FVV PRIMEMOVERS. TECHNOLOGIES.

The FVV Transfer + Networking Event | Spring 2026

Knowledge and technology transfer | New research programme

Science for a moving society

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Knowledge and technology transfer

Energy generation and mobility are undergoing a climate-friendly, resource-efficient transformation. For this to succeed, it will take economically viable solutions that do not weaken Europe as an industrial base, but underpin or even strengthen it. FVV supports this shift in energy, molecules, raw materials and powertrains via its international research network in which all partners work together on a pre-competitive basis, developing technologies and systems to phase out fossil energy as quickly as possible.

The FVV Transfer + Networking Event | Spring 2026 centred on energy conversion systems for power generation and powertrains with a low product carbon footprint (PCF), some of which place considerably greater demands on research and development than established concepts. The keynote by Dr Kai Ehrhardt of BASF SE, a case study on the green transformation from the chemical industry, sets out how product and process innovations can reduce the greenhouse gas footprint along value chains.

At the heart of FVV's activities are the pre-competitive research projects conducted under the umbrella of the Industrial Collective Research (Industrielle Gemeinschaftsforschung IGF) scheme. Alongside these, FVV conferences have established themselves as a forum for interdisciplinary exchange between experts from companies, institutes and associations. With the Transfer + Networking Event | Spring 2026, FVV once again offered attendees a substantive programme of events on future technologies and, as always, the opportunity to hear how current research projects are progressing and to expand their networks. This year's event was held for the first time at the Hotel Maritim in Bonn, Germany.


Dr. Ehrhardt

BASF is a global leader in the chemical industry. With an annual turnover of EUR 59.7 billion in 2025, the company supplies its more than 75,000 customers worldwide across its Chemicals, Materials, Industrial Solutions, Agricultural Solutions, Nutrition & Care, and Surface Technologies segments with products that meet business and society's current and future requirements regarding sustainability and climate neutrality.

BASF's product and process innovations support its customers on their journey to climate neutrality and play a major role in reducing the carbon footprint (PCF) of their products. The company itself is also making significant progress towards achieving net-zero CO_2 emissions, for example by investing increasingly in renewable energies to run its plants, and turning its attention to the use of bio-based and recycled raw materials.

DR KAI EHRHARDT

is Vice President Reaction Engineering and Executive Expert at BASF SE's Ludwigshafen site. He has been with the company since 1999, having previously studied Process Engineering at Karlsruhe Institute of Technology (KIT) and the Massachusetts Institute of Technology (MIT).

Dr Ehrhardt is a member of the Board of Trustees of the Max Planck Institute for Dynamics of Complex Technical Systems in Magdeburg and Deputy Chair of the Chemical Reaction Engineering Section at the DECHEMA Gesellschaft für Chemische Technik und Biotechnologie e.V. in Frankfurt am Main.

Chemical reaction engineering forms the core of the process industry's expertise and competitiveness – from raw material extraction through to the chemical and petrochemical sectors to the food and pharmaceutical industries, which in turn supply every one of the manufacturing and processing sectors.

The chemicals industry’s road to **climate neutrality**

Transforming the chemical industry towards climate neutrality is one of the most challenging tasks in industrial decarbonisation. As an energy-intensive industry that is closely woven into global value chains, it is both a major emitter of greenhouse gases and a key enabler of sustainable technologies. In his plenary speech, **Dr Kai Ehrhardt,** Vice President Reaction Engineering and Executive Expert at BASF SE, examined the key elements needed for the chemical industry to achieve net-zero CO_2 emissions by 2050, looking at the technological, systemic and economic dimensions.

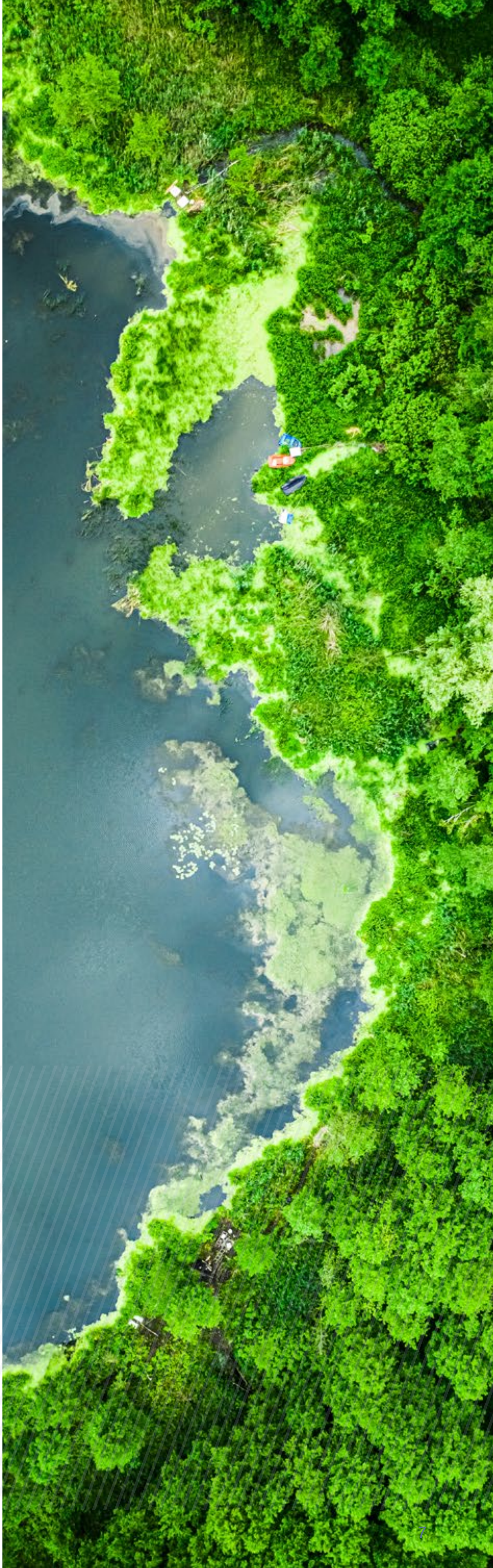
BASF's strategy is built around a long-term transformation aligned with the EU's climate targets. The aim is to cut direct and indirect emissions significantly by 2030, before achieving climate neutrality across the entire value chain by 2050. The defossilisation concept lays out a step-by-step reduction in emissions through the use of renewable energy, efficiency gains, low-emission steam generation and new climate-friendly technologies. »We are investing hundreds of millions of euros each year in these measures, and we regularly adjust our plans to align with technological and economic developments,« said Ehrhardt. In parallel, the product portfolio is being reshaped towards solutions that deliver measurable sustainability benefits. According to Ehrhardt, this shift is closely tied to market demand, as investments and technological changes are heavily influenced by what customers are willing to pay.

The first step in BASF's defossilisation plan is to swiftly implement easy-to-deliver optimisations and measures underpinned by a clearly defined business model. The second step is shaped by a focus on market demand. This will be achieved by securing increasing volumes of renewable raw materials and expanding the range of products with sustainable properties to match customer needs. The final step is the reconfiguration of production plants – decarbonising existing plants and investing in competitive new technologies, in perpetual alignment with customer demand and the net-zero targets. A key element in this is the systematic recording of greenhouse gas emissions along the value chain, so that emissions and emission savings can be documented transparently. Digital tools make it possible to calculate emissions for a large number of products, taking into account process energy, raw materials and upstream emissions from suppliers – which at BASF account for around 50% of total emissions. This information matters not only for internal optimisations, but is also relevant for customer decision-making and regulatory requirements.

Technological and systemic approaches

Switching the chemical industry's raw-material base is a central pillar of the transformation. BASF is increasingly moving away from fossil sources towards renewable sources and circular carbon solutions. This includes both the use of bio-based materials and the integration of recycling flows. These more environmentally friendly raw materials are typically processed alongside conventional base products in existing plants, with the share of bio-based and recycled materials accounted for via the mass balance approach. »This method allows sustainable raw materials to be allocated to specific products on paper, without having to fully separate the physical material flows. This enables a gradual economic transformation while still making use of the existing infrastructure,« explained Ehrhardt.

BASF is concentrating its decarbonisation efforts in particular on key processes at the start of industrial value chains, as this is where the greatest emissions-reduction potential lies. A range of technological options is available for these processes, each assessed on the basis of efficiency, costs and investment needs. Alongside electrification, the use of hydrogen and processes for carbon capture and storage also play a key role.



Hydrogen as a feedstock and energy carrier

In many sectors, such as transport, hydrogen is primarily seen as a potential molecular energy carrier. The chemical industry, however, needs hydrogen on a large scale as a process gas, given the molecular make-up of the chemical products it manufactures. »What is critical in this context is that hydrogen is more valuable when used as a process gas than when it is burned for heat,« explained Ehrhardt. Furthermore, if fossil feedstocks such as natural gas or naphtha are phased out altogether or used only to a limited extent, and replaced by biogenic feedstocks, recyclates or CO_2, the demand for hydrogen will rise further. Providing green hydrogen via electrolysis is energy-intensive and presents real challenges in terms of scaling and cost. Alternative routes such as methane pyrolysis offer promising prospects here, as they can produce hydrogen with comparatively low energy input and very low carbon dioxide emissions.

