Programmed for success

Hybrid powertrains and hydrogen as energy sources are crucial elements of the journey to climate neutrality. But that's not all – they are also central to two new FVV research programmes, encompassing numerous projects that are designed to provide scientifically sound answers to some of the most pressing questions of our era.

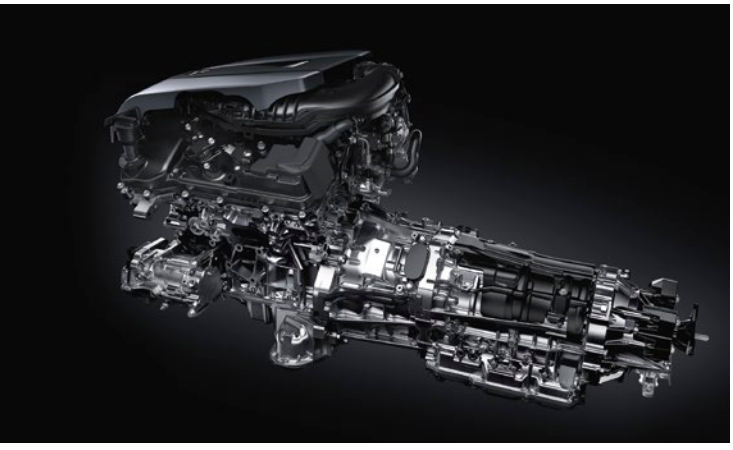
It's more about the journey than the destination // Given that most greenhouse gases are slow to break down in the atmosphere, it is important to identify the technologies that will allow us to rapidly reduce emissions. One of the options is to hybridise combustion engine powertrains; the other is to use hydrogen directly in the transport sector. Over the past twelve months, the FVV Board has launched hybrid and hydrogen research programmes to look at these options more closely. Both programmes comprise numerous individual projects in which companies and RTD performers are looking for specific, feasible technical solutions.

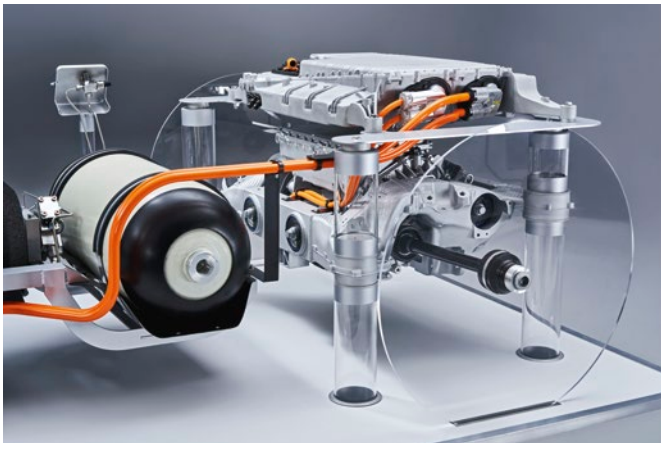
Hybrid powertrains are already commonplace in mass-produced vehicles – yet some key research questions remain unanswered. For example, there are many ways to combine electric and mechanical technology in hybrid powertrains. But what is the best way to combine these components such that the environmental benefit is maximised while also keeping production costs to a minimum? On behalf of FVV, the Technical University of Darmstadt is conducting research to answer this question. As part of this work, the university is aiming to develop a software program for suppliers, including medium-sized companies, by the end of 2022. The scientists have adopted an object-oriented approach from the world of IT, combining the high modularity of the system architecture with shortened computing times in the simulation. At RWTH Aachen University, meanwhile, researchers are studying how the operating strategy of a hybrid vehicle can be optimised to maximise the amount of time spent driving on electric power without producing local emissions. Traditional driving cycles are not ideal for this purpose, because they fail to account for factors such as special emissions zones or traffic congestion – but the predictive journey management system that the team in Aachen is developing would solve this issue.

Another relevant research topic is the combination of synthetic fuels and hybrid powertrains for all forms of transport that cannot be fully electrified. Efficiency is high on the agenda for these powertrains: high engine efficiency makes the entire energy chain more efficient, which in turn reduces the amount of solar and wind energy required for fuel production. FVV's ›ICE 2025+‹ project, which was completed last year, proved that synthetic fuels do have

→ Hybrid powertrains (below) are already a mature technology. The main area where research is required is the operating strategy.
For hydrogen engines (right), improving power density is just one area of research.

Photos: Toyota (below), BMW (right)





the potential to boost thermal efficiency. In the current follow-up project ›ICE 2030‹, scientists from Aachen, Braunschweig, Darmstadt and Stuttgart have set out to demonstrate that a thermal efficiency of at least 50 per cent is achievable.

