Ready for Horizon 2020!
The Strategic Pillars of Automotive Research & Innovation
About EUCAR
EUCAR is the European Council for Automotive R&D of the major European passenger car and commercial vehicle manufacturers. EUCAR facilitates and coordinates pre-competitive research and development projects and its members participate in a wide range of collaborative European R&D programmes. The European automobile manufacturers are the largest private investors in R&D in Europe with over €32 billion investment per annum, or 5% of turnover. EUCAR members are BMW, DAF, Daimler, Fiat, Ford of Europe, GM/Opel, Jaguar Land Rover, Porsche, PSA Peugeot Citroën, Renault, Scania, Volkswagen, Volvo Cars and Volvo Group. EUCAR is closely connected to ACEA, the European Automobile Manufacturers’ Association.

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The EUCAR Strategic Pillars

The European automotive manufacturers cooperate under the umbrella of EUCAR to fulfil its mission to “Strengthen the Competitiveness of the Automotive Manufacturers through Strategic Collaborative Research & Innovation”. EUCAR has identified the main priorities for collaborative research and innovation (R&I) in the automotive sector, expressing these as the “Strategic Pillars”. They are represented in the graphic below, showing the three Strategic Pillars of Sustainable Propulsion, Safe & Integrated Mobility and Affordability & Competitiveness as well as the cross-cutting Strategic Platform for Commercial Vehicles. Each contains a strategic vision statement expressing the main objectives to be targeted for collaborative automotive R&I in the domain.

**SUSTAINABLE PROPULSION**
Collaborative automotive R&I towards propulsion systems which are clean and energy-efficient over the full life-cycle, with cost-effective technologies while maintaining customer priorities

**SAFE & INTEGRATED MOBILITY**
Smart and safe vehicles for all purposes, integrated into a secure and intelligent transport system, progressing towards seamless mobility for all, maximum efficiency and ever-fewer accidents

**AFFORDABILITY & COMPETITIVENESS**
New sustainable approach for developing and producing affordable and competitive vehicles in Europe

**COMMERCIAL VEHICLES**
An integrated approach for reliable, clean, safe and efficient freight and passenger transport, through dedicated vehicle concepts and effective logistics

The accompanying Executive Summaries and associated roadmaps represent the priorities and recommendations of EUCAR for automotive R&I activities in each of the above domains in the Horizon 2020 Framework Programme for Research & Innovation. The documents can be accessed via the links in the above graphic.

**About the automotive industry in Europe**

Some 12.9 million people - or 5.3% of the EU employed population - work in the automotive sector. The 3 million jobs in automotive manufacturing represent 10% of EU’s manufacturing employment. Motor vehicles account for over €385 billion in tax contribution in the EU. The sector is also a key driver of knowledge and innovation, representing Europe’s largest private contributor to R&D, with over €32 billion invested annually. The automotive sector contributes positively to the EU trade balance with a €92 billion surplus. This contribution is highly significant today as the EU economy as a whole struggles with a total trade deficit for goods of €152.8 billion.
Overview

EUCAR’s members, the European automotive manufacturers, strive for a competitive industry whose products meet the needs of society. European collaborative research & innovation (R&I) supports this strategic objective by enabling cooperation between stakeholders and providing co-funding to mitigate part of the risk inherent in automotive research. In the area of Sustainable Propulsion, co-funded research supports the development of technologies which meet customer demands whilst fulfilling ever more stringent regulatory standards.

The EUCAR R&I roadmaps define the strategic recommendations of the manufacturers for collaborative R&I, detailing the necessary topics for R&I projects aligned with the strategic objectives. They are a vital and unique contribution, since they represent the outlook of the manufacturers, who themselves have the ultimate responsibility to innovate in bringing the resulting technologies to market.

In Horizon 2020, the programmes on “Smart, Green and Integrated Transport” and “Leadership in Enabling and Industrial Technologies” are of direct relevance to R&I in Sustainable Propulsion. The roadmaps for Sustainable Propulsion present recommendations for collaborative R&I in two areas: “ICE-based Powertrains” (powertrains based on an internal combustion engine) and “xEV-based Powertrains” (powertrains which have a fully electric drive function). These incorporate the cross-cutting technology domains “Fuels and energy carriers” as well as “Thermal and energy management”.

For ICE-based powertrains, collaborative research should concentrate on affordable design changes which increase efficiency and reduce emissions in engines for light and heavy-duty vehicles, including downsizing, advanced flexible combustion processes and alternative fuels supported by advanced after-treatment and efficient thermal management. Demonstration activities for holistic concepts for heavy-duty vehicles are an additional priority. For xEV-based powertrains, priorities include lithium-ion and post-lithium-ion batteries, fuel-cell systems, hydrogen storage, improved electric drives, charging systems and concept demonstration, as well as electrification for heavy-duty vehicles.

The expected outcome from these activities is a technology readiness for enhanced conventional powertrain technologies and advanced alternative technologies such as electrification of the vehicle as a platform for further development and eventual industrialisation. The final target is to meet customer and regulatory demands for lower fuel consumption and emissions whilst maintaining utility, performance and affordability of passenger and commercial vehicles, supporting a highly innovative and competitive European automotive industry which secures jobs and prosperity.
The Strategic Framework for Automotive Research & Innovation

EUCAR’s members have analysed in depth the strategic motivation for performing research and innovation (R&I) activities and specifically collaborative R&I, in order to set out a future vision for these activities. The following questions need to be answered: “why is collaborative automotive R&I important”, “what should policy makers and stakeholders expect to gain from EUCAR’s roadmaps and this summary, and how is it related to Horizon 2020”. The motivation and the answers to these questions can be considered in terms of three strategic elements at different levels of detail:

→ **The main relevant Strategic Trends**: these set the context for long-term strategy and have been identified by EUCAR’s members as the long-term global driving forces and trends which motivate change and require identification of the key automotive R&I themes.

