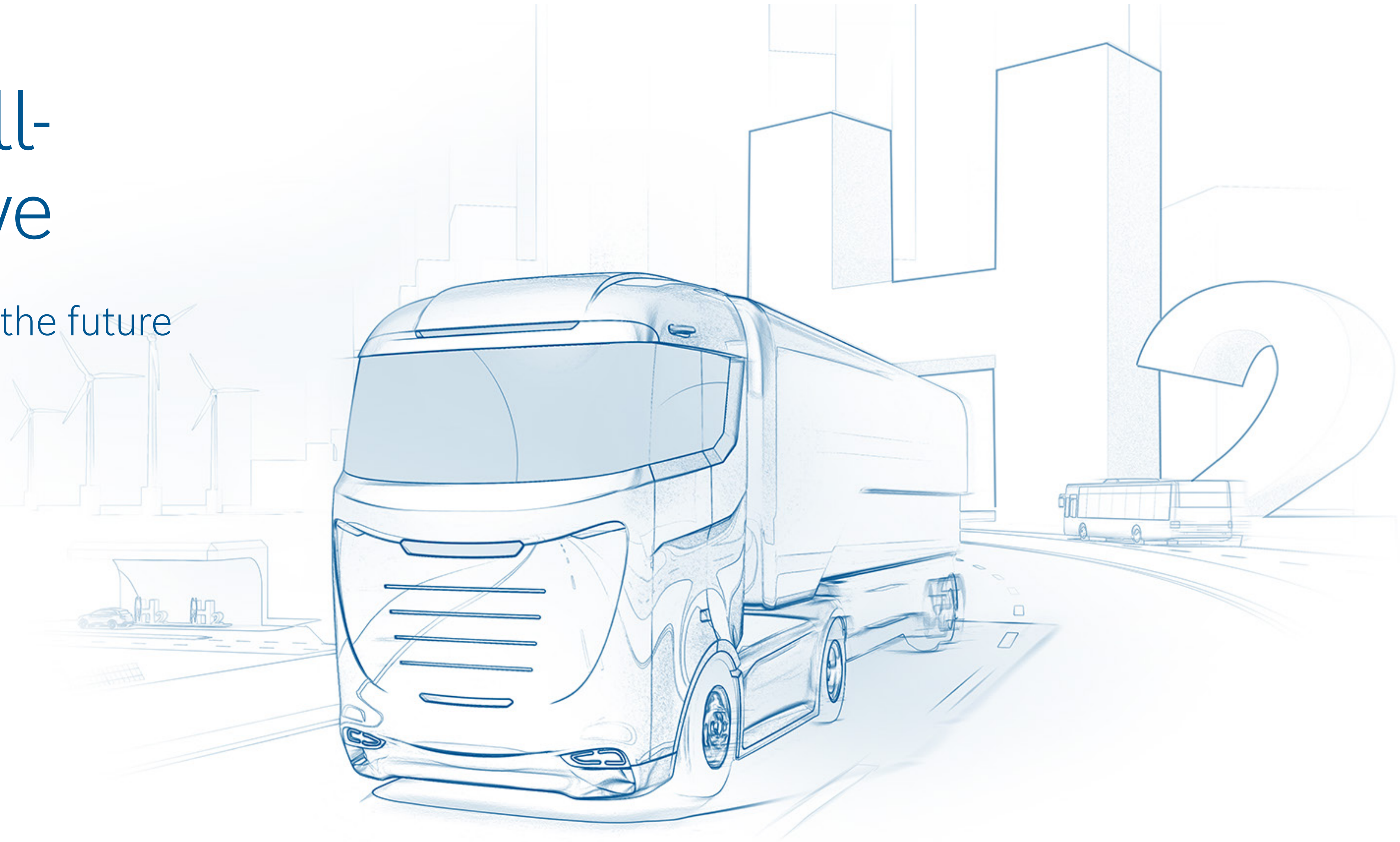




The fuel cell-electric drive

Our drive solution for the future



The fuel cell

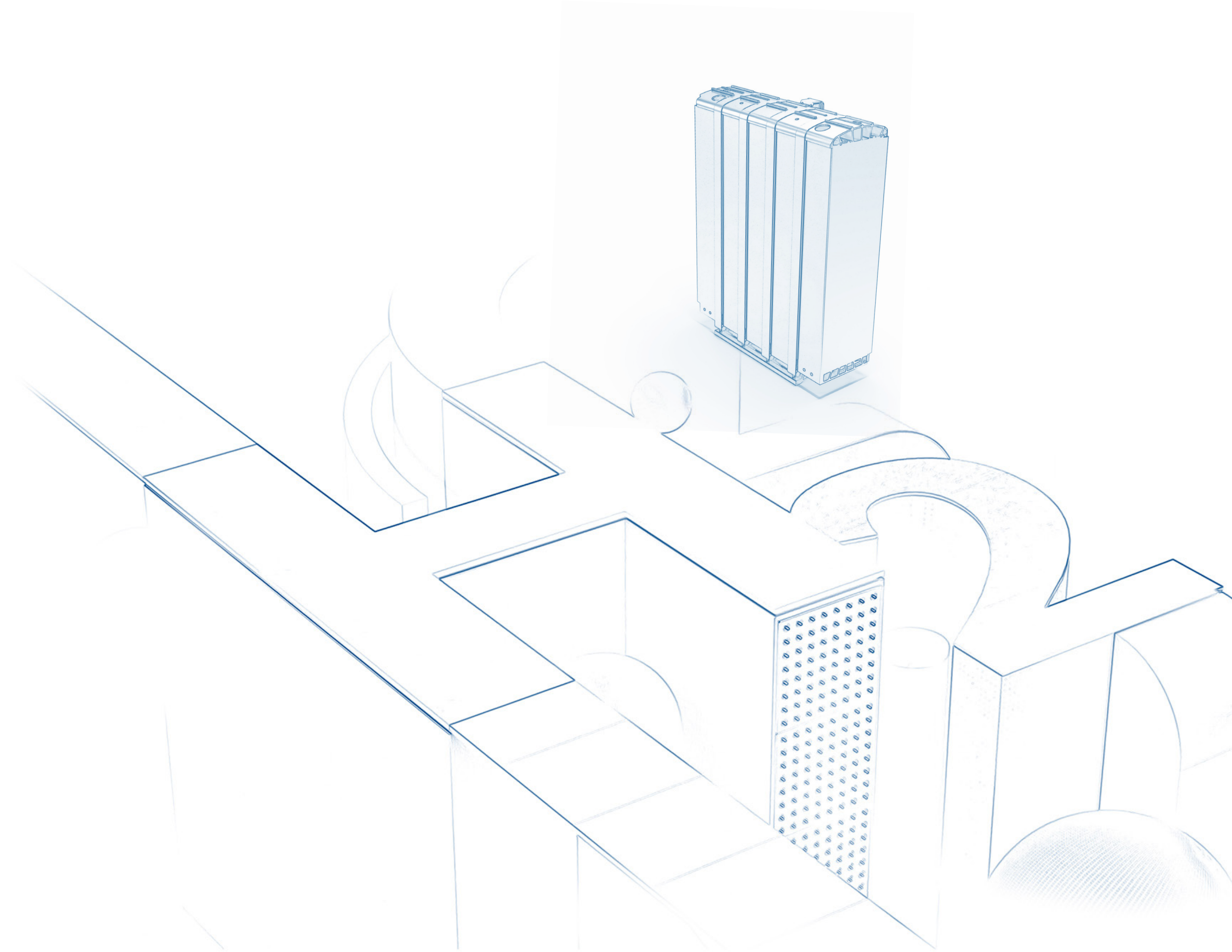
Long-distance electromobility

With the fuel cell-electric drive, we can provide an attractive and economical solution for a new type of mobility with zero local emissions.