At a molecular level, hydrogen is the simplest of all synthetic fuels. If it is generated via electrolysis from solar and wind energy, it can be used to power combustion engines in a way that is completely climate-neutral. This means that hydrogen engines are an attractive and readily available alternative for sectors such as heavy goods transport, where it will not be possible to achieve complete electrification in the foreseeable future. However, to run on hydrogen, a number of key engine technologies – including the carburation and ignition systems – will need to be adapted to the new energy source. There are still some fundamental phenomena that need to be explored here, for example in order to significantly increase power density while also preventing uncontrolled auto-ignition. The Karlsruhe Institute of Technology and a number of other organisations are currently investigating these questions on behalf of FVV. In another project initiated by IAV, a team is creating a simulation model for direct hydrogen injection.

An understanding of the phenomena that occur in an engine – along with the realistic simulation of these processes – have always been key to the collective research conducted by FVV. »Switching to hydrogen as an energy source means that we need to revisit many research questions,« explains Martin Nitsche, Deputy Managing Director of FVV. This is true of research into both operating safety and materials. As the results will be available to all member companies, they will accelerate the introduction of new technologies while also strengthening the competitive position of medium-sized suppliers.

FVV's hydrogen research programme includes the use of fuel cells as energy converters. The focal points of this fuel cell research – which is organised by a specific planning group – are operating behaviour and system design. After

all, the stack alone does not determine the costs, and therefore the market penetration, of the technology; what matters most is its behaviour in real-life conditions. The current projects are investigating topics such as cold-start characteristics and air supply.

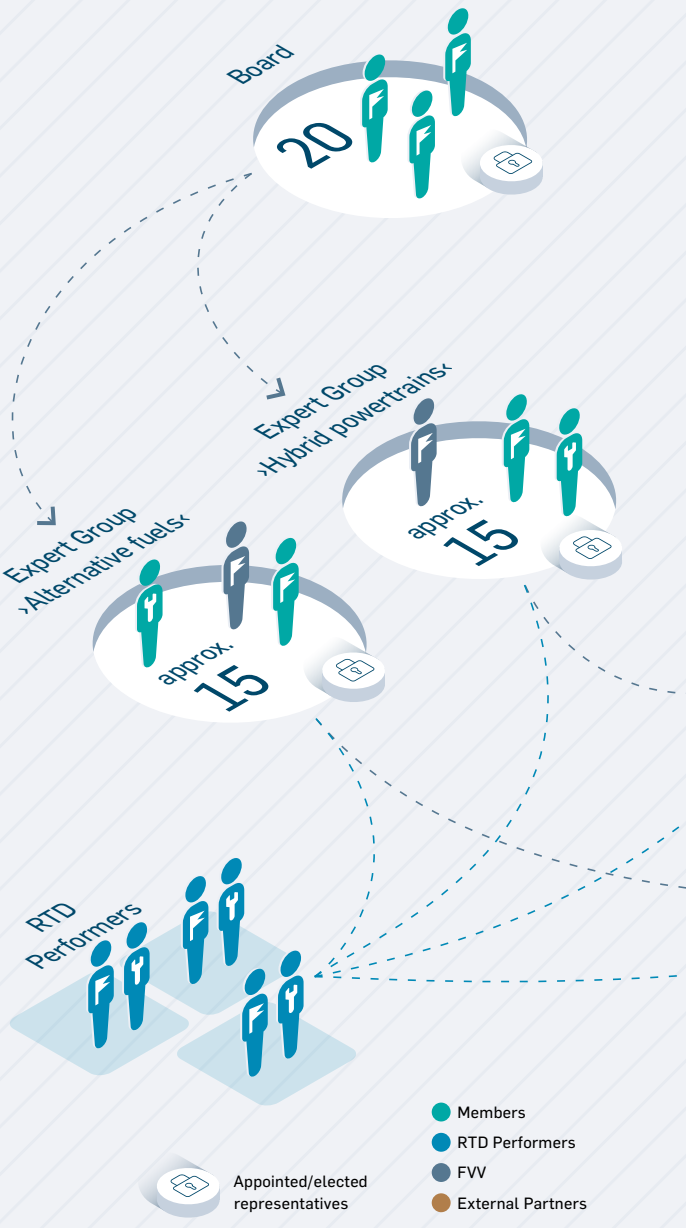
The hybrid and hydrogen research programmes are the direct results of a transformation process in which the FVV Board is responding to the rapid shift towards climate-neutral energy and transport systems. The strategic research questions for the programmes were initially formulated by the Board and the Scientific Advisory Committee. The RTD performers working with FVV were then able to submit specific project proposals. »By doing this, we are complementing the initial bottom-up approach with a top-down process,« explains Nitsche. »This enables us to align Industrial Collective Research even more closely with the questions that urgently require a scientific answer.« //

