HTSM Automotive
Roadmap 2020 – 2030
Stakeholder Summary
Preamble

The Dutch Automotive Industry accounts for one of the largest export volumes in the Netherlands. About 20 billion annually. In a country with a high cost-structure like ours, this can only be achieved by delivering world-class technology. World-class technology is based on world-class knowledge. And that is what we are working on, every day. Not only at DAF Trucks, but also together with the Dutch Automotive Community. The Automotive Industry is one of the cornerstones of the High Tech Systems and Materials sector. A car or a truck is a remarkable High Tech System. Easily equipped with over 30 micro-processors, a high-tech Internal Combustion Engine with sophisticated after-treatment system, Fuel-cell, Battery-pack. You name it. It delivers you or your cargo in a sustainable, fast, safe, reliable, cost effective way to where ever you need.

Since you are related to the Automotive Industry you know the challenges we are facing the coming decades. With CO2-reduction being by far the most important at this moment for many of us. Where local air quality and traffic safety, in particular regarding vulnerable road users, are top priorities for our society as well. But also with inevitable digitisation impacting our products and business in an unprecedented way. All of this are the ingredients for a complete new Automotive Roadmap, that will be released today. As Chairman of the Automotive Roadmap working group, I can not stress enough the importance of the focal points addressed within this Roadmap for the position of the Dutch Automotive Industry, but also for achieving important societal goals. Subjects like hydrogen as direct fuel for HD combustion engines, HD hybrid drivetrain technology and battery and battery-pack technology are of great importance but also sensing, driver assistance and navigation technology that come from our Dutch industry.

We as a company take the lead in many of these subjects. But we would like to cooperate with Dutch partners in these innovations, although we of course have to look beyond the border. We also count on cooperation with the Dutch government in achieving these very demanding Roadmap challenges.

I hope you get inspired by the new Automotive Roadmap.
1. The HTSM automotive landscape

The HTSM Automotive Roadmap 2020 – 2030 is succeeding the HTSM Automotive Roadmap 2018 – 2025. The reason for this is the creation of the Klimaatakkoord and the ‘Meerjarige Missiegedreven Innovatieprogramma Duurzame Mobiliteit 2020-2024’. The objectives from the Climate Agreement to reduce CO$_2$ emissions from mobility to a maximum of 25 Mton by 2030 (7 Mton lower than the current situation) and to be reduced to almost zero by 2050 require acceleration of plans.

The Dutch “Top sector Policy” applies to key economic areas (the top sectors$^1$). For these areas, a national approach of smart collaborations between industrial parties, research institutes and academia (universities), and the government has been defined. Within this so-called Triple Helix innovation framework Roadmaps have become the focal points in guiding Research and Development (R&D) within the “Top sector Policy”. The subsequent document relates to ‘Automotive Industry’ as a part of the top sector “High Tech Systems & Materials” (HTSM).

The top sector High Tech Systems and Materials (HTSM) is an important contributor to the Dutch economy, driving technological developments and so is the automotive industry. The automotive industry develops and applies technologies that can make a vital contribution to the Dutch economy and the societal challenges in the decade(s) ahead.

The primary audience for this document includes Automotive Industrial stakeholders (OEM$^2$ and TIER$^3$ suppliers), research institutes and educational stakeholders, regional governments and the ministries of Economic Affairs and Climate Policy, Infrastructure and Water Management, Finance and Foreign Affairs.

1.1 Goal and Scope

The **Goal of this HTSM Automotive roadmap** is to provide a joint stakeholder view on the R&D needs of the Dutch automotive sector up to 2030 with its **Scope** at vehicle level. This roadmap aims to provide guidance for (i) the industry and its stakeholders for developments and (ii) the government for their supportive strategy to meet the needs of the next decade.

---

2. Original Equipment Manufacturer
3. Suppliers within the manufacturing chain
Whilst the focus is on future on-road vehicles, other modalities can also benefit from the sector’s innovations. Due to the international playing field of the automotive sector, these vehicles are studied in a national as well as European context.

The automotive industry sector is a global market and companies from all over the world are competing in solving the societal issues. Within the European context, the EC ambitions stated in its Mobility Packages⁴, are relevant to both Smart and Sustainable mobility, as well as its intersection. On national level, the Climate Agreement together with the associated Multi-year Mission-orientated Innovation Program (MMIP) on Sustainable Mobility⁵ and Integral Knowledge and Innovation Agenda (IKIA) on climate and energy⁶ give clear directions in terms of focus areas for future-proof mobility systems:

1. Behavioural change and social structures;
2. Digitization and platforms;
3. Making vehicles sustainable;
4. Next generation battery technology;
5. Energy carriers and engines;
6. Smart mobility and logistics.

