aspects) of active and light travel modes in SUMPs

SUITS
Supporting Urban Integrated Transport Systems: Transferable tools for authorities

SUITS aims at substantially increasing the capacity of small and medium-sized local authorities to develop and implement transport strategies and systems, policies, technologies, practices, procedures, tools and measures that are sustainable, inclusive, integrated and accessible. These will recognise the end-to-end travel experiences of all users and freight.

There is a gap between the needs and demands of the cities that should develop and implement SUMP and higher administrative institutions that should prepare the ground and provide (national) support programmes to encourage cities to develop and implement SUMP.
SUMPs-Up
*European Programme for Accelerating the Take up of Sustainable Urban Mobility Plans*
SUMP{s}-{U}p brings together eight partner organisations and seven partner cities, all of whom are seeking to help European cities to introduce cleaner and more sustainable mobility. The project assists planning authorities to overcome the barriers that prevent or make it difficult to implement SUMP{s}: capacity building, tailored information, and support during development and implementation phases will equip them with the necessary knowledge and skills to do so. Planning authorities and their staff will be involved in all stages of the project, with the focus on countries and areas where SUMP take-up is particularly low.

Prosperity
*Prosperity through innovation and promotion of Sustainable Urban Mobility Plans*
PROSPERITY closes this gap by facilitating a unique approach of involvement and activation. The three projects cooperate well and have developed common tools and processes. The three projects relate to the following research topics in the UM roadmap:
- SUMP{s}/Study on how to properly incorporate freight and electromobility into SUMP{s}
- SUMP{s}/Consolidation of knowledge based on the performance of existing tools
- SUMP{s}/Promote best practice exchange including sharing economy mobility
- SUMP{s}/Appraisal, monitoring and evaluation approaches, including simulation tools that provide scientific evidence RTD 2030
- SUMP{s}/Innovative tools for stakeholder interaction, strengthening the user perspective

CIVITAS living laboratories
CIVITAS ECCENTRIC
*Innovative solutions for sustainable mobility of people in suburban city districts and emission free freight logistics in urban centres.*
ECCENTRIC focuses on sustainable mobility in suburban districts and innovative urban freight logistics, two important areas that have previously received less attention in urban mobility policies.

PORTIS
*PORT-Cities: Integrating Sustainability*
CIVITAS PORTIS will test innovative and sustainable urban mobility solutions in five European port cities. It will improve governance for an enhanced cooperation between cities and ports, create more sustainable and healthier city-port environments, shape more integrated transport infrastructure and mobility systems and improve the efficiency of urban freight transport.
DESTINATIONS

Integrated & innovative approaches to address sustainable mobility and green tourism in 6 touristic European islands

CIVITAS DESTINATIONS builds up an integrated approach to address mobility and tourism, testing balanced strategies to face the rising challenges of these two growing sectors and to achieve sustainable development and a better quality of life in Funchal, Limassol, Rethymno, Elba, Las Palmas de Gran Canaria and Valletta. The project help island cities to cope with new tourism trends and adapt their mobility systems accordingly, sharing mobility solutions for citizens & tourists alike, switching to less polluting transport modes, and the development of business models to guarantee the financial viability and lasting impacts of the measures.

All projects develop activities in 8 areas (so-called CIVITAS Thematic Areas):

- collective passenger transport
- demand management strategies
- mobility management and travel awareness
- safety and security
- urban freight logistics
- information systems and services
- clean fuels and low emission vehicles
- car independent lifestyles.

They are also involving local politicians in their activities.
Green Vehicles

IMPERIUM
IMplemenTation of Powertrain Control for Economic and Clean Real driving emission and fuel ConsUmpption

The overall objective of IMPERIUM is to achieve fuel consumption reduction of trucks of up to 20% (diesel and urea) compared to 2014 whilst keeping the vehicle within the legal limits for pollutant emissions by combination of new and partners background R&T.

To reach these targets a velocity optimiser with predictive cruise control, a predictive energy management system as well as eHorizon approaches are considered. Among others the interaction between relevant subsystems of a powertrain is considered selecting the best combination of the respective individual subsystem strategies to improve fuel consumption and to reduce emissions. Preliminary results already showed that the fuel consumption can be reduced by 7% only with a complete powertrain control and a predictive, integrated online energy management. Besides, predictive transmission control is considered to optimise gear shifts for upcoming routes using the eHorizon which further reduces the fuel consumption. Another important aspect of the project is the model-based validation of all considered technologies. Within the project a simulation platform for validation has been set-up allowing traffic micro-simulation and vehicle modelling in co-simulation as well as having an eHorizon reconstructor. This simulation platform uses traffic scenarios based on real life data and measured ambient condition. Which such a platform the impact of technologies on fuel consumption and emissions can be assessed fast and efficient.

optiTruck
optimal fuel consumption with Predictive PowerTrain control and calibration for intelligent Truck

The objectives of optiTruck are on combining advanced technologies from powertrain control and intelligent transport systems in order to achieve a global optimum for fuel consumption with at least 20% reduction. The concept and approach foresee the utilisation of cloud-based data for ITS and mission planning, on-board optimisation of powertrain control as well as eco driving training and eHorizon approaches.

The project has defined 10 innovation elements ranging from optimisation of powertrain control and calibration according to real world driving conditions over predictive management and control of auxiliary systems to driver support information systems. Each of the ten innovation elements reduces fuel consumption from 1 – 5%. Within this context OptiTruck is focusing to developed a truck demonstrator to carry out real-environment trials to demonstrate that a fuel reduction of minimum 20% is feasible with the proposed innovation elements. Besides, a cloud computing system architecture has been developed collecting and integrating the different data sources needed for run the truck always in its optimum. Currently real-environment trials are being prepared considering a national route within Turkey and an international route from Turkey via Greece to Italy. For the optiTruck
consortium, the involvement of all relevant stakeholders is important which was realised through webinars and dedicated sessions and ITS congresses. Besides, stakeholders can get involved through questionnaires published on the project website.

ALLIANCE
Affordable Lightweight Automobiles AlliaNCE
The ALLIANCE project, in which 6 OEMs are involved, is aiming at a weight reduction of 20-30% and a 6% reduction in GWP while the additional costs are limited to 3 €/kg saved. To achieve this, ALLIANCE is developing advanced steel and aluminium grades, associated manufacturing and joining technologies to realise multi-material designs as well as supporting design tools for life-cycle assessment, mass optimisation and multi-parameter design optimisation. The developed solutions will be applied in seven physical and virtual demonstrators on part level and their impact on GWP and overall weight reduction assessed virtually on full vehicle level. Currently novel 6xxx and 7xxx aluminium grades are available with excellent formability and weldability. As example, a special grade was developed qualified for remote laser welding, decreasing the process time from 11s down to 2s. Besides, the extended target weighing approach was introduced allowing the consider costs and life-cycle impact already in the concept phase. In this context, novel models for LCA and LCC have been developed currently being applied for the evaluation of the developed lightweight concepts.

In order to enlarge the pool of innovative solutions an Open Innovation Lightweight Challenge has been conducted and the winning solutions incorporated into the project. Overall the targeted weight reduction on full vehicle level will be achieved while the reduction in GWP is higher than expected. A challenge will be meeting the costs targets which are currently under investigation. But with taking into account secondary effects, the cost targets are feasible. Furthermore, advanced materials with much better performance are ready for upscale and advanced support tools have been developed accelerating the design and evaluation process.

eCAIMAN
Electrolyte, Cathode and Anode Improvements for Market-near Next-generation Lithium Ion Batteries
The overall objective of eCAIMAN was to develop a high volt Lithium-ion battery cell that can be produced in Europe aiming at an energy density of up to 270 Wh/kg and costs of 200 €/kWh. This should be achieved by investigating the potential of 5V high-voltage spinel cathode material (Cobalt free) together with a high-capacity composite anode material and a stable high-voltage electrolyte. The cells should feature properties allowing the integration in light, passenger, and heavy-duty vehicles.