In vehicles with fuel-cell electric drives, hydrogen is the energy source used by the fuel cell to generate electricity.

This drive solution is not only used for inner-city driving; in fact, it is most convincing when covering longer distances up to a range of several hundred kilometers. Fuel cell-electric vehicles also score points with their short refilling times of just a few minutes.

The requirements profile of fuel-cell technology makes it ideally suited to heavy-duty trucks or fleet vehicles, which are used in continuous operation with short downtimes.



How you benefit

efficient

Fuel cells boast high efficiency, combined with high power density and a low power-to-weight ratio.

long range

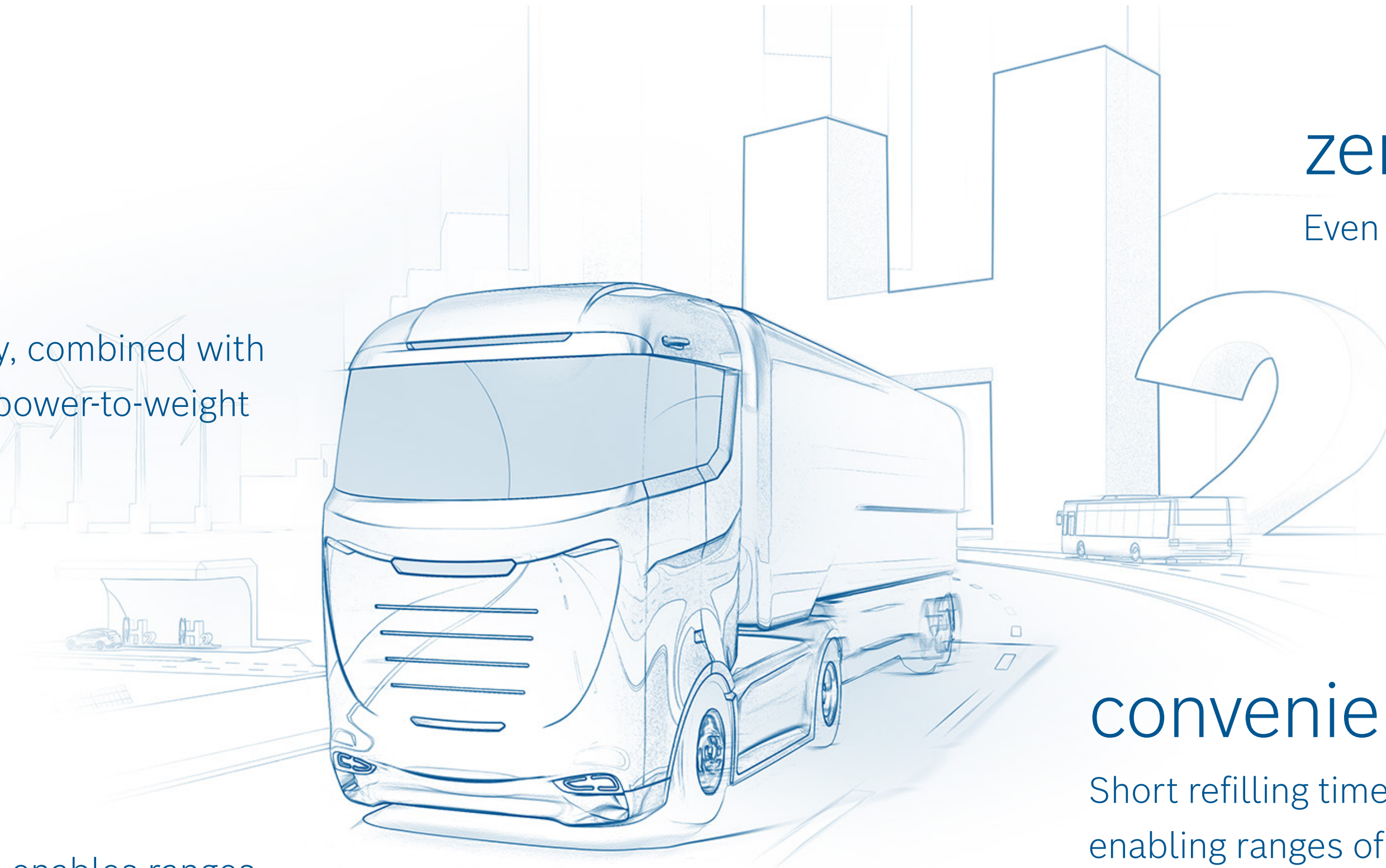
The fuel cell-electric drive enables ranges of over 500 kilometers.

zero local emissions

Even in long-distance applications

convenient

Short refilling time of just a few minutes, enabling ranges of up to several hundred kilometers

