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IAV Customer Magazine | 02/2020

Green Fuel from the Laboratory

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CO_2-neutral fuels and their contribution towards reducing pollutants

Dear Reader,

what drives us and our vehicles today and in the future?
What sounds so simple and straightforward is ultimately one of the most exciting and at the same time most difficult questions of our time. And if there is one thing we have learned, it is that there are rarely simple answers to difficult questions.

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This also applies to the future of drive technologies. Mobility in urban agglomerations and mega-cities has different requirements than in rural areas. We also see differences in needs between young and old. The differences between the transport of people and goods are even greater. A glance at the different market conditions in Germany, Europe, Asia and America also shows how different and diverse the respective requirements are (page 6). Often, however, we see such differences even in our direct environment. One colleague arrives every day by bicycle, another colleague by car, a third prefers to use an e-scooter, while others prefer public transport or sharing services. The variety and, thus, the possible combinations are increasing (page 32). At the same time, the new freedom also brings new challenges, because the complexity is increasing – both in development and in operation and the connection to user- and climate-friendly mobility.

In addition to the basic need for mobility, the issue of sustainability is becoming more and more important to both people and society. The goal is: climate-neutral mobility by 2050. An overview of the approaches Germany and other exemplary selected countries are pursuing are presented in the large supplement to this issue entitled "Plurality of Strategies". Two findings stand out. Firstly, without a change in energy policy, there can be no change in transport policy. Because: E-mobility can only make an effective contribution towards climate protection if there is sufficient regeneratively produced energy and an ambitious expansion of the network and charging infrastructure. The situation is similar with other promising alternative fuels, including hydrogen (page 18) and e-fuels, whose potential we highlight in our cover story (page 8).

Secondly: No single drive technology will provide the solution. Rather, the various technologies should play out their respective strengths.

An honest and well-founded consideration also includes looking at the CO_2 footprint of the individual technologies and modes of transport over their entire life cycle. Such a holistic view (keyword: cradle to grave) is becoming increasingly important. This encompasses the entire vehicle production process, including the extraction of raw materials, and also takes into account possible secondary use, including remanufacturing and recycling (pages 11 and 24). Governments are also increasingly pursuing this approach: China – the world's largest automobile market – has just adjusted its support and sanctions measures accordingly (page 42).

And what drives us at IAV? With our state-of-the-art development methods and more than 8,000 employees at more than 25 locations, we want to do even more to help solve our customers' most pressing problems, especially in challenging times. And because the generation, conversion, storage and distribution of energy is also becoming ever more demanding and because there can be no change in transport policy without a change in energy policy, we are also supporting the energy sector with our expertise to an even greater extent in precisely this sense. For example, by making wind turbines more powerful (page 35), by developing intelligent control software for network operators, or by using artificial intelligence to help energy suppliers expand charging infrastructure for electric vehicles as efficiently as possible in line with demand.

And so there is ultimately a simple answer to the difficult initial question of the optimum drive system, at least for us at IAV. For all development contracts are ultimately driven by a common goal: better mobility. With this in mind, we hope you enjoy reading this issue!

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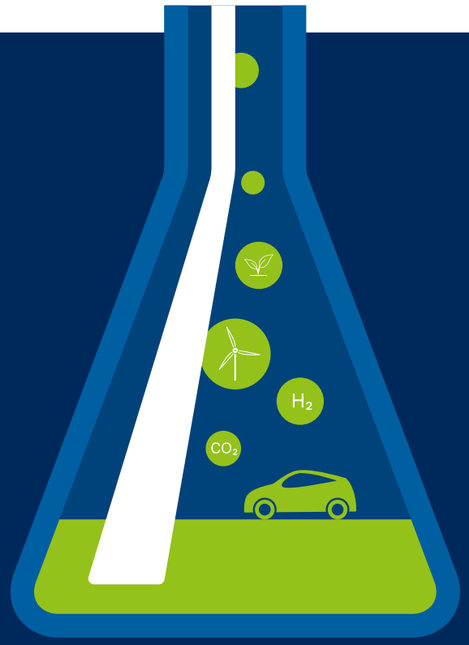
CO_2-neutral fuels and their contribution towards reducing pollutants

The transport sector can make a significant contribution towards the achievement of the climate objectives. In addition to excellent drive technologies and new mobility concepts, this requires an optimal mix of CO_2-neutral energy sources, as these can bring their potential to bear to varying degrees in the various markets.



"Electric Mobility Alone Will Not Make it Happen"

Which energy source really makes a contribution towards CO_2-neutral transport? Interview with Shell Manager Karsten Wilbrand and IAV Head of Technology Matthias Kratzsch

Topic focus

Driving forces

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Projects

Changing Track

About IAV

Advancing into a New Era

IAV's physiochemical laboratory is increasingly concerned with batteries and fuel cells.

Old Becomes New: Boom Market Remanufacturing

How can production be made more efficient and the demand for natural resources reduced? IAV focuses on recycling so-called old parts.

Putting a Stop to Hackers with the UNECE

UN regulations make new demands on security – a challenge for manufacturers and suppliers.

Voice Assistant Platform "Made in Germany"

IAV is working with Fraunhofer Institutes on the new language assistance platform "Made in Germany".

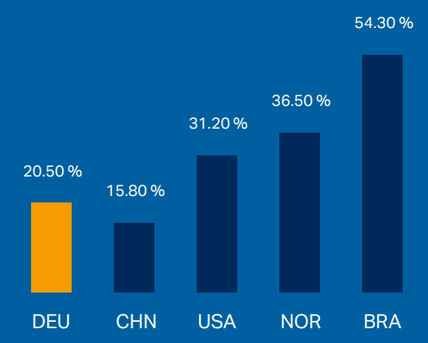
FOR A SUSTAINABLE MOBILITY OF THE FUTURE

Potential of the transport sector to reduce CO_2

Effective climate protection is one of the greatest challenges of our time. The reduction of greenhouse gases is a central component of this project. In order to leverage the high savings potential, holistic and cross-sectoral solutions are required.

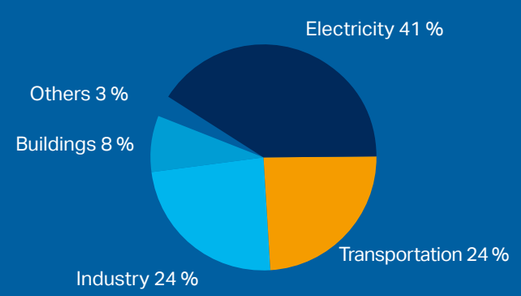
But not every country has the same prerequisites. Therefore, different strategies are required for effective CO_2 reduction – technologically, politically and socially. An exemplary look at Germany, China, the USA, Norway and Brazil makes this clear.

Share of the transport sector in CO_2 emissions



Source: CITI Research/Clean Energy Wire/Statistics Sentralbyra (2017)

CO_2 emissions by sector



Source: IEA (2017)

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37 billion tons of CO_2 worldwide

CO_2 emissions of all countries (2019)

24 % Share of the transport sector in global CO_2 emissions

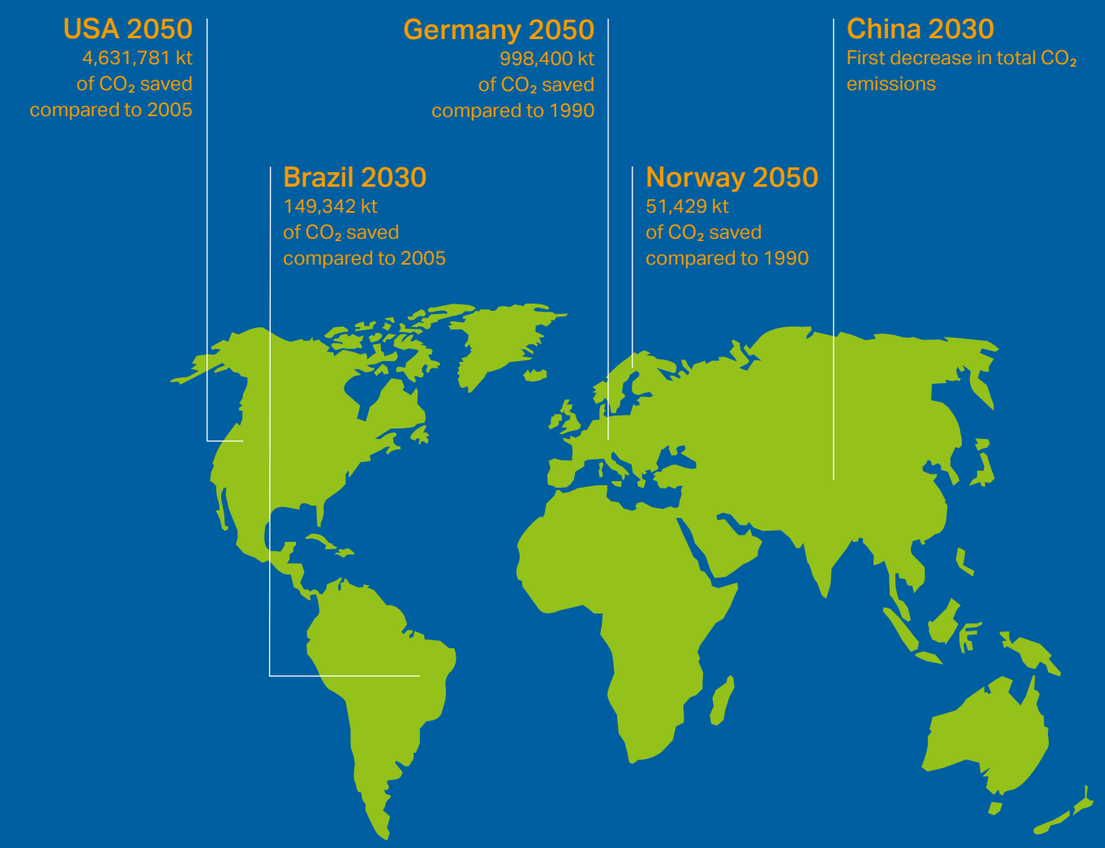
46.5 %

Share of electrified passenger cars in Norway

Power generation in China from coal 2018:
4,432.4 TWh

Total power generation in Germany 2018:
648.7 TWh

Total CO_2 reduction targets of selected countries



*All CO_2 savings refer to the overall emissions of the countries, not only to the transport sector.

E-fuels: Power of the Future

How can greenhouse gases in transport be sustainably reduced? The automotive industry is focusing on e-mobility, but it will take time for e-vehicles to establish themselves on the market. Experts agree that only with a bundle of measures will it be possible to meet the CO_2 reduction targets set. Synthetic fuels, produced from renewable electricity, so called e-fuels, play an important role, according to the National Platform Future of Mobility (NPM) in its latest report by the alternative drive systems and fuels for sustainable mobility work group. They can be made available using existing infrastructure, improve the CO_2 balance of fleets and could enable CO_2-neutral mobility if fossil fuels are substituted.

In light of the European Union's new climate targets, 2020 is a year of truth – for the first time, the strict 95 gram CO_2 guideline value applies. Which OEM meets or violates the emission standard can now be measured in practice. According to experts, the ongoing electrification of fleets and the resulting increase in electricity demand makes it all the more important to accelerate the change in energy policy and switch to renewable energies.

E-fuels offer an important opportunity to reduce CO_2 emissions in existing fleets without vehicle conversions while retaining the current infrastructure, thus, making mobility less dependent on fossil fuels in the future. They are currently still in the pilot and development phase, not least because their production using PtX (power-to-x) processes is still very cost and energy-intensive.

To produce e-fuels sustainably, water is broken down into its core components oxygen and hydrogen using regeneratively produced electricity. In a multi-stage process, the latter reacts with CO_2 taken from the air to form the basic product from which synthetic, electricity-based fuels can be obtained.

E-fuels based on hydrogen

Hydrogen can be refined with CO_2 to gaseous methane or liquid methanol or synthetic gasoline and diesel fuels including kerosene (power-to-liquid). During combustion in the engine, the amount of CO_2 is emitted that was previously added to the e-fuels. If the greenhouse gas is taken from non-fossil sources such as the air, for example, combustion is climate-neutral.