In parallel, the electrification of chemical processes is becoming increasingly important. A broad supply of renewable electricity is essential for this. Given the sheer scale of their emissions, energy-intensive key processes are a particular focus – such as steam cracking, in which long-chain hydrocarbons are thermally broken down into short-chain molecules through the addition of superheated steam. New sites and production plants offer the opportunity to integrate innovative technologies from the outset and so achieve significantly lower emissions than conventional plants. Significant progress can be made by combining renewable energy supply sources, electrified processes and integrated material cycles. »One example is our new Verbund site at Zhanjiang in southern China. There, we are using state-of-the-art technologies that allow us to cut the carbon footprint by around 50 % compared with a conventional gas-fired petrochemical site,« said Ehrhardt. At the same time, transforming existing plants remains a central challenge, as these account for the bulk of current production capacity. A large-scale heat pump system for harnessing waste heat is set to begin operations at the Ludwigshafen site in 2027. Converting waste process heat from the steam cracker into usable steam can significantly cut the use of fossil fuels. In conventional superheated steam generation in boilers, switching from natural gas to alternative energy sources such as electricity or hydrogen also offers scope for reducing emissions. »We expect green hydrogen to remain comparably scarce and expensive for the foreseeable future. Because we urgently need it as a process gas, our focus lies on electrifying steam generation and on direct electric heating of chemical processes,« Ehrhardt continued.

New pathways to success for sustainable industrial production – Dr Kai Eckart (third from left) in conversation with the FVV Board and Directorate (left to right): Max Decker, Dr Andreas Kufferath, Matthias Zelinger, Martin Nitsche, Prof Dr Markus Schwaderlapp

For emissions that are technically hard to avoid, carbon capture and storage is an essential complement. Implementing solutions of this kind, however, will require suitable regulatory frameworks and the development of the corresponding transport and storage infrastructure, Ehrhardt noted. International cooperation, he added, is pivotal here, as suitable storage sites are not available in every region and such cooperation allows for more economical scaling.

Transformation has to be economically viable

As the keynote made clear, decarbonising the chemicals industry is a complex, long-term process that combines technological innovation, systemic integration and the economic framework. Success will hinge largely on how well efficiency gains, new technologies and shifting market dynamics can be married into a coherent transformation pathway. The chemical industry has a pivotal role to play in this regard, as its products and processes have an impact well beyond the sector itself and can therefore make a decisive contribution to global climate neutrality. In addition to the technological aspects, the economic dimension is also crucial. The transformation calls for significant investment and pushes up manufacturing costs, while the willingness to pay for sustainable products is currently limited. »This creates a tension between environmental goals and economic viability. Policy instruments such as carbon pricing, regulation and funding programmes can support the green transformation, but they have economic consequences and shape global competition,« said Ehrhardt.

THEMIS
Keynote presentation
→ www.themis-wissen.de

Regenerative fuels
MTZ 06/2026
→ www.fvv-net.de

Acoustics · Materials engineering · Non-fossil energy carriers

// full project information from p. 31

PROJEKT 1493 · Power Density Increase of Hydrogen CI Engines
SCHWERPUNKT Efficiency / energy carriers
EXPERTENGRUPPE Engines

PROJEKT 1515 · Methanol Compatibility
SCHWERPUNKT Energy carriers
EXPERTENGRUPPE Engines

PROJEKT 1487 · Additively Manufactured High-pressure Components
SCHWERPUNKT Materials / components
EXPERTENGRUPPE Materials Science & Recycling

PROJEKT 1508 · Suction-sided Noise Emission from Centrifugal Compressors
SCHWERPUNKT Development tools
EXPERTENGRUPPE Turbomachinery

Materials engineering and non-fossil energy carriers paving the way for the development of carbon-neutral powertrains

With their low carbon footprints, the powertrain and energy systems of tomorrow are placing new demands on development that are often considerably greater than those of established concepts. FVV's pre-competitive remit creates the space for a 360° view of the challenges this brings. With this all-round perspective, the research projects are designed to lay the groundwork for the development of future energy carriers and energy conversion systems. Examples include projects in the acoustics and materials field, which investigated the compatibility of new fuels with established metallic materials and lubricating oils, the use of additive manufacturing processes, and noise phenomena in gas turbines. Another completed project successfully improved the efficiency of using hydrogen in a combustion engine by employing inert gas in a closed cycle.

Power density increase for hydrogen compression-ignition engines

The energy transition and the ever-stricter environmental regulations that come with it present major challenges for the energy and mobility sectors. The UK government, for instance, has set a target of sourcing 65 % of its electricity from renewables by 2030. Against this backdrop, hydrogen (H_2), and »green« hydrogen in particular, is becomingly increasingly important as a carbon-free energy source. A key technology for using hydrogen efficiently is combined heat and power (CHP). Conventional CHP plants run predominantly on fossil fuels, resulting in significant emissions – particularly of climate-damaging CO_2.

The complex exhaust gas after-treatment needed to meet emissions regulations is also a major cost factor. Using hydrogen in combustion engines makes it possible to avoid carbon emissions. However, burning hydrogen with air still produces nitrogen oxides (NOx) due to the elevated combustion temperatures, and reducing these likewise requires complex after-treatment. In a closed-cycle hydrogen combustion engine (H_2 cycle engine), NOx emissions are avoided altogether by running on an inert working gas (e.g. argon) instead of air, together with the controlled supply of pure oxygen. This removes the need for costly DeNOx exhaust gas after-treatment. As an earlier FVV research project had already shown, this opens up the possibility

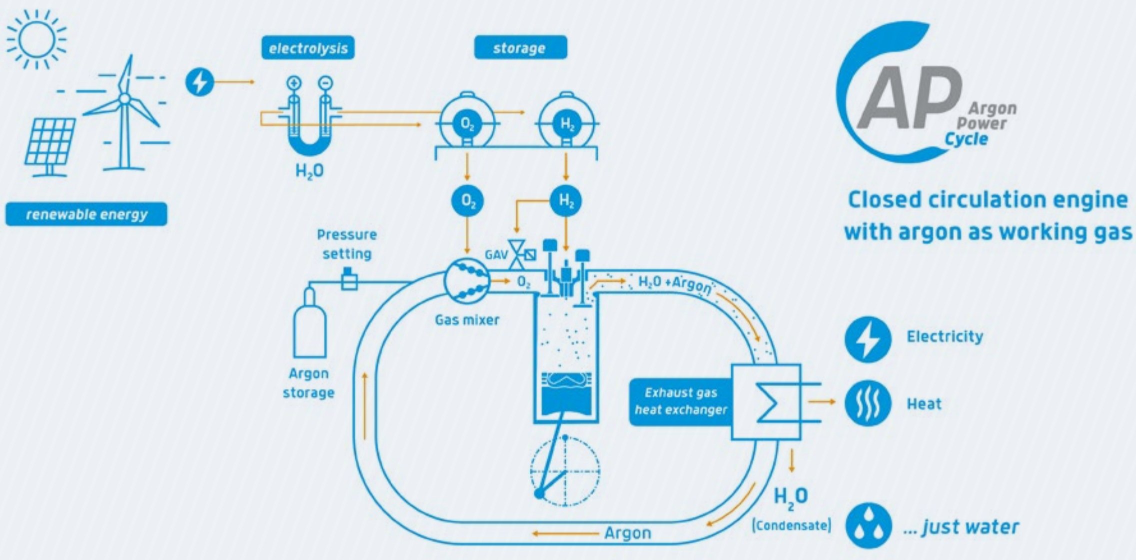


FIGURE 1

H_2 cycle engine // WTZ

of fully emission-free power generation, albeit at a comparatively low power density. The **Increasing the Power Density of a Compression-Ignition Hydrogen Engine in a Closed Working-Gas Cycle** (BMWE/IGF/01IF22917N) research project, funded by the Federal Ministry for Economic Affairs and Energy under the Industrial Collective Research IGF scheme, therefore systematically examined measures for increasing the power density of the H_2 cycle engine. A further aim was to deepen the physical understanding of the system as a whole. »The results enable us to refine the engine concept in ways that are essential for a techno-economic assessment,« explained project lead Dr Ing Christian Schnapp, WinGD Ltd.