The development of the Cobalt-free active materials for cathode (doped/coated LNMOs), anode (advanced graphite) and three new generations of electrolyte (eCAIMAN1 on LiPF6 basis upscaled for industrial cell level) along with the cell engineering to integrate these new materials were presented leading to three generations of pouch cells (Gen1-3) with a
maximum specific energy density of 123 Wh/kg of the Gen3 cell. In this context, a large number of active and inactive material combinations and process/engineering parameters has been evaluated for the engineering of the full cells. Causes of swelling for baseline cells have been investigated. These investigations were supported by modelling and simulations of the materials interactions. Finally, concepts were presented how to integrate the Gen2 cells in air-(2-wheeler-applications) or water-cooled modules (light and heavy-duty applications) with 24 cells providing an energy capacity of 0.9 kWh per module.

The presentation was concluded with an impact assessment stating that even if the energy density targets could not be reached yet, valuable results regarding Cobalt-free cathodes were achieved on which research should continue. However, material suppliers for these new cathode materials are not yet available. Further research on tin dioxide materials was proposed as an alternative to advanced graphite anodes.

**SPICY**

*Silicon and polyanionic chemistries and architectures of Li-ion cell for high energy battery*

The objectives of SPICY were the development of silicon and polyanionic chemistries and architectures for Li-ion cell of higher energy densities (+ 20%) along with a reduction of battery pack and system cost by 20%.

Various Cobalt free LFMP (lithium-iron-manganese-phosphate) material materials have been synthesised and high voltage electrolytes based on sulfolane (SL) and adiponitrile (AND) have been tested. Full graphite/NMC Li-ion cells have been operated at 4.5V with good performance.

Based on the optimised material combination, soft and hard prismatic as well as hard cylindrical cells were assembled by different project partners and their performance compared in ageing tests. The tests included also overcharging to check the cell performance under critical operating conditions as well investigation of the cell behaviour during a thermal runaway. It was concluded that hard cell housings show preferable performance over the soft cell types.

A final comparison of the KPIs of the 3 generation of cells developed indicated that last generation of cells Gen-3 including improved silicon-based anodes reached specific power densities of approximately 160 Wh/kg along with a cost reduction potential of 19% (vs. 20% target). These cells, however, did not meet the cycle stability requirements. The earlier cell generation Gen-1 met the targets of power density and almost of the cycle stability (3000 cycles vs. a target value of 3500) but hardly provide any cost reduction potential.

The presentation concluded with a summary stating that 3 different sub-models at electrode level, current collector level and cell level were also developed in the course of the project enabling the simulation of the cell behaviour at higher C-rates which is essential to identify and define future optimum cell designs such as electrode loadings & porosities.
FiveVB

Five Volt Lithium Ion Batteries with Silicon Anodes produced for Next Generation Electric Vehicles

The objectives of the FiveVB project were the development of an improved cell technology at industrial format cell with +28% gain in energy density and reduction of cost reduction by 20%, a stability of 2000 cycles, the assessment of the manufacturing and industrialisation potential of the new technology and a feasibility study for a standardised hard prismatic cell (PHEV1) up to system level. Further a standardisation of test procedures was investigated and elaborated in close co-operation with the eCAIMAN and SPICY project.

Three generations with new cell technologies based on innovative materials such as high capacity anodes, high voltage cathodes and stable, safe and environmentally friendly electrolytes were developed and investigated with prototype pouch cells. The 3rd generation of cells featured a specific power density > 200 Wh/kg. However, the cycle stability target was not reached with this cell type.

For the upsaling of the cell technology, it was switched to the development of hard case prismatic cells (PHEV1 cell) following automotive requirements and produced on a representative prototype facility. The respective scale-up of anode, cathode, and electrolyte was performed successfully. Due to constraints during this scale-up a non-prelithiated anode material is included in the PHEV1 cell. During the manufacturing process, the impact of swelling (variation of cell thickness upon charging / discharging) turns out to be one of the main driving factors that needs to be understood for future advanced Li-ion cell manufacturing. For increasing the knowledge and for enhancing future development efforts, a set of experimental and simulation methodologies was established. The cycle life of the new cell technology was below the target of 2000 cycles. However, there is no fundamental technological obstacle for increasing this cycle life further via subsequent development steps.

A final assessment of the cell technology developed showed that 180 Wh/kg specific energy density on cell level and 150 Wh/kg on module level are feasible. A module design was presented with 12 cells and an energy content of approximately 2 kWh. A cost reduction of 20% is feasible mainly due to the energy density increase. An introduction of batteries based on the cells developed is expected after five years.

JOSPEL

Low energy passenger comfort systems based on the joule and peltier effects.

The JOSPEL project investigated technologies for the range increase of EV by improving the efficiency of the battery as well as improving the efficiency of the vehicle by reducing the energy consumption. Particular targets were the reduction of at least 50% the energy used for passenger comfort (<1.250 W) and at least 30% for component cooling in extreme conditions relative to electric vehicles currently on the market.

Technologies for reduction of the energy consumption were investigated such as a heating system based on Joule Effect (-30%), a cooling system based on Peltier cells (-25%), a battery system with optimised thermal management (-12%), a thermal management of other EV
components and eco-driving technologies (- 12%) as well as a weight reduction and better insulation of the cabin (- 3%). The project works covered the investigation of a Joule-effect heating system with thermoplastic heating panels on doors and below the seats; a Peltier-effect cooling system for the roof, a dashboard pod and a glovebox cooler; improved insulation and new glazing; the improvement of the battery life due to better thermal battery management with liquid cooling and finally the introduction eco-driving strategies via a dedicated ICT platform with cloud connection.

In particular, the heating system based on Joule effect created a radiant heating in the vehicle cabin which - combined with fresh air fans for air renewal - results in an improvement of the passenger thermal comfort sensation. Thermoplastic panels and thermoset textiles were developed as heating elements, thereby reducing the energy consumption with at least 30 % compared to existing PTC heaters. Climatic chamber tests carried out to simulate extreme climate conditions in the car, thermal comfort was evaluated with sensors and real passengers.

Thanks to optimised thermal management of the battery and other vehicle components, and by adding eco-driving technologies, the project has achieved further energy reductions of 24 %. Last but not least, lightweight technologies and improved cabin insulation using new glazing designs shave an additional 3 % off the energy consumption. Moreover, the life of the electric vehicle battery was extended by 15% thanks to its improved thermal management.

In conclusion, it was stated that at the end of the project energy savings of more than 57% for heating and cooling systems combined with optimised thermal management, eco-driving technologies, weight reduction and improved cabin insulation were achieved.

OSEM-EV

*Optimised and Systematic Energy Management in Electric Vehicles*

The OSEM-EV project has investigated an entirely new concept of heat management for electric cars. The advances should enable a new generation of EVs with a greater and more predictable driving range by achieving temperature resilience, thus, considerably boosting the confidence in ELVs. The improved mileages and predictable ranges should be achieved without adding further cost and weight.

The OSEM-EV project investigated improved resilience of thermal management of batteries by using heat from the car and cooling or heating by means of heat pump techniques.

It was presented how thermal management solutions including insulation, thermal energy storage, innovative heating and cooling approaches, electronic control of electro-thermal energy and power flows, increased energy efficiency of electrified components and subsystems.

Energy substitution as well as energy harvesting functions were investigated and integrated in an overall approach. Particularly the heat pump concept and the reuse of waste heat from other subsystems are highlights of OSEM-EV project. Based on in-depth quantitative understanding of energy flows in electric vehicles, the consortium was able to design and optimise the vehicle’s energy architecture and to develop control algorithms for effective
coupled electro-thermal energy management. These improve not only the energy efficiency of the powertrain, but also the reliability and lifetime of every subsystem in the electric car. The technology was successfully demonstrated in two different classes of electric vehicles: one in the A-segment and one in the C-segment. These two segments were selected due to their very different requirements and topologies and, most importantly, for their high market potential.