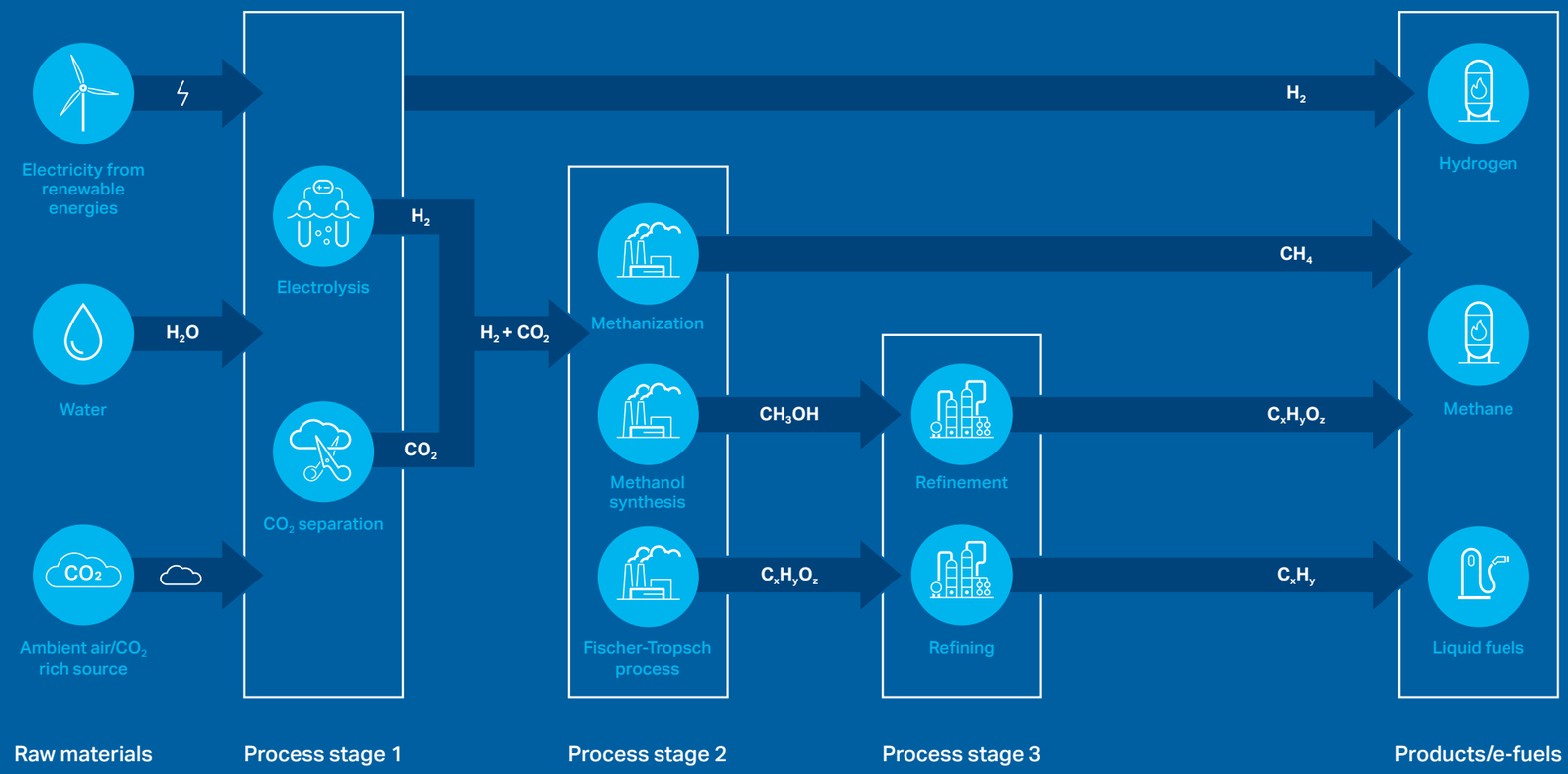
E-fuels can be distributed via the established network of filling stations and pipelines and, thanks to their high energy density, can be transported inexpensively over long distances. They are suitable not only for passenger cars and public transport, but above all for use in air, sea and heavy goods transport, where electrification is not practicable from today's perspective.

"Synthetic fuels are versatile and can make a valuable contribution towards reducing the CO_2 emissions of the existing fleet, which, due to an average holding period of almost ten years, also plays a significant role in our CO_2 emissions in the medium term", says Dr. Ralf Tröger, vehicle drive systems business consulting manager at consulting4drive, IAV's management consultancy.

The technical and economic possibilities of PtX fuels in terms of CO_2 reduction and neutrality will be one of the focal points of the IAV "Injection and Fuels" conference on December 1–2, 2020 in Berlin. Germany.

German energy agency sees important role for e-fuels

The EU's goal of reducing passenger car emissions by 37.5 percent by 2030 (based on the average target of 95 g CO_2/km in 2020) already makes it necessary to build up PtX capacities according to the German energy agency (dena).



"Feasibility study for the production of e-fuels at IAV's Berlin site", Dino Pfeiffer, January 2020

"We assume that power fuels, including H_2, will gradually gain market share and will and must play a major role beyond 2030", says Stefan Siegemund, Head of Sustainable Mobility and Alternative Energy Sources at dena. "Under the known framework conditions, it is not foreseeable that it will be possible to do without liquid synthetic fuels even with a rapid and successful ramp-up of fully electric mobility."

However, legislative changes are required to increase the potential of e-fuels. As long as the EU sticks to a tank-to-wheel approach for CO_2 fleet emission targets, companies will lack the incentive to invest in infrastructure and production. In vehicle operation, engines running on PtX fuels do indeed emit CO_2, even if this was previously extracted from the air. However, if the CO_2 absorbed during fuel production were to be taken into account in legislation (well-to-wheel), this could promote investment in the long term.

In principle, e-fuels could be blended with fossil fuels in any quantity with restrictions, as long as the energy source ultimately complies with the relevant European fuel standard (EN 590 for diesel and EN 228 for gasoline). However, industrial production of e-fuels is not taking place, among other reasons because of the relevant but missing EU requirements for the use of green electricity, lack of political support and high production costs.

In its report from June 2020, the NPM calls for the political framework conditions to be set to prepare the production of alternative fuels on a broad scale. In order to enable market launch and ramp-up, the German government should introduce specific use quotas for e-fuels or grant tax incentives, the NPM says.

Production abroad to reduce costs

Due to the increased costs caused by the complicated production process and the lack of support measures, it cannot be assumed that e-fuels will be used in transport in the medium term. In a research report by Prognos AG commissioned by the Federal Ministry of Economics and Energy (BMWi) in March 2020, a sales price of over 4.50 euros per liter of e-fuel is calculated for the year 2030. According to the BMWi, the topic of promotion is still in the testing phase.

However, e-fuels can only be successful if their costs are significantly reduced. Dena estimates that the price per liter would fall to 1–2 euros if e-fuels were produced directly where renewable energy is cheaply generated, e.g. through solar energy in North Africa or wind power in Norway.

This option would be attractive for climate protection. A comprehensive study by IAV colleagues led by Marc Sens, head of advanced powertrain development, on CO_2 emissions from the passenger car fleet in Europe based on a life-cycle analysis shows that despite rising new registrations, total emissions fall noticeably if fossil fuels are increasingly mixed with climate-neutral energy sources. See also the info graphics below "Comparison of CO_2 emissions over the life cycle".

"The introduction of CO_2-neutral fuels as a substitute for fossil fuels or as a blending in rates of up to a maximum of 30 percent after 2030 shows by far the greatest leverage on the life cycle CO_2 equivalent", says Sens. "Despite the high energy consumption associated with this, this technology should therefore not be abandoned." In order to implement a blending quota of 30 percent, however, considerably more legislative support is needed than before.

What is clear is that we need solutions that already effectively reduce CO_2 emissions, because even by 2050 there will still be market segments and application scenarios in which internal combustion engines are indispensable. However, these must then be operated as cleanly and efficiently as possible – with e-fuels, for example.

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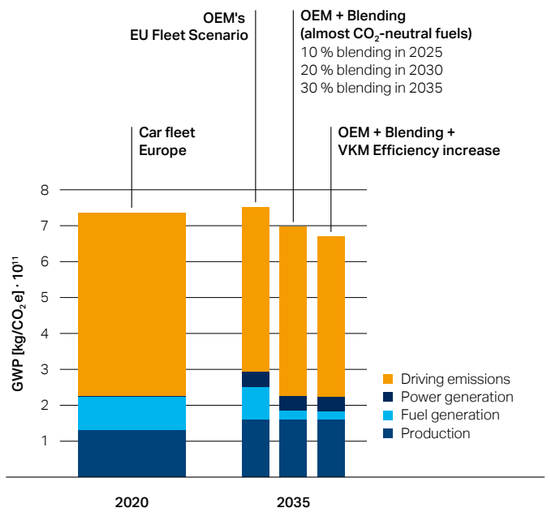
Comparison of CO_2 emissions in the life cycle view



"Electric Mobility Alone Will Not Make it Happen"

Electricity, hydrogen, biofuel, electricity-based fuels – there are many energy sources available for CO_2-neutral transport. IAV's Head of Technology Matthias Kratzsch discussed with Karsten Wilbrand, Shell Manager responsible for mobility research, what really contributes towards climate targets.

Dr. Karsten Wilbrand

was appointed "Senior Principal Scientist Mobility" at Shell at the beginning of 2020 and previously held various positions in fuel research at Shell. With a doctorate in mechanical engineering, he has spent his entire professional life in the energy industry.

"We must find solutions that reduce emissions, especially from existing vehicles."

With its Climate Protection Plan 2050, Germany has adopted ambitious CO_2 reduction targets for the individual sectors and thus also for the transport sector. Can this be achieved?

Wilbrand: In order to achieve the CO_2 reduction target of -40 percent by 2030, which is the target in the transport sector, enormous efforts are required. Electric mobility alone will not succeed – we must also decarbonize fuels.

Kratzsch: The report of the National Platform "The Future of Mobility" says it clearly: The speed of change is not enough; you must become faster and be open to new technologies. A single technology alone will not get us there; we need a coherent mix of alternative drives and fuels. Incidentally, this is also the result of a study we conducted and submitted for this year's International Vienna Motor Symposium on the evaluation of CO_2 equivalents according to the life cycle for various powertrain fleet scenarios up to 2035.

What opportunities do you see for accelerating change?

Wilbrand: We expect the share of electric drives in new registrations to rise; but we will still have many combustion engines in our inventory – with ten million electric drives (including fuel cell vehicles), there would still be almost 40 million passenger cars plus commercial vehicles in 2030. So we have to find solutions that reduce emissions, especially from existing vehicles. From our point of view, liquid biofuels would be suitable for this purpose, as they could usually be used immediately and seamlessly – but unfortunately the enthusiasm for biofuels has been somewhat lost after Super E10. Nevertheless, we are convinced that we will need something like E20 in the 2020s. By contrast, we do not (yet) see any relevant quantities of electricity-based fuels in this decade – at best the first pilot plants. We also see gas fuels, especially biogenic ones such as BioLNG, as an alternative for heavy commercial vehicles, whose fleet turnover is significantly higher than for passenger cars.

Kratzsch: As far as engines are concerned, much higher blending rates with synthetic liquid fuels than today would be possible. Depending on the type of fuel and combustion process, it is technically possible to replace up to 100 percent of fossil fuels in the existing fleet with CO_2-neutral, biogenic or synthetic fuels. And as our IAV study shows, a higher blending quota would be the most effective measure to reduce the fleet's CO_2 equivalents over its life cycle by 2030. What is missing are the appropriate political framework conditions and investment incentives in favor of larger fuel production capacities.

Wilbrand: In Germany, for example, hydrogenated vegetable oil, i.e. HVO, can be added to B7 diesel fuel up to a share of 26 percent, and the fuel named R33 will then have a total share of one third of renewable energy. The CO_2 advantage over purely fossil diesel is then around 20 percent. That would be the CO_2 reduction that would still be missing for ten million electric cars in 2030.

And what path do you propose for the gasoline engine?

Wilbrand: We can increase the ethanol content in gasoline. Bio-waste materials such as straw are available for this purpose, and plant capacity is also being further expanded. E20 would make a good contribution towards CO_2 reduction and would be compatible with most of today's vehicles. The biggest challenge, however, is probably to convince consumers of E20 – for this we also need the commitment of the car manufacturers. This is because the share of Super E10 has for years been at only 13 % of the industry average - and the trend is constant. If future engines are designed for E20 from the outset, the high knock resistance will also increase efficiency. The CO_2 avoidance costs would be low.

Matthias Kratzsch

is responsible on the IAV Management Board for the core area of technology. The graduate engineer has been working for the development partner since 1997, also on powertrain and engine development.

"One technology alone will not allow us to achieve our goal; we need a coherent mix of alternative drives and fuels."

Kratzsch: On the engine side, this is feasible for ethanol blends. Of course, the compatibility of older engines must be looked at again, for example with regard to the seals. But technically, I don't see any major problem there. Particularly in the case of diesel engines in the existing fleet, apart from compatibility with the DIN EN 590 fuel standard, there is no technical problem in using blending rates of HVO fuel higher than 26 %. This would in any case make a contribution towards reducing fleet CO_2 emissions in both the new and existing fleet in the very short term.

There are currently still several competing approaches for electricity-based fuels. Do you already have a clear preference?

Wilbrand: Electricity-based fuels can be produced well in the Fischer-Tropsch process for diesel fuels; for gasoline by methanol synthesis, we prefer to work with FT processes. We already make around seven million tons of gas-to-liquids products in Qatar. Shell GTL fuel can be used immediately in fleet vehicles – and leads to significant air quality improvements for older vehicles.

Kratzsch: Advanced fuels can make a valuable contribution towards reducing the CO_2 emissions of existing fleets, so it is also important to supply them with power-to-liquid and biomass-to-liquid fuels. However, if we are building a hydrogen economy anyway, then from a thermodynamic perspective it makes sense to use hydrogen directly – either in the H_2-capable internal combustion engine or in the fuel cell. We are working intensively on both technologies and are convinced that market penetration will not be long in coming. CNG, on the other hand, is an interim solution that immediately reduces CO_2 emissions by 20 to 25 percent in gasoline engines. This path only makes sense, however, if in the medium term we generate methane not from natural gas but from hydrogen or biogenic sources such as residual materials.

Wilbrand: I agree with you that hydrogen should be used as directly as possible. After all, hydrogen can achieve an efficiency of around 30 percent over the entire energy chain, while other e-fuels can achieve 15 percent at best. However, it will be a long time before corresponding vehicles come onto the market – and this in turn raises the question of what we do with the fleet. By contrast, the Fischer-Tropsch process allows us to produce both synthetic diesel and kerosene. In the long term, we believe that aviation, in particular, will be dependent on liquid electricity-based fuels, as this sector in particular is dependent on the highest possible energy density. And this is where liquid energy sources in light tank systems remain unbeatable over the long term.

What proportion of defossilized transport can electricity-based fuels achieve?

Wilbrand: The energy requirement for the production of synthetic fuels is particularly high. If the necessary carbon is removed from the air, this is (currently still) very expensive. But the necessary quantities of renewable electricity are also far from being available.

Would you use hydrogen in the fuel cell or the combustion engine?