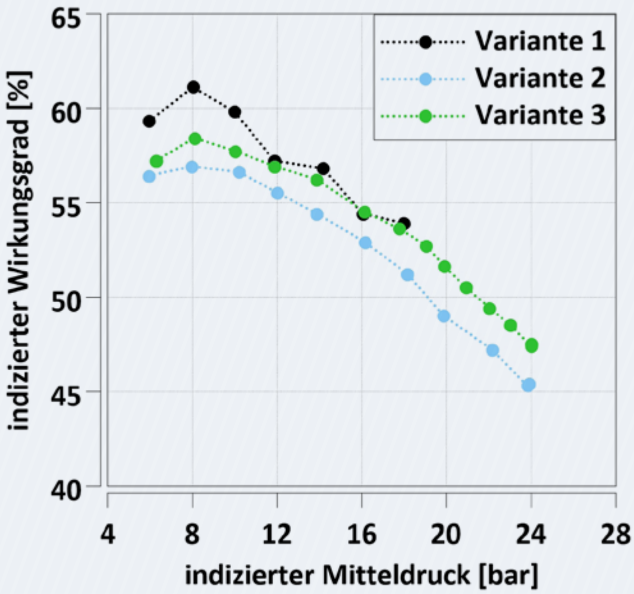


FIGURE 2

Efficiency gains through parameter variation // WTZ

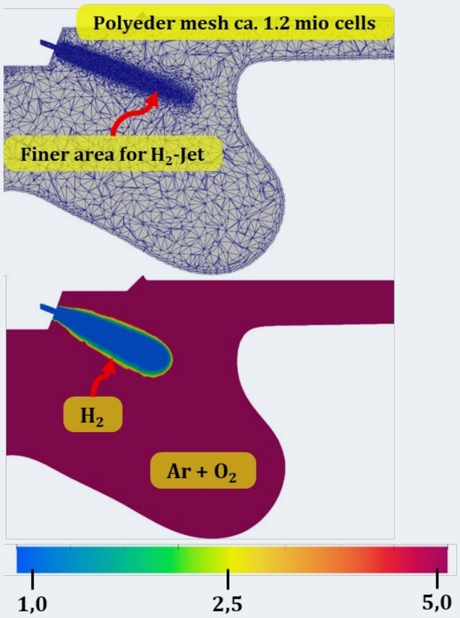


FIGURE 3

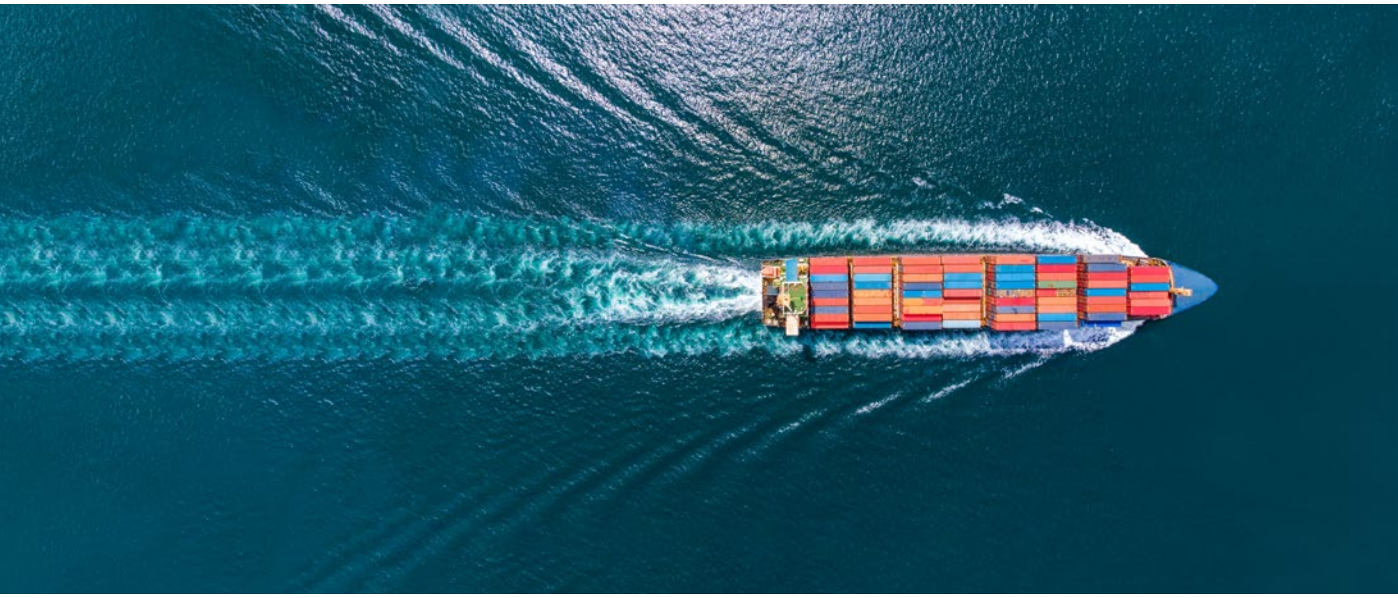
Symmetrical half-section of the combustion chamber: refined polyhedral mesh (H_2 jet) and simulation result for lambda of H_2 injection into $Ar+O_2$ // EMA

The project was a joint effort by the former Institute of Mobile Systems (IMS) – now the Institute for Engineering of Products and Systems (IEPS) – at the Chair of Energy Conversion Systems for Mobile Applications (EMA) at Otto-von-Guericke University Magdeburg, together with Wissenschaftlich-Technisches Zentrum Roßlau gGmbH (WTZ Roßlau). While the test-bench investigations were carried out at WTZ Roßlau, the EMA developed a simulation model of the H_2 cycle engine and calculated the potential for optimisation. For the technical implementation of the tests at WTZ Roßlau, an injector with an increased throughput was fitted to the existing four-cylinder test engine. This in turn necessitated modifications to both the engine and the gas supply. With the improved system, the team was able to run a range of parameter variations to analyse the engine's behaviour and, on that basis, increase the power density. Because the maximum cylinder pressure was expected to be the limiting factor, the researchers examined two further, lower compression ratios. In both cases, the target mean pressure of 24 bar was achieved. »A clear efficiency advantage shows up particularly in the part-load range, with combustion stability improving as the load rises. The improved stability at high loads can be traced back to the injector nozzle, which is operating close to its lower operating limits in the part-load range,« explained Lukas Kniestedt from WTZ. The investigations also indicated that raising the injection pressure could yield efficiency advantages in the high-load range.

The EMA supported the testing with continuous 1D and 3D simulations. »Our primary aim was to determine the operating limits and boundary conditions of the concept in an efficient and cost-effective way. This synergy between physical testing and numerical computation proved to be an extremely effective development strategy,« said Aristidis Dafis from the EMA. For example, various unforeseen practical challenges arose over the course of the project – such as a leak of the diesel oil used as a control fluid in the injector – which underlined the need to closely couple simulation with test-bench investigations. Because only one of the four cylinders was actively fired, it was essential to quantify the friction losses of the passive-running cylinders so that the measured indicated power could be converted into a reliable figure for the economic assessment.

In summary, the results of the research project show that the chosen methodology enables small and medium-sized enterprises (SMEs) in particular to save considerable costs and valuable test-bench time by using simulation to pre-select operation points. The economic analysis confirms the substantial potential of the cycle concept: despite the higher initial investment, its high efficiency of around 57 % leads to significantly lower operating costs and makes the technology the superior solution in the long term.

»The high efficiency speaks clearly for itself. The results of this project have mapped out the next steps in developing this concept into a highly efficient, emission-free powertrain technology,« said Schnapp. The researchers from the EMA and WTZ believe follow-on projects could achieve substantial further efficiency gains through the use of new mono-fuel injectors and additional refinements to the concept.



Methanol compatibility of engine components

Combustion engines running on regeneratively produced methanol are an important building block in the defossilisation strategy for the transport sector, such as in ship operation. This is especially true where electrification is not viable, for instance because the low energy density of batteries compared with liquid fuels would mean large, heavy battery packs on board ships, eating into cargo space, payload or passenger capacity. A further factor is the lack of charging infrastructure in many parts of the world. That said, the use of methanol requires key components in the fuel and exhaust paths to be modified to deal with material-related issues such as corrosion. There are also interactions with the engine oil t hat can lead to oil dilution and a loss of lubricity that need considering.
The FVV project **Methanol Compatibility** investigated the compatibility of methanol as a marine fuel with metallic materials and engine oils under the conditions relevant to ship operation. »The project has brought to light the fundamental material-related challenges of running combustion engines on methanol. The findings provide a solid foundation for focused follow-on work on methanol engines,« said project lead Dr Johann Wloka from Everllence.

The project was carried out by OWI Science for Fuels, with the researchers examining ten methanol grades in total. Alongside two extreme cases – an high-purity methanol and a highly contaminated variant containing 5 % water, 40 ppm acid and 1 ppm chloride – the test series included eight further methanol grades, each contaminated with either acid or salt (with the latter leading to a higher chloride content). »Compared with conventional fuels, alcohols such as methanol are generally more corrosive to ferrous metals. This is primarily due to the impurities that they contain, such as formic acid, acetic acid and chlorides, which significantly accelerate the corrosion process,« explained Dr. Karin Engeländer from OWI Science for Fuels.

The material samples were selected in consultation with the project user committee so as to represent the central fuel and exhaust-carrying components, such as injectors, pistons, piston rings and exhaust pipes. This makes it easier to transfer the findings to future engine projects.

The materials testing showed methanol grade to be the decisive factor for the intensity of corrosion. In the most heavily contaminated variant, clear signs of corrosion appeared on almost all of the material samples, whereas this was not the case with the high-purity methanol under otherwise identical conditions. The contaminated methanol led to various forms of corrosion including pitting, crevice corrosion and surface oxidation, especially in low-alloy steels and carbon steels such as 1.1303, 1.0308 and E711. The martensitic stainless steel 1.4718 showed localised pitting, which is consistent with its known behaviour under aggressive conditions. The tank coating proved the most stable in the contaminated methanol, showing only minimal discoloration even after prolonged exposure. »These results clearly indicate that the corrosion observed was caused primarily by the contaminants in the

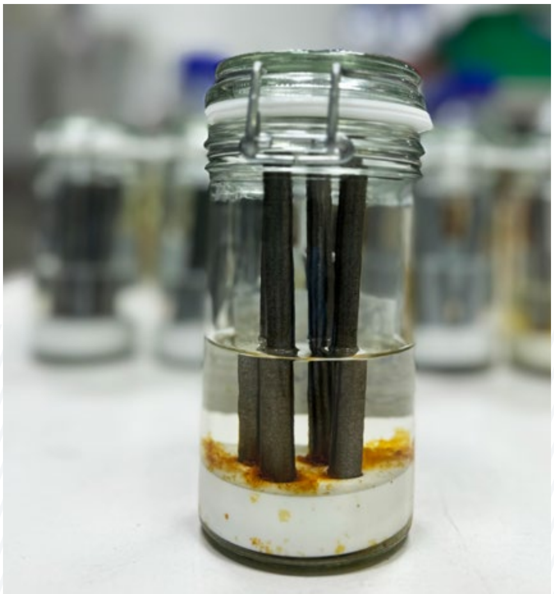


FIGURE 4

Test set-up of a material sample in methanol (storage period: one week) // OWI

FIGURE 5

Test set-up for the interaction of methanol exhaust gases with engine oils // OWI

methanol, not by the methanol itself. Tests with mid-grade methanol also showed that the salt concentration has a greater impact than the acid concentration,« said Engeländer. Some materials remained stable in both acid-contaminated and salt-contaminated methanol, while others showed surface corrosion. In some cases, corrosion occurred close to the phase boundary or in the gas phase, suggesting that the contaminants are also transferred via the gas phase.

