

- **R&D Challenges: Battery Electric Vehicle 2023+**
- **R&D Challenges: Fuel Cell Electric Vehicle and H₂ 2023+**
- **R&D Challenges: Hybrids and Sustainable Fuels 2023+**
- **R&D Challenges: Advanced Vehicle Concepts 2023+**
- **R&D Challenges: Innovative Materials and Vehicle Production Technologies 2023+**

The A3PS position papers are available for download online at <https://www.a3ps.at/a3ps-position-papers>.

A more extensive list of research requirements including mid-term (2025-2023) and long-term (2030+) topics can be found in the A3PS Roadmap “Austrian Roadmap for Sustainable Mobility – a long-term perspective, Version 2022” at <https://www.a3ps.at/a3ps-roadmaps>.

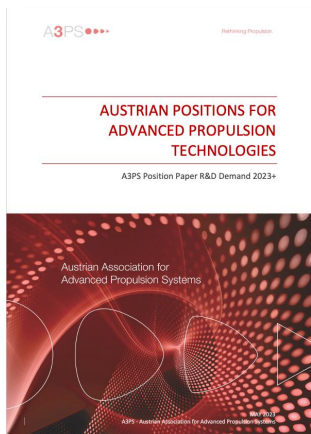
short-term until 2025

medium-term 2025-2030

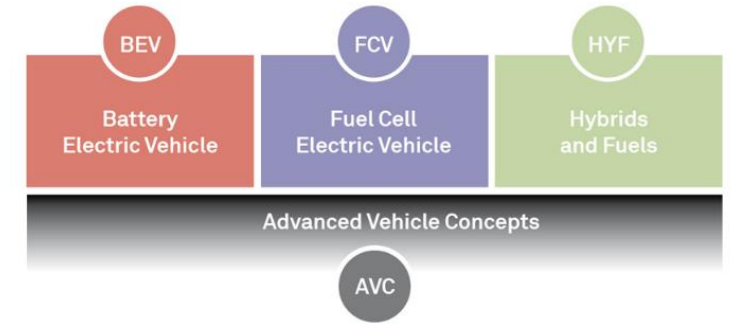
long-term 2030+



Austrian Roadmap for Sustainable Mobility – a long-term perspective



A3PS Position Paper
R&D Demand 2023+



A3PS expert groups have updated and identified actions and measures towards a **climate-neutral, sustainable, efficient and safe transport system** via:

- 1) **Technology-neutral support of mobility and powertrain innovations** in Austria, taking a holistic view of the value creation process, considering **LCA (Life Cycle Assessment)** requirements ("from cradle to grave") in order to meet the 2030 targets and to enable EU mission 2050 targets in full.
- 2) **Determination of the need of a legal framework**, norms, standards and a strategy, both for R&D activities, the rapid implementation of R&D results and for regular operation (street / off-road / rail).
- 3) **Fostering of core competencies** in the field of mobility and powertrain innovations in Austria with a strong focus on value creation in Austria.

A3PS members congregate in four thematic expert groups. These working groups elaborate positions, trends and R&D demands.

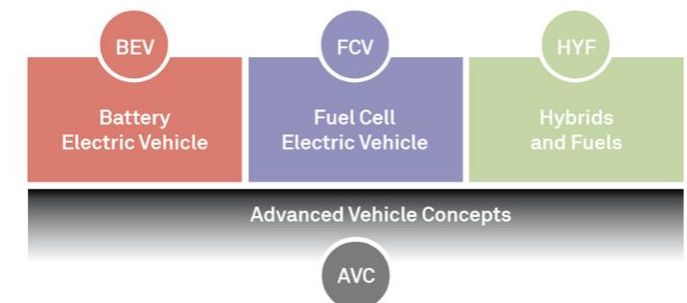
Goal:

To empower the Austrian industry & academia in R&D regarding a global perspective → keep Austria competitive

All R&D topics presented in the A3PS area comprise only CO₂-neutral solutions, global oriented

AK-Leiter Dr. Raimund Ratzl

- Battery-powered electric vehicles represent an outstanding opportunity and need further research & development & innovation to utilize the whole potential
- Specific research needs for product development for the European and Global market:
 - **Research & development to reduce cost** of full electric vehicles incl. charging by new HW/SW concepts and manufacturing methods
 - **Efficiency improvement of the whole electric powertrain** incl. storage, charging and efficient auxiliaries
 - **Research & development to increase specific performance** of electric and mechanical components and systems of the full electric vehicle eco system
 - **Research & development regarding materials and designs** to achieve solutions for circular economy and reduce pollutant emission in the production processes.