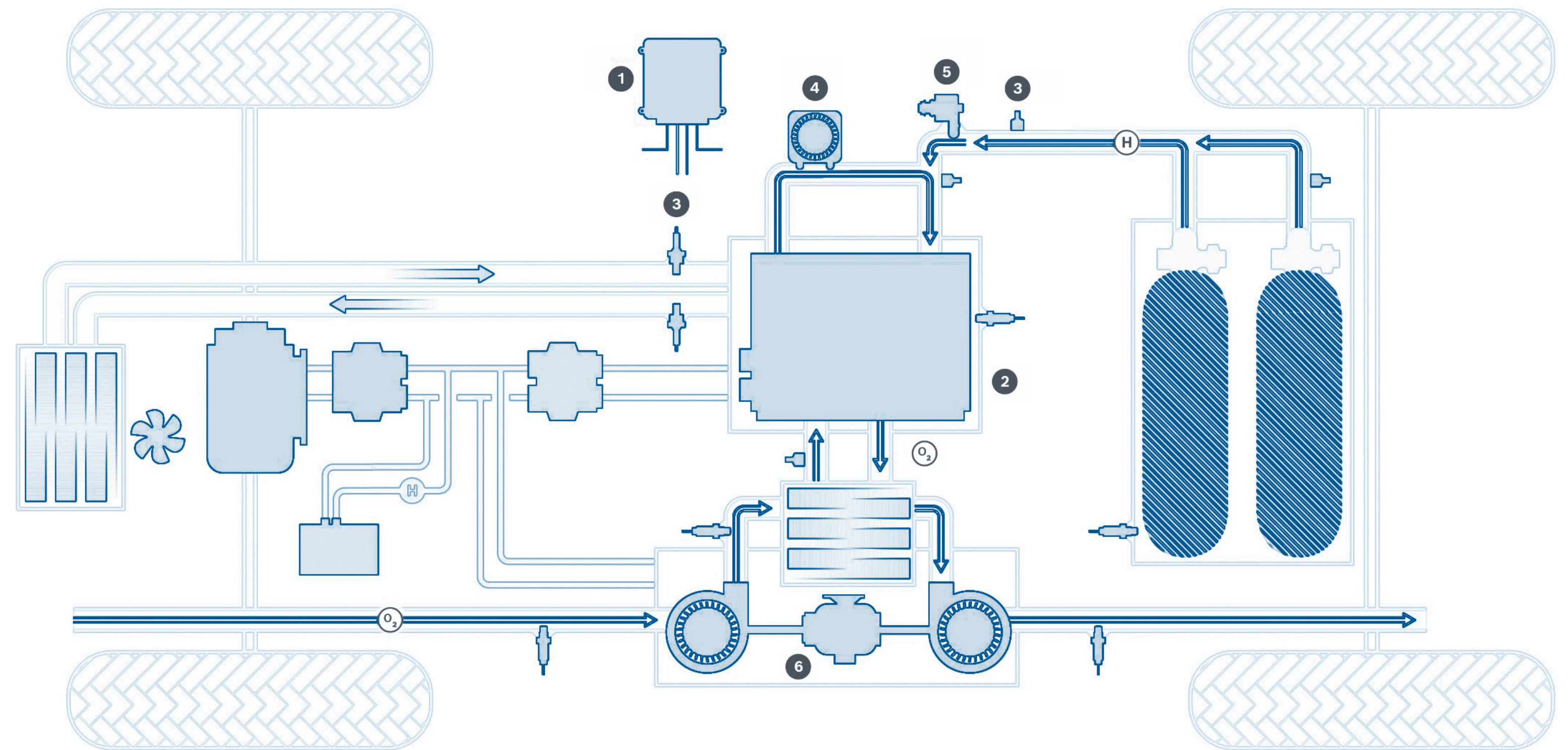


The system

Finely tuned

The components of the fuel cell-electric drive are perfectly matched with each other to achieve the highest performance.

1. Fuel-cell control unit
2. Fuel-cell stack
3. Sensors
4. Anode circulation blower
5. Hydrogen gas injector
6. Electric air compressor

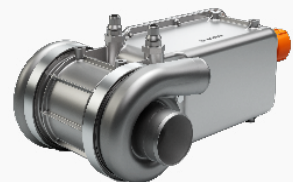


The components



Fuel-cell stack

The stack is the centerpiece of the system: After all, this is where the energy to power the drive system comes from. All of the subsystems come together here.



Electric air compressor

The electric air compressor provides oxygen. It transports the air into the cathode.



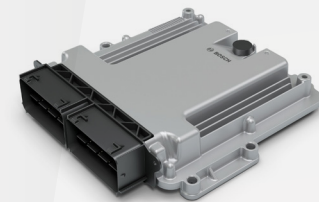
Anode circulation blower

The anode circulation blower actively promotes hydrogen recirculation, thereby extending the operational range of the fuel-cell system.



Hydrogen gas injector

The supply of hydrogen is controlled by the hydrogen gas injector. It provides the required quantity of hydrogen in the anode.



Fuel-cell control unit

The fuel-cell control unit is the central ECU for operation of the fuel-cell system – the “electrical power plant” so to speak. The FCCU controls operation of the fuel-cell system and its individual subsections, including the hydrogen supply, air system, thermal system, and water management system.



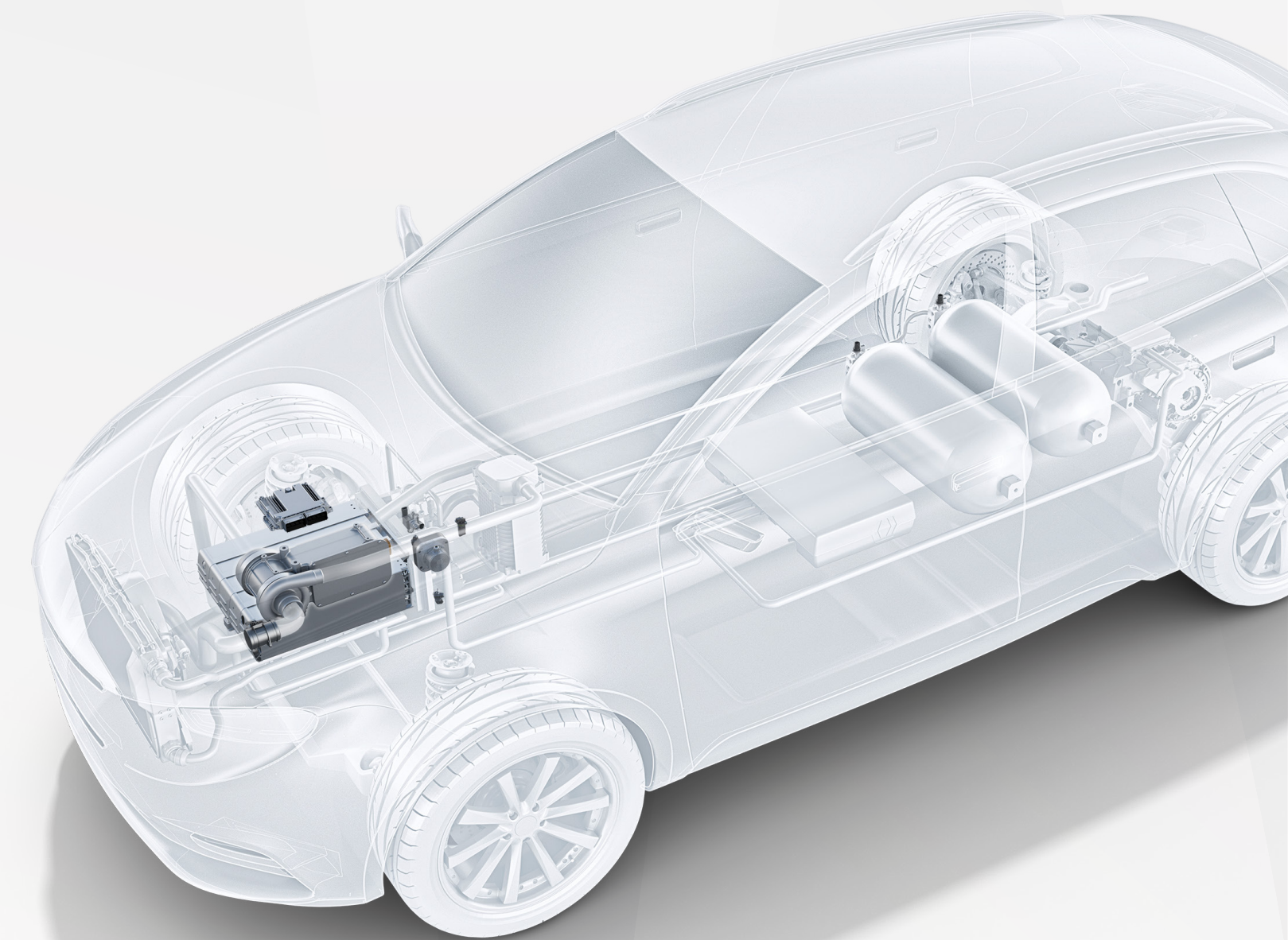
Hot-film air-flow meter

The hot-film air-flow meter with digital technology measures the air mass entering the combustion chamber. Moisture, pressure, and temperature signals can be evaluated at the same time.