To test compatibility with the combustion products of a methanol engine, samples of five representative materials were exposed to a surrogate exhaust gas. The concentrations of the various exhaust gas constituents were based on four measurements taken across different engine types, From which the researchers compiled a worst case scenario. The samples were stored for eight weeks at 100 °C in an air-tight container under the surrogate exhaust gas. The temperature was chosen to ensure that the components remained gaseous rather than liquid throughout the test. Under the synthetic exhaust gas conditions, degradation occurred mainly in the carbon steels, while the high-alloy stainless steels and aluminium remained unaffected.

The investigations into the interaction of engine oils with both pure and heavily contaminated methanol revealed no significant chemical changes in the engine oils tested. However, dilution effects arose due to the formation of emulsions, which affect the physical properties such as the viscosity of the engine oils. Due to these emulsion droplets, there is a non-linear correlation between the methanol concentration and viscosity, with a viscosity minimum at below 1 % added methanol. Slight changes were also seen in the acid number and base number of the engine oils once methanol was added.

Overall, the project findings underline the critical role that fuel purity and material selection play in ensuring long-term performance in methanol-powered marine systems. »Introducing methanol as a fuel in the maritime sector calls for particular care in material selection. We would also recommend measures to ensure consistently high methanol grades and to prevent contamination, especially with acidic substances and salts,« said Engeländer.

FIGURE 6

Various contaminated methanol variants // OWI

Additively manufactured high-pressure components

Additive manufacturing is emerging as an important production technology. Unlike conventional machining processes such as milling or turning, additive manufacturing enables the production of highly complex structures, including internal geometries that are difficult or impossible to achieve with traditional methods. This capability opens up new possibilities for optimising components. There is, however, a current gap in research into the use of additively manufactured components in high pressure applications. This has not yet been sufficiently investigated, particularly in combination with autofrettage, a process that increases the fatigue strength of components by introducing beneficial compressive residual stresses. With the research project **Increasing the Fatigue Strength of Additive Manufactured High-pressure Components** – funded by the Federal Ministry for Economic Affairs and Energy through the Industrial Collective Research IGF scheme (BMWE/IGF/01IF22713N) – crucial steps have now been taken to close this gap.

The research was conducted at the Institute for Steel Construction and Materials Mechanics (IFSW) at the Technical University of Darmstadt and the Materials Research and Testing Laboratory (MFPA) at Bauhaus-Universität Weimar. Both research institutes contri-buted to the project their extensive experience in the testing and simulation of autofrettaged components for fatigue strength, experience gained in part through a long series of FVV projects.

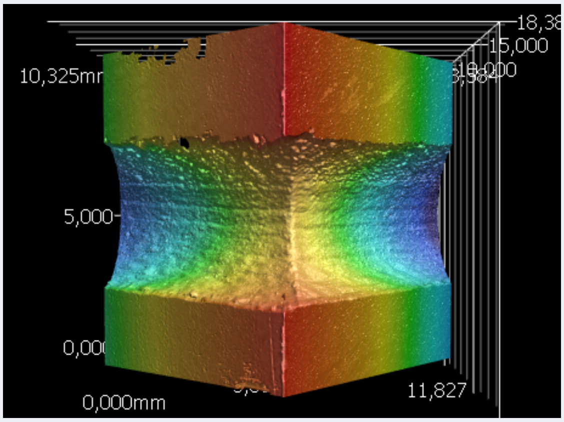


FIGURE 7

3D image of the 90° intersection edge of two printed channels // MFPA

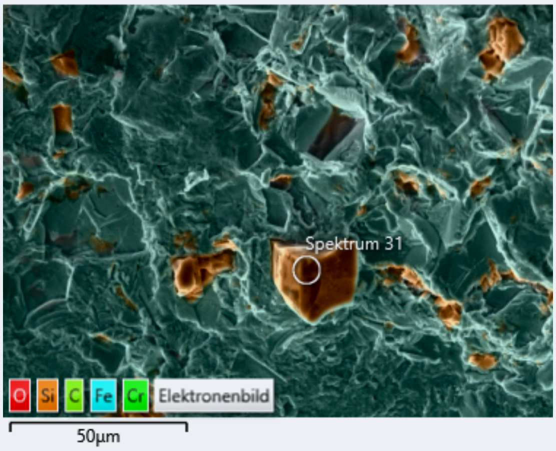


FIGURE 8

Imperfections at the fracture origin, pulsating internal pressure testing, cross-channel specimen with printed channels. Sharp-edged inclusions // MFPA

This project focused in particular on determining the fatigue and crack growth behaviour of the 3D-printed material under a range of manufacturing conditions. In addition, the team of researchers conducted crack surface analyses and microstructural tests to identify damage mechanisms and the impact of manufacturing-related defects. Component-like specimens were also produced and tested experimentally under pulsating internal high pressure of up to 3000 bar, to determine how well the findings can be transferred to real-world components. The experimental results provided the basis for developing theoretical-numerical models to describe crack initiation and propagation, and for deriving theoretical principles to extend the synthetic Wöhler curves – ultimately allowing fatigue strength to be captured computationally,« explained Prof Dr Anna Trauth of the IFSW.

For the research work, a high-strength hot-work tool steel was processed using laser powder bed fusion (LPBF) and investigated with a combination of experimental, analytical and numerical methods. Tests on the component-like specimens were conducted in both the non-autofrettaged and the autofrettaged state, with a focus on fatigue strength and the endurance limit. The material used for the additive manufacturing was the widely used high-strength steel X37CrMoV5-1. This steel is commonly used as an additive manufacturing material, and the required printing parameters are well known in production.

In their additive manufactured state, steels in this alloy group also achieve very high fatigue strengths and offer a fracture strain of more than 7 %, making them well suited to the autofrettage process.

To produce the specimens, blanks were printed from this material in the vertical, 45° and horizontal directions and then surface-finished. Axial fatigue tests on vertically printed material specimens that were notch-free, low in residual stress and with polished surfaces yielded a mean endurance limit of close to 600 MPa; the horizontally printed specimens achieved comparable values. Both data sets did, however, show significant scatter, which meant that no statistically significant difference between the specimens' build directions could be inferred. For the Wöhler curves prepared in line with the »FKM-Richtlinie Nichtlinear«(FKM Guideline »Non-linear«; available only in German) for the assessment of operational fatigue strength, the experimental findings for the three build directions investigated could likewise be evaluated together. Fractographic analyses revealed crack initiation at near-surface internal defects such as gas porosity, lack-of-fusion defects and microcracks, which acted as dominant causes of fatigue. Printed specimens with unmachined surfaces exhibited markedly poorer fatigue properties. »This is evidence of the crucial role that surface condition plays in the fatigue behaviour of additively manufactured components,« said Andreas Kleemann of the MFPA.

The next step was to produce component-like specimens with internal channels and test them under pulsating internal pressure loading. In some of the specimens, the channels were formed directly during the additive manufacturing

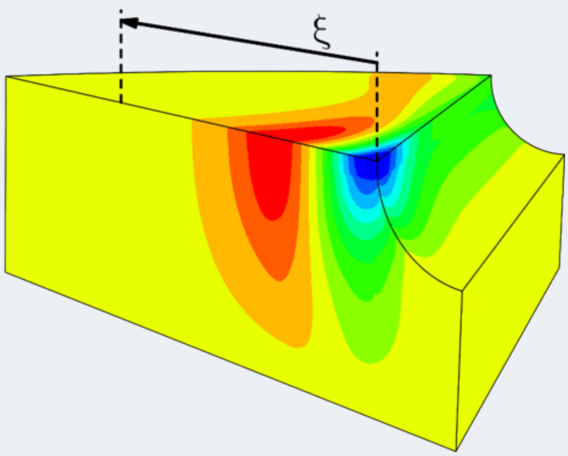


FIGURE 9

Residual stress components σ_z perpendicular to the crack propagation plane on the 1/16 simulation model of the autofrettaged cross-bore specimen. High compressive residual stresses (blue) in the region of the failure-critical location // IFSW process; in the others, they were drilled in afterwards. The tests showed that autofrettage delivers a significant increase in fatigue strength in additively manufactured high-pressure components as well. »This clear improvement demonstrates the high effectiveness of the autofrettage treatment, which significantly enhances the endurance limit against internal pressure loading even in specimens with printed channels, which exhibit the defects typical of additive manufacturing. Autofrettage therefore proves to be technically effective and well suited to industrial implementation,« said Dr Thomas Beier of the IFSW.

For the numerical assessment of the fatigue strength of the component-like specimen, the autofrettage process was first simulated and the crack-initiation life then calculated using the local strain approach, in which the locally determined elastic-plastic stresses and strains are used for the assessment.