Kratzsch: In the transport sector, the technologies that have the lowest costs over the life cycle will always prevail. Furthermore, the use case will determine which technology is used in a specific application. While the efficiency of the fuel cell is very good, especially at low power levels, the combustion engine is more likely to show its strength at high loads. To this extent, the application and TCO will drive this decision. We believe that both technologies are justified and will be used.

Wilbrand: In the medium term, however, I see no reason why fuel cells should not become significantly cheaper than they are today. In addition, fuel cells do indeed operate emission-free, whereas the combustion of hydrogen in the engine still requires exhaust aftertreatment.

Kratzsch: Indeed, exhaust aftertreatment is necessary – and that is what we are working on at the moment.

Are we following a special path in Germany?

Kratzsch: Let's look at China: The country has cut back on subsidies for electric vehicles. There are to be government subsidies or credits for low-consumption vehicles and the use of methanol as a fuel. These credits, in turn, can be used to reduce the necessary quota of battery electric vehicles that a manufacturer must bring to market. This will most likely lead to a surge in the development of new, very efficient combustion engines in hybrid environments, as the consumption targets will not be achievable with pure combustion engine drives. And I am convinced: New consumption-optimized combustion engines and electricity-based fuels would also be a good complement to electromobility in Germany.

To what extent can the efficiency disadvantage of electricity-based fuels be compensated for by innovative engine technology?

Kratzsch: If we manage to improve the average efficiency by ten percentage points, this will save 25 percent primary energy retroactively via the energy chain. We can only achieve this boost if we reduce losses at low loads, for example by reducing wall heat losses in the combustion chamber, by using an electrified turbocharger or by driving electrically in low load ranges.

Wilbrand: The efficiency chain of battery electric drives is excellent, with all transmission one still reaches more than 70 percent – this will never be achieved by an internal combustion engine, even if it is being further optimised to its theoretical limits. However, heavy vehicles that are used a lot in long-distance operations would require very large batteries and very high charging currents. This not only costs payload, but also an incredible amount of money. And that's where it can make sense to use hydrogen in the medium term. Electricity-based fuels, on the other hand, are not only comparatively inefficient; they are also difficult to place in the highly competitive road haulage industry.

Kratzsch: In our strategy for the use of hydrogen in transport, we must not forget other sectors such as the chemical and steel industries, as a result of which demand will exceed generation potential in Germany. We will therefore have to import energy sources, and liquid fuels will be available, the production of which in geographically favorable locations will also allow correspondingly lower prices.

How much diversity can we afford in terms of drives and fuels?

Kratzsch: That is not the crucial question for me. The question must be: From a technological point of view, what is the best way to achieve the greatest potential for reducing CO_2 emissions? And for us at IAV, the answer is: We will have to pursue several paths in the long term: on the one hand, the direct use of green electricity – in the coming years, we expect a significant increase in battery electric vehicles. On the other hand, we predict that hydrogen will become increasingly important. At the same time, combustion engines will have to be made fit for the Euro 7 emissions standard by 2025. In the next step, we will then have to look even more closely at how the efficiency of combustion engines can be increased – right up to engines that are specially designed for hybrid operation.

Wilbrand: We should also work on the increased blending of biofuels, as they are technically advanced. At the same time, however, we should not neglect research and development of electricity-based fuels.

Kratzsch: Agreed!

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Advancing into a New Era

IAV's physiochemical laboratory is increasingly engaged with batteries and fuel cells.

The IAV experts at the Physical-Chemical Laboratory (PCL) have enjoyed an excellent reputation for many years. Now, the tried-and-tested laboratory is expanding its spectrum: In the future, staff and measurement technology will also be available for topics relating to advanced propulsion systems – for example, for testing high-voltage batteries and fuel cells.

One thing remains the same even in the biggest upheaval in the automotive industry: Without physical-chemical expertise, neither conventional nor alternative drivetrains can be developed and tested. That's why the 30 or so employees in Jochen Schäffner's department believe they are ideally positioned for the mobility of the future. "We are made up of 50 % scientists and 50 % engineers, who combine high competence and application-specific knowledge in the field of exhaust aftertreatment", says department head Schäffner. "We can also use both for new tasks in the field of electric and hydrogen mobility."

This also applies to the equipment in the physiochemical laboratory (PCL) in Berlin. For example, when testing catalytic converters, the focus is on how the samples interact with the exhaust gas. Very similar questions also arise in connection with fuel cells. "Here we want to know, among other things, what influence pollutants from the ambient air have on the performance of the fuel cell. These findings can be used, for example, to improve the efficiency over the service life of the cell and thus also reduce hydrogen slip", says Schäffner. "We can measure this precisely with the existing systems." This is because, in addition to the experience gained from numerous customer projects, the PCL's unique selling point includes a broad portfolio of measurement technology – all of which are "Best in Class".

There are also parallels in the aging processes of catalytic converters and fuel cells. At high temperatures in the furnace, it is possible to simulate how catalytic converters later lose their performance over time due to surface processes in the vehicle. In fuel cells, the surfaces of the anode and cathode, the distribution of precious metals on them and the wear of the membrane also play an important role in the evaluation of aging. "We can measure them using the same methods as for catalysts", explains Schäffner. "The transfer to the field of new drives helps our customers enormously."

Simulations with artificial intelligence

Besides measurements, simulations are part of the PCL team's core business. So far, the experts have mainly modeled catalysts, filters and sensors. In the future, fuel cells and batteries are to be increasingly added. One focus of battery simulation is, for example, the power prediction of a cell under transient load and temperature. "We measure real components for this purpose and then provide our customers with a model that they can use as a digital twin in development", says Schäffner. This is where artificial intelligence (AI) is expected to play a greater role in the future: Although simulations based on physiochemical equations are very precise, they require a great deal of effort. In contrast, AI models learn from training data and are characterized by high speed.

Despite all the changes brought about by new drive systems, classic topics will also be on the agenda of the PCL team in the future. "New limits for CO_2 and pollutants, synthetic fuels or hydrogen engines are important trends here", reports Schäffner. "In this area, too, we are at the cutting edge of technology – for example in the simulation of WLTP measurements in the laboratory." One of the highlights of the PCL laboratory is the possibility of simulating the sweep operation of gasoline engines with its high dynamics. "Regardless of whether classic drives or new forms of drive: We will continue to bridge the gap between basics and applications for our customers in the future", summarizes Schäffner.

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IAV Cross

now also optimizes hydrogen burners

The proven IAV Cross (Injection Analyzer) is now also investigating the quality of hydrogen (H_2) injectors using real gas. In the future, hydrogen will become increasingly important as an energy carrier for engine combustion as well because it does not release CO_2. With the new development of the IAV Cross, injectors for combustion processes with external mixture formation (MPI) as well as direct injections into the combustion chamber can be analyzed in detail.

After almost 20 years of market success and continuous further development, the next evolutionary stage of the device, which is geared towards hydrogen applications, with special and secured measurement technology, enables a fast, cross-functional analysis of injectors under conditions as close to reality as possible. The new generation of instruments takes the physical properties of hydrogen into account and is based on IAV's Cross Type P for gaseous fuels.

The IAV Cross measuring system, which is unique in the world, consists of the hydraulic unit, the electronic measuring and control unit and the software. IAV Cross also differs from comparable products in the measuring method chosen, the tubular indicator principle. Its greatest technological advantage is also the fact that it can measure both injection rates and injection quantities simultaneously, thereby mapping the injection rate with high precision. This makes development much easier and leads to faster and better results.

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Product by IAV

Halving the Costs of Hydrogen Applications Expected by 2030

For a long time, hydrogen applications were considered too expensive. However, a study by the Hydrogen Council shows that one of the central obstacles to investment – the high production and development costs of the H_2 value chain – will largely disappear by 2030 thanks to the scaling of hydrogen production and distribution and the economies of scale in hydrogen applications. Similarly, in its National Hydrogen Strategy, the German government plans to build a strong and sustainable domestic hydrogen industry and intends to promote the production and use of H_2 to this end. The expected cost degression will give new impetus to the discussion on hydrogen applications as a promising way to achieve CO_2-neutral mobility.

In order to achieve the Paris CO_2 targets, alternatives to the fossil energy sources currently still in use, such as oil, natural gas and lignite, are urgently needed. Hydrogen, with its diverse potentials and possible applications, should play a central role in implementing the change in energy policy and decarbonization in the industrial sector.

As a company that is open to new technologies, IAV has been working on hydrogen-based drive and energy systems, e.g. fuel cell drives, for many years now, and also makes use of its profound knowledge of conventional and hybrid drive systems.

While the electrification of fleets is progressing across the industry and is set to reach a significant market volume in a few years' time, the ramp-up for H_2 technologies is expected to take place in 2030 according to the Hydrogen Council's "Path to Hydrogen Competitiveness" study and the assumptions made by the German government.

IAV has a wealth of expertise in the field of hydrogen:

- Development of fuel cell vehicles and necessary infrastructure
- Hydrogen-powered combustion engines
- Basis for customer-focused development services and consulting along the entire H_2 value chain
- Ultra-modern methods, test capacities for fuel cell development
- Designing the control system and process engineering of electrolyzers for different applications (after development of an electrolysis system by IAV)
- Conclusion: With an understanding of the entire value chain (energy production – electrolysis – use in H_2 drives), IAV can develop economically and technically optimal solutions for customers.

Market ramp-up requires investments of $70 billion

Hydrogen is the energy carrier of the future, can be used as a potentially CO_2-neutral fuel, as well as to generate electricity generate electricity and heat and can also be used as a raw material in industry. With its National Hydrogen Strategy, which was adopted in June, the German government wants to push ahead with the achievement of the climate targets and profit from the expected growth market with H_2 technologies. It is aiming for a strong domestic market: Germany should become the world's number one in hydrogen technologies.

This market with H_2 technologies could take shape in the coming years. The Hydrogen Council estimates that due to growing investment in the production, transport and use of hydrogen, the costs of many H_2 applications could fall by up to 50 percent by 2030.

In order to promote the market ramp-up and to build up electrolysis capacities, filling station and pipeline networks, investments of $70 billion are necessary in the world's largest automotive markets by 2030, according to the study, which evaluated value chains in China, the USA, Europe and Japan/Korea. According to the Hydrogen Council, this sum is considerable, but amounts to less than five percent of annual global energy investments. As part of the National Hydrogen Strategy, the German government has announced funds of nine billion euros to boost the domestic hydrogen economy.

Improved market opportunities for H_2-powered commercial vehicles and buses

"So far, costs have been an obstacle to development in the manufacture of fuel-cell-powered vehicles", says Ralf Wascheck, Head of the Fuel Cells and Hydrogen Mobility department at IAV. "The results are good news for H_2 applications as such and for technology-open companies like IAV."

According to the Hydrogen Council, long-distance freight transport in particular is suitable for the use of H_2 and fuel cell technology. It enables long ranges, fast refueling and, thus, high availability combined with high system efficiency, which is significantly higher than that of combustion engines. According to the study, H_2-powered heavy-duty vans and buses will be as competitive as their counterparts with combustion engines as a result of the expected decline in their operating costs by 2030.

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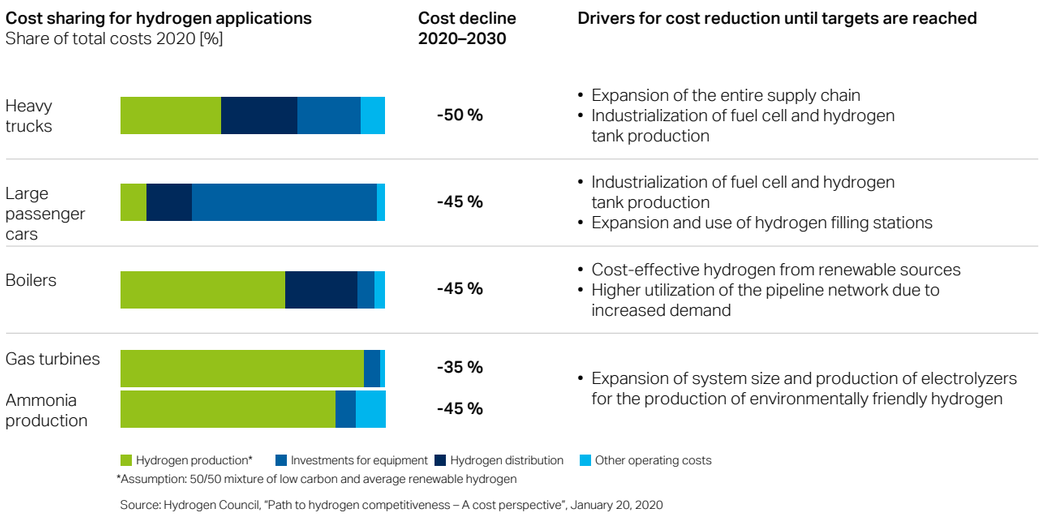

Source: Hydrogen Council, "Path to hydrogen competitiveness – A cost perspective", January 20, 2020

Modular E-drive System for Commercial Vehicles Goes into Production

Pollutant-free, quiet and efficient – this is what citizens want for tomorrow's private and public urban transportation. To ensure that Europe can meet its climate targets in line with the Paris agreement, the German government is also promoting the use of e-buses, among other things. The range of products offered by OEMs does not yet cover all market niches. IAV offers an innovative and flexible solution that could make a major contribution towards environmentally friendly local public transportation in a relatively short time: converting from diesel to electricity. The modular e-drive conversion kit can also be installed in other commercial vehicles such as trucks and mobile machinery and will be available to customers from starting in fall 2020.

For the majority of the population, climate change is one of the most urgent problems facing society. A major contribution towards solving the greenhouse gas issue falls to the transport sector, which is responsible for a large proportion of CO_2 emissions. Many cities and municipalities are working on making their transport systems climate-friendly – but there is still a long way to go. Merely converting car fleets to partially or fully electric drive systems is not enough to make the change in transportation a success. It is just as important to develop new mobility concepts, strengthen public transport and switch the energy supply to renewable energy sources. All these things have one thing in common – they do not happen overnight.