→ **Overall Objectives for automotive R&I**: aligned with the European policy perspective (aiming at Sustainable Transport and Competitive Industry) and the constituent programmes of Horizon 2020, these include:
  i. CO2 emissions regulations for cars, vans and trucks;
  iii. The 2011 Transport Policy White Paper;
  iv. The Clean Power for Transport proposal;
  v. The Strategic Transport Technology Plan;
  vi. The Horizon 2020 programmes “Smart, Green and Integrated Transport” and “Leadership in Industrial and Enabling Technologies”.

→ **Priority R&I Focus Areas**: these represent the key areas of R&I for the automotive sector, identified by the European automotive manufacturers through their collaborative activities in EUCAR.

These three strategic elements are highlighted and represented graphically in the following chart, which represents this strategic outlook in the domain of Sustainable Propulsion:

![Strategic framework for Sustainable Propulsion](image-url)
A number of key R&I priorities in Sustainable Propulsion derive from the need to meet societal and industrial challenges, within the global strategic framework of prevailing conditions and trends. These priorities relate to the need to reduce all types of exhaust emissions whilst ensuring that technologies are cost effective, through developing advanced conventional and alternative powertrains, with advanced fuels and efficient energy management.

The EUCAR Strategic Vision for Collaborative R&I

Derived from the above strategic framework, the statements presented below represent the strategic vision of the European automotive manufacturers in the domain of Sustainable Propulsion. They are to be considered as an expression of the ambition of the manufacturers for research and innovation in meeting future societal and industrial objectives. They also represent a motivating objective for the definition and performance of research and innovation activities by EUCAR’s members.

The statements include an overall vision statement for Sustainable Propulsion and four statements, each representing the strategic vision for part of the domain. This subdivision indicates the breakdown of the Sustainable Propulsion domain from the automotive manufacturers’ point of view into two vertical themes “ICE-based Powertrain” and “xEV-based Powertrain”. For each of these themes a EUCAR R&I roadmap has been compiled. The two horizontal themes “Fuels & Infrastructure” and “Vehicle Thermal and Electric Energy Management” are key elements of the powertrain domain and elements in each are considered in the two vertical powertrain themes and the corresponding roadmaps.

**SUSTAINABLE PROPULSION**
Collaborative automotive R&I towards propulsion systems which are clean and energy-efficient over the full life-cycle, with cost-effective technologies while maintaining customer priorities.

**ICE-BASED POWERTRAIN**
Highly efficient and affordable powertrains with an internal combustion engine as the major propulsion unit, based on most advanced components, system architecture and operation strategies.

**xEV*-BASED POWERTRAIN**
Highly efficient and affordable electrified powertrains, based on most advanced components and system architecture.

**FUELS & INFRASTRUCTURE**
Advanced fuels, including electricity, produced sustainably and under efficient processes including required infrastructure.

**VEHICLE THERMAL & ELECTRIC ENERGY MANAGEMENT**
Efficient management of thermal and electric energy flows in the vehicle.

*xEV includes BEV, FCEV, REEV, PHEV*
EUCAR Research & Innovation Roadmaps, Milestone Objectives and Correspondence to Horizon 2020

In order to create a productive link between the automotive manufacturers’ strategic vision and their priorities for collaborative research and innovation, milestones have been compiled, representing the objectives to be reached by technology at different levels of readiness.

Milestones and R&I priorities are described in EUCAR’s roadmaps. In particular, industrialisation milestones have been compiled, representing the objective for the industrialisation of the technology on the market, derived from the Strategic Vision and relevant indicators.

Industrialisation milestones can be considered as a more detailed expression of elements of the strategic vision and are listed below:

For the ICE Powertrain roadmap:

ICE1: “A reduction in per-vehicle CO2 emissions contributing the fulfilment of future regulatory standards” (through reduction in per-vehicle fuel consumption and reduction in carbon content of fuels)

ICE2: “Availability of affordable powertrains which are adapted to operate at optimum efficiency for use with alternative fuels”

For the xEV Powertrain roadmap:

xEV1: “A reduction in per-vehicle CO2 emissions contributing to the fulfilment of future regulatory standards” (through increased market penetration of xEVs and reduction in carbon content of energy)

xEV2: “A significant increase in vehicle range approaching the useful range of conventional vehicles, whilst maintaining vehicle utility (space) and maintaining or reducing cost”

xEV3: “A continuous reduction in per-vehicle energy consumption”

xEV4: “A significant reduction in cost of xEV powertrains whilst maintaining equivalent performance, enabling total cost of ownership to approach that of conventional vehicles”

In the domain of Sustainable Propulsion, roadmaps have been compiled which cover the following areas:

1. Internal Combustion Engine (ICE-based) Powertrain (light-duty and heavy-duty applications)
2. Electric Vehicle (xEV-based) Powertrain

In this domain, the corresponding elements of the proposed Specific Programme Horizon 2020 have been identified, as well as the relevant public-private partnerships:

<table>
<thead>
<tr>
<th>EUCAR Strategic Pillar</th>
<th>Horizon 2020 Specific Programme</th>
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<td>Sustainable Propulsion</td>
<td>Smart, Green &amp; Integrated Transport:</td>
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<td>41 Resource efficient transport that respects the environment</td>
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<td></td>
<td>4.3 Global leadership for the European transport industry</td>
<td>Joint Undertaking on Electronic Components and Systems for European Leadership (ECSEL)</td>
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<td>Secure, Clean &amp; Efficient Energy</td>
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<td></td>
<td>Leadership in Enabling &amp; Industrial Technologies</td>
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</tr>
</tbody>
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FIGURE 3 Potential correspondence to the Specific Programme Horizon 2020 and Public-Private Partnerships
The Research and Innovation roadmaps for Sustainable Propulsion have been published in parallel to this executive summary. They set out the collaborative technological research and pilot/demonstrator topics and their timing, which are priorities for the automotive manufacturers during the course of Horizon 2020 and beyond, in order to meet the defined strategy and milestones.

The following research and innovation areas are the priorities identified for the two Sustainable Propulsion powertrain roadmaps as well as for holistic sustainable propulsion concepts for heavy-duty vehicles:

### ICE-BASED POWERTRAIN – LIGHT DUTY

1. **Spark-ignition engine technology:**
   - A. Flexible injection and valvetrain
   - B. Downsizing / downspeeding
   - C. Aftertreatment & emissions control
   - D. Combustion process

2. **Diesel engine technology**
   - A. Fully flexible injection
   - B. Aftertreatment
   - C. Alternative fuels

3. **Alternative fuels**
   - A. Spark-ignition engine technology
   - B. Engines for gaseous fuels
   - C. Non-precious metal aftertreatment systems

4. **Transversal technologies and methodologies**
   - A. Lightweight engine solutions
   - B. Waste heat recovery & advanced cooling
   - C. Advanced control systems

5. **Alternative propulsions and transmissions**
   - A. Hybridisation
   - B. Advanced transmissions

### ICE-BASED POWERTRAIN – HEAVY-DUTY

6. **Efficient heavy-duty vehicles**
   - A. Hybridisation
   - B. Driveline control systems
   - C. Combustion improvements
   - D. Waste heat recovery
   - E. Statistics

7. **Diesel engine technology**
   - A. Concepts for high octane fuel combustion
   - B. Di-methyl ester concepts

### XEV-BASED POWERTRAIN

1. **Fuel-cell systems**
   - A. Next generation fuel-cell components
   - B. Materials and manufacturing technologies
   - C. Advanced fuel-cell systems
   - D. Standardised components
   - E. Fuel-cell range-extender

2. **Hydrogen storage systems**
   - A. Compressed Storage Systems
   - B. Hybrid Storage Solutions
   - C. Components optimization

3. **Electrochemical storage systems**
   - A. Lithium batteries ageing
   - B. Lithium-Ion applications in x-EV's
   - C. Safety evaluation of Lithium-based batteries
   - D. Second Use and Recycling
   - E. Post Li-ion batteries

5. **Electric drives**
   - A. Electric motors
   - B. Power electronics
   - C. Traction powertrains

6. **Electric vehicles**
   - A. Renewable Electricity for Electric Vehicles in cities
   - B. Assessment of advanced Infrastructures for “charge-while-driving”
   - C. New vehicle architectures for electric powertrain systems

7. **Technology demonstration**

### HEAVY-DUTY VEHICLES

8. **Heavy-duty electrification (fully electric and fuel-cell bus, fully electric truck)**
Research & Innovation Roadmaps for the EUCAR Strategic Pillar:
Safe & Integrated Mobility

EXECUTIVE SUMMARY

Overview

EUCAR’s members, the European automotive manufacturers, strive for a competitive industry whose products meet the needs of society. European collaborative research & innovation (R&I) supports this strategic objective by enabling cooperation between stakeholders and providing co-funding to mitigate part of the risk inherent in automotive research. In the area of Safe & Integrated Mobility, co-funded research supports the development of technologies and services which meet customer and societal demands whilst fulfilling ever more stringent regulatory standards.

The EUCAR R&I roadmaps define the strategic recommendations of the manufacturers for collaborative R&I, detailing the necessary topics for R&I projects aligned with the strategic objectives. They are a vital and unique contribution, since they represent the outlook of the manufacturers, who themselves have the ultimate responsibility to innovate in bringing the resulting technologies to market.

In Horizon 2020, the programmes on “Smart, Green and Integrated Transport” and “Leadership in Enabling and Industrial Technologies” are of direct relevance to R&I in Safe & Integrated Mobility. The roadmaps for Safe & Integrated Mobility present recommendations for collaborative R&I in five areas: “Safety” and “Transport-Travel Services”, “Traffic Efficiency”, “Value-Added Customer Services” and “ICT & Telematics”.

There is a high level of interconnection between these areas, due to the need to consider the transport system in a holistic manner as a safe, efficient and productive whole. Safety is considered in terms of passive and active safety of the vehicle as well as integrated safety - the integration of all safety elements into the traffic system. An important theme is the increasing automation of the vehicle, whether individual, in platoons or as part of a system, using cooperative systems and effective human-vehicle interfaces to reap the potential benefits in efficiency and safety. The roadmap on Road Automation has been compiled in cooperation with the iMobility Forum.