Potential crack arrest was calculated using linear-elastic fracture mechanics. The results matched the experimental data well.

The research findings make it possible to apply the autofrettage process to additively manufactured components subject to internal pressure loading. These include components for injection systems and pumps, components with cooling or heating channels, and complex tools with internal channels and cavities. »The groundwork laid in this project – in terms of manufacturing technologies, material behaviour and calculation methods – provides fundamental scientific insights for developing regulations, quality requirements and manufacturing standards, and thereby broadens the potential user base across the industry, in particular SMEs, along the entire value chain,« said project lead Stefan Zimmermann of Woodward L'Orange.

Suction-side noise emissions from centrifugal compressors

Centrifugal compressors have an extremely broad range of applications. They are used, for example, in their millions in turbochargers for passenger car, commercial vehicle, marine and stationary engines. The energy transition is opening up further fields of application for centrifugal compressors – such as in systems and units for energy storage, for carbon capture and compression, in large-scale heat pumps, and to pressurise the air supply for H_2 fuel cells. A key prerequisite for the acceptance of these systems is suitably low noise emissions, particularly where they are installed close to residential areas as part of a decentralised energy supply. In such cases, noise must be at, or ideally below, statutory limits.

Because centrifugal compressors account for a considerable share of the noise emissions, reducing this noise and certifying the reductions achieved represents a major economic challenge. The noise emitted by centrifugal compressors can be broken down into two components. Firstly, the compressor radiates sound directly into its surroundings via its housing. This type of noise can usually be sufficiently reduced by insulating and enclosing the centrifugal compressor. Secondly, sound is radiated into the suction and discharge lines connected to the compressor. The piping transmits the sound with no appreciable damping and releases it directly into the surroundings, both through the pipe walls and through the piping's open ends. Additional noise mitigation measures are therefore required on the piping and at its outlets. The sound present in the piping originates predominantly from the centrifugal compressor itself, while the additional sound created by the flow routing inside the piping is considerably lower. A precise understanding of the sound radiation into the suction line across the entire operating range is therefore essential for efficient acoustic optimisation.

The physical mechanisms behind the generation and propagation of sound, together with mitigation measures, were investigated in the FVV project **Development of prediction methods for the noise emission of centrifugal compressors in their suction line and derivation of guidelines for low-noise design.** The research was conducted at RWTH Aachen University's Institute of Jet Propulsion and Turbomachinery (IST) and funded by the Federal Ministry for Economic Affairs and Energy through the Industrial Collective Research (IGF) scheme (BMWE/IGF/01IF22980N). »This project provides companies that develop or use centrifugal compressors with best-practice guidelines for the numerical and experimental determination of the sound power level and for low-noise system design. This allows them to implement aeroacoustic noise mitigation measures faster and more cost-effectively,« explained project lead Vera van Dinther from Everllence.

For the investigations, the IST used frequency-domain RANS methods to simulate the aeroacoustic generation and propagation of sound from an industrial centrifugal compressor at eleven selected operating points, before analysing the modal sound field in the suction line in detail. Building on the numerical results, the IST adapted a measurement method developed in earlier FVV research projects for determining the tonal sound power level, tailoring it for use in the suction line. In an extensive measurement campaign, the suction-

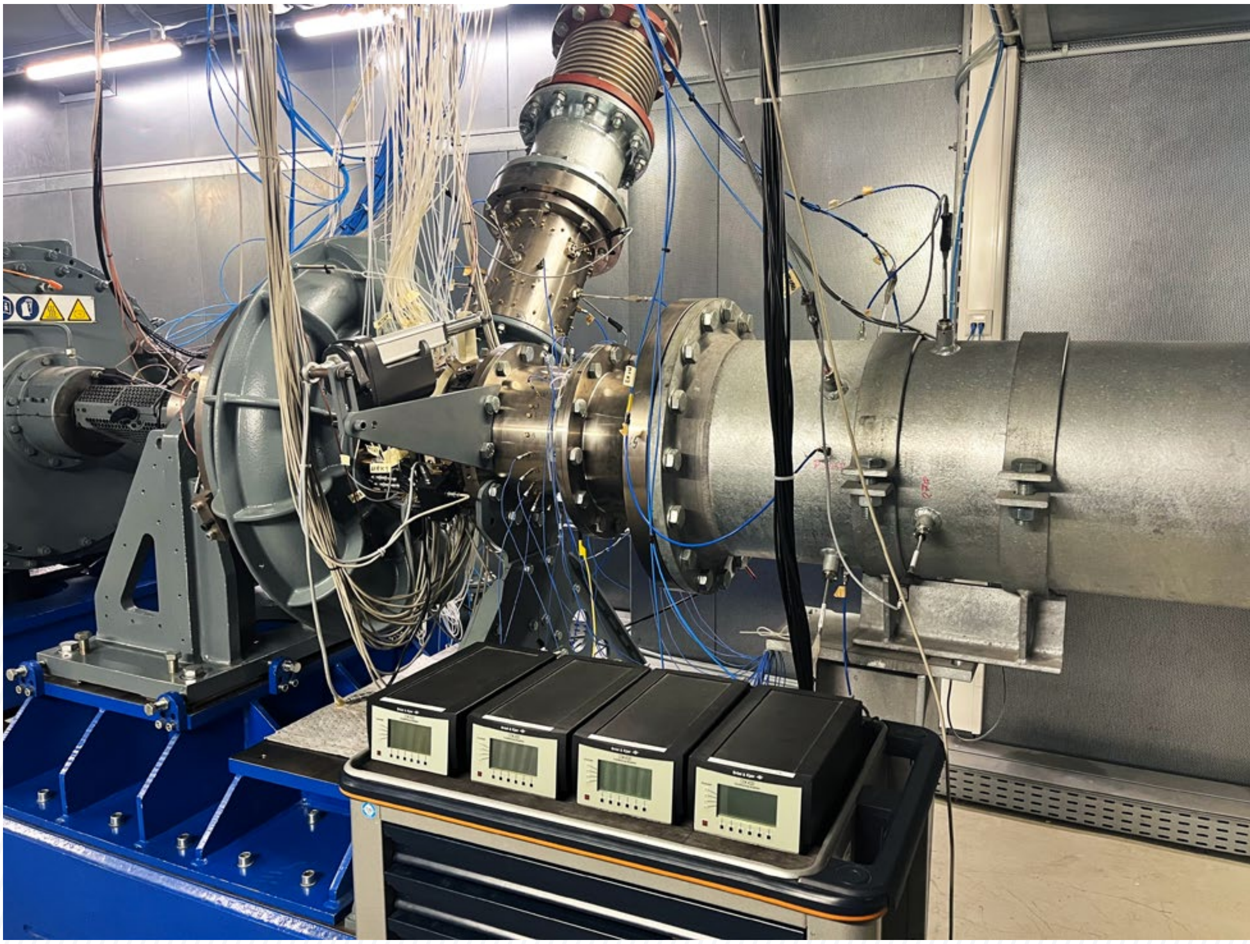


FIGURE 10

Highly instrumented centrifugal compressor test rig at the IST, with a measurement section in the suction line for determining suction-side sound emissions // IST

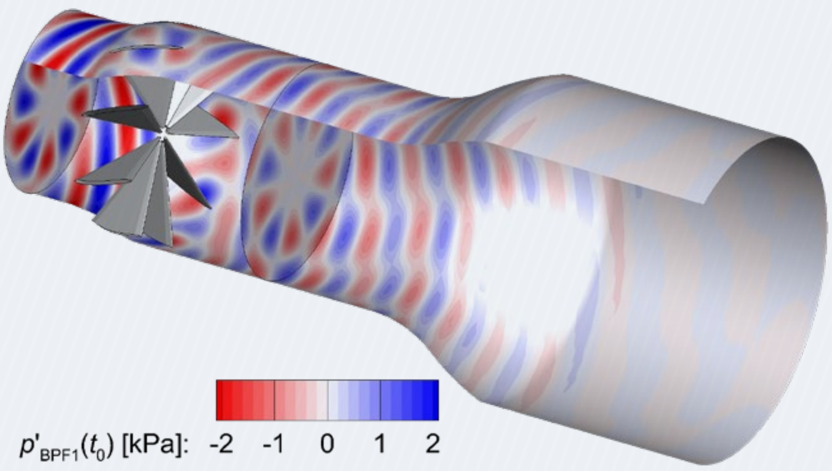


FIGURE 11

Simulation of the sound pressure for the first blade-passing frequency in the suction line using frequency-domain RANS methods // IST

side sound emissions were then investigated at various rotational speeds and inlet guide vane positions. Across large portions of the operating range, both the sound power level and the azimuthal mode spectrum at the first and second blade-passing frequencies could be determined successfully and reliably. »At high rotational speeds and high mass flows, however, some of the measurements were not always reproducible – which can be traced back to the occurrence of supersonic regions in the impeller. These prevent the otherwise dominant impeller-diffuser interaction modes from propagating upstream through the impeller, causing the structure-borne sound from the compressor casing to mask the compressor's aeroacoustic sound field during the measurements in the suction line. As a result, different sound emissions were measured at aerodynamically identical operating points under differing ambient conditions,« said Marius Geilich of the IST.