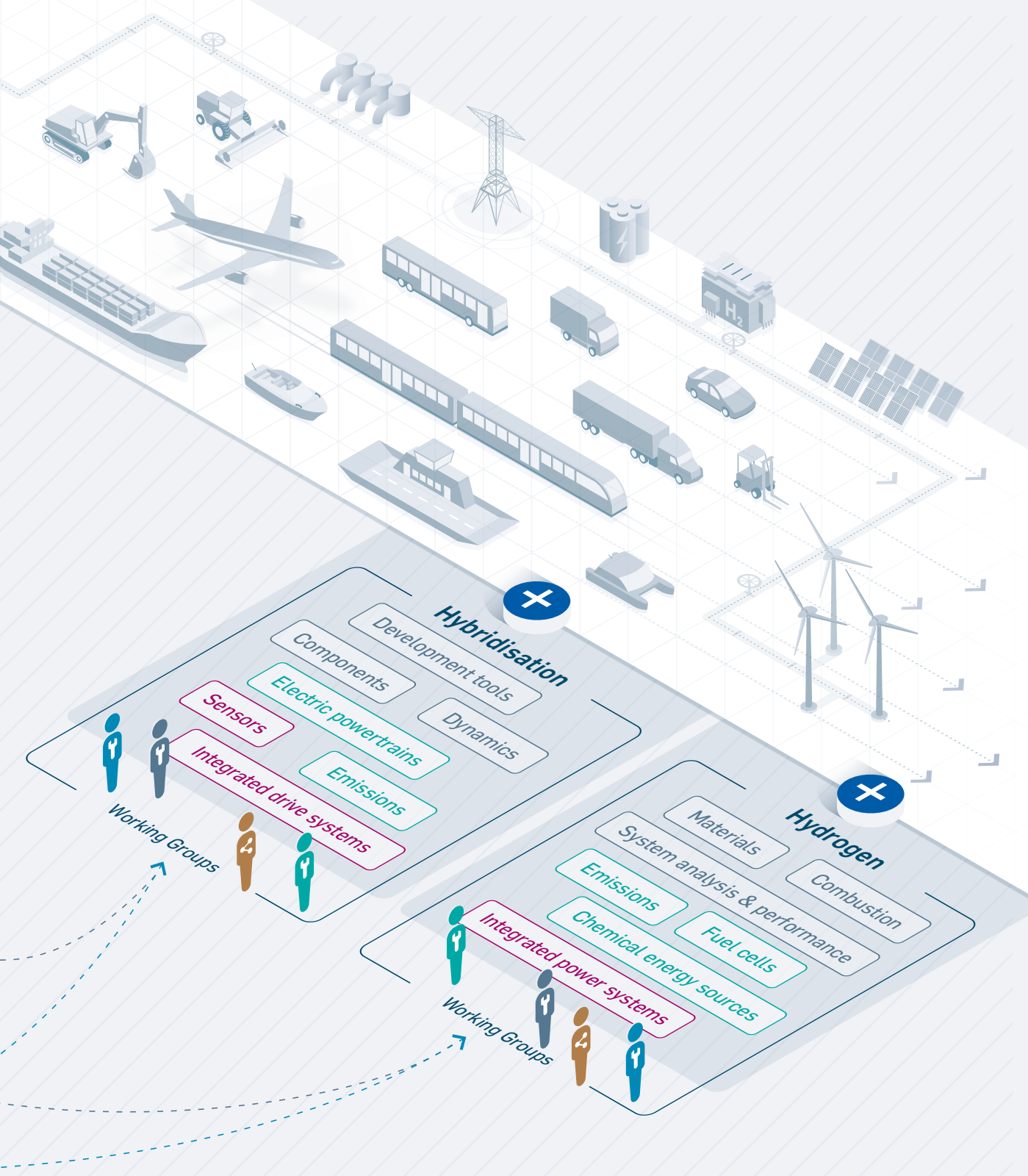
PROGRAMME HYBRID

PROGRAMME HYDROGEN

How can new future topics be rapidly accelerated towards the ›road to change‹?

In key areas of the transformation, the FVV management can accelerate the bottom-up innovation process [→ page 90] that is standard in Industrial Collective Research and manage this process centrally via expert groups.





→ The **Board** can use **expert groups** to generate ideas for key technologies in order to meet the zero emissions target.

→ Together with the **RTD performers**, concrete project ideas are developed and used as the basis for a research programme.

→ **Working groups** are formed for each individual project; the results generated by each group are available to all members.