The expected outcome from these activities is a technology readiness for vehicle, infrastructure and communication technologies that provides an effective holistic platform for further development and eventual industrialisation. The final target is to meet customer, societal and regulatory demands for enhanced safety of vehicles and the transport system as a whole, whilst offering the driver an enhanced experience, faster and more reliable journeys and appropriate travel information integrated into the modern electronic communication system.
The Strategic Framework for Automotive Research & Innovation

EUCAR’s members have analysed in depth the strategic motivation for performing research and innovation (R&I) activities and specifically collaborative R&I, in order to set out a future vision for these activities. The following questions need to be answered: “why is collaborative automotive R&I important”, and “what should policy makers and stakeholders expect to extract gain from EUCAR’s roadmaps and this summary, and how is it related to Horizon 2020”. The motivation and the answers to these questions can be considered in terms of three strategic elements at different levels of detail:

→ **The main relevant Strategic Trends**: these set the context for long-term strategy and have been identified by EUCAR’s members as the long-term global driving forces and trends which motivate change and require identification of the key automotive R&I themes.

→ **Overall Objectives for automotive R&I**: aligned with the broader policy perspective (aiming at Sustainable Transport and Competitive Industry) and the constituent programmes of Horizon 2020, these include:
  i. The EU Road Safety Programme 2011-2020 aiming at halving road deaths by 2020;
  ii. EU vehicle safety regulations;
  iii. EuroNCAP ratings;
  v. The Smart Cities and Communities initiative;
  vi. The Horizon 2020 programmes “Smart, Green and Integrated Transport” and “Leadership in Industrial and Enabling Technologies”.

→ **Priority R&I Focus Areas**: these representing the key areas of R&I for the automotive sector, identified by the European automotive manufacturers through their collaborative activities in EUCAR.

These are highlighted and represented graphically in the following chart, which represents this strategic outlook in the domain of Safe & Integrated Mobility:

![Figure 1: Strategic framework for Safe & Integrated Mobility](image-url)
A number of key R&I priorities in Safe & Integrated Mobility derive from the need to meet societal and industrial challenges, within the global strategic framework of prevailing conditions and trends. These priorities relate to the need to improve safety and efficiency of individual vehicles and road users within a safe and efficient mobility and transport system, providing the technologies, data and services to improve the driving experience and contribute to safety and efficiency.

The EUCAR Strategic Vision for Collaborative R&I

Derived from the strategic framework, the following statements represent the strategic vision of the European automotive manufacturers in the domain of Safe & Integrated Mobility. They are to be considered as an expression of the ambition of the manufacturers in meeting future societal and industrial objectives. They also represent a motivating objective for the definition and performance of research and innovation activities by EUCAR’s members.

The statements include an overall vision statement for Safe & Integrated Mobility and five statements, each representing the strategic vision for part of the domain. This subdivision indicates the breakdown of the Safe & Integrated Mobility domain from the automotive manufacturers’ point of view into four vertical themes “Safety” and “Transport/Travel System”, “Traffic Efficiency” and “Value-Added Customer Services”. For each of these themes, one or more EUCAR R&I roadmaps has been compiled. The horizontal theme “ICT & Telematics” is a key element of the Safe & Integrated Mobility domain which feeds the vertical domains.

FIGURE 2  EUCAR Strategic Vision for Safe & Integrated Mobility
EUCAR Research & Innovation Roadmaps, Milestone Objectives and Correspondence to Horizon 2020

In order to create a productive link between the automotive manufacturers’ strategic vision and their priorities for collaborative research and innovation, milestones have been compiled, representing the objectives to be reached by technology at different levels of readiness.

Milestones and R&I priorities are described in EUCAR’s roadmaps. In particular, industrialisation milestones have been compiled, representing the objective for the industrialisation of the technology on the market, derived from the Strategic Vision and relevant indicators.

Industrialisation milestones can be considered as a more detailed expression of elements of the strategic vision and are listed below:

→ **Safety**: “Reduction in the number of accidents, fatalities and injuries, contributing to the fulfilment of future EU guidelines, targets and regulations and to meeting increasing customer demands for safe road transport.”

→ **Transport / Travel System**: “An increase in the effective capacity of the road system(s) enabling projected future increases in traffic volume (projected 38% increase in passenger traffic and 68% in freight traffic by 2050 compared to 2005* with road capacity expected to grow at a minimal rate).”

→ **Traffic efficiency**: “A significant decrease in the variability of journey times compared day-to-day.”

→ **Value added customer services**: “Substantial and growing revenue from services (further metric to be identified).”

→ **ICT & Telematics**: “Enabling the fulfilment of future regulatory and standardisation demands on connected vehicles (e.g. eCall) supporting a competitive playing field for the automotive industry.”