**REWARD**  
*Real World Advanced Technologies for Diesel Engines*

The overall objective of the REWARD project was to develop the knowhow to effectively produce cleaner, highly efficient Diesel powertrains and aftertreatment technologies for future cleaner passenger cars that go beyond Euro6 RDE. On basic research level, technologies for high efficiency (combustion + friction) as well as advanced EATS optimised for the new combustion concepts and a 2-stroke Diesel engine architecture for B/C class vehicles have been successfully developed. These technologies have been integrated in two demonstration vehicles (B/C class PS: 1.6l Renault Kadjar and D/E class PC: 2.0l Volvo XC60). The REWARD targets were:

- for B/C class vehicle: ≥5% reduction in CO$_2$ emissions (based on ref MY2015 vehicle-130 mg/km – and tested in WLTC and RDE) and about 50% reduction in NOx emissions (based on EU6 limit) 40 mg/km (tested in WLTC and RDE)
- for D/E class vehicle: 5% reduction in CO$_2$ emissions (based on ref MY2018 vehicle and tested in WLTC and RDE) and about 50% reduction in NOx emissions (based on EU6 limit) 40 mg/km (tested in WLTC and RDE).

For the B/C class vehicle, the presentation highlighted the low swirl concept which provides a wide low NOx operation area, reduces soot formation and increases the fuel efficiency. A low cost EAS (closed couple SCR/SDPF, no LNT) was applied. For D/E class vehicle, the presentation highlighted the quiescent combustion concept and the advanced EATS applied (closed couple LNT+SCR/SDPF+under-floor SCR).

The project has been able to achieve all targets with one exception: the CO$_2$ emissions of B/C class vehicle in WLTC were reduced by 3% only. The presentation was concluded with an impact assessment stating that depending on the topic, the developments presented will be applied step by step immediately (i.e., combustion concepts).

The expected contributions concern reduction of operating costs (fuel) and system costs as well as reduction of pollutant and CO$_2$ emissions.

**GasOn**  
*Gas-Only internal combustion engines*

The GaSOn project aims to develop advanced CNG only, mono-fuel engines able to comply with the “2020” CO$_2$ emission targets, claiming the 20% CO$_2$ emission reduction with regard to the current best in class CNG vehicle segment, to fulfil the new homologation cycle and to guarantee a low fuel consumption in real driving conditions.
GASON is based on 3 parallel technology ways that lead to a full development of demonstrator vehicles, all based on the integration of the gaseous direct injection system developed in the project and focusing on the direct injection combination with the advanced Variable Valve Actuator system, on an advanced boosting system matched with Variable Compression Ratio and addressing a lean burn and/or charge dilution combustion approach and exhaust gas temperature control. Alternative combustion concepts, a quality fuel sensor and advanced after-treatment-solutions complete the full comprehensive project approach.

First, the presentation highlighted the development of the stoichiometric small turbocharged VVA DI engine and compared the performance of the prototype vehicle vs. that of a Fiat 500L CNG PFI. The results show a total reduction of GHG emissions of about 17.5 % in NEDC. The overall reduction was verified with PEMS measurement (20%). Second, the presentation highlighted the development of the advanced boosting & variable compression ratio for downsized CNG engines. The prototype vehicle built achieves 20% reduction in CO\textsubscript{2} emissions, and about 650 km mileage range. Fulfilling EU6+ emission levels is on track. Further, the presentation referred to the developments in charge dilution (internal & external EGR) and exhaust gas temperature management as well as to the development of the mono-fuel engine. The latter is able to operate with $\lambda>2$ to avoid inherent NOx-raw-emissions achieving efficiency of about 44%.

The expected contributions concern a new generation of extremely efficient CNG engines (injection system, combustion concepts, fuel quality sensor, advanced EATS and a Tank to Wheel GHG mitigation among 16% and 25% on NEDC cycle vs. current best in class.

**HDGAS**

*Heavy Duty Gas Engines integrated into Vehicles*

The HDGAS aims at the development, demonstration and optimisation of advanced powertrain concepts for dual-fuel and pure NG engines. The project’s ambition is to integrate these engines into HDVs and confirm achievement of Euro VI emissions standards, in-use compliance under real-world driving conditions and CO\textsubscript{2} or greenhouse gas targets currently under definition.

The presentation started with the targets of the developed demonstration vehicle (Comply with the Euro VI emission regulations; meet at minimum 10% CO\textsubscript{2} reduction compared to state of the art technology; mileage of at least 800 km on NG; be competitive in terms of performance, engine life, cost of ownership, safety and comfort to 2013 best in class vehicles) and continued with the spark ignition concept (an advanced “Medium Pressure Direct Injection (MPDI)” natural gas prototype spark ignited engine, as well as the related LNG (Liquefied Natural Gas) fuel system and the integration of this into a demonstrator truck).

The technology was tested in test-bed only and delivered a better fuel efficiency, with reduced CO\textsubscript{2} emissions (about 10%) and mileage range of 850 km. However, emissions of CH\textsubscript{4}, CO and NH\textsubscript{3} were above limit due to injector malfunction. The Dual fuel concept was also tested in test – bed only, without achieving the 10% reduction target and achieving a mileage range of 800 km. Further, although warm WHTC has shown emission compliance, composite cycle has
not. The HPDI (high pressure (300 bar) natural gas injection) concept which uses a diesel micro pilot to provide ignitable conditions for the natural gas. The technologies used are (LNG tank High pressure LNG pump; Common rail diesel pump; Dual media injector). The HPDI concept results in 20% GHG emissions reduction, in 800 km mileage range and in >90% substitution rate (Gas to Energy Ratio-GER). Emission compliance with Euro VI was also achieved.

The expected outcomes include:
- Market introduction of major technologies within 1-3 years
- Project resulted in approximately 2 years less in development work
- With a certain market share of NG powered vehicles, it will be easier to reach the CO₂ targets set (fleet average regulation)
- Pollutants will be lowered significantly
- The increased know how in gas powered trucks provided by HDGAS secures development of corresponding components and systems within the EU securing employment in the automotive industry.

ECOCHAMPS
European COmpetitiveness in Commercial Hybrid and AutoMotive PowertrainS

The overall objective of the ECOCHAMPS project is to achieve efficient, compact, low weight, robust and cost effective hybrid powertrains for both passenger cars and commercial vehicles (buses, medium duty and heavy duty trucks) with increased functionality, improved performance, comfort, functional safety and emission levels below Euro 6 or VI.

Five demonstrator vehicles were developed in ECOCHAMPS up to TRL 7. These vehicles were used to demonstrate the key innovations (Commercial Modular System; (pre-selected) hybrid electric components, optimised and integrated hybrid powertrains) and included:

1. A class B vehicle (FIAT 500X), designed as a plug-in hybrid with an electric range of 25 km
2. A class C vehicle, 48 V hybrid based on a Renault Megane
3. A medium duty vehicle based on an IVECO Daily
4. City bus based on a MAN Lion bus
5. A HDV based on a DAF XF truck that has been fitted with a parallel hybrid electric powertrain.

The majority of technical targets and End User Requirements met to a TRL of 7. Powertrain efficiency increases 20-30% in passenger cars, 30% in medium duty vehicle and 17-18% in city bus and HDV.

The outcomes include: a summary of exploitable results in graphical overview per demonstrator; improvement beyond the state-of-the-art for hybrid powertrains in terms of cost/benefit ratio; clear benefit from the use of technology from the light-duty into the heavy-duty sector; gaining the critical mass necessary to enable adoption of the benefits of the project, thanks to the involvement of the all automotive industry. The know-how gained in the project has increased the competitiveness of EU vehicle manufacturers and suppliers, securing European jobs; and could lead to market introduction of the novel hybrid
powertrains. Continuing research within the EU framework programmes will remain necessary to meet 2030 and 2050 CO₂ targets for the transport industry.

THOMSON  
Mild Hybrid cOst effective solutions for a fast Market penetration
The THOMSON aims at the development of cost-effective solutions, based on 48V architectures, answering the need in reducing the environmental impact of the transportation sector through a clever combination of advanced engines technologies, electrification and wider use of alternative/renewable fuels.

The project has already developed a global vehicle model for thermal, emissions and energy management. The model estimates a GHG reduction between 1-2% for thermal management on WLTP cycle. The presentation highlighted the developed demonstrators which are in the calibration phase (a 1.6l diesel engine 48V Mild Hybrid based on FIAT 500X and a 1.0l CNG DI Engine based on Ford Grand C-MAX) as well the targets for both vehicles:

- for the first one: comparable performance with 2.0l Diesel 140Hp version; 16% CO₂ reduction with regards to 2.0l diesel engine; real driving NOx Emission with CF ≤ 1.5;
- for the second one: CO₂ lower than 1.5l diesel engine; performance of next up 1.5 Ecoboost engine; ≥5% lower cost than 1.5l diesel, projected for EURO7; Engine (ICE): 110 kW, max. torque 240 Nm; mHEV: 12kW electric motor (48V boardnet).