This HTSM Automotive roadmap is directly connected to the focus areas 2, 3, 4, 5 and 6. Based on the current status of vehicle technology and on the challenges to reach the ambitious goals associated with future Sustainable and Smart mobility, this roadmap identifies the key technology development lines. By enhancing their technology position, the selected pathways strongly contribute to the competitiveness of Dutch companies in the automotive sector.

### 1.2 Economic role of the Dutch Automotive Industry

The Netherlands is the sixth largest economy in the European Union and is the 17th-largest economy in the world⁷. The Netherlands has a long history of innovations and as such it is globally recognized as an important knowledge generating country⁸. The present societal challenges stimulate the Dutch innovation strength and solutions create new products, manufacturing methodologies and services in the global market.

Within the Dutch automotive industry, roughly⁹ 45,000 people are employed, of which 10,000 at OEM’s, 4,000 in manufacturing special vehicles and trailers, 29,000 at Tier-suppliers and 2,000 working in research and knowledge institutes.

**Figure 1. Employment**

---

⁸ Automotive, e.g. Roland Berger and KPMG
⁹ [https://opendata.cbs.nl](https://opendata.cbs.nl)
The Dutch automotive industry consists of more than 300 companies. About 200 of them are united by their membership of RAI Automotive Industry NL\(^\text{10}\), representing the automotive industry on a national and international level. The export volume amounts € 20 billion per year, about 88% relates to export of which Germany is consuming the largest share (See Figure 2 below).

**TOTAAL TURNOVER**  
€20 BILLION

- Export 88%
- Internal market 12%

**Figure 2. Turnover and export**

### 1.3 Societal Challenges

Affordable and easily accessible transport of people and goods is a key element of today’s modern society. Its importance is expected to further grow in the future\(^\text{11}\). Driven by societal concerns related to air pollution, global warming, accessibility of cities and traffic safety, there is consensus on the long-term goals set for the various international research agendas and programs: zero emission and zero accidents in 2050. In this paragraph, five key drivers and trends for future developments are mentioned, which influences the changes in the automotive sector.

#### 1.3.1 Global warming and air quality

In the upcoming decades, the automotive industry faces enormous challenges to dramatically reduce CO\(_2\) emissions from vehicles. If human behaviour and vehicle technology remains unchanged, global greenhouse gas emission are expected to double in 2050\(^\text{12}\). There is not a single solution to realize the required massive reduction levels; besides change in human behaviour, a combination of logistical, traffic and vehicle measures with sustainable fuels and energy carriers is needed. This clearly illustrates the complex interaction between the different domains and the need for an integrated systems approach\(^\text{13}\).

Besides increasingly strict European legislation for vehicle’s real-world pollutant emissions, an increasing number of initiatives at the national, regional and local level are introduced to improve local air quality. As a first step, many European cities introduced low emission zones, allowing only vehicles that meet strict emission standards. As a next step, various European cities announced the introduction of zero emission

---

\(^{10}\) [https://www.raivereniging.nl/automotiveindustry.nl](https://www.raivereniging.nl/automotiveindustry.nl)  
\(^{12}\) UN Intergovernmental Panel on Climate Change (IPCC) - [https://www.ipcc.ch/report/ar5/wg3/](https://www.ipcc.ch/report/ar5/wg3/)  
zones by 2030. On national level, the Climate Agreement\textsuperscript{14} set out key actions to support the European Green Deal\textsuperscript{15}, including policy intention that 30 to 40 larger municipalities in the Netherlands introduce zero emission zones for city logistics by 2025. Also, zero emission construction traffic and mobile machinery is a target for 2030.

1.3.2 Traffic safety
It is a target of the European Road Safety action program\textsuperscript{16} to reach “zero fatalities” in Europe by 2050. The introduction of more and more smart mobility solutions with “Obstacle Detection functionalities” contributes to decrease the number of incidents on the roads, resulting in declining numbers for fatalities and (severe) injuries. Furthermore, smart mobility solutions should have a clear beneficial effect on the accessibility of cities, the inclusiveness of the mobility system and smooth and strengthened logistics chains.