For this reason, IAV has developed a further building block for climate-neutral mobility that can take immediate effect: with the IAV modular e-powertrain conventional diesel commercial vehicles can be converted into state-of-the-art e-vehicles.

"We are making environmentally friendly transportation tangible in its most ecological form and bringing the CO_2-neutral age a great deal closer."

"With the flexible IAV modular e-powertrain kit we can realize almost all commercial vehicle applications by leveraging fully developed modules."

IAV presented the modular e-powertrain in a double-decker bus for the first time at the IAA Commercial Vehicles 2018 with the intention of equipping vintage double-decker buses for Berlin tourists with this technology. The system is in keeping up with the zeitgeist of the environmental debate that has reached the heart of society.

Authority approval for on-road operation in July

Since its presentation two years ago, the technological basis of the E-modules has been developed to production level maturity and a comprehensive safety concept has been integrated into the overall vehicle in accordance with the international ISO 26262 standard, which has been part of the State-of-the-Art Commercial Vehicle Development process since 2018. This also includes the subsequent implementation of an ABS system in a vehicle from the 1970s.

Following a trial and test phase that has now been completed, the double-decker bus received its approval from official authorities and will start travelling on public roads fall time this year.

"We are making environmentally friendly public transportation a tangible experience in its most ecological form and bringing the CO_2-neutral age a good deal closer", says Utz-Jens Beister, Managing Director of IAV Cars GmbH, after a test drive with the open sightseeing bus on the Lausitzring. "Emissions no longer play a role, so you can experience your city without annoying exhaust and noise emissions. All in all, an extremely positive driving experience – for tourists and residents alike."

The technology is appealing for many reasons. Retrofitting a diesel bus is significantly less cost intensive than buying a new electric bus and would therefore be an additional possible option for public transport organizations, given the tight situation of public finances. In addition, the existing vehicle fleet can be converted to zero-emissions in parallel to new vehicle purchases, thus avoiding production-related CO_2 emissions.

Flexible forms of application, new distribution channels

The components for the e-drive conversion kit are supplied as a complete set of parts by IAV Cars GmbH. The modular e-powertrain was developed with the support of IAV engineers and partners and is integrated individually as a system into the target vehicle, in order to ensure smooth interaction between the electric drive and the other systems and components.

The modular system can be adapted to enable various power and range setups, if required, add a fuel cell range extender to the e-drive for buses and trucks to prevent range losses.

"With the flexible modular e-powertrain, we can realize almost all commercial vehicle applications by leveraging fully developed modules", says Florian Brandau, Director of Commercial Vehicles E-Mobility at IAV.

The company is currently investigating possible new sales channels with potential partners, including the option of selling the modular e-powertrain for additional vehicle variants under a partner's brand. In addition, a powerful maintenance and spare parts network is being built up through cooperative ventures.

"This drive system, which has been tested at OEM level, offers intelligent and flexible solutions for all kinds of needs in the transportation of people and goods", says Beister.

Strategic significance – IAV as a system developer

In addition to its applicability and technical possibilities, the product is also of particular strategic importance for IAV as a company.

The transformation of the industry with its increasing requirements and costs for e-mobility means that OEMs and suppliers, instead of developing and validating products themselves as they used to in the past, are now increasingly asking IAV for turnkey technical solutions including tailored approval processes and homologation, says Brandau. As a strong partner with system development capabilities, IAV is perfectly positioned in this respect.

Comprehensive development services of this kind, as it was the case with the concept of the IAV modular e-powertrain for commercial vehicles require coordinated work across domain boundaries, pooling expertise from individual IAV divisions and integrating the corresponding development scopes completely and in a balanced manner, says Brandau.

For reasons of capacity and competence, OEMs will in the future assign even more topics that do not contribute towards brand topics to EDLs that do not according to a study commissioned by the VDA on the future value-added contribution of EDLs in April 2020. This also includes the development of driver assistance systems and energy management concepts – here, the scope of development is often too large to be handled independently by OEMs, the study says.

"System development means more responsibility for us, but it leaves us the freedom to be creative ourselves in order to develop additional value into the product for the customer", says Brandau. "We have also successfully implemented the modular e-powertrain thanks to a special product mindset in the team and specially set up processes from the early economic business model to the finished product."

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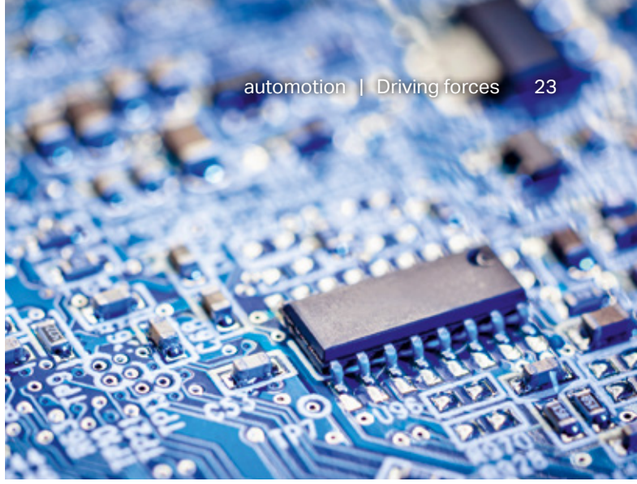
Technical data for the modular e-powertrain for MAN SD200/SD202

- Voltage range high-voltage system: up to 750 V
- Direct wheel drive, Ziehl-Abegg
  - Power (nominal/maximum): 2x 120 kW/200 kW
  - Torque (nominal/maximum): 2x 3700 Nm/8750 Nm
- Maximum speed: 65 km/h (limited)
- Installed battery capacity, e-Deutz: 147 kWh
- Consumption values, 20 °C, Sightseeing Berlin: less than 0.7 kWh/km (approx. 11 km/h Ø-speed)
- Range, guaranteed in operation min. 120 km
- Additional equipment features:
  - Power steering pump and air compressor, Moteg
  - Heating modules, Webasto
  - ABS brake system incl. combination brake
  - AC and DC charging capability
  - IAV Digital Service Assistant, Telemetry System
  - Touch display as driver interface with integrated camera inputs (upper deck and rear view camera)
  - Revised instrument panel with LED displays
  - Onboard power supply via DC/DC converter
  - Power reserves for sightseeing equipment are provided
  - Safety systems for drive, base vehicle and high-voltage technology
  - IAV power supply unit for flexible modular e-powertrain adaptation and expansion to fuel cell systems, for example

Product by IAV



What Does Data Look Like?

IAV Tronador bundles all the information from an ECU clearly in one program and visualizes it in seconds directly in the function documentation.

Electronic control units have it all. Their information for the application is usually distributed across many data sources and can only be visualized and processed using specialized programs. This program diversity makes the work of the developers considerably more difficult. But this no longer has to be the case! In close cooperation with our calibration engineers, we have developed a tool that bundles all the information of an ECU clearly in a single program: IAV Tronador. The software visualizes the information in seconds as an overlay directly in the function documentation and also enables the interactive analysis and visualization of measurement data. This makes work much easier for the calibration engineer, because he can do everything compactly and clearly with only one program.

Our product IAV Tronador thus kills two birds with one stone – increasing efficiency and quality. This means applicators can produce even better and more valid development results in less time. Development goals and SOPs are better adhered to in this way.

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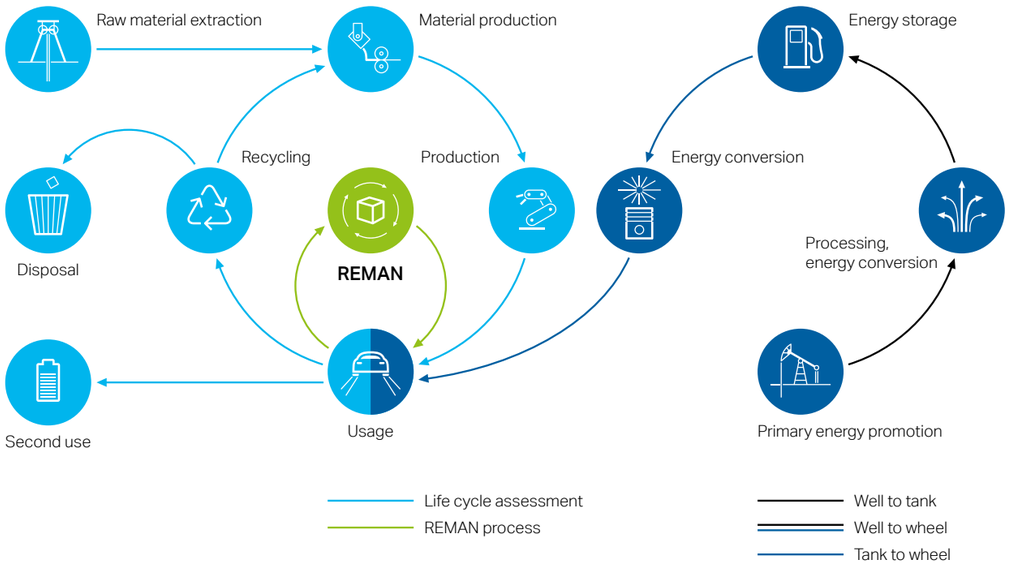
Product by IAV

Old Becomes New: Boom Market Remanufacturing



Conservation of resources and climate protection are closely intertwined. The absolute consumption of raw materials in industrialized countries is too high from an ecological point of view. How can production be made more efficient and the demand for natural resources reduced? In order to make a maximum contribution towards climate protection over the entire life cycle, IAV relies – alongside a large number of innovative technology and mobility concepts – on the remanufacturing of so-called old parts.

The goal of remanufacturing is praiseworthy and ambitious: It is intended to return products and components to a state as good as new or in line with their current value after their regular useful life and, thus, enable them to be reused. The procedure saves resources, energy and costs and makes an important contribution towards sustainable product life cycles. The Federal Government and the European Union also support this type of recycling management.

Probably the best known example of remanufacturing in the automotive sector is retreaded tires, which are particularly relevant for commercial vehicles. Since 2015, IAV has been developing the key processes for industrial remanufacturing of complex systems and components, for example in the fields of logistics, parts management, functional testing and validation of vehicle parts such as exhaust gas turbochargers (ATLs), automatic transmissions or complete engines.

Defective old parts are remanufactured using methods adapted to the product and, thus, allow for safe reuse in accordance with general and individual OEM design and safety guidelines. For process development, IAV draws on its experience gained from decades of developing conventional drivetrains.

Today, remanufacturing has established itself alongside pre-production and series development as an attractive and sustainable sector in the specialist field of combustion engines. In retrospect, exhaust-gas turbocharged internal combustion engines replaced naturally aspirated engines in the wake of stricter fuel and emission standards. As a result, the demand for spare parts for components such as ATLs, some of which are very expensive (approx. 1,000 euros new price plus installation costs), increased significantly and reconditioning developed into a viable alternative.

Better CO_2 balance, lower costs

"The remanufacturing of components improves the life cycle assessment and reduces costs", says Dr. Mirko Leesch, Head of the Internal Combustion Engines and Fuel Systems Department. "This is an important topic for our customers and it will become even more important in light of the growing importance of the carbon footprint of OEM production chains and the generally high cost pressure."

In line with the Paris Climate Conference of 2015, most countries in the world have committed themselves to continuously reducing greenhouse gas emissions, and have set themselves consistent decarbonization targets to be achieved by 2050 at the latest.

Subsequently, the OEMs declared electric mobility to be an essential building block for CO_2-neutral mobility. However, a comprehensive consideration of the entire life cycle, including production and recycling at the end of the vehicle's service life, makes it clear that battery-electric vehicles (BEVs) do not meet the climate targets per se due to their energy-intensive production and disposal and the currently available electricity mix, and that other technologies and measures are also required to meet the CO_2 target.

Focus on e-mobility, HV storage and BEV drivers

In IAV's view, such a measure is consistent remanufacturing: The ongoing electrification of fleets with a focus on BEVs will give the general overhaul and repair market a qualitative boost. According to Leesch, the remanufacturing of expensive components such as battery modules or cells will be in greater demand in the future, particularly for high-voltage (HV) storage systems for BEVs.

Before defective electrical components are reworked, they must be tested for their suitability for remanufacturing according to strict specifications. IAV's modern test benches, which use intelligent test methods to set benchmarks for both battery-electric and combustion-engine drives, are predestined for such measurements.

"We have very complex knowledge of test methods and the relevant processes in remanufacturing", says Jan Becker from the Department of Internal Combustion Engine Development. "We want to help shape the change process towards e-mobility and more sustainability with our expertise and specific know-how."

VDI sees exorbitant growth until 2030

With a view to the planned expansion of the e-vehicle range within the next ten years, OEMs must now begin to prepare replacement and spare parts, establish appropriate processes and set up contingents. IAV can provide optimum support for these OEM activities, thanks to the in-depth knowledge gained from pre-series and series development and accompany the anticipated market ramp-up. The focus here is on electrical systems and high-voltage technology. This is partly because the market is growing particularly strongly in this area and partly because the potential for savings for OEMs is particularly high in this area.

According to a research report published in December 2019, the Association of German Engineers (VDI) expects sales from the reconditioning and resale of used parts and components in Germany to increase to at least 43 billion euros in 2030, up from the current figure of around 8.7 billion euros per year. Two thirds of this business is accounted for by the aviation and automotive industries.

"At the moment, we are sharpening up the processes, especially for all e-traction components, in order to support vehicle manufacturers and suppliers in all powertrain remanufacturing issues", says Becker, adding: "Clean and sustainable mobility starts in development and goes beyond the classic life cycle of vehicles."