In the domain of Safe & Integrated Mobility, roadmaps have been compiled which cover the following areas:

1. Active Safety and Driver Assistance 2.0
2. Integrated Safety
3. Passive Safety
4. Automated Vehicles
5. Cooperative Vehicles
6. Driver-Vehicle Dialogues for Safe Driving
7. Driver Vehicle Dialogue for Efficient & Green Driving
8. Driver Vehicle Dialogue for Comfortable, Enjoyable and Informed Driving
9. Cloud-Integrated Vehicles

In this domain, the corresponding elements of the proposed Specific Programme Horizon 2020 have been identified, as well as the relevant public-private partnerships:

<table>
<thead>
<tr>
<th>EUCAR Strategic Pillar</th>
<th>Horizon 2020 Specific Programme</th>
<th>Proposed Public-Private Partnerships in Horizon 2020</th>
</tr>
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</table>
| Safe & Integrated Mobility | **Smart, Green & Integrated Transport:**
  4.1 Resource efficient transport that respects the environment
  4.2 Better mobility, less congestion, more safety and security
  4.3 Global leadership for the European transport industry
| **Leadership in Enabling & Industrial Technologies:**
  11 Information and Communication Technologies | Smart Mobility
  Logistics |

**FIGURE 3** Potential correspondence to the Specific Programme Horizon 2020 and Public-Private Partnerships
Research and Innovation Roadmaps

The Research and Innovation roadmaps for Safe & Integrated Mobility set out the collaborative technological research and pilot/demonstrator topics and their timing, which are priorities for the automotive manufacturers during the course of Horizon 2020 and beyond, in order to meet the defined strategy and milestones.

The vertical themes of Safe & Integrated Mobility from the strategic vision are presented schematically in the chart below, showing the positioning of the roadmaps. Due to the highly interconnected nature of the Safe & Integrated Mobility domain, the relationships between the domains are shown, with the overlaps and potential synergies between the R&I roadmaps being therefore clearly identified.
The following is a list of the R&I topics proposed in each roadmap.

### Roadmap: Safety
- **Active Safety**
  1. Driver centered heightening of driving assistance towards autonomous driving
  2. Sensors – technology, 360° intelligence and system architecture
  3. Vehicles dynamic and motion control 2.0
  4. Safe testing & assessment of intelligent vehicles with increasing level of automation
  5. Human behaviour and performance in cooperation with ADAS
- **Integrated Safety**
  6. Balancing safety measures for optimal safety and protection
- **Passive Safety**
  7. Virtual crash test
  8. Crashworthiness and advanced compatibility of light, new vehicle & safety concepts

### Roadmap: Driver-Vehicle Dialogues
- **Driver-Vehicle Dialogues**
  1. Driver-vehicle collaborative automation
  2. Attentive driving
  3. Behavioural coaching
  4. Safe and natural driving interaction
  5. Next generation driving environment
  6. Traffic efficiency and efficient use of human time
  7. Value added and customer demand services

### Roadmap: Cooperative Vehicles
- **Cooperative Vehicles**
  1. Communication and Sensing Network
  2. Cooperative and progressively automated driving
  3. Platform Design
  4. V2I application: context aware driving
  5. Freight & logistics
  6. Systems Architecture
  7. Business Prospects and Opportunities
  8. Cooperative ADAS

### Roadmap: Road Automation
- **Road Automation**
  1. Efficient Self-Operating Vehicles
  2. Collaborative Automation
  3. Cooperative Fully Automated Driving
  4. Interconnected traffic
  5. Automated Safety
  6. Urban Automated traffic
  7. Pilots & demonstrators (including highway, urban, intersection, speed adaptation, transport system)

### Roadmap: Cloud-Integrated Vehicles
- **Cloud-Integrated Vehicles**
  1. Data Processing
  2. Interfaces
  3. Communication
  4. Privacy and IT-Security
  5. Value Chains
  6. Pilots (efficiency, safety, automation)

### Roadmap: Fluid Vehicle Traffic
- **Mobility / Fluid Vehicle Traffic**
  1. Car2Car – communication
  2. Specific car design
  3. Traffic management system
  4. Intelligent traffic tools
  5. Better use of given capacity
  6. Improved logistic
  7. Intelligent choosing the form of transport

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Overview

EUCAR’s members, the European automotive manufacturers, strive for a competitive industry whose products meet the needs of society. European collaborative research & innovation (R&I) supports this strategic objective by enabling cooperation between stakeholders and providing co-funding to mitigate part of the risk inherent in automotive research. In the area of Affordability & Competitiveness, co-funded research supports the development of technologies which support a competitive automotive industry, producing affordable passenger and commercial vehicles meeting customer and societal demands, whilst fulfilling ever more stringent regulatory standards.

The EUCAR R&I roadmaps define the strategic recommendations of the manufacturers for collaborative R&I, detailing the necessary topics for R&I projects aligned with the strategic objectives. They are a vital and unique contribution, since they represent the outlook of the manufacturers, who themselves have the ultimate responsibility to innovate in bringing the resulting technologies to market.

In Horizon 2020, the programmes on “Leadership in Enabling and Industrial Technologies” and “Smart, Green and Integrated Transport” are of direct relevance to R&I in Affordability & Competitiveness. The roadmaps for Affordability & Competitiveness present recommendations for collaborative R&I in three areas: “Application of Suitable Materials for Future Vehicles”, “Virtual Engineering Product Process” and “Sustainable & Efficient Manufacturing”.

For interior materials, collaborative research should concentrate on improvements in functionality, appearance, stability and acoustics as well as integration into the production process. For lightweight vehicles, priorities include new materials, shapeability, joining, sheet forming and again integration into the production process. In manufacturing, R&I priorities enhance productivity through collaboration and automation including safety, surveillance, tracking, reflexes and algorithms. Advances in different levels of robotics assistance are important, covering co-manipulation, assistant tools and full automation of heavy processes. Also in the factory, energy and resources efficiency of plants, including planning, renewables use and recovery are key areas of R&I focus. These activities can be supported by the deployment of advanced virtual engineering, including simulation, modelling and assessment.