The expected contributions to EU high level objectives include: new mid-size Diesel engine integrating 48v P1f configuration and electrified boosting and aftertreatment systems; new generation of extremely efficient CNG engine, including off-axis P2 mHEV-module to support low CO₂ and pure electrically propelled use-cases; new generation of CNG direct injection system; advanced Boosting Systems (Diesel & CNG - electrically assisted booster in combination with gas turbocharger with the aim to support the engine “downsizing” approach); advanced EATS (Diesel & CNG - with the goal to increase effectiveness at low exhaust gas temperatures); tank – to - wheel GHG mitigation among 16% and 25% on cycle vs. current best in class; development of new simulation models to support the best use of the on-board energy and to optimise the thermal flow distribution.

ORCA  
Optimised Real-world Cost-Competitive Modular Hybrid Architecture for Heavy Duty Vehicles
ORCA aims to improve the efficiency and cut the costs of hybrid trucks and busses through enhanced powertrains, reduced fuel consumption and smaller internal combustion engines, as well as longer electric autonomy. The project will also look into replacing diesel engine by an advanced compressed natural gas engine, leading to further cuts in fuel consumption and higher efficiency levels. ORCA’s ambition is to reduce the fuel consumption of busses and trucks by up to 40%, downsize the internal combustion engines by at least 50% and improve the electric range from 10km to 30km.
The objectives highlighted in the presentation include:

- The reduction of Total Cost of Ownership (TCO),
- The architecture of the developed prototypes (a Volvo Hybrid Truck and a IVECO Hybrid Bus)
- The codesign sizing of components and the optimisation framework
- The energy management towards fuel reduction / range increase.

TCO is major issue for optimisation including initial vehicle cost, operational cost and lifetime.
The target of ORCA is to reduce the TCO to the same diesel vehicle TCO level. The architecture of the prototypes includes hybrid simplification via through-road approach for the Volvo truck (independent driveline systems with focus on modularity; multiple operational modes; commonly termed P4; possible operation in EcoCombi mode) and Mode-Choice for the IVECO bus (ZEV, by shutting-down and disconnecting the internal combustion engine; series hybrid, by using one electric motor for generation, the other for traction; parallel hybrid, by using both internal combustion engine and electric motors – use of one single possible – for traction; thermal mode: only internal combustion engine used for traction - mainly for limp-home mode and high speed for considerable time). Further, the presentation shows details of the proposed codesign framework for powertrain, the optimal control loop and the component sizing optimisation loop.

The expected outcomes include: strengthening of the European technical and technological leadership in the value chain of HDVs, enabling a leading position in this crucial field of hybridised vehicles and increasing the competitiveness of European heavy-duty road vehicle manufacturers and suppliers. It is foreseen that the technology will be ready for its first market introduction between 2021 and 2022.

**ADVICE**

*ADvancing user acceptance of general purpose hybridised Vehicles by Improved Cost and Efficiency*

ADVICE aims at reducing pollutant and CO₂ emissions on WLTP by 20% and increasing the electric driving range for P-HEVs by 25% at a maximum premium cost of 5% for HEV (15% for P-HEV) with respect to the best in-class non-hybrid diesel vehicle. These objectives will be accomplished by: architecture-level hybrid powertrain solutions; advanced predictive control strategies and model predictive control strategies, taking the entire vehicle into account (not only the hybrid part); novel optimised approaches in the EATS; newly developed high-temperature electronics, enabling novel strategies and approaches for energy- and thermal-management; multi-core processor architectures, enabling sophisticated control strategies and models processed on-board the vehicles).
In ADVICE, three physical demonstrator vehicles are built, ranging from mild-hybrid to full plug-in hybrid and – concerning fuel type – from gasoline to diesel-driven. The presentation focused on the project’s achievements in the first 18 months which included:

- achievements in control (ECO Routing, ECO Driving, HMI providing the driver real time information, powertrain energy management strategy, thermal management);
- achievements in components (eHC usage and control, high temperature electronics, analysis of emKERS (electro-mechanical Kinetic Energy Recovery System),
- Phase Change Material (PCM) as heat storage);
- achievements on the vehicle level (eHC concept definition, 48V battery development, first power-split strategies; and achievements in PHEV architecture (system architecture 0: Baseline – Alfa Romeo Julia; system architecture 1: Hybrid ZF 8 speed gearbox 4WD automatic; system architecture 2: Front eTwinster axle capabilities and torque vectoring; system architecture 3: Front axle dual motors with epicycloidal gears; system architecture 4: Front axle with differential and eMotor longitudinal).

The upcoming activities include:
1. Level 0 demonstrator calibration,
2. Analysis and optimisation of components and strategies
3. Implementation of dedicated interactions in level 1 and level 1.5 demonstrators.

The expected impacts include: environmental: increase of hybrid vehicles in premium class segment impacting CO₂ target through reduced cost, fun to drive and fuel efficiency measures; economic aspects: significant step forward in sales of European hybrid vehicles; and economic/technological aspects: components implemented in vehicles rising market penetration of components (eHC, 48 V P4 ...)

LOWBRASYS
a LOW environmental impact BRAke SYStem

The project LOWBRASYS expedites the development of a novel, low environmental impact brake system (LOWBRASYS). It aims at the reduction of both particle mass and particle number emissions at demonstrator level by at least 50%, improving the understanding of potential effects on health and environment and giving recommendations to policy makers.

The presentation highlighted the solutions applied to achieve the targeted reduction (novel disc and pads material, smart dashboard, by-wire brake system) as well as the reduction achieved in practice (new materials: >90% in PN and >30% in PM; smart dashboard: 50% in PN and >30% in PM; by-wire brake system: >40% in PN and >20% in PM). No significant difference was found between the level of toxicity of the debris obtained from the reference materials and the novel ones on aquatic and edaphic organisms.

The presentation referred further to the details of lung deposition modelling and closed with the expected impact of the project (optimisation of measurement procedures, protocols to assess brake particle and eco-toxic effects; influence of driving behaviour; for market introduction, automotive industry needs to optimise system integration and validation).
**PaREGEn**
*Particle Reduced, Efficient Gasoline Engines*

In order to gain understanding of the nano-particle formation – especially with sizes <23 nm – in gasoline engines, combustion processes of direct injection gasoline engines were investigated by simulation and experimentally. Fuel films particularly on the piston crown were identified as the most relevant reason and source for the particles. Injection strategies and model-based operating/control strategies were identified which allow the minimisation of the particles. Using this know-how, advanced engine technologies such as Miller process, lean combustion, water injection, friction reduction and high efficient charging were implemented in engines of two validator vehicles. The vehicles measurements were used to validate the efficiency improvements, the particle emissions as well as the performance of the aftertreatment system regarding <23 nm particles.

It was concluded that vehicles with gasoline engines will comply with upcoming Euro6 RDE limits even with 10 nm lower threshold. Market introduction of the technologies investigated are expected as early as 2020-2022 leading also to early impacts such as reduced fuel consumption of the passenger car fleet simultaneously reducing the particle emissions at < 23 nm size.

**DiePeR**
*Diesel efficiency improvement with Particulates and emission Reduction*

The project is aiming at an improvement of fuel economy ≥ 5% compared to MY 2015 diesel engines, pollutant emissions reduction to a level of < 50% Euro6d limits and particle emissions reduction to a level of < 20% Euro6d limit with particles down to 10 nm in size. Fuel consumption reductions up to 15% at particular operating conditions could be achieved with variable compression ratios along with optimised combustion systems, air management and exhaust gas aftertreatment systems. To improve fuel economy, insulation layers were applied to the piston crown, the fire deck and the exhaust port. Further, the thermal management system was optimised to keep active the aftertreatment system also in low load conditions. In such way, the particle filter reached the full filtration performance/efficiency >99 % already after <80 s. The results achieved so far on component level will be integrated and validated in two demo vehicles in the finale phase of the project.