R&D Challenges: Battery Electric Vehicle 2023+

Research Requirements - for global competitiveness

- Energy Storages
 - (Structural) Battery Integration from cell to pack to battery system
 - Advanced Lithium-Ion Batteries 3rd and 4th generation as well as advanced Battery Technologies
- Electric Components
 - Electric Motor technology and manufacturing for high voltages
 - Vehicle-, Motion-, Drive- or Powertrain-Control components & systems (Software & Hardware)
 - Inverter, Power Electronics for higher integration levels
- Charging Technologies
 - Ultra fast charging technology
- Thermal Management and Energy Management on BEV Level
 - New more efficient Technologies and system integration



R&D Challenges: Battery Electric Vehicle 2023+

Total R&D project volume of 80 M€ should be supported with a **funding volume** of about **40 M€** considering an average funding rate of about 50 %:

Project types / project volume allocations

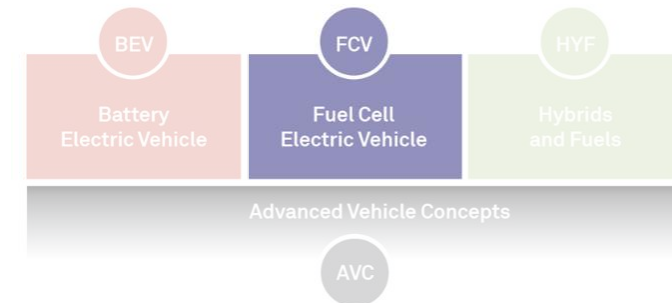
- 8 M€ for low TRL research: 8 projects à 1 M€
- 22 M€ for applied & cooperative research: 11 projects à x 2 M€
- 30 M€ for flagship projects or a cluster of flagship projects: 2 projects à 10-20 M€
- 20 M€ for F&E infrastructure (e.g. testing, pilot production, technology laboratory) excl. COMET, CD-Lab, public infrastructure)

Estimated allocation of projects/funding volume to the research areas:

- 1. Energy Storages: 3/10
- 2. Electric Components: 3/10
- 3. Charging Technologies: 2/10
- 4. Thermal Management and Energy Management 2/10

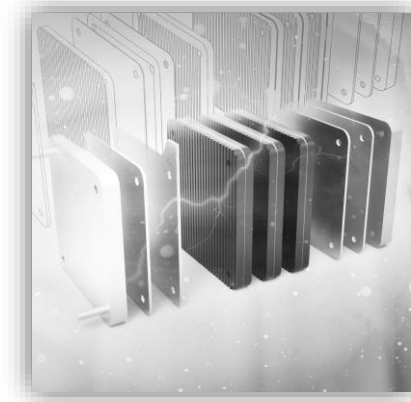
AK-Leiter Dr. Alexander Trattner

- Hydrogen and fuel cell technology in Austria offers the opportunity
 - to implement the energy transition quickly and efficiently,
 - to expand and use the country's own renewable resources in addition to the import of renewable hydrogen
 - to make an important contribution to greenhouse gas reduction, air pollution control and noise protection - especially in metropolitan areas
 - to improve the external trade balance while creating higher added values and new jobs in Austria
- Specific **research demand** on FCEVs primarily pertains to the further reduction of **costs** and the further increase in **lifetime** and **efficiency**.