The expected outcome from these activities is a technology readiness for automotive materials and for manufacturing technologies that provides a platform for further development and eventual industrialisation. The final target is to support the fulfilment of customer demands for automotive vehicles which are affordable and continue to meet their needs and expectations on functionality, quality and safety. This is integrated with the fulfilment of societal and regulatory demands on vehicles, and supports a competitive European industry which, as well as providing valuable products, is a key part of the industrial landscape providing jobs and wealth to the continent and its regions.
EUCAR’s members have analysed in depth the strategic motivation for performing research and innovation (R&I) activities and specifically collaborative R&I, in order to set out a future vision for these activities. The following questions need to be answered: “why is collaborative automotive R&I important?”, “what should policy makers and stakeholders expect to gain from EUCAR’s roadmaps and this summary, and how is it related to Horizon 2020?”. The motivation and the answers to these questions can be considered in terms of three strategic elements at different levels of detail:

- **The main relevant Strategic Trends**: these set the context for long-term strategy and have been identified by EUCAR’s members as the long-term global driving forces and trends which motivate change and require identification of the key automotive R&I themes.

- **Overall Objectives for automotive R&I**: aligned with the broader policy perspective (aiming at Sustainable Transport and Competitive Industry) and the constituent programmes of Horizon 2020, these include:
  i. EU Industrial Policy “Industrial revolution brings industry back to Europe”;
  ii. The Horizon 2020 programmes “Leadership in Industrial and Enabling Technologies” and “Smart, Green and Integrated Transport”.

- **Priority R&I Focus Areas**: these represent the key areas of R&I for the automotive sector, identified by the European automotive manufacturers through their collaborative activities in EUCAR.

These are highlighted and represented graphically in the following chart, which represents this strategic outlook in the domain of Affordability & Competitiveness:

**FIGURE 1** Strategic framework for Affordability & Competitiveness
The key R&I priorities in Affordability & Competitiveness are derived from this analysis, directly from the need to meet societal and industrial challenges, within the global strategic framework of prevailing conditions and trends. These priorities relate to the need continually to improve efficiency and productivity of production whilst increasing flexibility to meet intensifying customer demands and enabling the production of future vehicles with new technologies meeting stringent regulations.

**The EUCAR Strategic Vision for Collaborative R&I**

Derived from the above strategic framework, the statements presented below represent the strategic vision of the European automotive manufacturers in the domain of Affordability & Competitiveness. They are to be considered as an expression of the ambition of the manufacturers in meeting future societal and industrial objectives. They also represent a motivating objective for the definition and performance of research and innovation activities by EUCAR’s members.

The statements include an overall vision statement for Affordability & Competitiveness and three statements, each representing the strategic vision for part of the domain. This subdivision indicates the breakdown of the Affordability & Competitiveness domain from the automotive manufacturers’ point of view into three vertical themes “Application of suitable materials for future vehicles”, “Virtual engineering product process integrated approach” and “Sustainable and Flexible Manufacturing”. For each of these themes a EUCAR R&I roadmap has been compiled.
**EUCAR Research & Innovation Roadmaps and Milestone Objectives**

In order to create a productive link between the automotive manufacturers’ strategic vision and their priorities for collaborative research and innovation, milestones have been compiled, representing the objectives to be reached by technology at different levels of readiness.

Milestones and R&I priorities are described in EUCAR’s roadmaps. In particular, industrialisation milestones have been compiled, representing the objective for the industrialisation of the technology on the market, derived from the Strategic Vision and relevant indicators.

Industrialisation milestones can be considered as a more detailed expression of elements of the strategic vision and are listed below:

- **A&C1**: “A reduction in per-vehicle CO2 emissions contributing to the fulfilment of future regulatory standards”
- **A&C2**: “A significant increase in the capacity for individual production systems, facilities or lines to meet changing or volatile demands for differentiated products.”
- **A&C3.1**: “A substantial increase in the annual gain in production efficiency measured by number of vehicles produced per man-hour (compared to 2000-2010) for equivalent level of production.”
- **A&C3.2**: “A substantial decrease in the proportion of older workers removed from the production line due to physical limitations.”
- **A&C4**: “A substantial reduction in the full-cycle production and delivery cost differential between the EU and important developing countries.”
- **A&C5**: “A substantial increase in the annual gain in plant energy efficiency measured by kW-hours per vehicle produced (compared to 2000-2010) for equivalent level of production.”
- **A&C5.2**: “A substantial reduction in material waste per vehicle.”
- **A&C5.3**: “A substantial reduction in tonne-km transport needs per vehicle during the production process.”
- **A&C6**: “A substantial decrease in the number of serious injury-causing incidents per million hours of work.”

In the domain of Affordability & Competitiveness, the following five roadmaps have been compiled:

1. Materials, technologies and process for interiors
2. Materials, technologies, process and simulation tools for lightweight vehicle structure
3. People productivity: Collaboration and automation (robots, ergonomics and aging workforce)
4. People productivity: Ergonomics and automation (including aging workforce)
5. Energy and resource-efficient plants

In this domain, the corresponding elements of the proposed Specific Programme Horizon 2020 have been identified, as well as the relevant public-private partnerships:

<table>
<thead>
<tr>
<th>EUCAR Strategic Pillar</th>
<th>Horizon 2020 Specific Programme</th>
<th>Public-Private Partnerships</th>
</tr>
</thead>
</table>
| Affordability & Competitiveness | **Smart, Green & Integrated Transport:**
| | 4.1 Resource-efficient transport that respects the environment
| | 4.3 Global leadership for the European transport industry
| | **Leadership in Enabling & Industrial Technologies:**
| | 1. Information and Communication Technologies
| | 1.3 Advanced Materials
| | 1.5 Advanced Manufacturing and Processing
| | European Green Vehicles Initiative (ESVI)
| | Factories of the Future
| | euRobotics Initiative
| | Sustainable Process Industry through Resource and Energy Efficiency (SPIRE)

**FIGURE 3** Potential correspondence to the Specific Programme Horizon 2020 and Public-Private Partnerships
Research and Innovation Roadmaps

The Research and Innovation roadmaps for Affordability & Competitiveness set out the collaborative technological research and pilot/demonstrator topics and their timing, which are priorities for the automotive manufacturers during the course of Horizon 2020 and beyond, in order to meet the defined strategy and milestones.

The following research and innovation areas are the priorities identified for the EUCAR R&I roadmaps in Affordability & Competitiveness:

**Materials, technologies and process for interiors**
- In scientific research: modularity, new surface functionalisation, visual appearance and haptics
- In technological research:
  - Acoustics
  - Thermal stability
  - Shapeability
  - Process compatibility
  - New architecture
- Integration into the production process and large scale production in pilots and eventual industrialisation

**Materials, technologies, process and simulation tools for lightweight vehicle structure**
- In scientific research: new alloys and sheets
- In technological research:
  - Glass / composite reinforcement
  - Shapeability
  - Joining technologies
  - Sheet forming
  - Process compatibility
- Integration into the production process and large scale production in pilots and eventual industrialisation

**People productivity: Collaboration and automation (human with robots)**
- Safety
- Surveillance
- Tracking
- Reflexes
- Algorithms
- Testing on moving lines and with human interaction in the factory

**People productivity: Ergonomics and automation (including aging workforce)**
- Robotic assistance
- Full automation of heavy workstations
- Models and simulation tools
- Workers knowledge management

**Roadmap: Materials Technologies**

**Roadmap: Virtual Engineering & Simulation**
- Basic research in virtual engineering
- Simulation for manufacturing and ergonomic assessment
- Lightweight vehicle creation
- Simulation and modelling for materials and flexible parts

**Roadmap: People Productivity**

**Roadmap: Energy & Resource-Efficient Plants**
- Energy planning
- Renewables use
- Energy recovery
Overview

EUCAR’s members, the European automotive manufacturers, strive for a competitive industry whose products meet the needs of society. European collaborative research & innovation (R&I) supports this strategic objective by enabling cooperation between stakeholders and providing co-funding to mitigate part of the risk inherent in automotive research. In the area of Commercial Vehicles, co-funded research supports the development of technologies which meet the demands of the freight and passenger transport sector, whilst fulfilling ever more stringent regulatory standards.

The EUCAR R&I roadmaps define the strategic recommendations of the manufacturers for collaborative R&I, detailing the necessary topics for R&I projects aligned with the strategic objectives. They are a vital and unique contribution, since they represent the outlook of the manufacturers, who themselves have the ultimate responsibility to innovate in bringing the resulting technologies to market.

In Horizon 2020, the programmes on “Smart, Green and Integrated Transport” and “Leadership in Enabling and Industrial Technologies” are of direct relevance to R&I in Commercial Vehicles. The roadmaps for Commercial Vehicles present recommendations for collaborative R&I in two main areas: “Connected Commercial Vehicle” and “Efficient Commercial Vehicles”.

For Connected Commercial Vehicles, the primary R&I topic areas aim to support safe and fully integrated vehicles for effective transport and mobility operations. These areas are “Self-Operating and Resilient Trucks”, “Transport System Integrated Trucks”, “Traffic and Infrastructure Integrated Trucks” and “Vehicles for Advanced City Logistics”. For Efficient Commercial Vehicles, low emission and low consumption vehicles are the main target. The R&I areas are: “Tailored trucks and load carriers”, “Sustainable and new energy trucks”, “Advanced long-distance buses”, “Vehicles for advanced city logistics” and “Heavy-duty electrification”.

The expected outcome from these activities is a technology readiness for safe, integrated and efficient commercial vehicles that will allow further innovation activities by manufacturers and industrialisation of the technologies. The target for industrialisation is to meet customer demands for efficient goods and passenger transport whilst meeting societal goals and regulatory targets and supporting a competitive European industry.
The Strategic Framework for Automotive Research & Innovation

EUCAR’s members have analysed in depth the strategic motivation for performing research and innovation (R&I) activities and specifically collaborative R&I, in order to set out a future vision for these activities. The following questions need to be answered: “why is collaborative automotive R&I important”, and “what should policy makers and stakeholders expect to extract gain from EUCAR’s roadmaps and this summary, and how is it related to Horizon 2020”. The motivation and the answers to these questions can be considered in terms of three strategic elements at different levels of detail:

- **The main relevant Strategic Trends**: these set the context for long-term strategy and have been identified by EUCAR’s members as the long-term global driving forces and trends which motivate change and require identification of the key automotive R&I themes.

- **Overall Objectives for automotive R&I**: aligned with the European policy perspective (aiming at Sustainable Transport and Competitive Industry) and the constituent programmes of Horizon 2020, these include:
  i. CO2 emissions regulations for vans and trucks;
  ii. The 2011 Transport Policy White Paper;
  iii. The Clean Power for Transport proposal;
  iv. The Strategic Transport Technology Plan;
  v. The Horizon 2020 programmes “Smart, Green and Integrated Transport” and “Leadership in Industrial and Enabling Technologies”.