Despite these limitations, the dependence of the aeroacoustic sound power on the operating point could be clearly analysed. With only a few exceptions, the sound power level was higher at the first blade-passing frequency than at the second. At the first blade-passing frequency, the sound power level rose with increasing rotational speed and showed a minimum at low flow rates along the characteristic curves, with sharp increases towards the surge and choke limits. At the second blade-passing frequency, the sound power level was at a similar level across all rotational speeds, with a maximum at

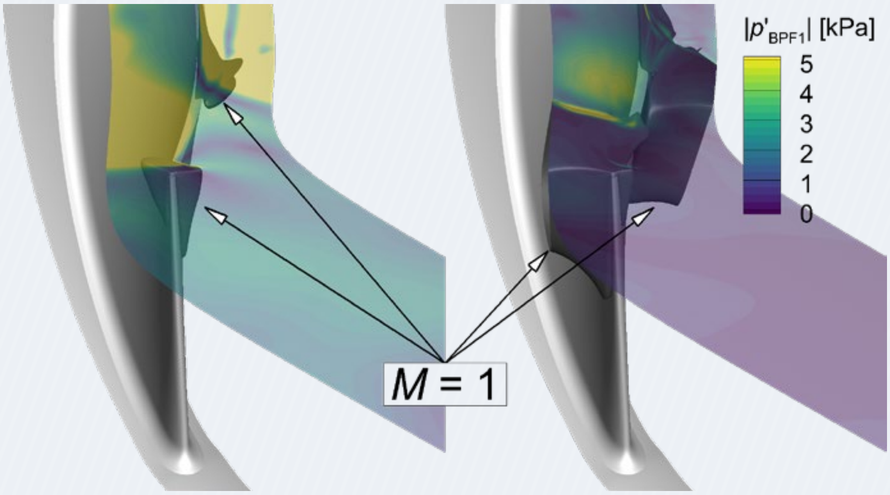


FIGURE 12

Influence of supersonic regions in the impeller on the propagation of the sound pressure upstream through the impeller into the suction line // IST

the surge limit and a marked drop-off towards the choke limit. The influence of the inlet guide vanes on the sound power level was small, owing to their large distance from the impeller. Although they did affect the mode field, they did not generate any additional acoustic energy. »Overall, the project's findings show that frequency-domain RANS methods can reliably reproduce the aeroacoustic sound emissions of a centrifugal compressor; that the under-determined azimuthal mode analysis allows the aeroacoustic sound field in the suction line to be determined with confidence; and that a sound under-standing of the dominant sound sources is essential for the targeted reduction of noise emissions from a centrifugal compressor,« explained Geilich.

THEMIS
Centrifugal compressor research in FVV | The research programme
→ www.themis-wissen.de

see also
Centrifugal compressor research in FVV | Anniversary magazine
→ www.fvv-net.de

Around **250** participants joined in lively discussions

A total of **18 projects** on scientific and technological foundations for climate neutrality and zero-impact emissions from sustainable energy conversion systems were presented

On **24. September 2026** we will meet again for the next FVV Transfer + Networking Event

Science for a moving society

Keeping an open mind **for the future**

Around 250 attendees from companies, research bodies and associations came together in Bonn to learn about the latest results of ongoing and recently completed FVV research projects (→ p. 31: research directory). The transformation of industry into a sustainable circular economy with net-zero greenhouse gas emissions and zero-impact emissions of other harmful substances is in full swing. The FVV supports this shift in energy, molecules, raw materials and powertrains via its international research network in which all partners work together on a pre-competitive basis, developing technologies and systems to phase out fossil energy as quickly as possible. Sustainable energy conversion systems for power generation and propulsion have a low carbon footprint (PCF – Product Carbon Footprint), some of which place considerably greater demands on research and development than established concepts. The case study on the green transformation from the chemical industry, set out how product and process innovations can reduce the greenhouse gas footprint along value chains.

Thus, participants gained valuable support and manifold stimuli for their own research and development activities.

In order to meet future research demand, FVV has structured the IGF project planning using the V-model: societal and the resulting technological requirements for sustainable energy conversion systems are specified from the system level right down to the component level and implemented in research projects (→ page 38: Expert groups and research fields (ToR)). The pre-competitive Industrial Collective Research (IGF) organised by the FVV thus lays the foundation for the development of even more environmentally friendly and resource-efficient engines, hybrid powertrains, fuel cells, turbines, compressors and the corresponding energy carriers.

In-person conferences remain an important platform for the exchange of information and ideas, and for expanding scientific networks. The next FVV transfer event will take place at the Maritim Hotel Bonn from 23 to 25 September 2026.

See also:
The FVV Transfer + Networking Event | Autumn 2026
→ www.fvv-net.de

NR	› TITLE › FUNDING ORGANISATION	› RTD PERFORMERS › PROJECT COORDINATION	› PROCEEDINGS › FINAL REPORT
1499	**› Modelling Approaches of Vehicle Induced PN/PM and Emission Reduction Strategies:** PN/PM tailpipe simulation, evaluation of modelling approaches for brake and tyre induced particles and development of advanced control strategies › FVV	› Prof Dr Stefan Pischinger (tme, RWTH Aachen University) › Dr Frank Bunar (IAV GmbH)	› R613 (p. 5–45) › H1409 (2025)
1488	**› Real Driving Data for Automotive Application:** Real driving data and use cases for automotive powertrain development › FVV	› Prof Dr Peter Eilts (ivb, Technische Universität Braunschweig) Prof Dr Roman Henze (ItF, Technische Universität Braunschweig) › Christopher Grießhaber (SEG Automotive Germany GmbH) Stefan Gottlieb (Robert Bosch GmbH)	› R613 (p. 46–80) › H1424 (2026)
1494	**› Condensate Formation in Exhaust Systems:** Surface condensation on exhaust gas conducting component surfaces under the influence of dynamic (cold start) operating conditions on a gasoline and diesel engine › BMWE/IGF	› Prof Dr Thomas Koch (IFKM, KIT Karlsruhe Institute of Technology) Prof Dr Dimosthenis Trimis (EBI-VBT, KIT Karlsruhe Institute of Technology)	› R613 (p. 81–110) › H1412 (2025)
1493	**› Power Density Increase of Hydrogen CI Engines:** Increase of power density of a hydrogen CI engine within a closed working gas cycle › BMWE/IGF	› Prof Dr Hermann Rottengruber (IMS-EMA, Otto von Guericke University Magdeburg) Dr Christian Reiser (WTZ Roßlau gGmbH) › Dr Christian Schnapp (WinGD Ltd.)	› R613 (p. 111–139) › H1417 (2026)
1492	**› Cold Start Optimisation for M-100 Methanol Engine:** Investigation of internal engine measures to improve the cold start behaviour of a M-100 petrol engine for drives of passenger cars and light commercial vehicles › BMWE/IGF, FVV	› Prof Dr Frank Atzler (IAD-LVAS, Technische Universität Dresden) Prof Dr André Casal Kulzer (IFS, University of Stuttgart) › Prof Dr Thomas Garbe (VOLKSWAGEN AG)	› R613 (p. 140–171) › H1423 (2026)
1515	**› Methanol Compatibility:** Methanol compatibility of engine components and lubricants › FVV	› Dr Sangeetha Ramaswamy (OWI Science for Fuels gGmbH) Karolina Kumarasinghama (OWI Science for Fuels gGmbH) › Dr Johann Wloka (Everllence SE)	› R613 (p. 172–190) › H1415 (2026)
1481	**› CO_2 Reduction by Shorter Burn Duration:** Well-founded investigations of innovative measures to reduce the burn duration in the diffusive burn-out phase of Diesel engines combustion in order to increase the combustion efficiency › FVV	› Prof Dr Stefan Pischinger (tme, RWTH Aachen University) Prof Dr Heinz Pitsch (itv, RWTH Aachen University) Prof Dr Michael Wensing (FST, University of Erlangen-Nürnberg FAU) › Dr Sascha Schönfeld (FEV Europe GmbH)	› R613 (p. 191–224) › H1413 (2025)
1455	**› CFD Simulation of Droplet Separators:** Development and implementation of an experimentally validated 3D-CFD model for the simulation of the separation efficiency of droplet separators for fuel cell systems › FVV	› Dr Dirk Lucas (HZDR eV) › Dr Michael Harenbrock (MANN+HUMMEL GmbH)	› R613 (p. 225–256) › H1408 (2025)