Research Requirements

- Development tools, measuring and testing technology
- Electrolysis (all types) - cell, stack, system and systems coupled with renewable energies
- Fuel cell (all types) - cell, stack and system
- Fuel cell vehicles for various applications ranging from passenger cars via commercial vehicle to off-road vehicles
- Functional Integration and secure packaging
- Hydrogen refueling infrastructures for all vehicle categories
- Hydrogen storage technologies for mobile and stationary applications
- Laboratory infrastructure for research and development work including real-gas, real-size testing infrastructure for hydrogen systems and components with focus on supplier industry



Total R&D project volume of 60 M€ should be supported with a **funding volume** of about **30 M€** considering an average funding rate of about 50 %:

Project types / project volume allocations

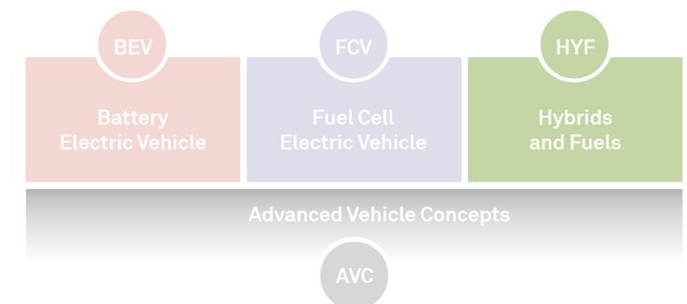
- 10 M€ for cooperative projects of oriented basic research: 10 projects à 1 M€
- 10 M€ for cooperative R&D projects, experimental development and industrial research: 5 projects à 2 M€
- 30 M€ for Flagship Projects: 3 projects à 10 M€
- 10 M€ for R&D infrastructure (support of laboratory infrastructure)

Additionally to the necessary funding volume for R&D projects we suggest about 40-60 M€ budget for the implementation of fleets and infrastructure.

AK-Leiter Dr. Peter Prenninger

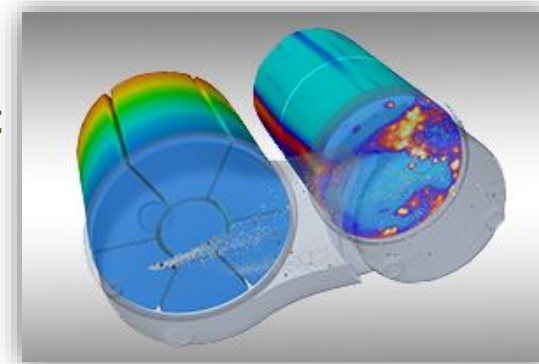
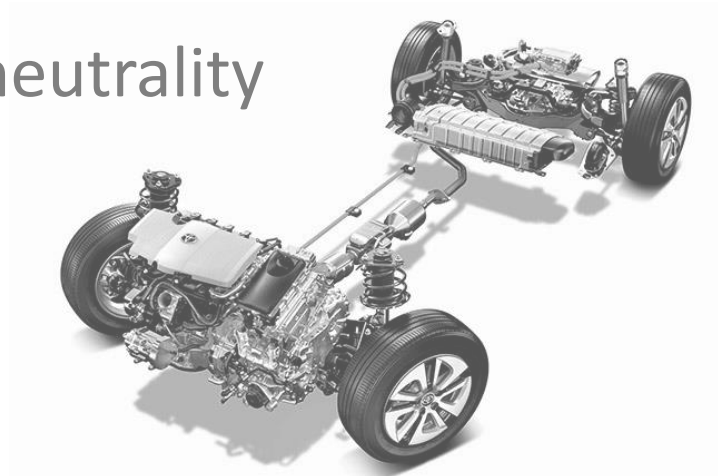
Specific research needs for product development for the European and global market:

- **Efficiency improvement of hybrid powertrain systems** incl. efficient auxiliaries
- **Research & development of sustainable fuels** – covering synthetic fuels from renewable electricity sources and CO₂ as well as biomass-based energy carriers.
- **Research & development on hybrid transmissions** to achieve highest powertrain operation efficiency.
- Overall **efficiency improvement of internal combustion engines (ICE)** for hybrid powertrains in combination with sustainable liquid and gaseous fuels including hydrogen.