1.3.3 Urbanization
Almost three quarters of Europe’s population lives in cities, towns and suburbs. Recent decades have experienced a trend back to the inner cities – re-urbanization – at least to the vibrant inner cities. At the same time, most cities have been experiencing urban sprawl with housing, jobs and commercial activities located in increasingly dispersed suburbs. Furthermore, accessible, inclusive and affordable mobility for all will become a huge challenge in the coming decades.

1.3.4 Demographic trends
Ageing is one of the greatest social and economic challenges of the 21st century for European society that will affect most policy areas. By 2025, more than 20\% of Europeans will be 65 or older, with a particularly rapid increase in numbers of over 80. Older people are most likely to experience mobility difficulties. Accessible mobility for them is a challenge.

1.3.5 Labour market trends
In the labour market, we are currently facing major challenges. Exceptional economic developments, societal challenges and transitions in technology, digitization, robotization, climate and climate adaptation require an agile response on the labour market. Organizations are organized differently, old jobs and tasks are replaced by new ones and the content of the work changes. In order to maintain our global top position and realize our ambitions for the societal challenges, we must continue to invest in our well-trained workforce and commit ourselves to providing all talent with a place on the labour market.


\textsuperscript{15} https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_nl

\textsuperscript{16} https://ec.europa.eu/transport/road_safety/home_en
1.4 Transformation of the Automotive Sector

The Automotive sector is facing major challenges. Next to the societal trends, challenges are national and international agreements with regard to sustainability. The impact of the corona pandemic on the manufacturing industry and in particular the Automotive industry, is an additional obstacle. Therefore, investing in innovation is a top priority for the Dutch automotive industry to maintain a strong international position and to overcome the economic downturn.

The sector worldwide is on the eve of a major transition to a sustainable, smart and safe mobility system. Driven by social aspects, digitalisation becomes more and more important, as data and artificial intelligence (AI) can contribute to a sustainable, safer and more efficient mobility systems. Due to the growing population, accessibility is under pressure. In terms of road safety, the ambition of zero road casualties is not yet in sight. Also, CO2 emissions in the transport sector have grown instead of decreased since 1990, which puts additional pressure on achieving the climate targets.

The Netherlands is well prepared to occupy a leading position here. In addition to market leaders, such as DAF, NXP, VDL, TomTom and Bosch VDT, the Netherlands has a strong position and players in the field of navigation / localization (TomTom, HERE, MapScape / NavInfo) and software / smart infrastructure (Van der Lande, Prime Vision, Dynniq, Vialis and Siemens). These players are surrounded by a wide supply chain to SMEs and innovative startups and scale-ups (To address challenges and strengthen position, programs are defined, such as: Green & Smart Transport delta)

Transitions, needed for the transport sector, require huge investments and strong cooperation between industry, knowledge institutes and government. The amount of investments is at least comparable with the amount of money of innovation programs such as the green and smart transport delta.

1.5 Cross-sectoral context

A strong cooperation between industry, knowledge institutes and government in the automotive field as well as its correlation to other relevant roadmaps is deemed vital for the future success of this roadmap and the Automotive sector. This requires a holistic approach. Therefore, besides technology development, also essential development in enabling fields, such as education and facilities, are discussed.

Furthermore, there is a strong link to the Topsector Energy and Topsector Logistics as enabling technologies and context for developments in both Sustainable and Smart Mobility. Within the HTSM domain, the automotive roadmap is interconnected with the following HTSM roadmaps:

- Business Cluster Semiconductors
- Photonics
- Embedded Systems
- High Tech Materials
- Smart Industry
- Solar
- Components & Circuits
2. Research priorities

2.1 General

As described in the previous chapter, the Automotive sector is facing major challenges. Investing in innovation is a top priority for the Dutch automotive industry to maintain a strong international position and to overcome the COVID-19 related economic downturn. Major steps have already been taken at various levels in the Netherlands when it comes to making the Automotive sector more sustainable. Closer cooperation and mutual goal setting between parties within the sector can therefore lead to an acceleration of this transition. The goal of this HTSM Automotive roadmap provides a joint stakeholder view on the priorities in R&D needs up to 2030.