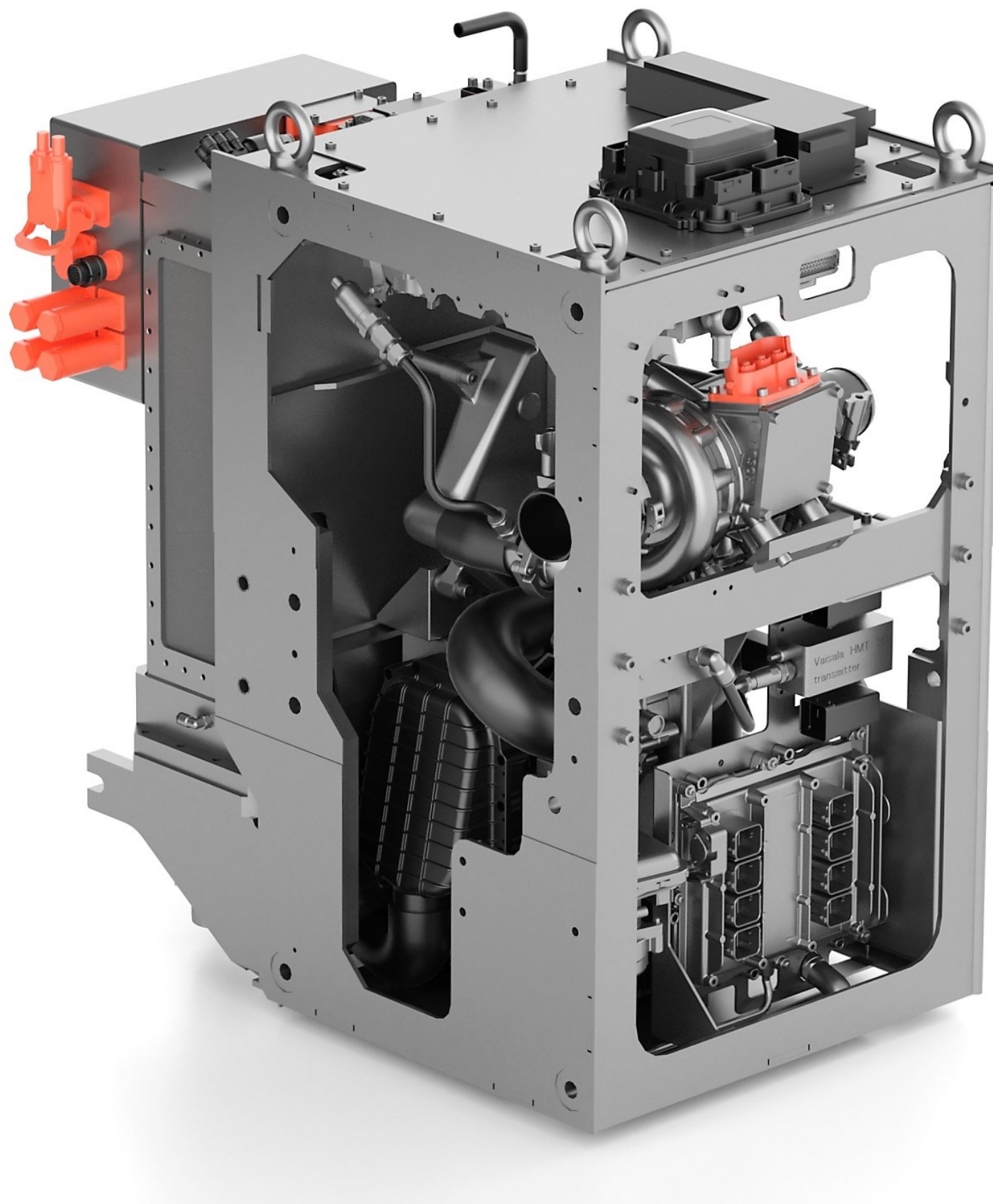


Sensor system and valves

Sensors and valves based on Bosch volume-production technologies and especially adapted for fuel-cell operation ensure that the system runs smoothly at all times.



The components



Fuel-Cell Power Module (FCPM):

The power module is custom-configured for heavy-duty applications. It includes all components required for the fuel cell-electric drive, enabling these to be integrated into preexisting vehicle systems. Prefabrication of this module is standardized, making it available as an off-the-shelf solution.

Smart, made-to-measure system solutions

For any application in any vehicle segment...

...where you would like to use a fuel cell-electric drive, we can offer you a custom system solution. Whether engineering, system architecture, simulation, or integration – with our expertise, we can address your individual requirements very precisely. By putting our wide range of services and solutions at your disposal, we support you throughout every project phase – and beyond.

What we also offer you:

- ▶ ▶ Comprehensive portfolio of electromobility solutions
- ▶ ▶ Easily integrated, tried-and-tested components
- ▶ ▶ Economies of scale through bundling of batches in production
- ▶ ▶ Assistance in complying with current and future environmental legislation



Fuel-cell component set

Our range of products for fuel cell-electric drive systems covers a variety of expansion stages. With our fuel-cell component set, we enable our customers to design a fuel cell-electric drive system that addresses all specific needs and requirements. The component set is based on our portfolio of tried-and-tested Bosch components. We choose all the required components on your behalf and can thus satisfy a wide range of requirements in terms of performance, system efficiency, and component lifetime.

In doing so, we design the system so that it ideally meets your individual performance requirements.

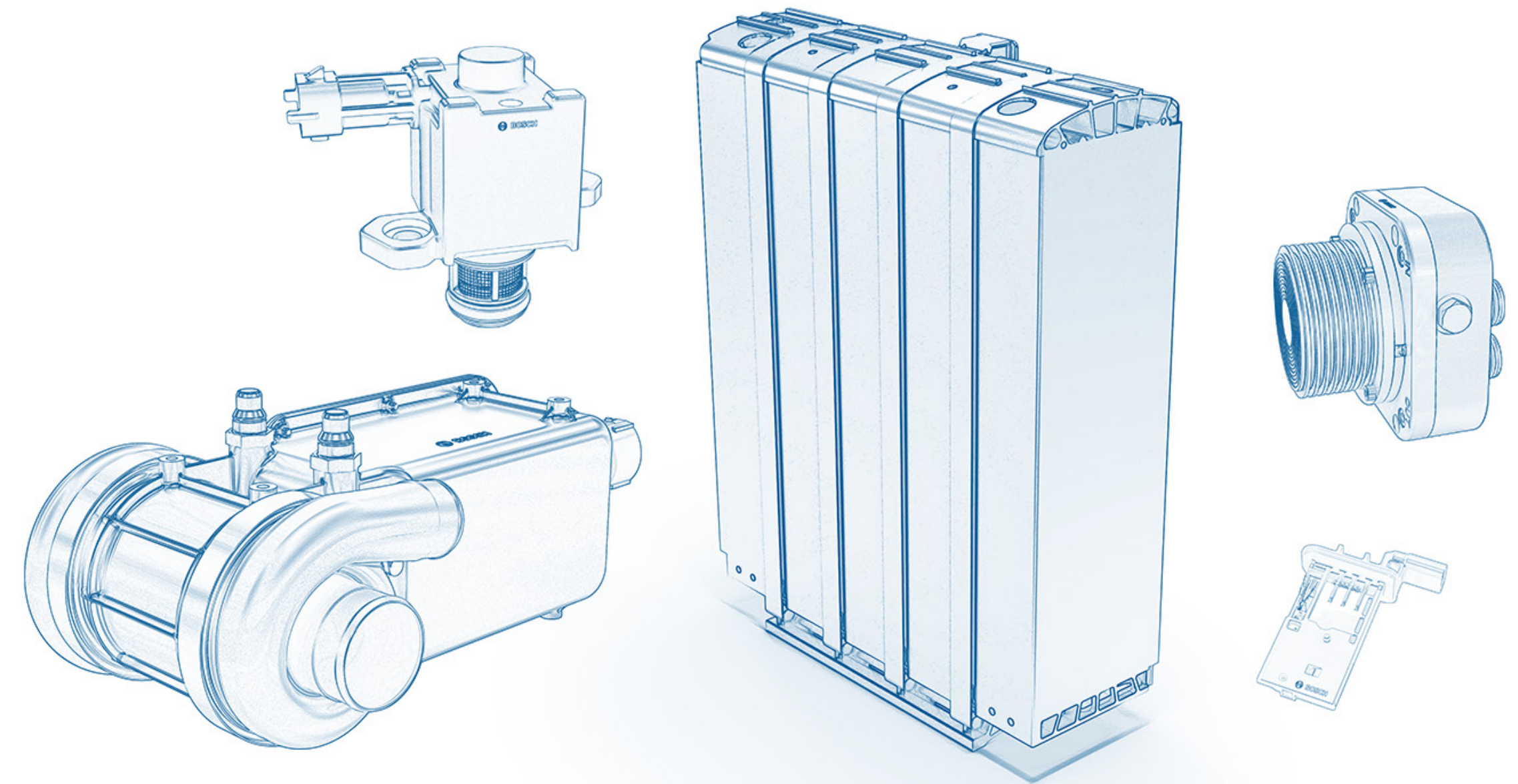
Technical data:

System power output: from 40 kW

Power density: individual package based on FCPM

System efficiency: 45 % or 55 % (@100 kW rated power / max. @35 kW)

Service life: 6,000 h (2023) / 20,000 h (2025)



“Innovative technology and custom solutions – with a view to the impending commercialization of fuel-cell technology in many fields, we offer our customers a broad range of tailored system solutions based on Bosch products developed for volume production.”

Holger Hofmann, Bosch Engineering

Our portfolio of services

Requirements
analysis



1

To develop your ideal system solution, we first identify your requirements and components that might satisfy your needs.

System analysis
System configuration
Simulation



2

In the next step, we analyze the existing technical boundary conditions and put together a draft system configuration. Taking the required components into account, we analyze and calculate the power that your system will need to deliver.

System design
and integration



3

Once we have identified the optimum system configuration and finalized all feasibility studies, work switches to the concrete system design and – finally – to the installation of the new drive system in your vehicle or across your entire fleet.

Assistance with homo-
logation and ramping
up volume production



4

As soon as the system's design has been finalized, it is transferred to the test bench. Here, all components of the fuel-cell system are assembled, which includes efficient precautions for ensuring safe system operation. In addition, we assist you with homologation for the overall vehicle and with ramping up volume production.

Our portfolio of services

individual and flexible

We offer tailor-made, optimized system solutions based on proven Bosch technology for all vehicle segments.

tried-and-tested

Bosch's entire portfolio of fuel-cell technology is geared toward volume production.

safe and reliable

We enable holistic, reliable system development with an integrated control strategy and the safety concept to match.



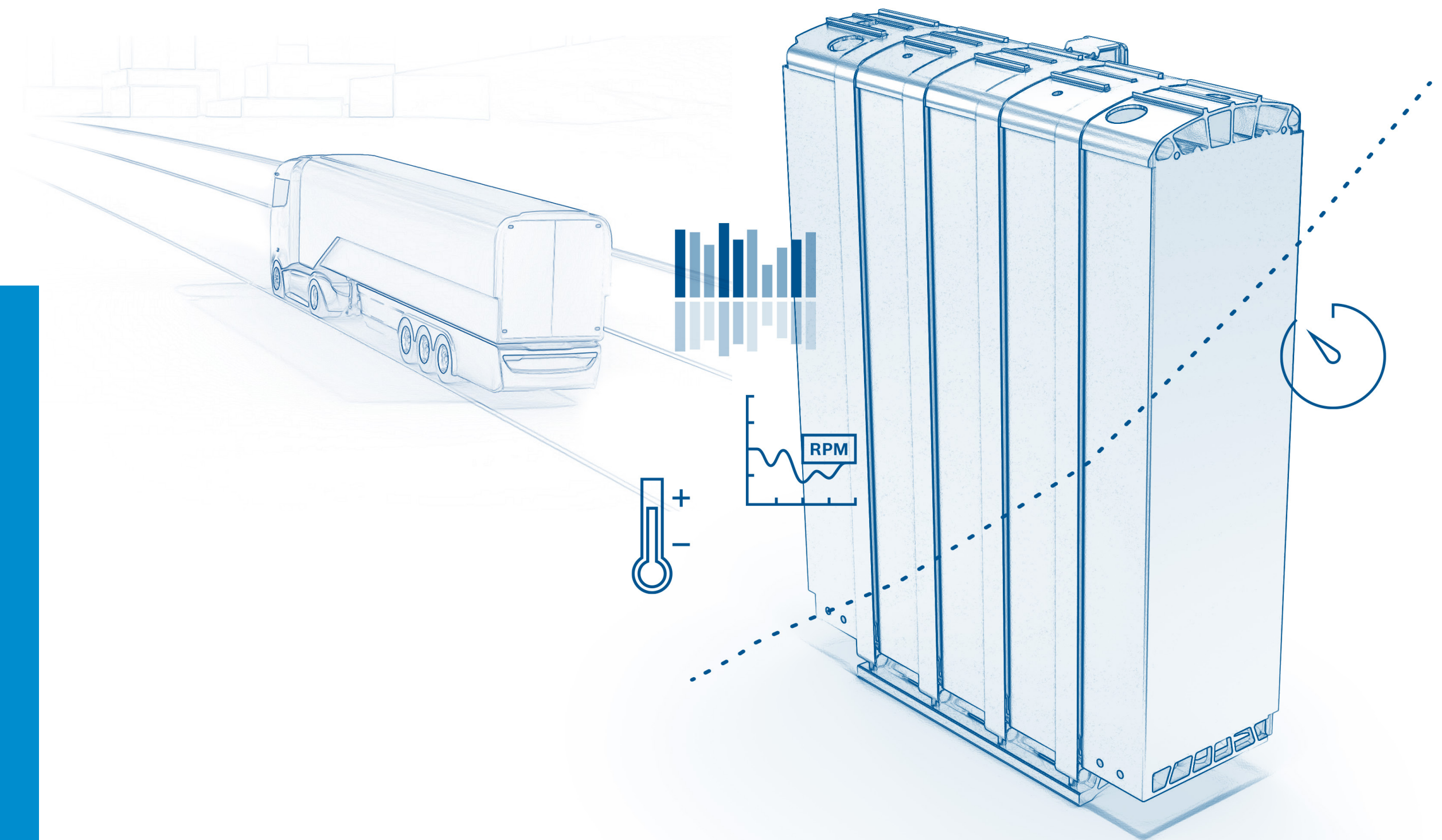
“We can respond to our customers’ highly individual needs and offer maximum flexibility right from the start of development. In doing so, we enable optimum system design and integration into the respective vehicle so that all requirements are fully satisfied.”