Research Requirements – for CO₂-neutrality

- **Hybrid System**
 - New more efficient hybrid topologies
 - Electrified and on-demand-driven auxiliary units
 - Energy management (including thermal management)
 - Control of the hybrid system for max. efficiency
- **Sustainable Fuels**
 - Efficient and “green” (i.e. sustainable) production, on-board storage and use of CO₂-neutral energy carriers
 - Material technology for advanced / new CO₂-neutral fuels/energy carriers
- **Hybrid Powertrain**
 - Transmission and clutch technology for hybrid vehicles
- **Thermodynamics of the ICE including Exhaust Gas Treatment**
 - Combustion technologies for sustainable fuels incl. hydrogen
 - Enhanced exhaust gas after-treatment for sustainable fuels
 - Material technology for engine improvements



Hybrids and Sustainable Fuels (HYF)

Total R&D project volume of 64 M€ should be supported with a **funding volume** of about **32,5 M€** considering an average funding rate of about 50 %:

Project types / project volume allocations

- 8 M€ low TRL research: 8 projects à 1 M€
- 12 M€ for applied & cooperative research: 6 projects à 2 M€
- 30 M€ for flagship projects / a cluster of flagship projects: 2 projects à 10-20 M€
- 15 M€ per year for R&D infrastructure

Estimated allocation of projects/funding volume to the research areas:

- 1. Hybrid System: 1/5
- 2. Sustainable Fuels: 2/5
- 3. Hybrid Powertrain: 1/5
- 4. Thermodynamics of the ICE including exhaust gas treatment: 1/5

Expert Group Advanced Vehicle Concepts

AK-Leiter Dr. Bernhard Brandstätter

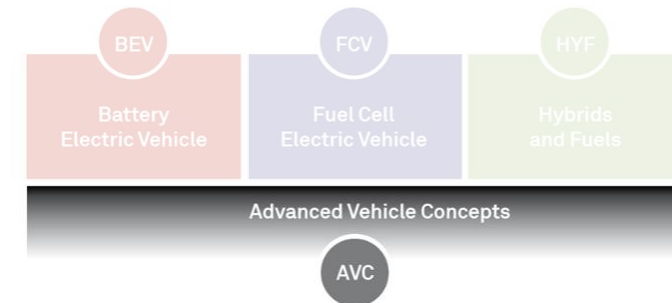
Expert group AVC deals with **advanced and future vehicle concepts** comprising **new lightweight materials, innovative production technologies & digitalization of processes** and **digitalization & automation of vehicles and infrastructure**. The group links to the other three expert groups and focuses on a system perspective and integration.

- This group addresses a wide range of different technologies
- Separation of the topic within this group in two chapters in the position paper:
 - **Advanced Vehicle Concepts** (incl. Automatization, digitalization, connectivity → vehicle as part of the „system of systems“)
 - **Innovative Materials and Vehicle Production Technologies**

R&D Challenges: Advanced Vehicle Concepts 2023+



- The vehicle is increasingly understood as part of a **system of systems**.
- **Energy efficiency** and **safety** are leveraged by this new view.
- Research Requirements:
 - General needs for **digitalization, automation** and **connectivity**
 - **Optimal control** and associated **off-board functionality**
 - Specific research needs for **energy efficiency, vehicle safety** and **non-exhaust particle emissions**
 - **Life cycle assessment**, which becomes increasingly important for Vehicle Design and Vehicle Concepts



Total R&D project volume of 62 M€ should be supported with a **funding volume** of about **37 M€** considering an average funding rate of about 50 %:

Project types / project volume allocations

- ▶ 37 M€ for applied and cooperative research: 3 proj. à 1 M€, 11 proj. à 2 M€, 4 proj. à 3 M€
 - ▶ 3 M€ low TRL research: 3 projects à 1 M€
 - ▶ 6 M€ low TRL research: 3 projects à 2 M€
 - ▶ 16 M€ for applied & cooperative research: 8 projects à 2 M€
 - ▶ 12 M€ for applied & cooperative research: 4 projects à 3 M€
- ▶ 25 M€ for flagship projects: 5 projects à 5 M€