Drivers for innovation are the shared ambitions to achieve zero fatalities and zero emissions in road transport. The themes Sustainable Mobility and Smart Mobility are the building blocks to achieve this. Sustainable Mobility and Smart Mobility have become more and more related to each other. Sustainable Mobility focuses on development strategies related to the delivery of power to the wheels from an energy source (tank-to-wheel). The ambition is to reach zero emissions in road transport.

Smart Mobility is divided in four subthemes; Cooperative Driving, Automation, Connectivity and Smart Mobility Services. In the near future, especially the first three themes are likely to come together and combine functionalities to enable Automated Driving. Driver for innovation is to achieve zero fatalities in road transport. In the roadmap both Sustainable & Smart mobility have a vehicle focus. Enablers, such as e.g. Manufacturing and the learning community, both addressed the Roadmap, are to be involved. The overviews of investments and priorities are positioned at the end of this chapter.

2.2 Sustainable Mobility

In the upcoming decades, the automotive industry faces enormous challenges to contribute to climate neutral mobility in 2050. For the short term, tailpipe CO\(_2\) emissions from passenger cars as well as heavy-duty vehicles have to be reduced by 30% in 2030 (compared to 2019). Simultaneously, very challenging real-world pollutant targets have to be met and various European cities announced the introduction of zero emission zones by 2030.

To realize the required, massive reduction levels, an integrated system approach is required. Besides changes in human behaviour, a combination of logistical, traffic and vehicle measures is needed. From a cross-sectoral, well-to-wheel perspective, it is essential that future vehicle technologies also support the energy transition by enabling the use of sustainable energy carriers. Currently, there is general consensus that there is not one single energy transition pathway towards sustainable mobility. To meet future decarbonization targets at lowest possible cost, all energy carriers that can contribute will be needed. Three pathways are considered to be most promising for mobility:

- Renewable electricity,
- Renewable hydrogen and
- E-fuels (or power-to-X).

For passenger cars, a clear shift towards battery electric vehicles (BEV) is picking up, but also fuel cell vehicles (FCEV) are foreseen. A similar shift will take place for city distribution and bus applications. Internal combustion engines (ICE) will remain the primary power source for future heavy-duty powertrains in the upcoming decades. To meet requirements for zero emission zones, hybridization of ICE-based powertrains will play an important role.

Based on these trends, five research priorities are identified in this HTSM Automotive roadmap. These research priorities are important for the Dutch automotive industry to strengthen its economic position and to accelerate developments that contribute to the missions specified in the national knowledge and innovation agenda. These priorities are robust for possible shifts in the energy mix and for changing focus on energy carriers. First, battery technology is crucial for all pathways in the energy transition; new generation battery systems are required to enhance energy density, cost efficiency and durability. Second, for ICE-based concepts, highly efficient combustion concepts that enable a wide range of E-fuels are key. Besides application of carbon-based E-fuels, also hydrogen (H\(_2\)-ICE) is attracting increasing attention as a
zero (tailpipe) CO₂ emission solution. Third, there is a need for modular, highly efficient powertrain components and systems for all powertrain concepts. In addition, important enabling technologies are smart vehicle energy management and geofencing to maximize real-world performance within emission limits and advanced development tools to minimize development time and costs.

Besides the research priorities, the following related topics are identified:

1. **Societal driven priorities**
   - Contribute to national and international climate agreements, which aim for zero greenhouse emissions;
   - Address local air quality by introduction of zero emission zones, especially around large cities;
   - Realize infrastructure of smart electric charging stations and of hydrogen fuel stations. This requires cross sectoral alignment and cooperation with related sectors (Energy and Logistics);
   - Towards affordability and circularity for battery electrical systems and hydrogen powered vehicles.

2. **Technology focussed priorities**
   - For assessment of real-world performance and impact of new sustainable vehicle concepts, realization of advanced testing facilities (incl. Battery Competence Centre and hydrogen test capabilities) and large scale field labs is essential;
   - Development of robust emission monitoring concepts to enable geofencing concepts and new adaptive control methods;
   - Development and implementation of new mixed testing (i.e. combination of virtual and physical testing) to guarantee real-world performance and dramatically reduce development time and costs;
   - Development of compact and safe hydrogen storage solutions to enable vehicle range;
   - Development of E-fuels for use in highly efficient internal combustion engines.

### 2.3 Smart Mobility

Safety challenges from new (multi-modal and/or shared) mobility concepts need to be tackled for all road users including vulnerable road users and users of new vehicle types. The aim to achieve zero casualties is the main driver for the activities in the field of Smart Mobility.

