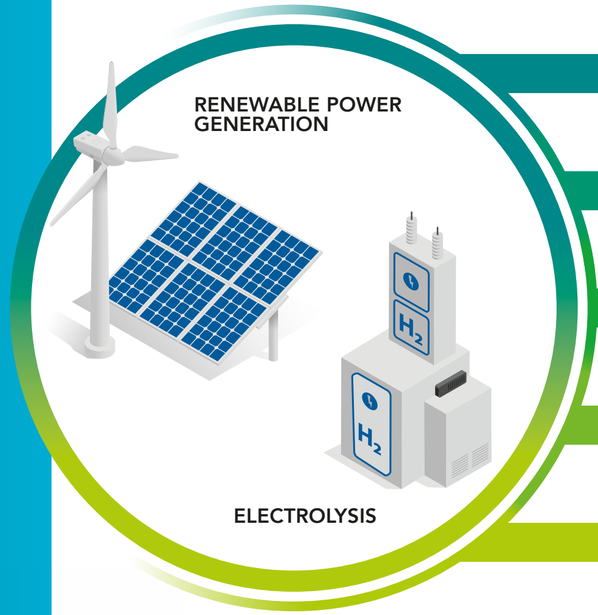
AVL Hydrogen and Fuel Cell Technology

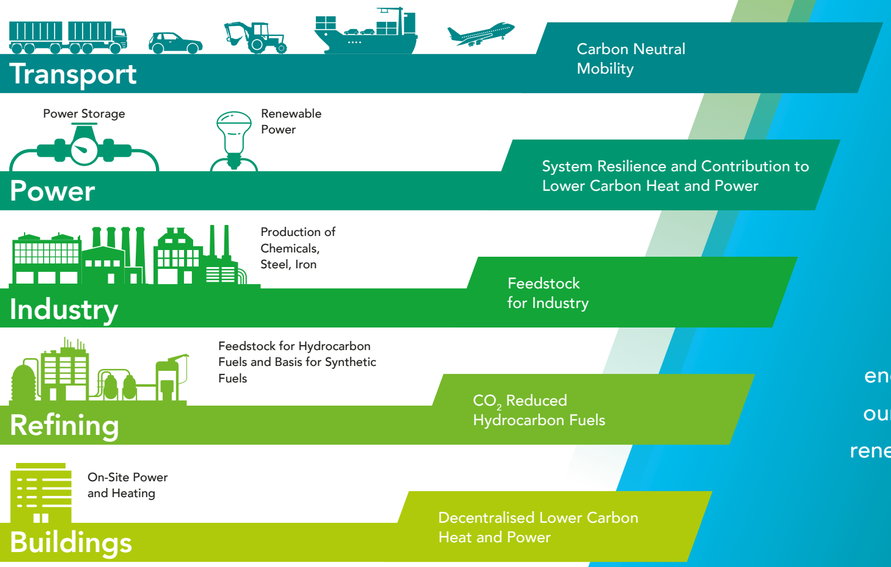
Key Enabler Towards Carbon Neutrality

The Hydrogen Journey

Hydrogen plays a key role in the global effort to reach net-zero emissions by 2050. Because of its unique character hydrogen offers a long-term, scalable and cost-effective option for deep de-carbonization in many sectors. It not only supports the energy storage of the growing renewable energy production from wind, solar and hydro, but also will be a key enabler for the future of synthetic fuels and in end-use applications like transport, building heat and power generation using fuel cell technologies.

We strongly believe that hydrogen is the core pillar of a renewable energy system. From engineering, simulation, as well as testing we apply our systematic view in the whole value chain of hydrogen. With our cross-sectoral approach, covering the areas of hydrogen production from renewable electricity to the use of hydrogen in mobile and stationary applications, we are a reliable partner in many different stages of the hydrogen journey.





„AVL aspires to contribute to the rise of a complete hydrogen ecosys-tem for new mobility and energy solutions. We strongly believe in a much broader use of hydrogen as a major energy carrier to transform our energy system towards renewable resources such as wind and solar."