The presentation concluded with an outlook on the impact expected: diesel engines featuring even higher efficiency than today, improved particle filters and engine operation strategies for the reduction of emitted particles to below 20% of Euro6d PN limit with focus on sub 23nm particles (> 10nm) as well as advanced aftertreatment systems to reduce emissions below 50% of Euro6d limits.
EAGLE

Efficient Additivated Gasoline Lean Engine

The project focuses on the investigation of technologies to achieve 50% peak thermal efficiency by ultra-lean engine processes with H2 boosting, a pre-chamber ignition system, optimised intake ports, coatings for reduction of heat losses and high-efficient optimised NOx after-treatment systems.

It was shown in a simulation study, that these measures along with plug-in hybridisation, allow the CO2-emissions of a mid-size car to be reduced from 140 g/km down to approximately 43 g/km – well below of a fleet target of 50 g/km envisaged. It is generally agreed that stable lean burn operation of gasoline engines is difficult with air excess ratios > 1.6. Hence, measures such as H2-enrichment or pre-chamber ignition were investigated and proved to be suitable to stabilise the combustion in such high air excess ranges leading to indicate efficiencies up to 47%. In parallel to the combustion development, a tailor-made NOx storage catalyst for ultra-lean SI engines was investigated.

In the final phase of the project, the combustion system will be further optimised by means of 3D CFD simulation and then the results transferred to a multi cylinder engine for final validation.

DownToTen

Measuring automotive exhaust particles down to 10 nanometres

In first step, the project aimed, in parallel, at the development of a measurement technique for the analysis of particles in the size range 10-23 nm as well as models to understand the particle formulation and transformation from the tailpipe to the atmosphere. This knowhow will be applied in collaboration with other EU projects such as PaREGEn, uPGrAde, DiePeR, THOMSON and GasOn to validate the measurement technique as well as the formation of ultrafine particles to finally synthesize/provide policy recommendations.

Taking into account the particle formation processes, suitable sampling techniques were identified and three generations of instruments built up – the 2nd to be used for stationary and the 3rd for mobile measurements. The new instruments proved to be in excellent agreement with standard equipment for particle measurements > 23 nm. New concepts were investigated for the chemical characterisation of the ultrafine particles. Analysis of the particles’ composition of different powertrain systems with various aftertreatment systems have indicated that during the majority of the tests, the particle number even considering the <23 nm particles do not exceed the regulatory limits. However, in particular cases and short events, respectively, the total number of particles could exceed the limit by a factor of 10.

Finally, it was concluded that there is no urgent need to change the regulatory particle number size cut-off for Diesel+DPF and Gasoline+GPF cars.
SUREAL-23

Understanding and measuring SUb-23 nm particle emissions from direct injection engines including REAL driving conditions

The objectives of the project are the extension of existing instrumentation for particles below 23 nm, the detailed characterisation of the nature of the particulate emissions below 23 nm and the support to future emissions compliance through technical developments in RDE.

The particularly innovative aspects are the development of size and composition analysis methods suitable for transient engine emissions, novel instrumentation for measuring aerosol particles below 23 nm providing backward compatibility with established PN measurement technology, the enhancement of instrument specifications to allow operation with less demanding sample conditioning requirements and finally the integration of the most suitable components of the extended sub-23 nm measurement toolset into PEMS along with the verification in real driving conditions.

An advanced Sampling and Conditioning Particle System (SCPS) consisting of a two-stage dilution (porous tube and injector) with catalytic stripper and adjustable dilution ratio was developed, minimising particle losses and simultaneously eliminating artefacts. The dilution ratio is both stable and flexible and the technique is compatible with the needs of PEMS. As a suitable approach, it was found to measure total particle number concentration for particles down to 10 nm at high temperature to minimise dilution requirements. Work started from an existing automotive particle detector and the settings were optimised to measure also particle down to 10 nm. The new device was modified to achieve operational temperatures up to 200°C and it was made suitable for PEMS. The hot and cold ICAD measurements are in excellent agreement with the SMPS with deviations of only 1.9 and 3.7 %, respectively. In the final phase of the project, developments of the instrumentation will continue regarding a Condensation Particle Counter (CPC) with sizing capability, a Super Continuum Laser – Multiwavelength Photoacoustic sensor (SCLMPAS). For in-situ particle composition analysis, the techniques developed will be integrated in a PEMS and validated in the course of measurements on chassis dynos for GDI and CNG vehicles as well as RDE measurements.

PEMs4Nano

Portable Nano-Particle Emission Measurement System

Main objectives of the project were the development of robust and reliable measurement equipment for particles down to 10 nm supporting research and legislation, the fundamental understanding of formation, composition, size distribution and transport of exhaust particles in order to support the development of the measurement equipment including the impact on the measurement procedure and, finally, to identify robust and reliable measurement procedures for particles down to 10 nm verified under real driving conditions.

The technology development comprised a laboratory-based equipment for research/certification and PN PEMS for RDE, the optimisation of Condensation Particle Counter (CPC) with D_50 ≤ 10 nm and the optimisation of PEMS Catalytic Stripper (CS) to at least 50 % detection efficiency at 10 nm. A CPC and CS have been optimised according to these
targets. The CPC was integrated in an existing PEMS and optimised for 10 nm measurement. The PEMS CPC was calibrated with 350°C conditioned flame soot aerosol and optimised for 50% detection efficiency at 10 nm. 10-15% improvement in solid particle penetration were achieved meeting the ambiguous target of 60% penetration even at 8 nm particle size. Regarding the understanding of the particle formation process, a Model Guided Application (MGA) was developed combining physic-chemical and statistical algorithms to simulate the particulate emissions in IC engine driven vehicles. This allows to understand the sensitivity of PM and PN to operating conditions in IC engines and vehicles, the particle size distribution (PM & PN), the aggregate composition and morphology as a function of fuel characteristics, the engine operating modes, after-treatment and RDE attributes as well as the thermodynamic boundary conditions at various sampling points to reduce the need for measuring “everything”. The instrumentation developed was validated with measurements on engine and roller test benches. It was concluded that relative trends observed from engine test bench measurement are transferable to roller test bench and that the new measurement system can be applied and handled like an established PN23 measurement system.

Finally, it was stated that two systems (laboratory + PEMS) including subcomponents have been optimised for >10 nm particle measurements and that the laboratory system can be applied and handled according to PMP-recommendation with detection limits below 23 nm. The validation at a laboratory showed that current calibration procedure e.g. PCRF factor evaluation might be reconsidered for sub-23 nm equipment. A MGA combining physic-chemical simulation and statistical algorithms can offer sensitivities in particle characterisation as a function of RDE attributes for single- and multi-cylinder engines.

**EU-LIVE**

*Efficient urban light vehicles*

EU-LIVE is presented as a comprehensive platform for the next generation of electrified, cost- and energy-efficient light urban vehicles (L-category) for future personal urban mobility, showcased by three different demonstrators (L3e, L5e, L6e). The objective of EU-LIVE is to overcome the existing barriers of L-category vehicle industry on the basis of intense collaboration and transfer of know-how concerning methods, components and technologies from the high-volume automotive industry.

Within the scope of establishing the "EU-LIVE modular platform" the project has followed three storylines that include efficiency and the reduction of GHG and noise, comprehensive modularity and finally the transfer of know-how and of the development approach from the classic automotive industry. These will not only have an impact on the reduction of GHG, but also ensure the cost reduction by applying the principle of economies of scales used in the automotive industry. In particular, the storyline “comprehensive modularity” looked at design elements that were targeted for the L5e vehicle, but consider modularity principles that foresee multiple usage in the L3e and L6e vehicles in order to be able to take advantage of scale economies. Demonstrators for the L3e and L5e vehicles have been built up and tested. The L5e demonstrator was built up as a 3-wheel PHEV with a top speed of 130 km/h and range...
of 300 km. An innovative approach was taken for the L6e demonstrator by using a public contest to solicit inputs and merging attractive elements and ideas that were entered into the contest. The outcome is a user driven design that should appeal to a broad public of urban travellers. This vehicle was only validated by means of co-simulation that was an important pillar in the overall project approach.