The automotive industry is undergoing the initial phase of a transition from vehicle provision towards provision of mobility. Accessible, inclusive and affordable mobility for all will become a huge challenge in the coming decades. The need for less congestion, especially in cities, the changing infrastructure enabling mass transit as well as active modes of transport much more than before and the sharing economy are playing an important role in this transition. In this transition, mobility and transport will become more and more smart.

Missie D+ , MMIP 9, 10 and especially the ‘deel Kia Toekomstbestendige Mobiliteitssystemen’ give directions to this transition and the underlying development needs. For the activity field of Smart mobility the main challenge is to develop and implement systems which maximally address the social drivers (safety, environment and throughput), making efficient use of the possibilities offered by e.g. digitalization and automation in relation to robustness, security and redundancy.

The four subthemes (Cooperative Driving, Automated Driving, Connectivity and Smart Mobility Services) are linked and their developments go hand in hand. For next stages of the developments, cross sectoral cooperation with e.g. urban planners and telecom industry will be needed. The connectivity enables data transfer, data storage and data sharing as part of the ongoing digitalisation of mobility. Cyber security and AI (Artificial Intelligence) are emerging topics, as well as connecting the individual mobility needs to the overall mobility system; an optimisation for both, in a balanced way, needs to be established.

---

17 Smart Mobility. It inherently includes mobility of people and transport of goods.
Several Dutch cities and regions are willing to open up their infrastructure to test and trial new mobility solutions. Discussions on Physical and Digital Infrastructures and Operational Design Domains of new vehicles show the need for close collaboration between the automotive industry and (regional) road authorities.

1. Societal driven priorities:
   - Contribute to the Vision Zero aims: no road mobility fatalities;
   - Tackle safety challenges from new mobility concepts, including challenges for vulnerable road users;
   - The increasing call for urban transitions: more shared space, less car focussed street occupation;
   - Optimisations to include human behaviour in changing conditions, including transition of control;
   - Address the operational needs and opportunities to increase efficiency, flexibility and reduce travel time and costs;
   - Include the vehicles in the traffic flow combined with active modes of transport, with many interactions.

2. Technology focussed priorities:
   - Driving in mixed traffic conditions, with road users equipped and not-equipped with connected and/or automated vehicle functions;
   - Develop advanced safety functions and human centred Advanced Driver Assistance Systems (ADAS);
   - Define and develop the essential digital and physical infrastructure to enable large scale deployment of smart mobility solutions;
   - Extend the Operational Design Domain of ADAS and autopilot, make clear steps beyond the use in confined areas;
   - Development of understandable, explainable and trustworthy AI solutions to further boost the smart mobility developments;
   - Develop and use assessment tooling and facilities, including digital twins of physical infrastructure, supporting the development, validation, assessment and monitoring automated driving functions;
   - Further developments on radar technology and other perception system related technologies.

2.4 Sustainable and Smart Manufacturing

The automotive industry is shifting from traditional production towards sustainable and smart manufacturing. This means that production methods/processes, natural resources and energy sources are in the process of optimization and adapting new technologies in order to contribute to environmental, social and climate related themes. The business climate for the Dutch Automotive Industry has developed over the past decades from regional to European and even global. The current playing field is an international industry where companies must deal with international competitors, customers and suppliers and their challenges. An issue today, which will remain in the future, is fluctuating demand from a more diverse customer base. This forces companies to include a higher level of flexibility in their manufacturing process. In addition, manufacturing companies are faced to reduce CO₂ emissions and introduce circularity, driving a growing awareness of strategical adaptations to remain competitive. Future prospects and the development of high-quality, sustainable (incl. circularity) and smart (incl. Big data and AI) production are actual trends.

In addition, depending on the development of various mobility concepts, we may see trends such as; maximum production volume flexibility and low cost high volume production lines. Whilst adding value is and remains an absolute necessity to make sufficient margin.

COVID-19 teaches us that reliance on supply chains outside the EU can be risky and EU supply chains may offer more stability. Products will also imply a strategy for future disassemble, refurbish and recycle as part of a product life cycle. Sustainable and smart manufacturing is strongly interconnected with the Roadmaps High Tech Materials and Smart Industry.
2.5 Automotive Learning Community

In order to make sustainable and smart innovations pay off quickly in practice, companies and education will have to team-up quickly and people must be adequately trained and equipped with the state of the art technology.