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Efficient Thermal Management

New two-phase cooling as a building block for compliance with RDE and Euro 7

Classic combustion engines must also make a contribution on the way to climate-neutral transport in 2050. By reducing thermal losses, fuel consumption and exhaust emissions can be further reduced.

The starting point for IAV's development of a climate-friendly two-phase cooling system in the combustion chamber is the experience among engine developers that an engine does not work particularly efficiently if only little power is drawn off. In partial-load operation, fuel consumption is higher in relation to the energy generated, which leads to poorer efficiency.

This is why IAV has developed a two-phase cooling system in which the coolant temperature can be set between 80 and 200 degrees Celsius irrespective of the operating point. The closed circuit works with a mixture of water and ethanol as coolant. It evaporates in the engine, is expanded via a valve and condensed again in a radiator. A high-pressure pump feeds the medium into the engine at a pressure between one and 12 bar.

"The higher the pressure, the higher the temperature in the circuit", says Thomas Arnold, team leader for combustion engine design and testing. "In this way, we can set the optimum pressure and thus also the most favorable wall temperature for combustion, depending on the operating point of the engine." And we do this with great accuracy: The temperature difference between the wall and the coolant is between five and 20 Kelvin maximum.

Almost six percent less fuel consumption in the WLTC

While the highest possible wall temperature is desired in the partial load range, it should be as low as possible in the full load range to protect the components. This is also made possible by the new two-phase cooling system: "By reducing the pressure, we achieve significantly lower temperatures at full load than conventional cooling systems", says Arnold. "This also increases the service life of the engine."

To demonstrate the potential of two-phase cooling, IAV has equipped a conventional turbocharged 1.4-liter gasoline engine with the new technology. Tests show that this reduces fuel consumption in the WLTC by 5.6 percent. The lower coolant mass flow also contributes to this: Depending on the operating point, it is only one to two percent compared with conventional liquid cooling, meaning the coolant pump requires significantly less drive power.

Increased customer interest, new exhaust regulations

"With our comprehensive and long-standing engineering expertise, we are the right partner in the transformation", says Matthias Krause, Head of the Internal Combustion Engine Design department. "We not only provide our customers with the best solutions for efficient and flexible thermal management, but also ensure that everything functions optimally in the overall system."

Interest in the two-phase cooling system is currently receiving a boost from the increasing global requirements for exhaust gas emissions and CO_2 output. In January 2021, for example, the second stage of the RDE test procedure for measuring real driving emissions will come into force. When the standard was introduced in September 2017, a vehicle was still allowed to emit 2.1 times the legally stipulated limit value. Next January, this conformity factor will drop again to 1.5.

"With the increasing demands on emissions, all reasonable savings potentials must be raised. Two-phase cooling can make a very good contribution in many engines", says Krause.

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E-test Bench to Go

Flexible, effective and economical: With IAV Auros, we offer mobile test bench automation for electric drives and auxiliary units.

Electric mobility is picking up speed. Nearly all manufacturers will launch new models on the market in the next few years. And the trend is rising. For developers, this means a growing need for suitable test benches to put high-voltage components and electric drives through their paces. Conventional test benches are suitable for this purpose, but the test bench times are rare and relatively expensive. In order to resolve this area of conflict, we have developed IAV Auros, a mobile test system for electric drives that is easy to transport and yet contains all the features required for high-voltage testing. With our system, all rooms with a voltage supply of 63 amps become potential high-voltage test benches.

Despite its compact size, the mobile test bench does not compromise on performance. It can control and monitor a single motor or two electric motors in so-called back-to-back operation. Drive motors with up to 150 kW mechanical power – such as traction drives for hybrid or electric vehicles – can thus be tested without any problems. An expensive test bench, for example for endurance tests, is not required. IAV Auros can be booked as a customized service package for specific projects or purchased as a fully functional test bench solution.

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Putting a Stop to Hackers with the UNECE

With increasing interconnectivity, vehicles also offer criminals more scope for attack. Security is therefore becoming an even higher priority for manufacturers and their suppliers. In addition, UN regulations impose new requirements – a challenge that IAV is tackling.

IAV offers special expertise and experience in ...

- the establishment of a cybersecurity management system
- the analysis of threats and risks
- the creation of cybersecurity concepts on process, product and information level
- the design of vehicle architecture with domain separation
- the observation of hacker progress, CVEs and CWEs (especially for FOSS software)
- penetration tests

No motorist wants to experience something like this: From the sofa, two hackers from the "Wired" magazine demonstrate a remote attack on a Jeep Cherokee in 2015. From a distance, the two will take control of the vehicle, switch off the engine, deactivate the brakes and intervene in the steering. How could this happen? The vehicle's control unit architecture was insufficiently protected by Wi-Fi and mobile communications, and the other entrance gate to the attack was inadequately secured software updates. A series of security problems enabled the two hackers to take control of the vehicle via radio.

Today, many vehicle manufacturers and their suppliers must struggle with security problems: The number of known cybersecurity attacks has increased sevenfold between 2010 and 2019, according to the Upstream Security Global Cybersecurity Report 2020. This is because with increasing interconnectivity, the targets and possibilities for attacks on vehicles are multiplying – whether via charging stations, vehicle keys, Wi-Fi, Bluetooth or mobile communications, to name just a few examples. And in the future, too, the problem is likely to grow rather than shrink: Already today, more and more functions are being combined on domain computers. In the future, these will be at least partially outsourced to the cloud – and thus create new targets for attacks.

Combine security and safety

How can this be prevented? An important step is to combine security and safety, i.e. cybersecurity and vehicle safety. An attacker only needs to find one way to attack a vehicle, while the developers need to know and protect all of them. This means that the safety systems in the car can be infiltrated in a targeted manner by a remote attack, as in the example above. Safety and security are thus closely related – even if in the past they were usually considered separately.

The United Nations has also intervened to further improve the cybersecurity of vehicles: The Working Party on Automated/Autonomous and Connected Vehicles (GRVA) within the UN/ECE Economic Commission is working on a new regulation on cybersecurity and software updates. Comprehensive changes are planned, which, although not yet fully in force, will already have an impact on the work of manufacturers and suppliers, as they will be relevant for type approval from 2022 and for all new registrations from 2024.

Shared responsibility

A central point of the new regulations is that manufacturers, subcontractors, suppliers and potential third parties will in the future be jointly responsible for improving the security of systems in vehicles. In doing so, all must prove that they meet the official requirements in terms of the principles of security. In the future, vehicle architectures must be designed in such a way that by overcoming one component it is not possible to access the next. In addition, it will be the task of companies in the future to digitally monitor cybersecurity throughout the entire life cycle of a vehicle and to react to incidents accordingly.

A mammoth task for vehicle development

This is a mammoth task for all those involved – including IAV. For example, all ECUs with security relevance must be checked and functions such as a dedicated security module for communication (e.g. Autosar SecOC – Secure Onboard Communication) must be added. The new standards also fundamentally change the customer process: This means that a risk analysis will be central to every system and every function in the future.

IAV is already working flat out to master this complexity and implement the new standards. For instance, the company is currently redefining processes and roles – also together with customers. We are also expanding the methodological expertise of our employees through security training. Furthermore we are already conducting risk analyses on behalf of our customers. Although there is still some work ahead of us in implementing the directive – the goal is clear: We do not want to give hackers a chance.

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UN-ECE WP.29: New rules for cybersecurity (CS)

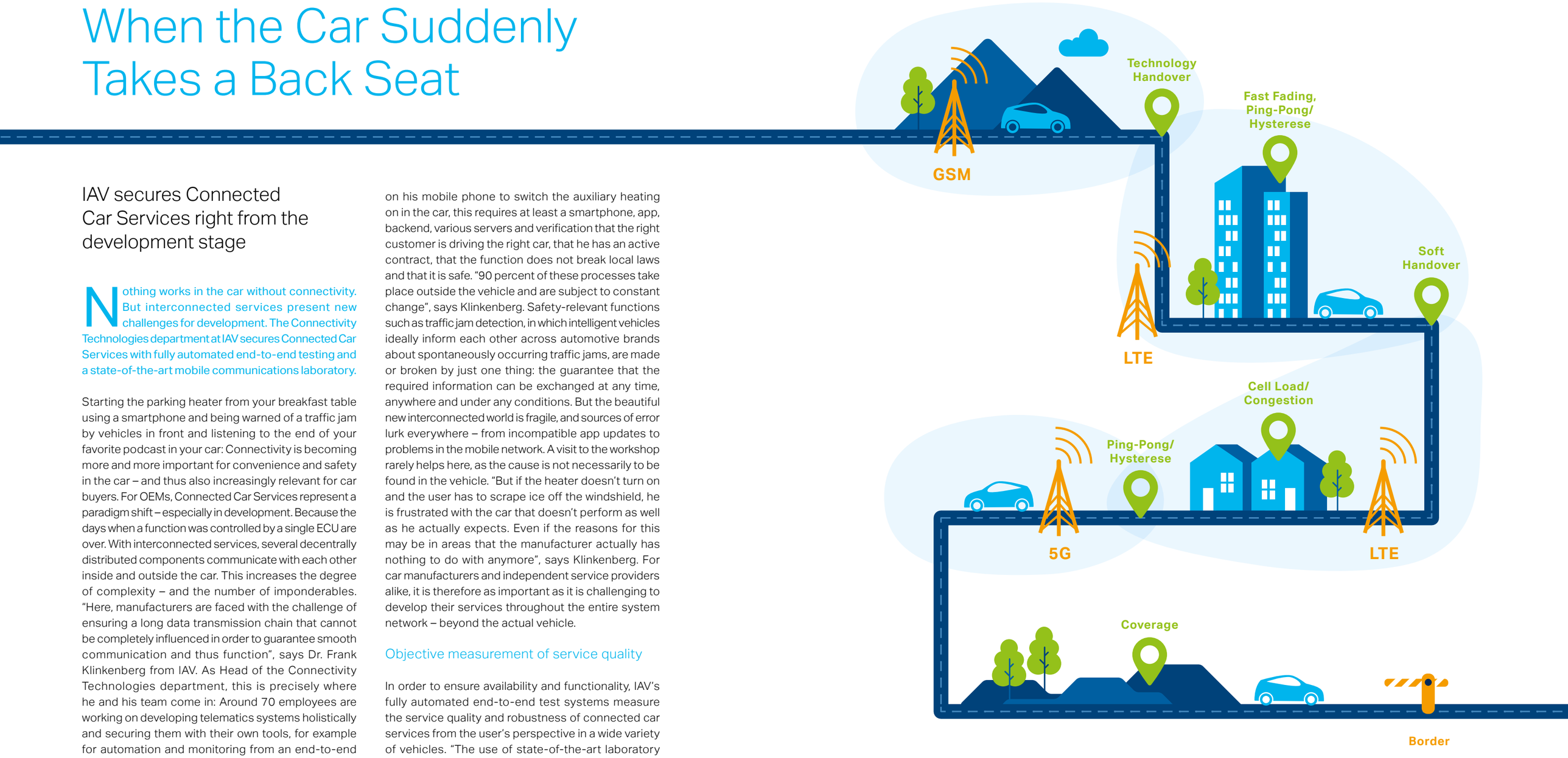
Cybersecurity requires the vehicle to have:

- Architecture with domain separation
- Security protection for critical vehicle systems such as systems with an influence on:
  - external interfaces
  - safety (including longitudinal and lateral acceleration)
  - availability (including theft protection)
  - type approvals
  - emissions
  - personal data
- Manipulation detection (intrusion detection)
- Passed penetration tests

Cybersecurity requires companies to:

- establish a Cybersecurity Management System (CSMS)
- introduce processes and responsible persons (roles)
- manage security for suppliers and service providers
- identify, assess and respond to risks
- monitor attacks, threats and vulnerabilities (e.g. hacking successes, quantum computers)
- continuously evaluate the effectiveness of previous measures
- always be ready to respond to (detected and threatened) attacks
- quickly deploy security patches even after EOP

When the Car Suddenly Takes a Back Seat



IAV secures Connected Car Services right from the development stage

Nothing works in the car without connectivity. But interconnected services present new challenges for development. The Connectivity Technologies department at IAV secures Connected Car Services with fully automated end-to-end testing and a state-of-the-art mobile communications laboratory.

Starting the parking heater from your breakfast table using a smartphone and being warned of a traffic jam by vehicles in front and listening to the end of your favorite podcast in your car: Connectivity is becoming more and more important for convenience and safety in the car – and thus also increasingly relevant for car buyers. For OEMs, Connected Car Services represent a paradigm shift – especially in development. Because the days when a function was controlled by a single ECU are over. With interconnected services, several decentrally distributed components communicate with each other inside and outside the car. This increases the degree of complexity – and the number of imponderables. "Here, manufacturers are faced with the challenge of ensuring a long data transmission chain that cannot be completely influenced in order to guarantee smooth communication and thus function", says Dr. Frank Klinkenberg from IAV. As Head of the Connectivity Technologies department, this is precisely where he and his team come in: Around 70 employees are working on developing telematics systems holistically and securing them with their own tools, for example for automation and monitoring from an end-to-end user perspective – something that is fundamental to the "Quality of Experience".