- **Priority R&I Focus Areas**: these represent the key areas of R&I for the automotive sector, identified by the European automotive manufacturers through their collaborative activities in EUCAR.

These three strategic elements are highlighted and represented graphically in the following chart, which represents this strategic outlook in the domain of Commercial Vehicles:
A number of key R&I priorities in Commercial Vehicles derive from the need to meet societal and industrial challenges, within the global strategic framework of prevailing conditions and trends. These priorities relate to the need to ensure efficiency, reliability and safety of road freight and passenger transport whilst ensuring that new technologies are cost effective, through development of new vehicle concepts, powertrains and services.

The EUCAR Strategic Vision for Collaborative R&I

Derived from the above strategic framework, the statements presented below represent the strategic vision of the European automotive manufacturers in the domain of Commercial Vehicles (trucks and buses). They are to be considered as an expression of the ambition of the manufacturers for research and innovation in meeting future societal and industrial objectives. They also represent a motivating objective for the definition and performance of research and innovation activities by EUCAR’s members.

The statements include an overall vision statement for Commercial Vehicle and different statements, each representing the strategic vision for part of the domain. This subdivision indicates the breakdown of the Commercial Vehicle domain from the automotive manufacturers’ point of view into Connected Commercial Vehicle, Safe Commercial Vehicle and Efficient Commercial Vehicle.

![Figure 2](image-url)

**COMMERCIAL VEHICLES**

An integrated approach for reliable, clean, safe and efficient freight transport and passenger mobility, through dedicated vehicle concepts and effective

**CONNECTED COMMERCIAL VEHICLE**

Commercial Vehicles that are connected to the infrastructure, operators and drivers, supporting an efficient and resilient transport system and effective logistics

**SAFE COMMERCIAL VEHICLE**

Commercial vehicles that protect all road users and avoid and mitigate accidents through advanced vehicle technology, cooperative systems and increasing levels of automation

**EFFICIENT COMMERCIAL VEHICLE**

Commercial vehicles with optimum efficiency and performance, making use of advanced propulsion and energy systems and dedicated vehicle configurations
In order to create a productive link between the automotive manufacturers’ strategic vision and their priorities for collaborative research and innovation, milestones have been compiled, representing the objectives to be reached by technology at different levels of readiness.

Milestones and R&I priorities are described in EUCAR’s roadmaps. In particular, industrialisation milestones have been compiled, representing the objective for the industrialisation of the technology on the market, derived from the Strategic Vision and relevant indicators.

Industrialisation milestones can be considered as a more detailed expression of elements of the strategic vision and are listed below (milestones to be determined):

→ **Connected Commercial Vehicle**: “An increase in the effective capacity of the freight transport system(s) enabling projected future increases in volume with increased reliability of schedules (projected 68% increase in freight traffic by 2050 compared to 2005 with road capacity expected to grow at a minimal rate).”

→ **Safe Commercial Vehicle**: “A concurrent reduction in the number of accidents, fatalities and injuries due to road freight transport, contributing to the fulfillment of future EU guidelines, targets and regulations, and to meeting increasing public demands for safe road transport.”

→ **Efficient Commercial Vehicle**: “A reduction in per-vehicle CO2 emissions contributing to the fulfillment of future regulatory standards and customer expectation for lower running costs.”

In the domain of Commercial Vehicles, complementing the relevant roadmaps from the three Strategic Pillars, Commercial Vehicle-specific roadmaps have been compiled which cover the following areas:

1. Connected Commercial Vehicle
2. Efficient Commercial Vehicle

In this domain, the corresponding elements of the proposed Specific Programme Horizon 2020 have been identified, as well as the relevant public-private partnerships:

<table>
<thead>
<tr>
<th>EUCAR Strategic Platform</th>
<th>Horizon 2020 Specific Programme</th>
<th>Public-Private Partnerships and potential Public-Private Partnerships in Horizon 2020</th>
</tr>
</thead>
</table>
| Commercial Vehicles         | **Smart, Green & Integrated Transport:**  
41 Resource-efficient transport that respects the environment  
42 Better mobility, less congestion, more safety and security  
43 Global leadership for the European transport industry  
**Leadership in Enabling & Industrial Technologies**  
11 Information and Communication Technologies                                                                 | European Green Vehicles Initiative (EGVI)  
ICT for Smart Mobility  
Logistics                                                                                                    |
## Research and Innovation Roadmaps

The Research and Innovation roadmaps for Commercial Vehicles are to be published in parallel to this executive summary. They set out the collaborative technological research and pilot/demonstrator topics and their timing, which are priorities for the automotive manufacturers during the course of Horizon 2020 and beyond, in order to meet the defined strategy and milestones.

The following research and innovation areas are the priorities identified for the two Commercial Vehicles roadmaps:

### Connected Commercial Vehicle
1. Self-operating & resilient commercial vehicles
2. Transport system integrated commercial vehicles
3. Traffic and infrastructure integrated commercial vehicles
4. Connected trucks for advanced city logistics

### Efficient Commercial Vehicle
1. Tailored trucks and load carriers
2. Sustainable and alternative energy HD commercial vehicles
3. Advanced long distances bus systems
4. Efficient trucks for advanced city logistics
5. Commercial vehicle electrification

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**Figure 4** R&I roadmaps