As such, learning instruments and training facilities will be integral part of R&D and pre-deployment. Digital twins, big data and artificial intelligence (AI) are key enablers for efficient and smart mobility, directly related to the Engineers of the Future.

The goals of the relevant human capital activities are related to two aspects:

1. **Quantity**: Sufficient numbers of “Engineers of the future” at all levels.
2. **Quality**: Education programs based upon the future needs of the industry.
## 2.6 HTSM Automotive Priority List

This section presents an overview of priorities in time. Three time blocks have been defined to guide the main drivers on short, mid and long-term.

### Abbreviations used:

- **ADAS**: Advanced Driver-Assistance Systems
- **BCC**: Battery Competence Centre
- **ICE**: Internal Combustion Engine
- **ICSP**: Innovation Centre for Sustainable Powertrains
- **ODD**: Operational Design Domain
- **RAM**: Reliability Availability Maintainability

### Table: HTSM Automotive Priority List

<table>
<thead>
<tr>
<th>Legend</th>
<th>Green</th>
<th>Smart</th>
<th>Manufacturing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drivers (societal/strategic)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 2025</td>
<td>2025 - 2030</td>
<td>&gt; 2030</td>
<td></td>
</tr>
<tr>
<td>Passenger car</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Optimization EV towards affordability and circularity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High efficiency vehicle concept for geofencing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy transition towards green electricity, green H2 and E-fuels</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zero emission public transport (NL Climate Agreement)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zero emission urban (NL Climate Agreement, AMAP)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact Circularity &amp; Life cycle assessment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urban Zero Emissions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Call for urban transitions: more shared space</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urban mobility solutions (buses &amp; PRT)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Optimization EV towards affordability and circularity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High efficiency vehicle concept for geofencing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy transition towards green electricity, green H2 and E-fuels</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zero emission urban (NL Climate Agreement, AMAP)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact Circularity &amp; Life cycle assessment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fully automated passenger car</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Applications</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Long haul (heavy-duty)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current and next generation battery systems</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sensor-based monitoring &amp; diagnostics for emissions, Fault Detection &amp; Predictive Maintenance (AI &amp; geofencing)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Modular and high efficient powertrain components and systems</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cybersecurity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reliable maps, new functional layers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Advanced sensor technology for ADAS (radar based)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Highly automated vehicles on Open Roads</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Highly automated vehicles Hub-to-Hub operation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Highly automated vehicles on Open Roads</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enabling Technology</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Validation / roadworthiness</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Advanced lab facilities for sustainable vehicle development &amp; validation (BCC, ESF H2 capabilities, ZE lab)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Large scale field lab for real-world data library of sustainable vehicles &amp; smart grids</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ground truth infrastructure including capability of testing and evaluation of allowed modules</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Digital infrastructure, Communication and Sensing Network System architecture and framework for data sharing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Virtual homologation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manufacturing &amp; Materials</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>New products by new manufacturing systems, high volume additive manufacturing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High performance manufacturing and equipment towards zero defects production (MM)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ICT enabled and intelligent manufacturing towards autonomous plants</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sustainable manufacturing towards circular production</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Notes:

- **Legend** refers to the priorities in green, smart, and manufacturing categories.
- **Priorities in time** are categorized into three time blocks: < 2025, 2025 - 2030, > 2030.
Publisher Contact
RAI Automotive Industry NL
Automotive Campus 30, 5708 JZ HELMOND, The Netherlands
info@raivereniging.nl
+31(0)492.562.500

Authors
Gerard Koning RAI AINL
Margriet van Schijndel-de Nooij TU/e
Frank Willems TNO & TU/e

Contribution & Review
Thomas van Berkel RAI AINL
Joëlle van den Broek TNO
Thomas Chiarappa TNO
Jean-Pierre Heijster RAI AINL
Xander Seijkens TNO & TU/e
Peter van Gompel TNO & TU/e
Richard Smokers TNO
Steven Wilkins TNO & TU/e

Roadmap Team
Ron Borsboom (Chairman) DAF
Rik Bross minezk
Kees Gehrels NXP
Merlijn Jakobs NWO
Menno Kleingeld VDL
Leo Kusters RAI AINL
Jack Martens DAF
Margriet van Schijndel-de Nooij TU/e
Martijn Stamm TNO