Prof. Helmut List
Chairman and CEO, AVL

EMPOWERING THE ENERGY TRANSITION

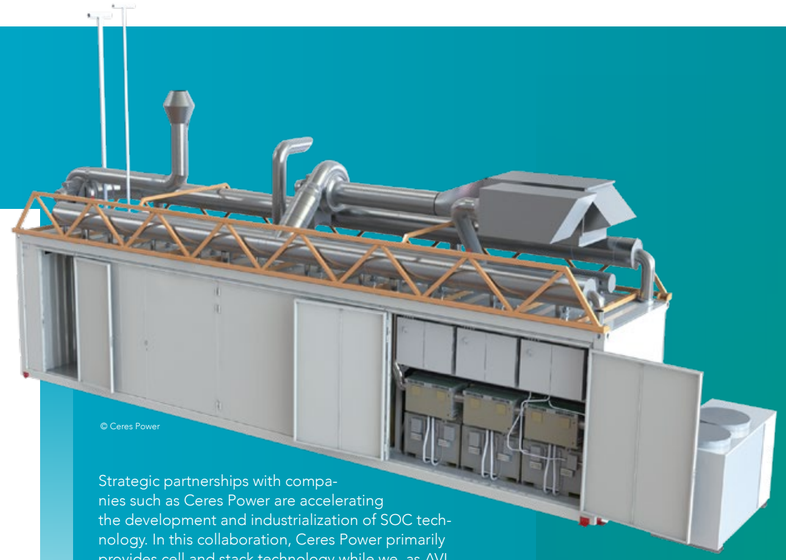
Hydrogen and E-Fuel Production

The path to a more sustainable future in all sectors and industries is driven by the shift from fossil fuel sources to renewables. In a global energy trade system, hydrogen-based chemical energy carriers play a major role in the efficient utilization, conversion, storage and distribution of renewable resources. In order to achieve that hydrogen cost comes down to an economic affordable level, energy efficiency of the production process is of utmost importance.

At AVL, we help you to make the best decisions with regards to future energy and fuel pathways. We look at your unique situation from a broad variety of viewpoints and parameters, including technology, energy and market. From highly volatile energy availability to consumer expectations, competition and global regulatory requirements. With our insight you get a clear picture of what your energy options are today and what your best choices will be in the future.

© Greenlight Innovation

The PEM and alkaline electrolyzer testing product line from our partner Greenlight Innovation is a reliable and proven solution for all R&D and durability testing applications from 500 W up to 500 kW+.



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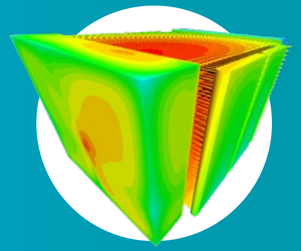
Strategic partnerships with companies such as Ceres Power are accelerating the development and industrialization of SOC technology. In this collaboration, Ceres Power primarily provides cell and stack technology while we, as AVL, contribute with application, integration and system know-how.



AVL SOLID OXIDE ELECTROLYZER CELL (SOEC) SOLUTIONS

Based on its high efficiency and low required energy input, SOC-based electrolysis is considered a promising technology to improve the production efficiency of hydrogen and e-fuels.

The AVL SOEC Solution is based on an innovative process. With this technology we can achieve an efficiency improvement by 15 to 30% compared to PEM and alkaline electrolysis. This efficiency is additionally boosted by another 10%, if the system can be supplied with steam instead of liquid water.

Scalable SOEC Simulation Solutions

The optimization of Solid Oxide Electrolyzer Cells (SOEC) with respect to efficiency and lifetime is a major development focus for successful market introduction. Our scalable simulation solutions offer dedicated multi-physics capabilities to support in the analysis and optimization of the complex species flow, thermal and electrochemical processes on stack and system level.

POWER-TO-LIQUID DEMONSTRATION PLANT FOR E-FUEL PRODUCTION

As part of the "Innovation Liquid Energy" project, we have developed the most innovative power-to-liquid plant concept based on the thermal coupling of the SOEC and Fischer-Tropsch synthesis reactor unit. Consequently, we will be able to manufacture affordable synthetic fuels using green electricity, green hydrogen and CO_2. AVL and Institut für Wärme- und Öltechnik (IWO) are currently building up the demonstration plant in Austria to proof the feasibility and high efficiency of this process.