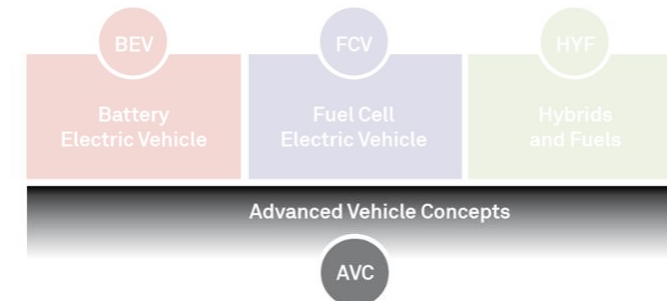
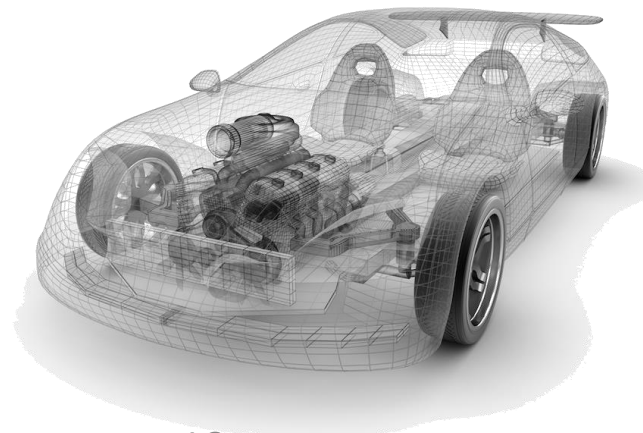
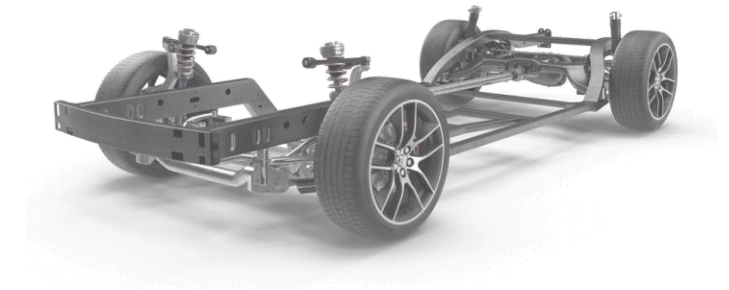
Estimated allocation of projects/funding volume to the research areas:

- 1. Digitalization, Automation and Connectivity 1/5
- 2. Optimal Control and Offboard Functionality 2/5
- 3. Energy Efficiency, Safety and Non-Exhaust Particle Emissions 1/5
- 4. Life Cycle Assessment 1/5

R&D Challenges: Innovative Materials and Vehicle Production Technologies 2023+

The demanding requirements regarding CO₂/GHG emissions and safety make integrative vehicle concepts a major driver of innovation, in which functional, material engineering and joining technology lightweight construction are systematically linked.

- Research Requirements:
 - Innovative Material Design
 - Construction Based Lightweight Design
 - Material Based Lightweight Design
 - Innovative Development Processes
 - Innovative Production Technologies
 - Digitalization of Processes



Total R&D project volume of 50 M€ should be supported with a **funding volume** of about **25 M€** considering an average funding rate of about 50 %:

Project types / project volume allocations

- ▶ 10 M€ for cooperative projects of oriented basic research: 10 projects à 1 M€
- ▶ 10 M€ for cooperative R&D projects, experimental development and industrial research: 5 projects à 2 M€
- ▶ 20 M€ for Flagship Projects: 2 projects à 10 M€
- ▶ 10 M€ for R&D infrastructure (support of laboratory infrastructure)

Estimated allocation of projects/funding volume to the research areas:

- | | |
|---|-----|
| ● 1. Innovative Material Design | 1/5 |
| ● 2. Innovative Development Processes | 1/5 |
| ● 3. Innovative Production Technologies | 2/5 |
| ● 4. Digitalization of Processes | 1/5 |

Estimated national R&D project/funding volumes



Research Area	low TRL research (M€)	Appl./coop./ indust. research (M€)	flagship projects (M€)	F&E infra- structure (M€)	total project volume (M€)	Funding volume (M€)
Battery Electric Vehicle	8 (8p x 1M€)	22 (11p x 2M€)	30 (2p x 10-20M€)	20	80	40
Fuel Cell Electric Vehicle and H₂	10 (10p x 1M€)	10 (5p x 2 M€)	30 (3 p x 10M€)	10	60	30
Hybrids and Sustainable Fuels	8 (8p x 1M€)	12 (6p x 2 M€)	30 (2p x 10-20M€)	15	65	32,5
Advanced Vehicle Concepts	9 (6p x 1-2M€)	9 (12p x 2-3M€)	25 (5p x 5M€)		62	31
Innovative Materials and Vehicle Production Technologies	10 (10p x 1M€)	10 (5p x 2M€)	20 (2p x 10M€)	10	50	25
In Total	45	63	135	55	317	158,5