NR	› TITLE › FUNDING ORGANISATION	› RTD PERFORMERS › PROJECT COORDINATION	› PROCEEDINGS › FINAL REPORT
1487	› **Additively Manufactured High-pressure Components:** Increasing the fatigue strength of additively manufactured high-pressure components › BMWE/IGF	› Prof Dr Carsten Könke (MFPA Weimar) Prof Dr Anna Trauth (IFSW-WM, Technische Universität Darmstadt) › Stefan Zimmermann (Woodward L'Orange GmbH)	› R613 (p. 257–287) › H1426 (2026)
1520	› **HT-Threshold Calculation Methods II:** Advanced computational methods and testing technique for the evaluation of threshold and propagation behaviour of mechanically short cracks at different temperatures and frequency ranges › BMWE/IGF	› Prof Dr Peter Gumbsch (Fraunhofer-IWM) Prof Dr Matthias Oechsner (MPA-IfW, Technische Universität Darmstadt) › Julian von Lautz (MTU Aero Engines AG)	› R613 (p. 288–322)
1518	› **Integrated Creep-fatigue Assessment:** Generalization, extension and verification of damage accumulation approaches for an integrated assessment of realistic operation loads within FEM-Programs › BMWE/IGF	› Prof Dr Peter Gumbsch (Fraunhofer-IWM) Prof Dr Stefan Weihe (MPA, University of Stuttgart) Prof Dr Matthias Oechsner (MPA-IfW, Technische Universität Darmstadt) › Dr Martin Reigl (GE Vernova)	› R613 (p. 323–360)
1521	› **Simulation-Crack Behaviour Coarse Grain II:** Optimization of the high-temperature crack behaviour assessment of coarse-grained materials › BMWE/IGF	› Prof Dr Stefan Weihe (MPA, University of Stuttgart) Prof Dr Matthias Oechsner (MPA-IfW, Technische Universität Darmstadt) › Markus Fried (MTU Aero Engines AG)	› R613 (p. 361–394)
1458	› **Creep-fatigue Crack Behaviour of Welded Joints II:** Assessment of flaws in welded joints in power plants under flexible operation › AVIF	› Prof Dr Stefan Weihe (MPA, University of Stuttgart) Prof Dr Matthias Oechsner (MPA-IfW, Technische Universität Darmstadt) › Dr Shilun Sheng (Siemens Energy Global GmbH & Co. KG)	› R613 (p. 395–429) › H1427 (2026)
1447	› **Flexible HP-Turbines:** Aerothermal interaction mechanisms at the outer casing region of modern high-pressure turbines › DFG, FVV	› Prof Dr Heinz-Peter Schiffer (GLR, Technische Universität Darmstadt) › Christoph Lyko (Rolls-Royce Deutschland Ltd & Co KG)	› R613 (p. 430–457)
1439	› **Fuel Cell Compressor Design:** System efficiency optimal compressor design for PEM fuel cells in mobile application › BMWE/IGF, FVV	› Prof Dr Stefan Pischinger (tme, RWTH Aachen University) Prof Dr Peter Jeschke (IST, RWTH Aachen University) › Dr Thomas Hildebrandt (NUMECA Ingenieurbüro GmbH & Co. KG)	› R613 (p. 458–482)
1508	› **Suction Sided Noise Emission of Radial Compressors:** Development of prediction methods for the noise emission of centrifugal compressors in their suction line and derivation of guidelines for low-noise design › BMWE/IGF	› Prof Dr Peter Jeschke (IST, RWTH Aachen University) › Vera van Dinther (Everllence SE) Nicolai Ehlenbeck (Everllence SE)	› R613 (p. 483–517)

Innovative and sustainable research cooperations need a stable funding framework. Our projects are financed by contributions from member companies, co-operations and from public research funding. We would like to thank all our research partners for their fantastic support over many years:

AVIF

German Steel Application Research Foundation / Forschungsvereinigung der Arbeitsgemeinschaft der Eisen und Metall verarbeitenden Industrie e.V.

BMWE

The aforementioned projects were/are supported by the Federal Ministry for Economic Affairs and Energy (BMWE) on the basis of a decision by the German Bundestag.

CORNET

COllective Research NETworking

DFG

German Research Foundation / Deutsche Forschungsgemeinschaft e.V.

IGF

Industrial Collective Research (Industrielle Gemeinschaftsforschung IGF) is a successful Europe-wide, open-topic and pre-competitive funding programme of the Federal Ministry for Economic Affairs and Energy (BMWE) that provides small and medium-sized enterprises (SMEs) with easy access to practice-oriented research and the latest research results. In the IGF, companies or associations, research organisations and research & technology (RTD) performers determine the research needs and research topics of their industry collectively. The supervision of the research projects by the companies guarantees the practical relevance of the research work. The results of IGF projects are public and are available to all interested companies on equal terms. In this way, the IGF strengthens the competitiveness of SMEs in Germany and thus makes a significant contribution to Germany's innovation sovereignty.

Further Information:
→ www.igf-foerderung.de

Collective intelligence –
FVV members

→ **www.fvv-net.de/en/network/members**

Empowering a moving society –
Participating research and technology (RTD) performers

→ **www.fvv-net.de/en/network/rtd-performers**

Science for a moving society

New research programme

FVV's innovation and transfer network is all about dynamism, future, responsibility and power. Pre-competitive fundamental research produces sustainable, environmentally friendly and climate-effective technology solutions.

Industrial Collective Research is pre-competitive, forward-looking and open to all topics. FVV's pre-competitive research enables companies to solve shared technology problems and issues, such as on efficiency, life cycles, materials and the circular economy, at a systemic and component level on a sound scientific basis.

Unlike other transfer and technology platforms, FVV is a ›collaborative undertaking‹: industry-oriented research can only succeed where it is developed and designed together. That is why the expert groups come together on the second day of our transfer and networking event to determine their shared need for research and design projects accordingly, guided by experienced members.

THEMIS
The new FVV research programme
→ www.themis-wissen.de

Planned and ongoing projects // Status: 01.05.2026

The pre-competitive project work of the FVV enables collaborative research to be performed on fundamental questions, thus allowing the ever stricter requirements regarding materials, fuel efficiency and environmental friendliness to be met. In doing so, the FVV research programme also contributes to enhancing the competitiveness of its member companies.

Members of the FVV innovation network can find a list of all planned and ongoing projects in the FVV research programme in THEMIS:
→ see p. 43

90
planned
projects

124
ongoing
projects

214
projects in
Q2/2026

77 %
financed through
external funds
BMWE/IGF, DFG, CORNET, ...

23 %
financed through
own funds

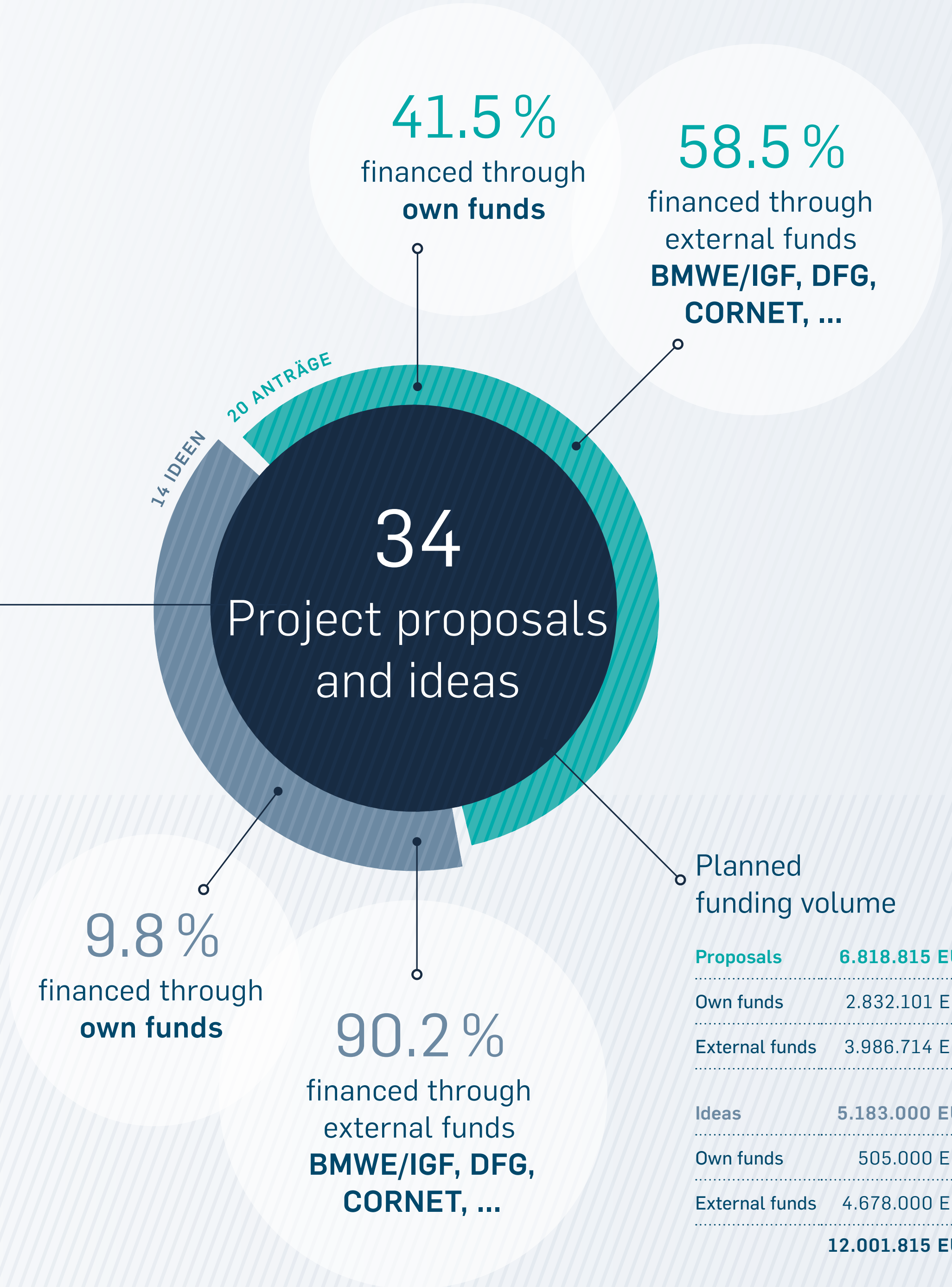
14
started
in Q1 and Q2
2026

75 %
financed through
external funds
BMWE/IGF, DFG, CORNET, ...

25 %
financed through
own funds

New project proposals and ideas // Status: 22.05.2026

In spring 2026, a total of 14 new project ideas and 20 project proposals were up for discussion in the expert groups' face-to-face meetings in Bonn and in the written silence procedure. The following package, with a planned funding volume of € 12 million, was submitted to the FVV Board for final approval.