GAMECHANGER TOWARDS A
RENEWABLE TRANSPORT SYSTEM

Hydrogen-Powered Mobility

CELL & STACK

SYSTEM DEVELOPMENT

VEHICLE INTEGRATION

FROM THE FIRST IDEA TO SOP

- **Benchmarking and Target Setting**
- **Concept and Feasibility Studies**
- **Series Development and Integration**
- **Functional and Controls Development**
- **Validation and Verification**
- **Calibration**
- **Demonstrator Built**
- **Production Engineering and Industrialization**

The AVL HyTruck is a compact fuel cell system demonstrator for a long-haul truck application that provides outstanding power density.

IMPROVING DURABILITY AND RELIABILITY

Fuel cell technologies are moving towards industrialization across the industry, with long-haul heavy-duty trucks and intercity buses leading the way.

Zero-emission options like hydrogen fuel cells are still battling to achieve long driving ranges and short refilling times. That's why it is important to continuously optimize durability and reliability. As experts in development and validation, our experience has enabled us to develop PEM fuel cell systems with market-leading power densities and robustness. This is achieved using optimized components and system control strategies.

Thanks to our technical expertise – from stack to the complete PEM fuel cell system – and our leading test solutions, we are the preferred partner when it comes to future hydrogen-powered propulsion.

AVL HYDROGEN ENGINE

Apart from the usage of hydrogen in fuel cells, hydrogen ICEs enable carbon-neutral transportation with the possibility to utilize already existing base technology with only minor modifications. Although the usage of hydrogen results in a reduction of the power density, a high overall efficiency can be achieved.

With the example of the AVL Hydrogen Engine we could demonstrate a clean propulsion unit with attractive driving ranges and shortest time-to-market.

AVL's Gen-0 stack is the state-of-the-art, robust, durable PEM fuel cell stack solution for market entry in commercial vehicles, marine and industrial applications.

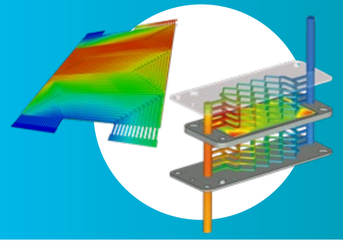
MASTERING VIRTUAL FUEL CELL DEVELOPMENT – FROM COMPONENT LAYOUT TO SYSTEM INTEGRATION

We offer tailored simulation solutions ranging from concept analysis and component optimization to system development and integration. Covering all relevant aspects, our PEM fuel cell simulation solutions help to tackle key challenges related to cell, stack and system performance and lifetime.

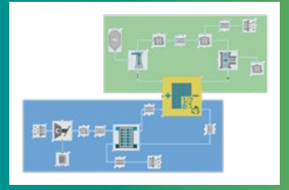
Our 3D multi-physics simulation solution provides detailed insights into the complex multiphase flow, thermal and electrochemical processes on cell level. On stack level, it helps to optimize fuel/air and coolant supply to ensure uniform distribution of reactants and temperature across all cells.

Proper dimensioning of the system's Balance of Plant (BoP) and coolant circuit components, as well as a tailored operating strategy, are crucial for achieving the highest efficiency and maximizing the lifetime of fuel cell systems. To meet these challenges our simulation solution can optimize the fuel cell system including relevant BoP components such as compressors, humidifiers and water separators as well as the associated coolant loop.

The virtual evaluation of the fuel cell system's performance and lifetime is based on sophisticated, real-time capable stack models as well as chemical kinetics and mechanical degradation modelling approaches. These are applicable both in the office and in Software in the Loop (SiL) and Hardware in the Loop (HiL) environments.



Simulation supported cell and stack performance and durability optimization.



Degradation modelling with state-of-the-art AVL-proprietary software from cell to system including entire Balance of Plant (BoP).

A PROVEN TEST ENVIRONMENT FOR HYDROGEN AND FUEL CELL TECHNOLOGY

The unprecedented momentum in hydrogen and fuel cell technology requires deep technology expertise paired with cutting-edge test environments for the continuous optimization of fuel cell systems. The interplay of virtual and real hardware supported by simulation is essential to shorten development time while reaching the development targets and mitigating investment risk. At the same time holistic systems engineering approaches must be supported with a closed toolchain and data-backbone connecting development, production and in-use.