The vehicle in the supporting role

After all, the interconnected vehicle is no longer an isolated object, but part of a digital ecosystem in which it interacts with many other components – and sometimes plays a new role. Take the example of auxiliary heating: When the customer gives the order in the morning on his mobile phone to switch the auxiliary heating on in the car, this requires at least a smartphone, app, backend, various servers and verification that the right customer is driving the right car, that he has an active contract, that the function does not break local laws and that it is safe. "90 percent of these processes take place outside the vehicle and are subject to constant change", says Klinkenberg. Safety-relevant functions such as traffic jam detection, in which intelligent vehicles ideally inform each other across automotive brands about spontaneously occurring traffic jams, are made or broken by just one thing: the guarantee that the required information can be exchanged at any time, anywhere and under any conditions. But the beautiful new interconnected world is fragile, and sources of error lurk everywhere – from incompatible app updates to problems in the mobile network. A visit to the workshop rarely helps here, as the cause is not necessarily to be found in the vehicle. "But if the heater doesn't turn on and the user has to scrape ice off the windshield, he is frustrated with the car that doesn't perform as well as he actually expects. Even if the reasons for this may be in areas that the manufacturer actually has nothing to do with anymore", says Klinkenberg. For car manufacturers and independent service providers alike, it is therefore as important as it is challenging to develop their services throughout the entire system network – beyond the actual vehicle.

Objective measurement of service quality

In order to ensure availability and functionality, IAV's fully automated end-to-end test systems measure the service quality and robustness of connected car services from the user's perspective in a wide variety of vehicles. "The use of state-of-the-art laboratory technology enables us to simulate virtual journeys and communications in practically every country and mobile phone network in the world, even under conditions of the latest 5G mobile communication standard", Klinkenberg explains. After all, with a 5G laboratory and the planned construction of our own 5G campus network at the Gifhorn site, the foundations have been laid for mediating the quality of a interconnected service with all conceivable connection qualities and thus optimizing the overall system. For example, the team is clarifying for customers how fast their online services are in the car, i.e. how long the user has to wait, for example, until his podcast starts in the car. The monitoring and analysis results in anomalies – and thus the necessary adjustments to improve the user experience. "We are usually called in when new territory has to be entered or when customers are confronted with extreme complexity. We specifically address the parameters of variance and complexity, which increase with each mobile phone and app generation, each update, each new vehicle model", says Klinkenberg. Manufacturers must make these parameters manageable in their balancing act between the classic product- and hardware-driven automotive industry and the interconnected mobility universe of the future. Klinkenberg: "Here at IAV, we have both worlds in focus. This bridge helps us a great deal – and thus also our customers."

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Car Sharing – Are We Flogging a Dead Horse?

Tomorrow's mobility should be smarter, greener and more flexible for all road users. How can this be achieved? This is what the experts at consulting4drive, IAV's innovation and management consultancy, are thinking about. An interview with Managing Director Timm Kellermann, Dr. Ralf Tröger, Vehicle Drives Business Consulting Manager and Senior Project Manager Holger Gentgen.

Timm Kellermann

"What we still cannot do today is to convince people with their own car to sell it and use only mobility services."

Dr. Ralf Tröger

"For these cars, which are operated exclusively as a fleet in urban areas, a completely emission-free drive with a speed of less than 120 km/h would be sufficient."

Holger Gentgen

"When I want to get to the office in the morning, I might take my own car, because it is quick and easy."

There are more and more sharing service providers on the German market, but at the same time demand is stagnating. Is sharing still the solution of the future?

Gentgen: Car sharing is one of many ways to get around. I find it difficult to imagine a perfect mobility solution, since each person decides very subjectively which means of transport is most useful to them in the current situation. When I want to get to the office in the morning, I might take my own car, because it is quick and easy. If I'm out on the town with friends in the evening, my own car might not be the best choice, so then I'm also open to other solutions.

Kellermann: This need to be able to move around freely and make decisions seems very basic to us humans. Our task as the automotive industry is to respond to these wishes and needs and to make the various alternatives ecologically sensible and sustainable.

However, many municipalities may lack the financial means to offer different mobility solutions in parallel and nationwide. How can this step nevertheless succeed?

Gentgen: That is correct, and that is why it is all the more important for local authorities to look at the options that are already available and those that will be available in the future, and to make the concepts that are suitable for them attractive, so that they can control the market, for example by means of charges or special lanes. In the municipal sector, no single perfect solution will not prevail across the board; here, too, there are different, regional requirements.

Germans have a reputation for not being able to let go of their cars. Doesn't the majority choose their own car every day?

Kellermann: I regularly try out sharing myself and notice time and again that it is rarely as convenient as your own car. Sharing today has similar restrictions to public transport, but costs almost as much as your own car. The current offers are therefore particularly attractive for people who have never owned a car before. What we still cannot do today is to convince people with their own car to sell it and use only mobility services. I don't think the problem is insurmountable; we just haven't solved it yet in such a way that it is an attractive alternative for the majority of the urban population.

What would be necessary to make more people switch to alternative mobility solutions?

Kellermann: To start with, certainly a more attractive offer for city centers in terms of price and convenience. It would help if legislators at federal and European level joined forces to make CO_2 emitting mobility solutions fairer to the polluter and above all gradually more expensive. If local authorities also invest in a city worth living in, these additional revenues would make it possible to explicitly promote sharing in addition to local public transport in order to accelerate the abandonment of private vehicles in conurbations. As is well known, public transport is profitable only in exceptional cases – why do we believe that sharing can be profitable on its own in free competition? We therefore see the need for consortia to develop special sharing vehicles in addition to funding. These are neither small nor highly motorized. Their interior offers much more privacy and comfort than bus or train. Virtually every manufacturer has the expertise to develop something like this.

Tröger: For these cars, which are operated exclusively as fleet and in urban areas, a completely emission-free drive with a speed of less than 120 km/h would be sufficient. The controlled chassis focuses on comfort and disconnection from the road instead of lateral acceleration. We could think of the implementation of the "brake" function differently than in universal vehicles for private ownership. In share fleet operation, it would be best if driver assistance systems could not be configured or switched off by the user at all: They are monitored and continuously maintained by the fleet operator.

And how can manufacturers push technical development?

Tröger: In general, subsidized consortia help to push such targeted developments. This not only reduces costs but also the risk for each manufacturer or supplier involved. The differentiation lies less in the basic vehicle than in the travel experience. Nor does differentiation bring benefits to consumers or society in terms of billing systems, interfaces, technical compatibility in loading, security and testing procedures.

However, vehicle manufacturers could learn not only from each other, but also from customers in the sharing area, for example by analyzing vehicle data. Is this already happening?

Kellermann: With regard to vehicle data, yes. The key question, however, is how a manufacturer can regularly obtain consent from all its customers to also use personal and contextual data. As a customer, I will only be willing to share my data with a manufacturer if the manufacturer does something to improve my personal travel experience or reduce my planning stress.

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Favorite Sound: Silence

An intact transmission must run like clockwork. Even the slightest discrepancy affects the interaction of the individual components and can shorten the service life. Indications of this can be, for example, unwanted interference noise.

These can have a negative impact on the performance of a wind turbine and, even worse, can promote wear and tear of the components. Desirable and undesirable noises in a vehicle, machine or component are summarized as Noise Vibration Harshness (NVH). IAV has many years of experience in this field and has now been able to help a wind turbine manufacturer to optimize the NVH behavior of its transmissions. This initially required a whole series of analyses to precisely localize the noise sources in the transmission. "Our analytical and numerical investigations of transmission errors drew an initial picture of the load distribution and served as the basis for subsequent corrections to the transmission geometry", says Dr. Christian Lohse, NVH Simulation Powertrain Team Leader at IAV.

To this end, IAV experts used various mathematical approaches such as multi-body simulation to generate a model of the transmission. Using the finite element method, a method that is particularly well suited to examining geometrically complex bodies, they then determined the natural frequencies of the entire transmission.

With success. The results of these two methods showed a high degree of agreement for all load cases and confirmed the reliability of the previous investigations. "As a result, we were able to effectively optimize the NVH behavior of the transmission and thus help our customer to produce quieter, more powerful and more durable transmissions", Lohse sums up.

What NVH or engineering challenge do you have for us? The more complex and complicated the task, the better.

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"As a result, we were able to effectively optimize the NVH behavior of the transmission and thus help our customer to produce quieter, more powerful and more durable transmissions."

Digitalization of the Middle Class

Medium-sized business goes industry 4.0

Whether hardware-in-the-loop testing, control software or data science – IAV transfers methods and processes from the automotive industry and helps medium-sized companies take the next technological step. IAV achieves this by retrofitting existing systems with new communication and interconnectivity technologies, among other things.

Production facilities in industry are enormously expensive. This is why they are built to be as robust and durable as possible. But of course, the world continues to turn after the purchase. Medium-sized companies in particular are often faced with a choice: either remain at the state of the art and spend a lot of money on new machines, or do not invest and perhaps lose touch. IAV offers a solution to this problem: keep the old equipment and upgrade it for the future by means of retrofitting.

Subsequent digitization

In the case of subsequent digitization, the first step is to obtain data in the first place. To do this, IAV uses, among other things, mesh networks that are highly dynamic and also use a large number of different sensors for data acquisition.
"It doesn't matter how old the system is or which manufacturer it comes from, because mesh networks are small nodes that operate autonomously and are equipped with their own sensor technology, communication and power supply", explains Sören Heinrich, software developer at IAV. Once the data has been successfully transmitted, it is stored and evaluated. The results range from simple condition monitoring, i.e. the live status of the machine, to possible process optimization and process control or condition-based maintenance (predictive maintenance).

Does the system have to be timed differently? Do processes have to be varied? We find the answers to these questions using data science methods and models, thereby saving the operator money. Subsequent digitization – i.e. data acquisition, data transmission and data processing – is supported by an IoT platform adapted by IAV. "This includes, among other things, device management in which all sensors attached to the system by means of retrofitting are clearly displayed along with all the information", explains Heinrich. Device Management also allows a firmware update to be carried out over-the-air (FOTA) so that the installed mesh network can be easily optimized for changing measurement tasks. A corresponding security and safety concept is also implemented.

Hardware-in-the-Loop-Testing and control software in the industry

The Data Science methods often lead to an update of the control software with the help of the measurement results. This poses particular risks when production must run around the clock, 365 days a year. Production downtimes due to faulty software must be avoided at all costs – and this is where IAV benefits from its many years of automotive expertise.

In vehicle development, it is standard practice to put software through its paces in a real-time simulation environment, a hardware-in-the-loop (HiL) test bench, before it is integrated into the car. IAV is now also transferring this method to other industries. "In industry, production facilities must be stopped for operation-related optimization. The software is then transferred – manually and virtually untested – to the plant control system", explains Volker Weck, Team Leader for HiL Testing at IAV. "Regularly, this leads to longer plant downtimes. In this case, a preceding virtual commissioning using HiL-Testing ensures that the start-up phase is as error-free and shortened as possible."

To ensure the best possible transfer of know-how, IAV has developed a HiL test bench for a production plant. "With the help of this facility, we can create a digital twin of a real plant", says Weck. The real machine control (PLC) with its new software is connected to the test bench. A software model of the production plant is calculated in real time on the simulator and supplies the control system with plausible signals for sensors and actuators. In this way, tests can be run on a simulation basis without risk, which could also be dangerous to humans and machines on a productive plant. "In addition, plant availability is increased because the plant is not blocked by software troubleshooting and further tests. Furthermore, personnel, energy and maintenance costs are saved", Weck calculates.

The software product INCA FLOW developed by IAV is used to automate the test process on the HiL test bench. Using tried and tested methods from test operations for automotive applications, the tool offers simple graphical modeling of test processes. Furthermore, an integrated OPC UA interface provides access to current industrial applications.

When creating plant simulations, IAV benefits from its experience in model-based software development in the automotive industry. "We serve all phases of the V-model and use professional tool chains. This is why we can guarantee that the software we create is of high quality and can be maintained, adapted and extended for many years to come", Heinrich explains.

With this approach, IAV has already aroused great interest among machine manufacturers, plant operators and control system developers. This service is aimed particularly at medium-sized companies that have not yet gone digital.

IAV offers tailor-made and customer-specific solutions – from simple data acquisition to the development and implementation of complex control software.

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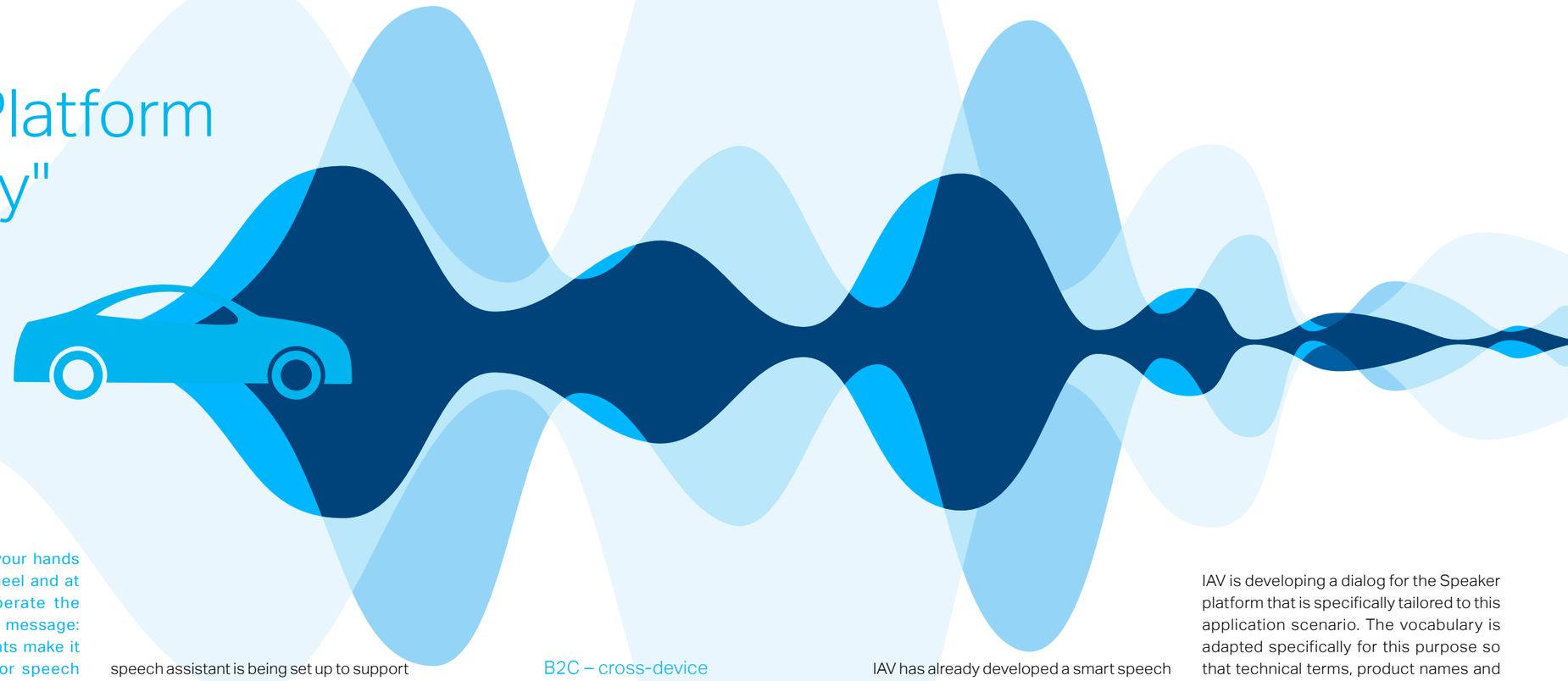
Voice Assistant Platform "Made in Germany"

IAV is working with Fraunhofer Institutes on safe and efficient speech assistants



While driving, keep your hands on the steering wheel and at the same time operate the navigation device or send a message: Speech recognition assistants make it possible and the demand for speech recognition is growing. Current market studies indicate that within the next four years, 25 percent more devices with speech recognition functions will be used annually in both the private and commercial sectors.