**ESPRIT**

_Easily distr ibutable Personal Rap id Transit_

The results of the ESPRIT project have been summarised in the presentation. The project encompasses an innovative ‘last mile’ system designed to complement the public transport in suburban areas, by offering a solution for the people living/working a few kilometers from the public transport hubs; and, at the same time, offer a solution for congestion within peri-urban areas. This project is based on innovative quadricycles that can be linked together to form road trains, and redistributed in groups. Hence the project has developed a purpose-built, light weight L6 or L7 category electric vehicle that can be linked together to gain space and, at the same time, enable the transport of multiple vehicles. Thanks to pioneering coupling systems, up to 8 ESPRIT vehicles could be nested together in a road train, 7 being towed for an efficient redistribution of fleets and a smartly-balanced and cost efficient transport system. Within the project, 3 user scenarios concerning a last-kilometre personal mobility system to existing public transport infrastructures in peri-urban areas have been evaluated. A potential mode share has been estimated, representing up to 12% of the trips made in the simulated areas. These have been simulated using and agent-based simulation model in 3 different geographical use cases (Glasgow, Lyon and L’ L’Hospital de Llobrregat near Barcelona). The operator is allowed to move multiple vehicles whereas the system users is allowed to move only two vehicles in order to ensure the highest standard of safety. Safety has been demonstrated with a linked five-vehicle chain using the classic elk-test to validate the ability to avoid an object in the lane without rolling over. Furthermore, the unique vehicle connector and power electronic architecture allows charging a connected chain through just one vehicle. ESPRIT thus contributes an important building block that has the potential to motivate private users to use more public transport and car-sharing solutions rather than their private vehicles and leading to seamless intermodal transport, decongestion and significant reduction of noise and air pollution.

**RESOLVE**

_Range of Electric Solutions for L-Cat egory Vehicles_

RESOLVE complements the previous presentations by focusing on full electric L-Category vehicles that offer adequate range and ride experience to increase the willingness to use light electric vehicles (ELV).

The presentation covers the main results of RESOLVE project aimed at developing a range of cost-effective, energy efficient and comfortable ELVs (Electric L-category Vehicles) as an
alternative to conventional cars in urban areas. Thus, ambitious targets were set for energy efficiency, comfort and ease of use, as well as affordable cost. This is of particular importance since many car drivers do not consider LVs as a viable and comfortable option. Two product concepts of four-wheel tilting vehicle have been built up to take on this challenge. At the same time, RESOLVE developed components and systems that meet the very low-cost requirements for the ELVs segment, particularly modular and scalable LV-specific electric powertrains and battery architectures. This includes state of the art electric motors and inverters, a drivetrain management module and innovative user interface including smart range management and regenerative braking, as well as modular battery packs that also offer a swappable option. From the user perspective, the project delivers an exciting and attractive ELV driving experience in prototype vehicles, while keeping energy consumption at very low level. All these advances have been successfully demonstrated in two tilting (narrow-track) four-wheeler demonstrator ELVs (L2e and L6e category). Also, a L2e tilting three-wheelers (two wheels in front) has been delivered, proving that components and systems have been designed and built-up in such a way that they can be applicable to the complete range of ELVs (including powered-two wheelers) and thus can begin to have an impact on future vehicles relatively soon after completion of the project.

**SilverStream**

*Social innovation and light electric vehicle revolution on streets and ambient*

SilverStream took on the important challenge associated with sustainable and affordable personal mobility for the growing and ageing population in congested European cities. The project combines both ergonomic concepts conceived for elderly people and advanced automotive technologies that are quiet, clean, energy efficient and safe. The particular objectives of SilverStream were:

- Developing specifications related to the needs of urban and ageing population
- Achieving enhanced vehicle manoeuvrability for urban context
- Including sustainable ergonomics, health monitoring and adaptive HMI for minimum-fatigue vehicle operation
- Developing a dual voltage 12/48 V power network for modular and scalable E/E architecture
- Realising a hybrid energy storage system, combining a new generation of Lithium SuperCap and standard Lithium batteries, for extended operating life, increased efficiency and environmental compatibility
- Implementing compact in-wheel drive units for light urban mobility solutions.

In the presentation it was clear that SilverStream has been very successful in achieving the targets and especially effective in considering the needs of elderly people to maintain their individual mobility in urban areas. Improved access for entering the vehicle as well as an enhanced turning radius to aid in manoeuvring are just some of the ergonomic aspects combined with innovative HMI specific for elderly needs are some particular highlights. This sets an important reference point for further development work and future projects.
SilverStream has not only been effective in technical areas such as in-wheel motor technology and e-axles, but also in providing quality content to establish new large R&D initiatives such as the ECSEL Lighthouse project Autodrive and the Green Vehicle project STEVE, Smart-Taylored L-category Electric Vehicle demonstration in heterogeneous urban use-cases. The SilverStream vehicle is currently used for the refinement of vehicle control strategies and will be the basis for a potential industrial development led by some partners of the consortium. A modular chassis, integrating some of the technical solutions proposed within SilverStream, will support the development of a family of LEVs realised in Italy.

**NeMo**

*Hyper-Network for electroMObility*

NeMo is setting up a pan-European eRoaming Hyper-Network that allows seamless and interoperable use of electromobility services throughout Europe, in order to address challenges that face EV users such as limited charging options, lack of interoperability, absence of a unified identification/payment process, unclear charging tariffs and restrictions due to risk of energy grid overload. The vision is to develop a hyper-network of tools, models and services to enable the provision of seamless and interoperable electromobility services creating an open, distributed and widely accepted ecosystem for e-mobility. By achieving a common understanding of EV services along with standardised electromobility data it will be possible to involve numerous stakeholders, even on a pan-European level. This will not only improve the user experience, but will also allow access to multiple stakeholders and thus also support the implementation of new business ideas and models.

First steps are proceeding by establishing a common NeMo metalanguage that will serve as the basis for the platform and by enabling the quick building of data translators from proprietary to the Nemo protocol. Tools enabling the easy creation of composite services, using smart horizontal services and other existing services already available in the Hyper-Network, have also been prepared. In particular, the NeMo Hyper-Network is a distributed environment with open architecture based on standardised interfaces, in which all electromobility actors, physical (i.e. CPs, grids, EVs) or digital (i.e. CPOs, DSOs, etc.), can connect and interact seamlessly, exchange data and provide more elaborate electromobility ICT services in a fully integrated and interoperable way both B2B and B2C. The connection will be based on dynamic translation of data and services interfaces according to needs of the specific scenarios and involved stakeholders. The first nodes of the Hyper-Network are already operational. Test sites in Austria, France, Germany, Italy and Spain are being prepared for a cross-country demonstration in 2019. Potential future entrepreneurs such as service providers are encouraged to join the discussions towards the establishment of the BAEM (Business Alliance for Electromobility) which will be launched on the 1st of October 2019 after the successful completion of the project in September 2019.
ELECTRIFIC

Enabling seamless electromobility through smart vehicle-grid integration

ELECTRIFIC complements NeMo quite well by taking a closer look at the actual charging interface between vehicle and grid and thus revolutionise how electric vehicles are integrated into the grid and the user’s life. ELECTRIFIC is of particular importance since it combines both the perspective of the user’s (with the vehicle) and the grid in one single project.

The fundamental premise on which the project is working is that significant improvements to electro-mobility can be unlocked by increasing coordination of all the actors in the electro-mobility ecosystem (drivers, charging service providers, fleet providers and grid operators). To this end, the project delivers novel techniques and ICT tools for enabling such coordination.

At the grid level, the project is developing solutions for “grid-friendly” smart charging stations capable of dynamically controlling charging rate and of avoiding peaks of energy consumption.

At level of EV users, the project is developing advanced driver assistance services that facilitate seamless integration of charging process in the daily trips and “green-charging” incentives taking also into account charging prices. Additionally, the project is developing charging management tools that help to optimise fleet operations, maximising battery lifetime and minimising charging costs. These solutions are being tested in real scenarios in Bavaria (DE), Barcelona (ES) and the National Park of eSumava (CZ).
Cooperative ITS and infrastructure for CAD

**TIMON**

*Enhanced real time services for an optimized multimodal mobility relying on cooperative networks and open data*

The TIMON project developed a cooperative open web-based platform and mobile application, which form a framework of services, in order to deliver real-time information and services to all users of the transport ecosystem; drivers, vulnerable road users, and businesses.