Werner Belschner, Bosch Engineering

System concept and simulation

Our services in detail:

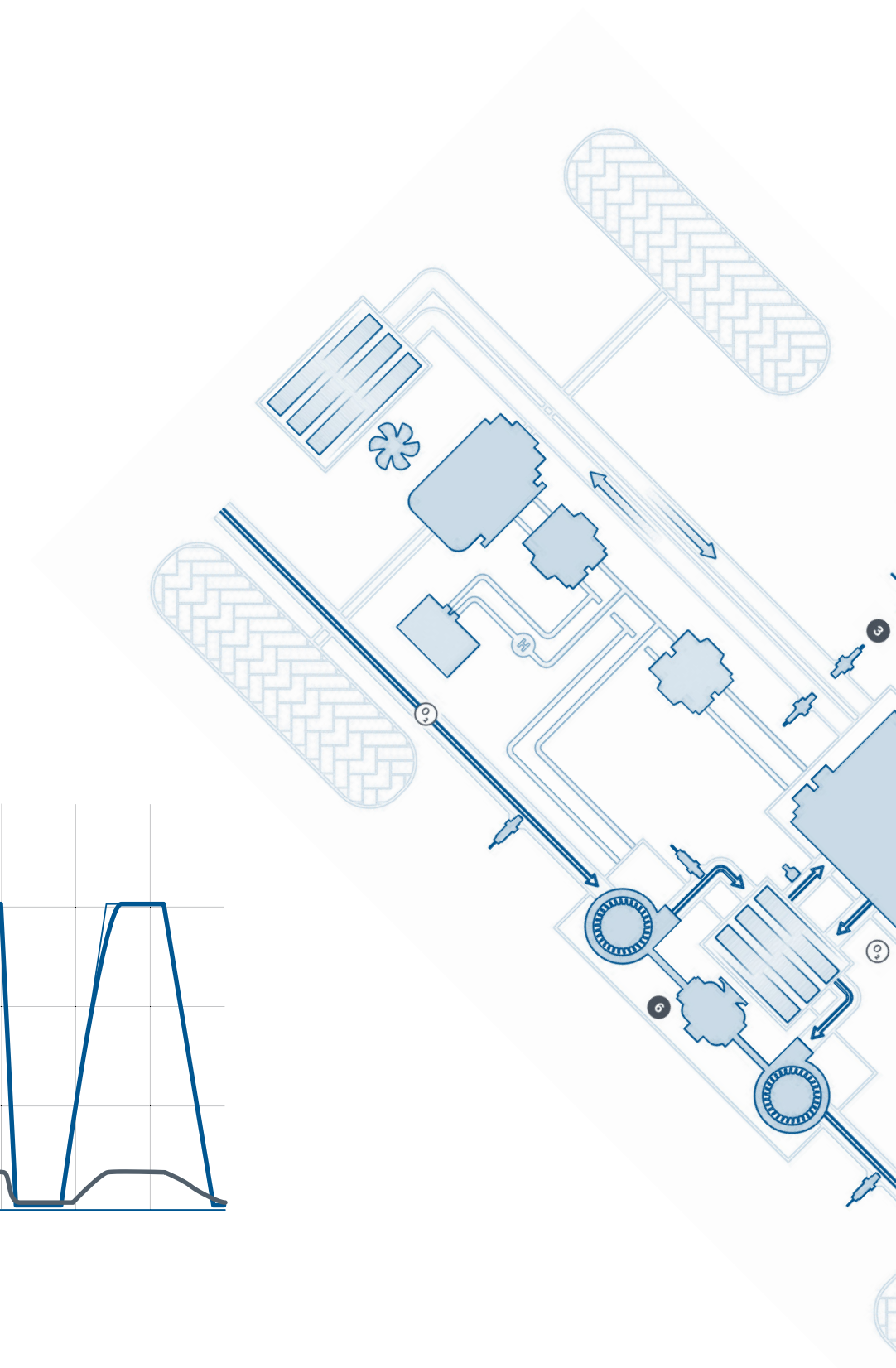
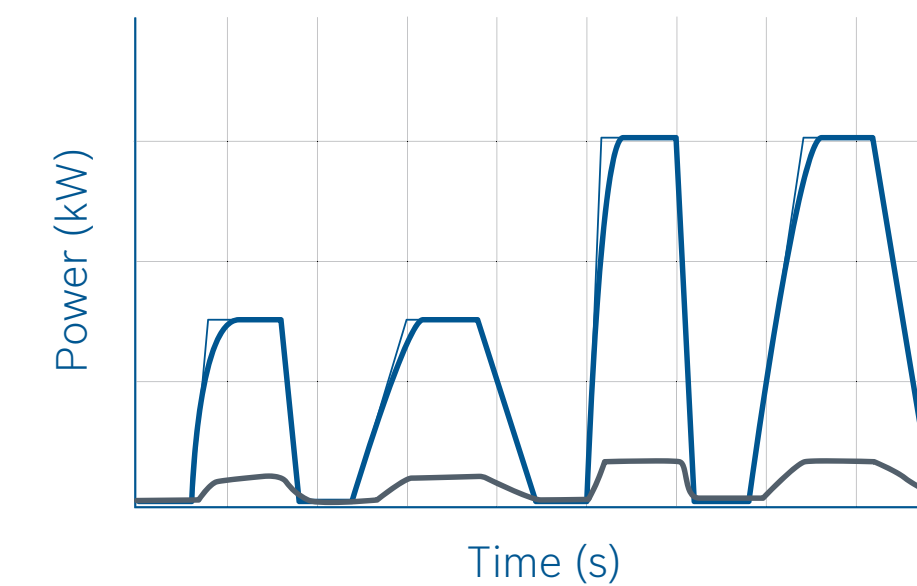
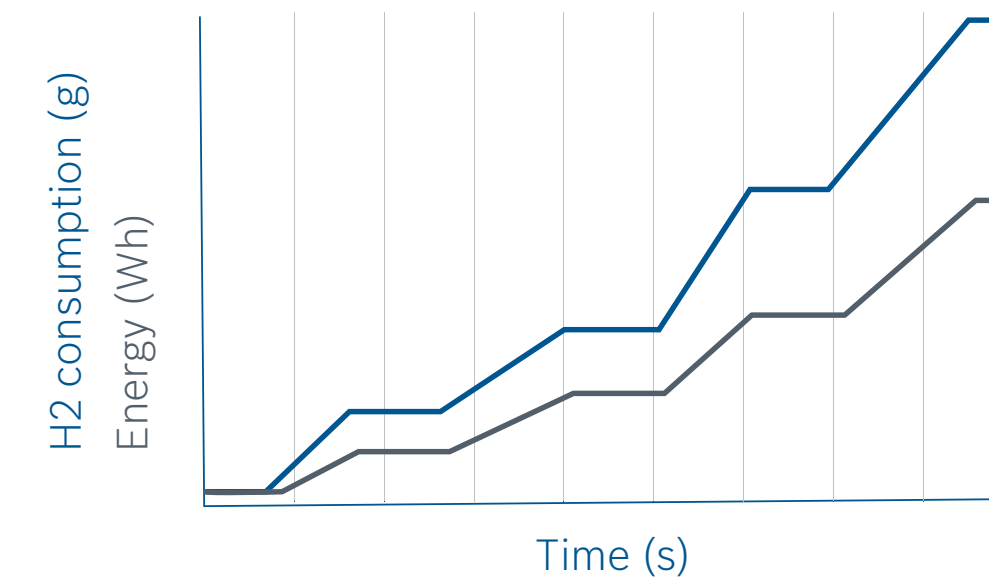
- ▶ ▶ Creation of various vehicle and system concepts while considering the size of the hydrogen tank as well as the power, electricity, hydrogen, and battery consumption.
- ▶ ▶ Design and evaluation of subsystems
- ▶ ▶ Creation of component load profiles and specifications; component selection for customer-specific fuel-cell systems (Bosch or third-party products)
- ▶ ▶ Feasibility and potential analyses for new applications
- ▶ ▶ Planning and realization of system-design operating strategies
- ▶ ▶ Simulation-based function development and application (model-based)



System design and integration

Our services in detail:

- ▶ ▶ Design and evaluation of the fuel-cell system, taking into consideration the packaging, thermodynamics, water management, performance requirements, and voltage levels
- ▶ ▶ Design and evaluation of the subsystems; selection of the appropriate variants
- ▶ ▶ Evaluation of the various concepts' effectiveness (system design and vehicle performance)
- ▶ ▶ Vehicle integration
- ▶ ▶ Electrical integration (DC/DC and high-voltage battery)
- ▶ ▶ Mechanical integration (CAD packaging, brackets etc.)
- ▶ ▶ Thermal integration (design of the cooling/coolant circuit)

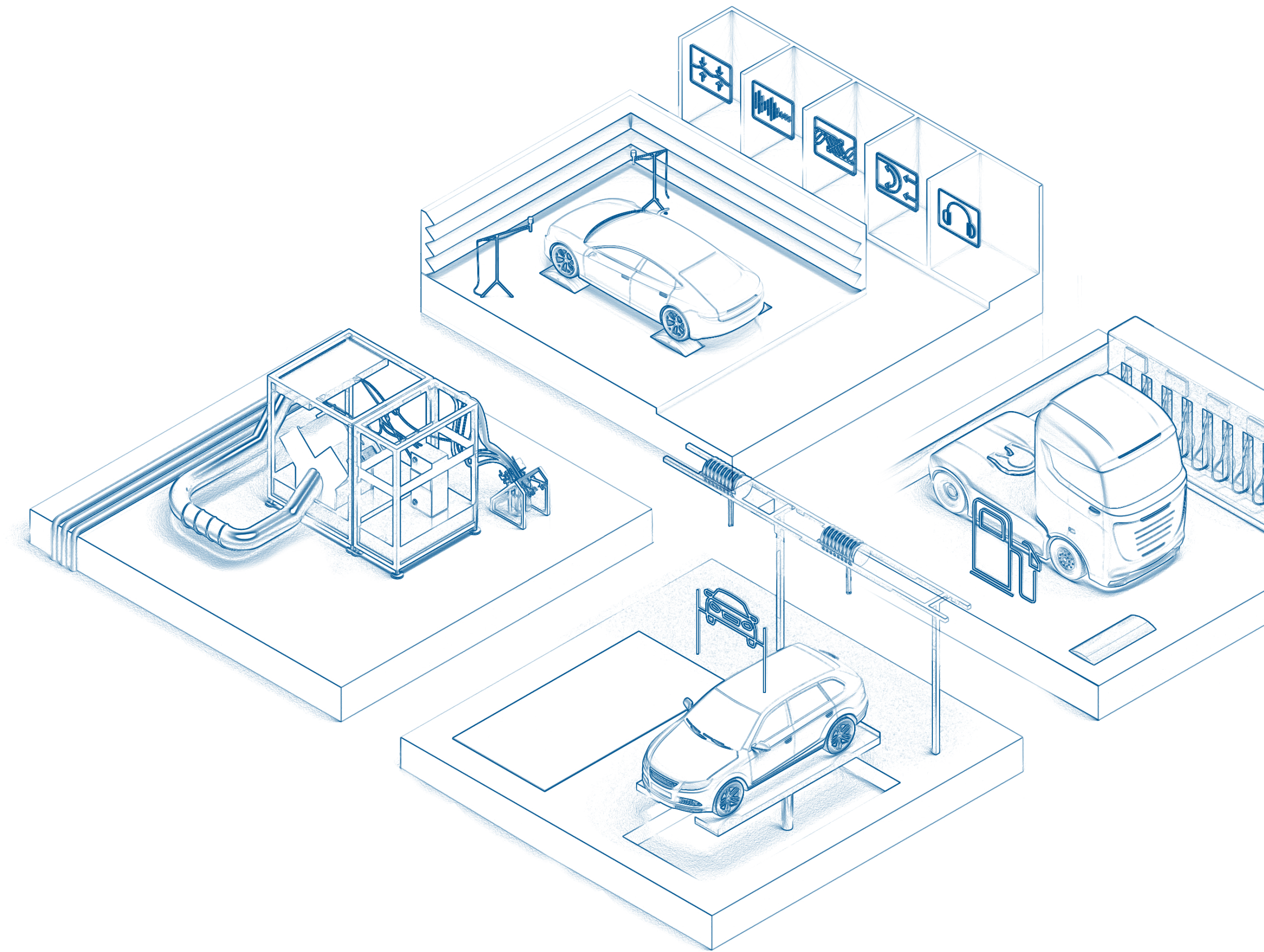


Homologation and validation

We assist you with obtaining official approval for prototypes and with homologation for volume production.

Our services in detail:

- ▶ ▶ Assembly of the fuel-cell system on the test bench and taking efficient precautions for ensuring safe system operation
- ▶ ▶ Integration of the drive system into the overall vehicle and precautions for ensuring safe system operation in the vehicle
- ▶ ▶ Assistance with homologation for the overall vehicle
- ▶ ▶ Assistance with fleet operations



“All of our components are tried-and-tested and ideally matched in the best possible way. Irrespective of the individual target requirements, we pay close attention to the tiniest technical details, characteristics, and interdependencies. This allows every system component to deliver the very highest performance.”

Harald Fischer, Bosch Engineering

Technical details

The fuel-cell control unit

Fuel-cell control unit

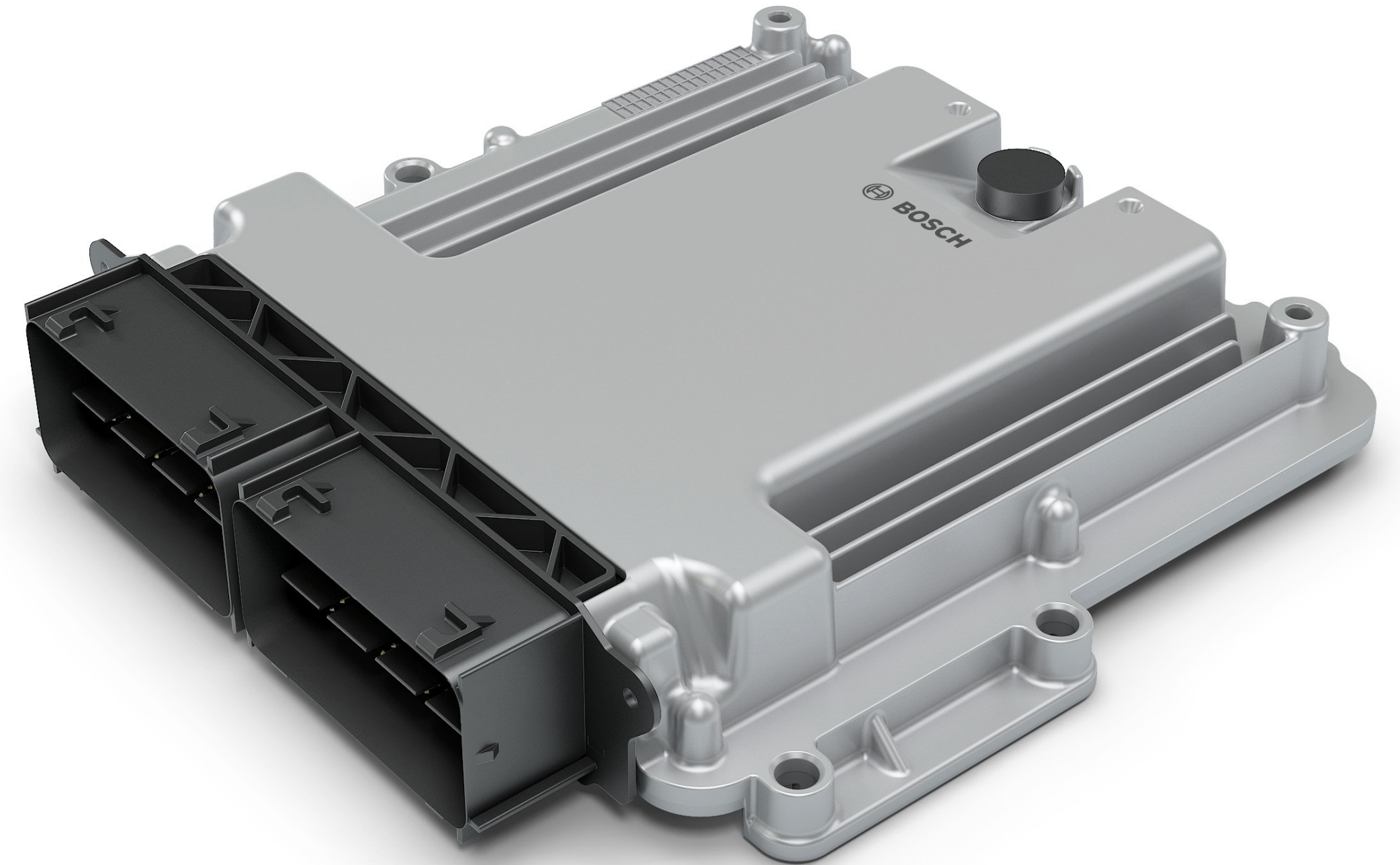
The fuel-cell control unit (FCCU) controls operation of the fuel cell in the vehicle. All individual subsections such as the hydrogen supply, air system, thermal system, and water management are controlled here. A monitoring concept is integrated into the FCCU to guarantee safe operation.