A major problem: data security. Some OEMs have integrated speech assistance systems into their infotainment solutions – microphones are constantly active for keyword recognition. But the user cannot control where dialogs are processed and stored. Sensitive data from research and development must also be protected. However, the current market leaders do not work according to European standards. A platform "Made in Germany", on the other hand, would guarantee compliance with the requirements of the general data protection regulation of the European Union.

Data secure, open, modular and scalable

This is exactly where the Speaker Project of the Fraunhofer Institutes for Integrated Circuits IIS and for Intelligent Analysis and Information Systems IAIS and its partners comes in. IAV is participating with two application scenarios: In the B2B segment, a speech assistant is being set up to support vehicle development. As a B2C case, IAV is developing a cross-device, personalized speech assistant. In this way, IAV is helping to develop solutions that offer state-of-the-art technology and data sovereignty and can be adapted to workflows, specialist terminology and the needs of different sectors. The innovative speech assistance platform will provide services, data and technologies via combinable interfaces and will therefore be modular and scalable. The speaker modules will be multilingual, retrainable and not only run cloud-based, but also offline and on-premises (on locally operated servers).

IAV is the only consortium partner from the automotive sector with the necessary expertise in vehicle architecture and development and is able to integrate speech assistants with a wide range of functions in a robust and reliable manner. "Our most important contribution to the overall Speaker project is to bring the platform to the automotive sector with specific use cases", explains IAV project manager Maurizio Guida. "One of the ways we do this is by incorporating both data protection specifications and technical requirements from our industry into the development of the platform."

B2C – cross-device communication with multiple users

New applications of speech assistants can make driving safer. IAV aims to further improve user-friendliness by enabling personalized dialogs to be continued virtually seamlessly across multiple terminals. At present, it is not possible to switch from a smartphone to the vehicle infotainment system, for example. Moreover, personal profiles are not tied to the voice but to login data.

IAV is developing multi-user scenarios so that several speakers can interact with the assistant. On the Speaker platform, it will be possible to distinguish between several users by means of speaker identification and thus conduct more complex dialogs with different people present. With access points – i.e. microphone arrays with the interface to the speaker platform – different users will be able to use the assistant in a personalized way. This is made possible by IAV's expertise in the fields of speech dialog development, UX, HMI development, vehicle integration, acoustic protection and the creation of relevant algorithms.

IAV has already developed a smart speech recognition system that allows software to react differently to different people in the vehicle. This is made possible by individual rights assignment and zone recognition that identifies whether a voice is coming from the driver's seat or the back seat. The use case was presented at the CES 2020 technology fair in Las Vegas.

More efficiency in vehicle development tests

In vehicle development, too, an intelligent speech assistant can help to record data, control complex test sequences and record errors that occur during testing as well as voice notes. Whereas two people were previously required for test drives and their documentation, in the future the driver will be able to carry out and document the tests on his own. Usability is a decisive factor in ensuring that a speech assistant is actually used later on. In order to scale this up as much as possible, components such as Automatic Speech Recognition (ASR), Natural Language Understanding (NLU) and Natural Language Generation (NLG) must interact robustly and users must already be involved in the development process of the assistant.

IAV is developing a dialog for the Speaker platform that is specifically tailored to this application scenario. The vocabulary is adapted specifically for this purpose so that technical terms, product names and abbreviations are also recognized by the speech assistant. IAV also contributes knowledge of vehicle electronics and connectivity as well as extensive experience in vehicle interior acoustics. This interaction is essential for recording speech signals while driving in such a way that the signal quality is suitable for further machine processing.

So far, non-European companies in particular have dominated the market for voice-controlled dialog assistants – although research in Germany has achieved groundbreaking results in this area. The Speaker project will integrate all of these on the new platform – and help to usher in a new, more secure data age.

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Fraunhofer

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BVG and IAV Bring New Mobility to Alt-Tegel

As part of the "Shuttles & Co" research project, three highly automated minibuses will be rolling through Berlin's urban traffic in Alt-Tegel from the end of the year

The yellow minibus is coming back to Alt-Tegel – and it's bringing reinforcements: A total of three highly automated shuttles will run for 12 months from the end of the year between Alt-Tegel underground station and Greenwich Promenade on Lake Tegel. IAV is a partner in the project, contributing over 20 years of experience in the field of automated driving. Passengers can use the minibuses operated by Berliner Verkehrsbetriebe (BVG) free of charge.

They can be chauffeured comfortably from the underground station to stroll along the promenade: This is made possible by the "Shuttles & Co" project launched in January on the digital urban traffic test field. The ten project partners – including the Senate Department for the Environment, Transport and Climate Protection (overall coordination), the BVG, the Berlin Agency for Electric Mobility eMO and IAV – want to test automated and interconnected driving in public transport and gather experience on the opportunities and risks involved in shaping urban mobility of the future.

To this end, three highly automated shuttles will be in operation in Berlin's Alt-Tegel district by the end of the year. The yellow fleet will be operated by BVG, which has already carried out a six-month test phase with a highly automated shuttle in 2019 in the "Sea Mile" project. BVG companions will also be on board the self-propelled minibuses of the "Shuttles & Co" project. However, with longer operating times, the vehicles now serve a larger area of operation between the Alt-Tegel underground station and the Greenwich Promenade on Lake Tegel. In addition to more demanding route guidance, the speed will also be increased by up to six kilometers per hour from the previous maximum 12 km/h to 18 km/h.

The project timetable also includes research into other basic technologies for the future digitalization of transport – in particular the improvement of digital maps and traffic information. The project builds on the findings of the "SAFARI" research project, which has already been completed. As part of this project, IAV and partners have developed and tested high-precision, self-updating digital maps that are fed by vehicles and smartphones.

IAV's focus in the "Shuttles & Co" project is now on developing and integrating new perception functions in highly automated vehicles and optimizing communication between vehicles and between vehicles and infrastructure (V2X). Specifically, the focus is on improving the localization of vehicles in challenging environments: in tunnels and at junctions, for example. In addition to classical algorithms, algorithms from the field of artificial intelligence are also being tested.

Another focus is on the fusion and integration of vehicle and infrastructure information into a highly up-to-date, dynamic map. The aim is to use this Local Dynamic Map to provide other road users with information on the traffic situation, the speed of road users, as well as roads and road works from the travel operation side. "To this end, we are investigating how the exchange of information between vehicle and infrastructure and between the vehicles themselves can improve perception and ultimately driving functions", says Paul Czerwionka, Project Manager for "Shuttles & Co" at IAV.

IAV is contributing more than 20 years of experience in developing the entire technology portfolio for interconnected and automated driving to the "Shuttles & Co" project.

However, the acceptance of new forms of mobility by passengers also plays an important role. For this reason, the project partners are researching the topics of user acceptance and social acceptance of automated shuttles in addition to optimizing the technology and testing the vehicles. Regular surveys of passengers, citizens' conferences and project workshops are planned for this purpose. Last but not least, during the 18 months of test operation, citizens will now also have the opportunity to experience and use innovative technologies in everyday life and thus form their own opinions. Get on board!

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Shuttles & Co

In addition to IAV, the "Shuttles and Co" project involves the Senate Administration for the Environment, Transport and Climate Protection (overall coordination), the Berlin Transport Authority BVG, the Berlin Agency for Electromobility eMO, the German Aerospace Center, Fraunhofer FOKUS, the Free University of Berlin, Hella Aglaia Mobile Vision GmbH, the Technical University of Berlin and VMZ Berliner Betreibergesellschaft mbH.

The project is funded by the Federal Ministry of Transport and Digital Infrastructure.

How the Largest Automotive Market is Promoting the Mix of Drive Technologies

Yonghui Shen, Manager of Competence Center Powertrain, IAV China

From 2021, car manufacturers in Europe will have to pay large fines on CO_2 emissions. The aim is to encourage them to convert their fleets to more environmentally friendly alternatives. China, on the other hand, is also promoting innovations for internal combustion engines – but this is not a departure from the promotion of electric drives.

CO_2 limits are also a big issue in China. This is because the Chinese central government has signed an agreement to reduce CO_2 emissions as part of the Paris Climate Agreement. This is why the subsidy rules for electric vehicles are changing in the world's largest and most important automotive market – the aim is to achieve qualitative growth in e-mobility and at the same time promote fuel-saving combustion technologies.

A points system is replacing the purchase premiums for electric vehicles as they have been in force until now. China is thus also reflecting on even more efficient internal combustion engine drives. After all, we will need the conventional engine for many years to come – but with clear limits and lower fuel consumption, so that China can deliver what it promised in Paris. Fuel consumption can easily be converted to CO_2 emissions. Nevertheless, China is not saying goodbye to electromobility.

New Energy Vehicles (NEV), i.e. vehicles with fully electric (BEV), partially electric (PHEV) and fuel cell drive (FCEV), are to continue to be promoted as part of a five-year plan until 2025, albeit to a lesser extent. In the future, purchase premiums will only be paid for electric cars with a range of at least 300 kilometers – previously it was 250 kilometers. If the range is less than that, the car is not eligible for sponsorship. Subsidies for NEVs will be reduced by ten percent in each of the next few years (2020, 2021 and 2022) and will only apply from July 22, 2020 to cars with a base price of less than 300,000 yuan (approx. 39,500 euros).

New "low fuel consumption passenger car" segment

The sales quota for NEVs continues to exist. This year, BEVs, PHEVs and FCEVs must account for 12 percent of total vehicle sales in the country. The ratio will increase by two percentage points annually to 22 percent in 2025.

However, the new points system does not rely solely on NEVs, but also promotes more efficient combustion engines. Although there are many start-ups and many investors in the NEV segment in China, cars with high-voltage batteries are not yet mature in terms of range, safety and robustness. Instead of continuing to quickly let many electric cars of sometimes unsatisfactory quality enter the market, the Chinese government is encouraging more research and development of electric models to make them more competitive. However, electric cars cannot completely replace conventional vehicles. That is why a new segment was created in 2019 with the "low fuel consumption passenger car".

This is a good new regulation and points the finger in the direction of fuel-saving technologies, which will be more strongly rewarded under the new policy.

The development of hybrid models in particular could benefit from the classification of the "low fuel consumption passenger car". Due to the coronavirus pandemic, we currently have a low fuel price, which means that buyer interest in conventional vehicles is increasing again and therefore fits in with the new political concept.

> "We will need the conventional engine for many years to come – but with clear limits and lower consumption, so that China can deliver what it promised in Paris."

Sanctions: no sale of new combustion engine vehicles, no approval of new plants

The dual-credit system obliges car manufacturers to collect a certain number of points. If a manufacturer does not reach the specified quota, it can buy credits from other companies via a state platform. The required number of credits must be proven within 90 days of the points being published.

The manufacturer is subject to sanctions if the targets are not met: It does not receive homologation for new cars with combustion engines and is therefore not allowed to sell new vehicles in this category or invest in new plants – a painful punishment for car manufacturers, because most money is still earned with combustion engines. Electric cars are not subject to the penalties; they may continue to be sold despite the lack of credits.

The Chinese dual-credit policy is based on two evaluation criteria: CAFC (Corporate Average Fuel Consumption) credits and NEV credits. The former assess fuel consumption and apply to vehicles with combustion engines. The target set for this is based, among other things, on the weight of the vehicle and the number of seats. The NEVs must all be made in China and run on electric power. Manufacturers who produce or import more than 30,000 cars per year are assessed by NEV credits.

Regionally different solutions

The regulation is intended to motivate manufacturers to further develop their internal combustion engine vehicles. OEMs from Germany are already well positioned in the field of conventional drives. There are already very good engines on the market – small adaptations are already achieving a significant reduction in consumption. The Chinese OEMs are still lagging a few steps behind and must develop engines of better quality. We at IAV in China are currently looking into this question in an internal study: Which technology can we use to achieve the fuel consumption targets for the "low fuel consumption passenger car"? With just a modern and efficient combustion engine, a 48-volt mild hybrid or a PHEV? We have received many inquiries from Chinese manufacturers for a concept development.