The TIMON services are structured in five key areas:

1. Driver assistance services to increase safety and hazard warnings
2. Services for vulnerable road users (VRUs),
3. Multimodal dynamic commuter service,
4. Enhanced real time traffic API, focused on enhancing road transport efficiency, such as car sharing applications and Electro-Mobility services
5. TIMON collaborative ecosystem will promote end users to share their experience on a social network-based application.

**HIGHTS**

*High precision positioning for cooperative-ITS*

The HIGHTS project focused on how to provide resilient sub-metric localisation performance of connected vehicles using available standard technologies through low-complexity cooperative fusion.

- Achievement of sub-meter localisation based on currently used sensing and communicating systems through vehicle cooperation.
- Delivery of platform with optimal positioning algorithm according to the sensing and communicating systems available within the cooperative vehicle available.

HIGHTS results will be integrated into the facilities layer of ETSI C-ITS architecture and will thereby become available for all C-ITS applications. The project will go beyond ego- and infrastructure-based positioning by incorporating the building blocks to develop an enhanced European-wide positioning service platform based on enhanced Local Dynamic Maps and built on open European standards. HIGHTS will combine traditional satellite systems with an innovative use of on-board sensing and cooperative wireless communication technologies (e.g., Wi-Fi, ITS-G5, UWB tracking, ZigBee, Bluetooth, LTE...) to produce advanced, highly-accurate positioning solutions for C-ITS. The project achieved <0.25m accuracy 70% of the time.
ROADART
Research On Alternative Diversity Aspects for Trucks

The project presentation covered a novel hybrid diversity communication technique applicable to heavy duty vehicles which was developed and demonstrated. The investigation of future-oriented diversity and beamforming techniques resulted in the ROADART platform to assure a sustainable and holistic approach for corporative ITS systems in a way that state-of-the-art systems cannot provide today.

The main objectives are:

- Perform measurements for Truck-to-Truck, Truck-to-Infrastructure mobile radio channel conditions.
- Perform full statistical characterisation of ROADART-specific multi-antenna radio channels.
- Develop novel radio channel models (both stochastic geometric and ray tracing models) for T2T and T2I channels with support of multiple antenna systems.
- Investigate multiple antenna diversity techniques in order to provide increased throughput and reliability in T2T/T2I wireless links.
- Evaluate the use of beamforming for T2T/T2I communications with the proposal of possible new elements to existing vehicular communication standards. Moreover, the use of parasitic antennas will be assessed in order to increase multi-antenna functionalities with minimum interventions on the Truck structure.
- Introduce spatial modulation as a transmission technique for improved vehicular radio communications.
- Analyse antenna array aspects for T2T/T2I communication links, including the number of elements, the type of antennas, the introduction of parasitic antennas, antenna placement and mounting on the trucks, as well as antenna structures for the infrastructure especially for special use cases e.g. tunnels.
- Investigate communication system improvement through cooperative techniques and relays, focusing especially in the T2T relaying for platooning systems and coordinated multi-point T2T/T2I reception.
- Develop novel localisation and detection techniques for conditions where Satellite global navigation systems are not applicable, such as tunnels, using cooperative and adaptive communication techniques as well as sensor measurements and information from infrastructure.
- All the proposed techniques will be extensively evaluated through simulation using the realistic, measurement-based ROADART channel models.
- Cooperative Adaptive Cruise Control, a safety-critical application, will be implemented on a truck, to evaluate the theoretical results and to support the measurements. Herewith, a safety approach for increasing robustness w.r.t. wireless communication impairments on the application layer will be developed and implemented.
- Based on the results and conclusions, a novel multi-antenna T2T/T2I communication platform will be developed that will achieve optimised and reliable use of the radio
channels in order to provide T2T/T2I services in terms of safety, traffic/route control, transportation efficiency and environmental awareness, while taking into account practical issues regarding the installation of complicated communication systems on heavy duty vehicles.

The developed platform will be demonstrated and evaluated for specific scenarios that include special use cases, i.e. tunnels and platooning.

Results and expected impacts:

- New course material has been already added in MSc: Design of ESPAR (reconfigurable) antennas for MSc students
- Cooperation for the development of new reconfigurable antennas is expected to continue after the end of the project
- Platooning is enabled providing up to 10% fuel reduction
- Improved localisation technique

**COEXIST**

'AV-Ready' transport models and road infrastructure for the coexistence of automated and conventional vehicles

The project developed an automated vehicle ready framework for road authorities and fosters technological development of traffic simulations tools, based on a cross-disciplinary approach and the engagement of relevant stakeholders. By simulating automated vehicles in four European cities, with different urban structures and traffic compositions, the project analysed the effects of automated vehicles on urban road infrastructure, especially in a context of “co-existence” between automated and conventional vehicles.

The mission of CoEXist was to systematically increase the capacity of road authorities and other urban mobility stakeholders to get ready for the transition towards a shared road network with an increasing number of automated vehicles, using the same road network as conventional vehicles. AV-ready transport and infrastructure planning in cities are a key precondition for fulfilling the promises of automated vehicles to reduce road space demand and improve traffic efficiency and safety.

The project addressed three key steps in transport and infrastructure development.

- Automation ready transport modelling including user interaction
- Automation-ready road infrastructure
- Automation-ready road authorities

Resulting in an automation ready (Coexist) framework as an annex to Sustainable Urban Mobility Plans (SUMP) plans.

The project has also established a EU-US twinning with the Federal Highway Administration (FWHA), with the objectives of

- Definition of AMS Framework – globally applicable?
- Sharing of Use Cases / Case Studies
- Exchange on modelling tool development
INFRAMIX

Road Infrastructure ready for mixed vehicle traffic flows

The key outcome of the ongoing INFRAMIX project will be a “hybrid” road infrastructure able to handle the transition period and become the basis for future automated transport systems. The main objective of INFRAMIX is to prepare the road infrastructure with specific affordable adaptations and to support it with new models and tools, to accommodate for the step-wise introduction of automated vehicles.

In detail the project will:

- Design new and upgrade existing physical & digital road infrastructure elements.
- Design and develop elements for the new digital road infrastructure, integrating also information received by automated vehicles; in turn, this digital infrastructure will become the basis for an enhanced electronic horizon for automated vehicles.
- Adapt and upgrade elements of the existing physical infrastructure to enable the stepwise insertion of automated vehicles. Develop a co-simulation environment
- Develop new traffic flow models (sub-micro and microscopic) combined with mature simulation tools (e.g. VSimRTI, ICOS) integrating real vehicle algorithms for automated driving and human driver behaviour to examine mixed traffic scenarios under various penetration rates of different levels of automated vehicles.
- Design and implement novel traffic estimation, monitoring and control strategies
- Design and implement traffic estimation, monitoring and control strategies dynamically adapted to the different penetration levels of automated vehicles, the infrastructure equipment and the overall traffic status.
- Develop hybrid testing system
- Develop a hybrid testing system by coupling infrastructure elements and vehicles on real roads (or test tracks) with virtual traffic environment including representative mixed traffic situations within the three predefined scenarios.
- Design novel signalling and visualisation elements
- Design new forms of visual and electronic signals to be integrated into the “hybrid” infrastructure, making them readable and “understandable” by both automated and conventional vehicles.
- Evaluate user’s appreciation and acceptance
- Evaluate users’ appreciation and acceptance in terms of visual signals, messages and relevant TMC control actions developed for mixed traffic scenarios.
- Evaluate traffic safety
- Evaluate safety performance in the three selected scenarios, for mixed traffic situations; collect /monitor critical situations mixed traffic data to identify new safety performance criteria for road infrastructure.
- Create a Road Infrastructure Classification Scheme
- Design and create consensus for a scheme of classifying road infrastructure into “automation- appropriate” levels.
The expected (long-term) impacts of the project are:

- New traffic estimation and control algorithms for mixed traffic environments
- Simulation environments and hybrid testing for mixed traffic situations
- Extension of traffic messages
- Extensions of existing technologies
- Infrastructure classification scheme (for automation levels of vehicles)
- Set of minimum interventions for infrastructure upgrades
- New safety parameters for assessment
Future Logistics and urban freight

NEXTRUST

Building sustainable logistics through trusted collaborative networks across the entire supply chain

NexTrust was an EU-funded project which brought together 31 partner organisations to drive collaboration in the logistics industry. Its objective was to increase efficiency and sustainability in European logistics.