We have addressed these challenges of developing and validating fuel cell systems – from a single cell up to complete systems. Individual testing tools, modular testbed solutions or turnkey facilities – all can be tailored to your fuel cell development needs. Our fuel cell test solutions are designed to provide highly efficient and accurate testing while minimizing integration efforts.

Services for plant and production engineering to complete tailored solutions for In-Process Verification (IPV), End-of-Line (EoL) cold and hot, Quality Assurance (QA) and Conformity of Production (CoP) testing.

R&D-optimized fuel cell system testbeds which can adapt to and grow with your R&D needs.

AVL HYDROGEN AND FUEL CELL TEST CENTER

With our Hydrogen and Fuel Cell Test Center, we have established a unique facility to support the industrial breakthrough of hydrogen and make fuel cell and electrolyzer technologies efficient, durable and affordable. The state-of-the-art testbeds and development environments are set for high-performance applications of the future.

- 600 m² facility with a maximum allocation of up to 20 testbeds
- Separate control and service area with fully automated, remote-controlled testbeds
- One of the most powerful facilities in the world, with a total capacity of up to 2 MW
- Cutting-edge testbeds for SOFC/SOEC and PEM systems up to 400 kW

HIGHLY EFFICIENT POWER GENERATION

Solid Oxide Fuel Cell Technology (SOFC) for Stationary Applications

Energy security will be a major topic considering a renewable energy scenario in the future. In stationary applications such as combined heating and cooling power (CCHP) systems or data center applications, the SOFC technology has already proven its potential to mitigate the risks. Designed to be used with any type of carbon-based fuel, from conventional fuels to future biofuels, operators can achieve CO_2-neutral use with SOFC technologies. In addition, design-to-cost and design-to-manufacture development practices and low fuel consumption keep operating costs low.

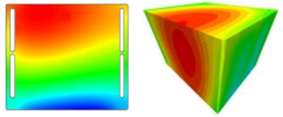
By taking advantage of unique synergies, we offer highly creative, mature and application-specific solutions covering the complete development process – from system simulation, layout analysis, optimization, component development (reformers, media supply, burners etc.), design and packaging as well as controls – all the way to prototype manufacturing and testing.

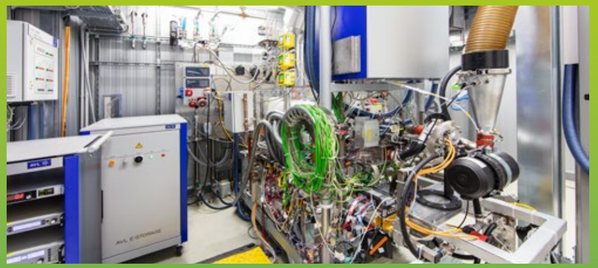
- **Development of fuel flexible SOFC, CHP and CCHP systems**
- **Substantial AVL IP on software and system architecture**
- **Operational intelligence and damaging models to support lifetime and accelerate testing**
- **Prototyping and testing facilities from kW to MW scale**

Our Solid Oxide Fuel Cell Combined Heat and Power (AVL SOFC CHP) stationary power generator is a clean, efficient, cost-effective technology. It generates electricity with near-zero pollutant emissions at efficiencies of up to 60% – even in small power ranges.

Simulation Solutions Supporting SOFC Development

By providing detailed insights into the complex multi-physics processes in SOFC systems, our scalable simulation solutions help to optimize transient start-up and stationary operation with respect to media utilization, fuel conversion efficiency and lifetime-related aspects.





AVL SOFC SYSTEM TESTBED

For SOFC systems we offer testing solutions from cell to system level, providing our customers the complete range of testing possibilities for ultra light, light and heavy-duty applications. Our unique, modular SOFC testbeds can be used for many test cases and are extremely reliable. As a customer we are giving you not only absolute confidence in carrying out your tests, but also the possibility to expand your testing program.

5 KW ETHANOL SOFC CHP SYSTEM DEMONSTRATOR

The stationary 5 kW SOFC CHP prototype system is built to demonstrate the feasibility of ethanol as fuel. It converts the chemical energy of the fuel directly into an electric current with an efficiency target of around 58%. Compared to an engine-based CHP, the electrical efficiency of the system is almost twice as high as of the engine-based. The rest of the energy is converted into heat, leaving the system with cooling water from a heat recovery heat exchanger. This leads to a total efficiency of around 90%.

FIND OUT MORE

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