Technical data

Multicore microcontroller: Dev.1–Dev.4

CPU speed: 80–300 Mhz

Flash memory: 1.5 MB–8 MB



How you benefit

dynamic and efficient

Control algorithms with model-based, self-learning software functions make for a short time-to-market and efficient, economical data calibration.

flexible

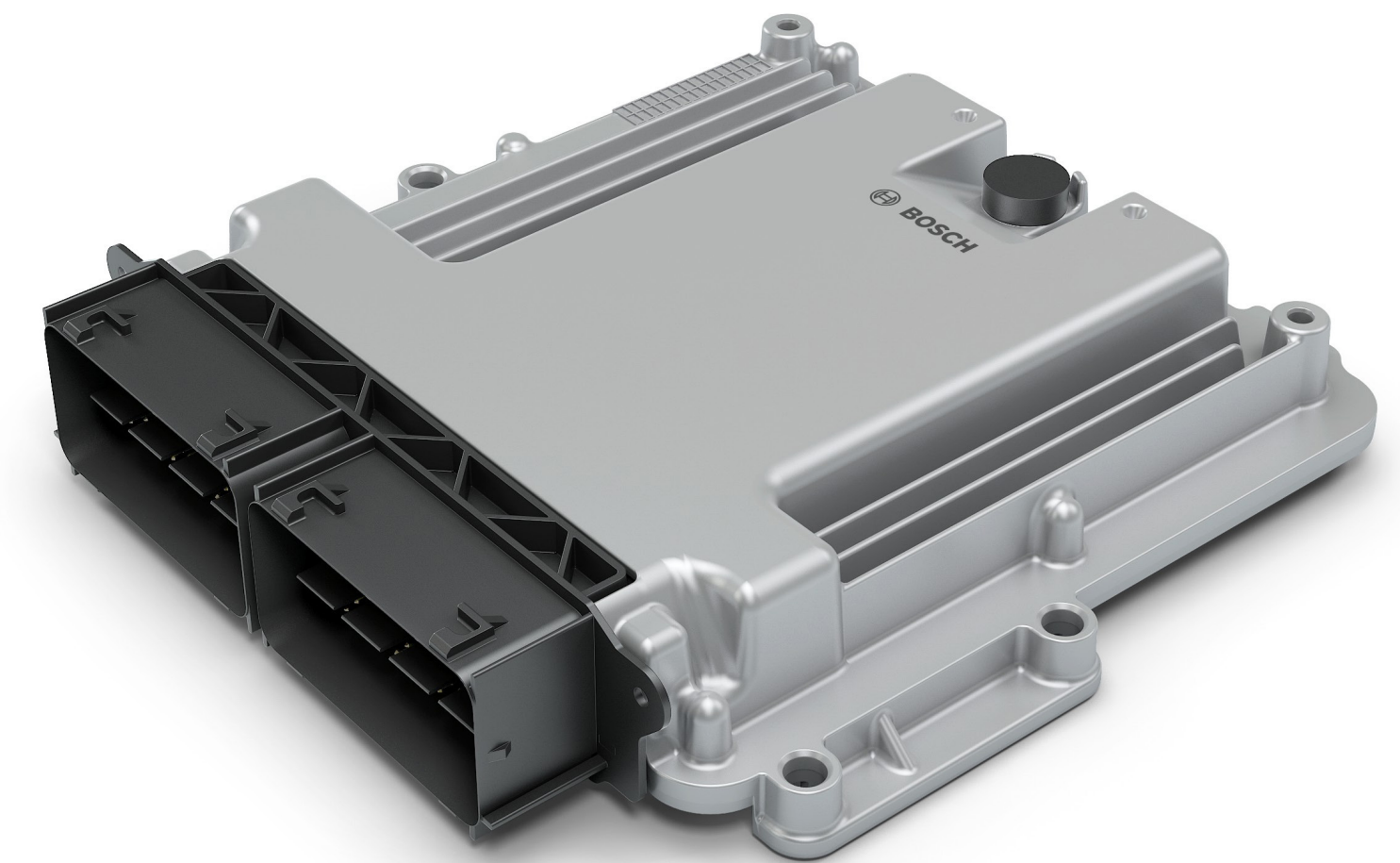
configuration and scalability in the hardware and software portfolio for made-to-measure solutions

future-oriented

Modular software optimized for easy integration into future E/E architectures of electric vehicles

tried-and-tested

Same hardware concept as mass-produced engine control units



The fuel-cell stack

The powerhouse

The stack generates the electrical energy required by the vehicle. It consists of several hundred stacked fuel cells in a series configuration. Here, a “cold combustion” process takes place that converts the energy from the chemical reaction between the continuously fed hydrogen and airborne oxygen into electricity. The only products of the reaction are water, electricity, and heat.

The stack partner: PowerCell

Bosch has entered into a cooperation with Swedish fuel-cell stack manufacturer PowerCell Sweden AB with the aim of jointly advancing and producing stacks. Taking the PowerCell S3 stack as a basis, both partners are advancing the technology further to make it ready for production.

Technical data

Power output: 60 to 120 kW

Power density: 3.5 kW/l

Coolant temperature: < 80 °C

Service life: 6,000 hours (2022) or 20,000 hours (2025)



How you benefit

high efficiency

compared to conventional “hot combustion”

zero local emissions

Water is the only product of the reaction.

compact dimensions

Optimized packaging enables a wide range of application scenarios and a small volume per kilowatt.

optimized

for automotive applications

broad portfolio of services

to meet individual customer requirements



Hydrogen has the power to change the future of mobility.

Are you interested in our products and services?

Then get in touch with us right away: We will help you plan your new fuel cell-electric drive system.

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