The project concluded in October 2018 after delivering several breakthroughs in the freight transportation market. These included:

- Innovative new trustee business model created enabling a networked collaboration-centric approach
- Large scale collaboration between shippers for the first time ever in European logistics history - involving over 90 industry players
- 40+ pilot projects completed, demonstrating CO₂ reductions of 20%-70%
- Collaboration in logistics is achieving a breakthrough: building sustainable logistics through collaborative trusted networks across the entire supply chain.

SYNCHRO-NET

Synchro-modal Supply Chain Eco-Net

SYNCHRO-NET is an integrated optimisation and simulation tool (eco-net), incorporating different modules developed to de-stress the supply chain, to reduce emissions and costs for logistics operations while simultaneously increasing reliability and service levels for logistics users. Perhaps the most important output of SYNCHRO-NET will be the demonstration that slow/smart steaming, coupled with synchro-modal logistics optimisation delivers amazing benefits to all stakeholders in the supply chain (reducing cost, CO₂ emissions, risks, etc).

This will lead to lower costs for all stakeholders – shipping companies and logistics operators will benefit from reduction in fuel usage, faster turnaround times in ports & terminals and increased resource utilisation/efficiency. Customers and end users will have greater control of their supply chain, leading to more reliable replenishment activity and therefore reduced safety stocks and expensive warehousing. Authorities and governmental organisations will benefit from a smoother, more controlled flow of goods through busy terminals, and reduction of congestion on major roads, thus maximising the utilisation of current infrastructure and making the resourcing of vital activities such as import/export control, policing and border security less costly.
**SELIS**

*Towards a Shared European Logistics Intelligent Information Space.*

SELIS is aimed at delivering a “platform for pan-European logistics applications” by:

- Embracing a wide spectrum of logistics perspectives and creating a unifying operational and strategic business innovation agenda for pan European Green Logistics.
- Establishing an exceptionally strong consortium of logistics stakeholders and ICT providers, that can leverage EU IP from over 40 projects so as to create proof of concept
- Common Communication and navigation platforms for pan-European logistics applications deployed in 8 living labs representing the principal logistics communities.
- Establishing a research and innovation environment using the living labs to provide data than can be used for discovery of new insights that will enable continuous value creation supporting the large scale adoption of SELIS.

The Shared European Logistics Intelligent Information Space is a network of logistic communities’ specific shared intelligent information spaces, termed SELIS Community Nodes. SELIS Community Nodes are constructed by individual logistics communities to facilitate the next generation of collaborative, responsive and agile green transportation chains. SELIS Community Nodes link with their participants’ existing systems through a secure infrastructure and provide shared information and tools for data acquisition and use, according to a “cooperation agreement”. Connected nodes provide a distributed common communication and navigation platform for Pan European logistics applications. Each Node decides what information participants wish to publish and what information they want to subscribe to. The SELIS Community Node concept represents the evolution of a longline of research in this area. The fundamental principle is that it provides a “lightweight ICT structure” to enable information sharing for collaborative sustainable logistics for all at strategic and operational levels.

**AEOLIX**

*Architecture for EurOpean Logistics Information eXchange*

AEOLIX represents a flagship project and is developing a solution for connecting logistics information systems of different characteristics, intra- and cross-company, for immediate (real-time) exchange of information in support of logistics-related decisions. The ambition is to develop architecture for a distributed open system for exchange of information among key logistics actors (commercial companies as well as relevant authorities), enabling increased use and impact of such information in the all value chain.

- Gain a thorough insight in the lessons learned, needs and requirements in the domain of ICT applications for logistics
- Design an architecture for a collaborative IT infrastructure for operational connection of logistics information systems
- Implement an appropriate data access management model
• Build a common but user-tailored interface and tools to enable the IT infrastructure
• Test, validate and implement the AEOLIX prototype in 11 living labs of logistics business communities across Europe
• Monitor the impacts of AEOLIX based on environmental, economic and social impacts
• Develop an exploitation business model to enable roll-out and deployment of the concept across Europe, and possibly rest of the world

CLUSTERS 2.0
Open network of hyper connected logistics clusters towards Physical Internet
The CLUSTERS 2.0 project addresses transport planning and optimisation within logistics clusters and across networks of clusters through collaboration, co-ordination and standardisation. CLUSTERS 2.0 is to research on a new technical system based on modular transport loading unit in line and facilitating the Physical Internet.
CLUSTERS 2.0 will:
• Establishing CargoStream, a European wide community for freight sharing and collaboration (demand side)
• Developing New Modular Loading Units and innovative handling and transhipment technology to accelerate handling processes within clusters for road and intermodal modes
• Enhanced services on the supply side introducing the concept of Proximity Terminal Networks (PTN) enabled by enhanced information and asset management
• Optimised handover and asset management through real time services at depots and terminals
• Newly developed governance models introducing the role of a neutral agent forming the basis for new business models
• Regulation and policy enhancing the set-up of collaborative cluster environments

SUCCESS
Sustainable Urban Consolidation CentrES for conStruction
SUCCESS delivered the first comprehensive data collection effort focussing on the analysis of construction supply chain across four heterogeneous pilot sites and clear, unbiased scientific knowledge on the viability of consolidation centres that can lead to larger adoption with benefits for the affected urban areas and the other stakeholders.
The simulations performed by SUCCESS showed that the daily number of freight vehicles for both direct and reverse logistics can be reduced by 42 to 54%, CO₂ emissions can be reduced by 13 to 33%, NOx ones by 8 to 41% and PMx ones by 19 to 30%, the distance travelled by construction vehicles can be reduced by 20 to 42%, small deliveries can be eliminated entirely and the load factor can be increased by 41% to 232%. Also, proper management of a CCC can make it a viable business, with a payback that is often very short (less than a year) and only in one case out of four is of 5 years.
CITYLAB

City Logistics in Living Laboratories

The aim of the H2020 Citylab project was to:

1. Improve basic knowledge and understanding the impacts of freight distribution and service trips in urban areas
2. Test and implement seven innovative urban freight management solutions that could positively influence business profitability, reduce traffic and emissions, and have wider roll-out potential for the logistics sector
3. Provide a platform for replicating and disseminating the supported solutions.

The Citylab solutions focus on four axes for intervention:

- Understanding the highly fragmented last-mile delivery operations that currently exist in city centres
- Identifying the specific freight impacts arising from large activity centres such as public administrations and higher education institutions
- Investigating the ways in which service trips (waste and recycle management and reverse logistics systems) could be made more efficient to reduce freight vehicle impacts
- Quantifying the role logistics facilities and infrastructure could play in redesigning supply chains serving urban centres

Main highlights and recommendations from CITYLAB project are:

- Strong requirements for Sustainable Urban Logistics Plans (SULP) and
- Common actions for establishing mutual indicators and data collection (indicators and collection of data that could be used in SULP’s)
- Cooperate to share infrastructure and capacity
- To promote Zero Emission vehicles

NOVELOG

New cooperative business models and guidance for sustainable city logistics

The NOVELOG project addresses the following challenges:

- To understand, assess and capture current needs and trends in Urban Freight Transport, revealing the reasons for failures in city logistics implementations and to identify the key influencing factors and develop future Sustainable Urban logistics scenarios.
- To enable determination of optimum policies and measures, based on city typologies and objectives, link them to tailored business models and test and validate them.
- To develop a modular integrated evaluation framework for city logistics that will portray the complexity of the life cycle of UFT systems and implement it to assess the effectiveness of the policies and measures.
• To incorporate the best fitting policies and measures in integrated urban planning and SUMP, at local level, to facilitate and guide multi-stakeholder cooperation for improved policy making.

• To field test, implement and validate all the above, in selected EU cities, demonstrate applicability and sustainability of the tools, and ensure the continuity of the impacts by creating and establishing take-up strategies and roadmaps for the best city logistics solutions.