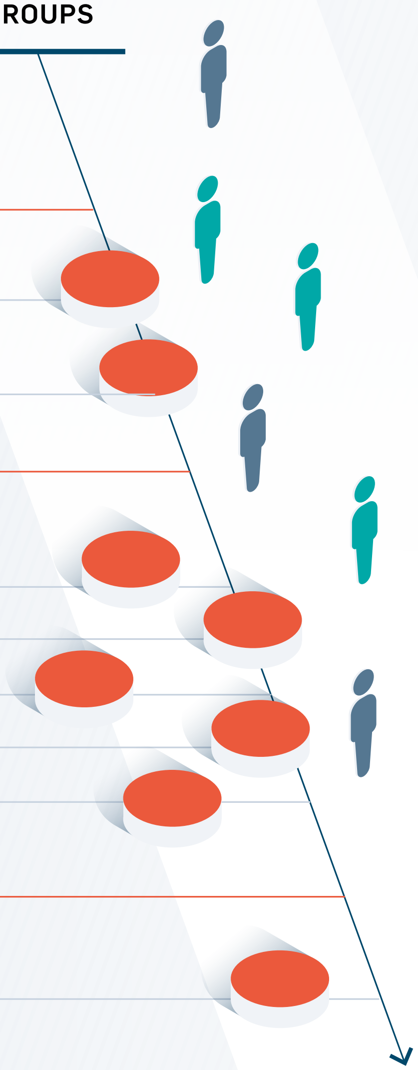
Planned funding volume

Proposals	**6.818.815 EURO**
Own funds	2.832.101 EURO
External funds	3.986.714 EURO
Ideas	**5.183.000 EURO**
Own funds	505.000 EURO
External funds	4.678.000 EURO
	12.001.815 EURO

Scientific coordination

Together we develop ideas for the future. Experts from member companies meet in the groups to identify common research needs and design projects accordingly. The Scientific Advisory Committee of the FVV appoints chairpersons for each group to lead the scientific work.

EXPERT-GROUPS



SYSTEM

Energy Infrastructure and Storage

Hans-Jürgen Hitz · Robert Bosch

Sustainable Powertrain Systems

Thorsten Oberpenning · Rolls-Royce Solutions

SUBSYSTEMS

Energy Conversion Systems

→ **Engines** | Dr Christian Weiskirch · Traton R&D Germany

→ **Electric Motors** | Dirk Weberskirch acting · Traton R&D Germany

→ **Fuel Cells** | N.N.

→ **Turbo Machines** | Heinz Knittel · MTU Aero Engines

→ **Zero-impact-Emissions** | Dr Frank Bunar · IAV

COMPONENTS

Materials Science and Recycling

Dr Dieter Eppinger · SEG Automotive Germany

See also:
»Make it new – Science for a moving society« (ToR)
→ www.fvv-net.de/en/

Terms of references (ToR)

The assignment of research topics to the expert groups, which replace the former planning groups, is made along the system cascade of the V-model.

SYSTEM

Energy Infrastructure and Storage

Interaction of energy sources and system components, energy infrastructure and external storage

→ Chemical energy carriers and alternative fuels beyond application
→ Standardisation → Life cycle analyses

+ General issues related to demand and availability of energy sources / carriers
+ Production, quality, distribution and availability of hydrogen, electricity-based and alternative fuels
+ Standardisation topics on future energy carriers and related issues such as infrastructure and storage
+ Life cycle assessment (LCA)
+ Development of collaboration projects with other institutions to serve the interests of FVV members (e. g. workshop with the fuel / energy industry, ...)

Sustainable Powertrain Systems

Road / rail vehicles: classic powertrains (ICEV), hybrid / electrified powertrains (PHEV, BEV, FCEV), aircraft engines, marine propulsion, mobile machinery, power systems

→ Energy storage within the application
→ System efficiency → Air pollution, global warming, noise, sound, radiation
→ E-machine combined with battery

+ Questions on energy storage in the aforementioned applications
+ System efficiency of energy conversion processes e. g. charging, system control / regulation, sensor technologies, ...
+ Thermal management
+ Zero-impact emissions, greenhouse gas emissions (e. g. CO_2), noise, sound, electromagnetic compatibility (EMC)
+ E-machine combined with battery / ICE [interface to E-MOTIVE platform]
+ Impact of legal, social and political requirements onto powertrain systems, circularity
+ Development / engineering of tools for i. e. the system architecture and interaction of powertrain assemblies

Energy Conversion Systems

Innovative and / or optimised energy conversion systems minimising environmental impact and maximising process efficiency and engine performance

SUBSYSTEMS

→ Engines

+ All conventional engine development topics
+ Optimisation and development of new energy conversion processes focusing on e. g. increasing process efficiency of future varieties of fuels (including use of hydrogen)
+ Reducing the environmental impact
+ Process-focused adaptation of related components and (sub-) assemblies
+ Effects of increasing electrification to the ›engine‹ subsystem and its aggregates
+ Digitalisation
+ Development and improvement of related development / engineering tools based on changing and adopting application / subsystem requirements

→ Electric Motors [interface to E-MOTIVE platform]

+ Improvement of electrical motor properties in mobile applications
+ Electrical energy storage systems (battery)
+ Power electronics of the electrical motor and electrical energy storage system
+ Application-focused adaptation of related components and (sub-) assemblies
+ Development and improvement of related development tools e. g. simulation tools, measurement and testing methods

Energy Conversion Systems

Innovative and / or optimised energy conversion systems minimising environmental impact and maximising process efficiency and engine performance

SUBSYSTEMS

→ Fuel Cells [interface to E-MOTIVE platform]

- + Air and hydrogen system path, media conditioning and purification
- + Thermal management of the fuel cell stack
- + Optimisation of fuel cell specific components and (sub-) assemblies e. g. ion exchanger, compressors, …
- + Research on materials at fuel cell specific conditions and effects, e. g. on bipolar plates, membranes, sealings concerning stack performance, loading characteristics, ageing (durability, degradation), humidification, …
- + Stack performance / efficiency improvements e. g. performance effects of component and assembly tolerances
- + Safety requirements and definitions
- + Development of defined evaluation methods towards industry standards (generic, ›best practice‹)
- + Technology comparison PEM, High-temperature PEM, SOFC
- + Development and improvement of fuel cell specific development tools e. g. simulation tools, measurement methods (e. g. impedance analysis)

→ Turbo Machines

- + All conventional turbomachinery development topics
- + Optimisation of aerodynamics
- + Optimisation of turbomachinery specific components and (sub-) assemblies
- + Research on materials of turbomachinery specific conditions and effects; e. g. high-temperature, loading characteristics, ageing, resonances, use of hydrogen
- + Development and improvement of turbomachinery specific development tools

Energy Conversion Systems

Innovative and/or optimised energy conversion systems minimising environmental impact and maximising process efficiency and engine performance

SUBSYSTEMS

→ **Zero-impact Emissions**

- Exhaust aftertreatment concepts, systems and components
- Alternative aftertreatment system technologies and approaches
- Effects of the use of alternative fuels and operating liquids
- Interactions of exhaust components, primary and secondary exhaust species
- Non-exhaust emission evaluation of all mobile applications (incl. electrified), e.g. brake dust, tyre abrasion, …
- Interaction emission and immission/air quality
- Carbon capture approaches and technologies
- Development and improvement of related development tools, e.g. simulation tools, measurement and evaluation methods

Materials Science and Recycling

All conventional topics on materials research in connection with new energy sources, production methods and recycled materials

COMPONENTS

→ Strength → Tribology → Recycling

- Tribology, strength, fatigue models and improvements
- Properties, strength and fatigue characteristics of materials for electric powertrains (e.g. copper)
- Durability and robustness of electrically isolating materials (e.g. aspect of partial discharge, …)
- Impacts and interactions on components and (sub-) assemblies caused by novel energy types (e.g. hydrogen, e-fuels, methanol, …)
- Components made by additive manufacturing, their properties and related method approaches
- Material properties impact of recycled materials
- Energy footprint of components and assemblies depending on material and manufacturing process, circularity
- Development and improvement of group related development tools e.g. simulation tools, measurement and evaluation methods

THEMIS Database

Members of the FVV innovation network can find a list of all planned and ongoing projects in the FVV research programme and dates for the discussion groups, workshops and project user committees in THEMIS.

Project list

Status: 01.05.2026

Meeting dates

Status: always up to date

Research programme

Status: always up to date

The publication ›**The FVV Transfer + Networking Event | Spring 2026**‹ is available online

→ www.fvv-net.de/en/ | Transfer | Projects | Transfer reports

Science for a
moving society

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AUTHOR

Richard Backhaus, Wiesbaden

EDITORS

Petra Tutsch, Adelina Buchar,
Max Decker und Martin Nitsche, FVV

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Cover: MIDJOURNEY AI

Transfer // Industrial Collective Research (IGF) empowers companies to solve joint research and technology problems on a science-based approach. It provides access to a continuous stream of new knowledge they can use to create their own products, processes and services. Industrial research and development benefits from the fact-/field-based collaboration with the science community, universities and non-profit research institutions, on the future of technology. This creates innovative power in industry and excellence in research, teaching and learning.

Networking // The research implemented by the FVV is based on a long-term cooperation between the partners. In spring and autumn, experts from the international innovation network meet regularly at the FVV Transfer + Networking Events. This report from the science series FVV Prime**Movers.** Technologies. summarises the main results.

FVV e V

Lyoner Strasse 18 | 60528 Frankfurt / M. | Germany
+49 69 6603 1345 | info@fvv-net.de

www.fvv-net.de