The central government is also currently discussing the role that synthetic fuels such as methanol could play. Currently, very few Chinese OEMs are investing in methanol. The fuel could be used regionally, as it is produced from coal and there are numerous coal-fired power plants in some provinces. Even though synthetic fuels still have a long way to go before they penetrate the market, for the Chinese authorities, it is important overall not to rely solely on battery electric drives. Alternatives must also be pursued.

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Bonus points for e-cars and fuel consumption

China striving for greener mobility

1. Dual point system

- The dual assessment of fuel consumption (CAFC) and electric cars (NEVs) within the framework of the "dual credits policy" is carried out by the Ministry of Industry and Information Technology (MIIT).
- Car manufacturers are obliged to comply with the requirements of the dual credits policy.
- The points system for CAFC was introduced in 2016; that for NEVs in 2019.

2. Sanctions for violations

- Car manufacturers with negative CAFC or NEV point scores must present countermeasures to MIIT and initiate them to compensate for the negative values.
- Car manufacturers who violate the rules have 90 days to rectify their negative score.

3. CAFC points calculation (CAFC points = standard value – actual value) x annual production and import volume of all vehicles

Magnification factor for NEVs

Time frame	2016–2017	2018–2019	2020
New energy vehicle (BEV, PHEV, FCV)	5	3	2
Energy-saving vehicle (effective fuel consumption </= 2.8 liters/100 km)	3.5	2	1.5

Correction factor

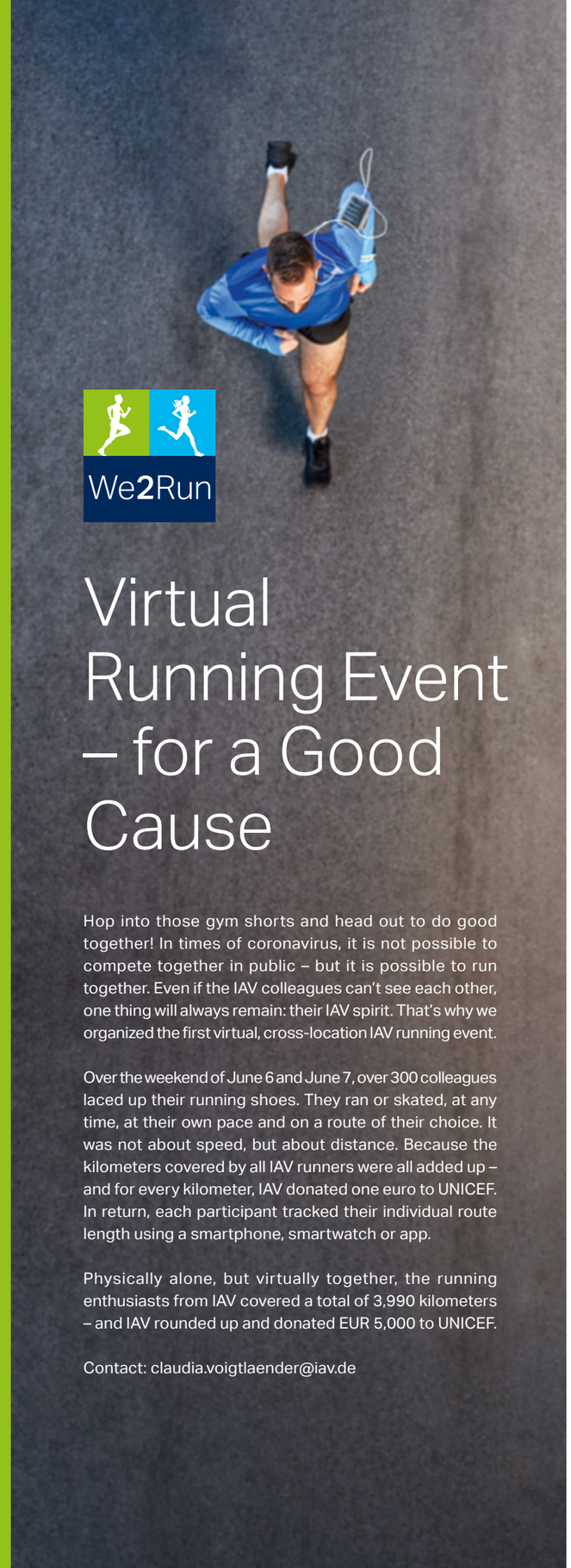
Time frame	2016	2017	2018	2019	2020
Correction factor	134 %	128 %	120 %	110 %	100 %

4. NEV points calculation (NEV points = actual value – reference value)

(Actual value = NEV simple point value x annual production and import volume of NEVs)

(Reference value = annual production and import volume of conventional vehicles x NEV proportional constant)

Time frame	2019	2020	2021	2022	2023	2024	2025
Proportional constant	10 %	12 %	14 %	16 %	18 %	20 %	22 %



Virtual Running Event – for a Good Cause

Hop into those gym shorts and head out to do good together! In times of coronavirus, it is not possible to compete together in public – but it is possible to run together. Even if the IAV colleagues can't see each other, one thing will always remain: their IAV spirit. That's why we organized the first virtual, cross-location IAV running event.

Over the weekend of June 6 and June 7, over 300 colleagues laced up their running shoes. They ran or skated, at any time, at their own pace and on a route of their choice. It was not about speed, but about distance. Because the kilometers covered by all IAV runners were all added up – and for every kilometer, IAV donated one euro to UNICEF. In return, each participant tracked their individual route length using a smartphone, smartwatch or app.

Physically alone, but virtually together, the running enthusiasts from IAV covered a total of 3,990 kilometers – and IAV rounded up and donated EUR 5,000 to UNICEF.

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Code Competition Automation

In cooperation with the IT-Talents.de platform, IAV invited entries for an online programming competition in May. Numerous software talents took up the challenge and developed a graphical user interface for the visual evaluation of drone data.

Modern vehicles are equipped with numerous assistance functions that make driving more convenient and, in particular, safer. They range from emergency brake assistants, adaptive cruise control or parking aids to higher levels of driving automation. IAV develops these for a wide range of automobile manufacturers and ensures that they function perfectly. The evaluation of reference data from drone recordings can make a major contribution towards this. The coding enthusiasts have tried their hand at a real-life case study and programmed their solutions as desktop applications, apps or web applications.

The IAV team headed by Frank Gann is impressed by the solutions submitted: "We are thrilled by the creativity and commitment of the up-and-coming programmers. We can see how much time and passion for coding they have put into solving our really challenging task. And perhaps we were also able to convince one or two of the up-and-coming programmers of IAV as a potential employer."

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IAV Further Expands Compliance Structures

Compliance is not a voluntary exercise for IAV. Compliance is indispensable and firmly anchored in our corporate structures. This enables us to keep a constant eye on compliance risks in our processes. Known risks are relatively easy to control. It is much more complex to identify new – perhaps even future – compliance risks and to manage them properly. To achieve this, we at IAV rely on regular and dedicated analyses, among other things. This means that we first identify potential triggers for rule violations and then align our compliance management system to address these in the best possible way.

Over the past few years, we have thus built a strong foundation. Our Code of Conduct is the most important source of orientation. This guideline creates a framework on the basis of which all IAV employees make decisions and act according to consistent standards. The Code of Conduct is supplemented by more detailed compliance policies for specific subject areas.

Compliance – at IAV, it's more than just a set of rules

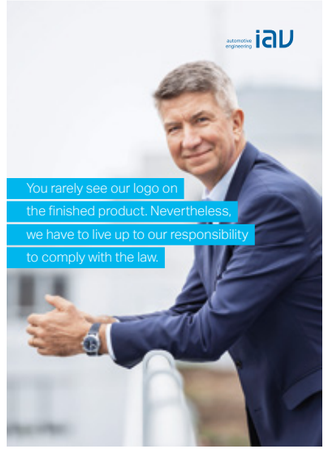
One of our main focus areas are compliance aspects in the engineering services we provide for our customers. This is a particular challenge: In many of the areas in which we operate, we are – together with our customers – so far ahead in terms of technology that there are as yet no clear legal regulations. One example of this are complex ethical considerations when it comes to autonomous driving. For such cases, we also need a clear framework for how we are to proceed.

To support our employees in projects, we have therefore built up a network of experts across all our technical areas since last year. They provide support in complex technical issues relating to compliance with laws, regulations and ethical and moral aspects.

"In the future, we want to increasingly provide our customers with advice and support when we break new technological and therefore often also new regulatory ground together.

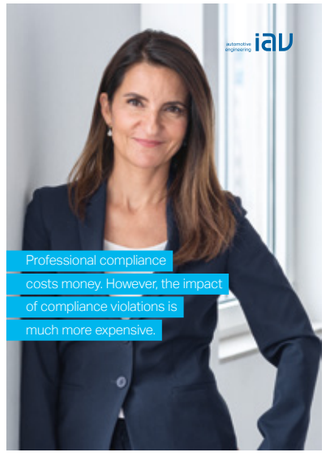
Over the next few months, we as Compliance will continue to enable our colleagues to do so", Oliver Predelli says, explaining his compliance approach. Predelli has been the new Chief Compliance Officer since the beginning of May and continues to drive forward the advancement of compliance at IAV.

In addition to training and enabling our employees to advise customers on the legal framework, we are also focusing on numerous initiatives to ensure that all employees embody the principles of compliance every day. These include, for example, firmly anchoring compliance in our project life cycle as well as regular discussions between executives and employees. And we are currently rolling out a poster campaign at all IAV locations worldwide. The protagonists are, on the one hand, the members of IAV's management and, on the other, employees from all hierarchical levels who are using personal messages to promote the importance of compliance.



Dr. Ulrich Eichhorn
President, CEO
IAV GmbH, Berlin, Germany

Matthias Kratzsch
President, CTO
IAV GmbH, Berlin, Germany



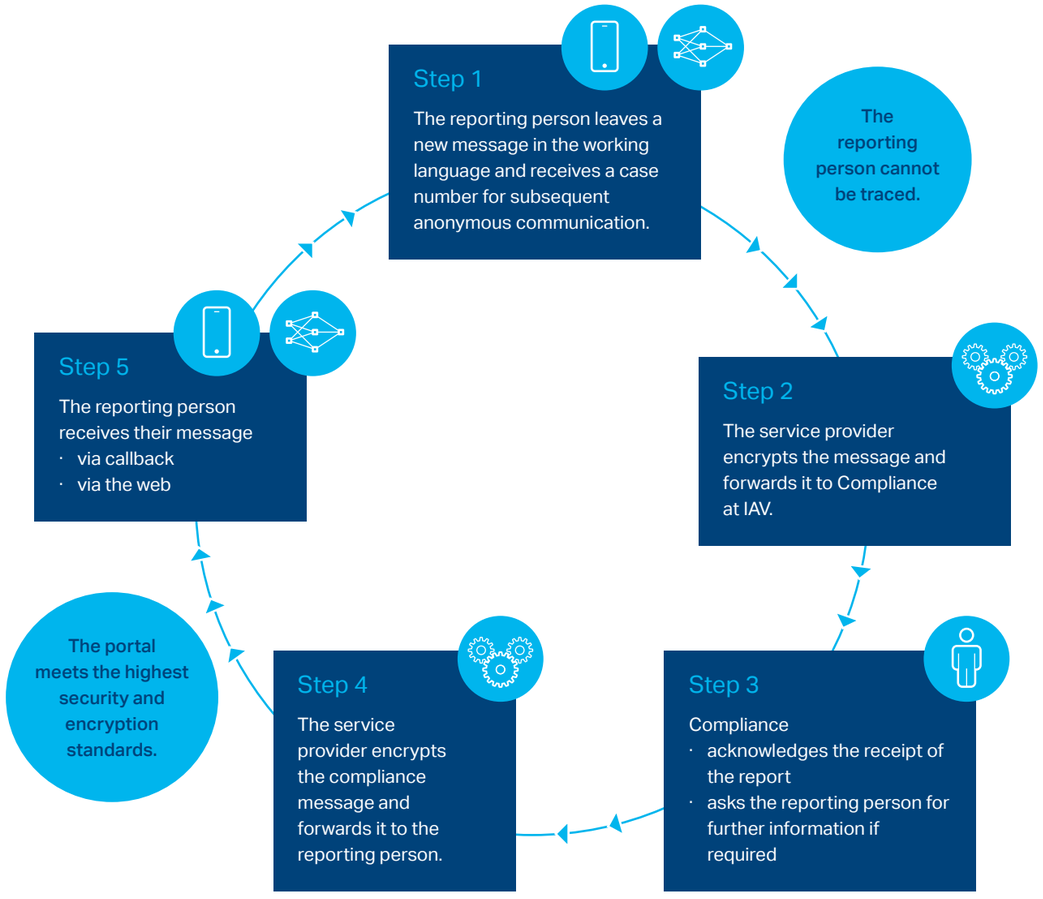
Katja Ziegler
President, CFO
IAV GmbH, Berlin, Germany

Dr. Uwe Horn
President, CHRO
IAV GmbH, Berlin, Germany

IAV's management board – like numerous other employees – is advertising the importance of compliance at IAV locations worldwide in a new poster campaign.

Anonymous, in all working languages, 24/7

SpeakUp portal



New IAV SpeakUp portal

However, no compliance system in the world can prevent violations with 100 percent certainty – no matter how good it is. We have our IAV SpeakUp system for reports on possible violations. We have recently expanded this system once again.

In addition to existing reporting channels, anyone – whether internal or external – can submit reports of potential violations by IAV employees in numerous languages 24 hours a day, 365 days a year. And, if desired, this can also be done completely anonymously. The corresponding online portal "SpeakUp" is operated by an independent service provider. It meets the highest security and encryption standards. If the reporting person wishes to remain anonymous, there is no way of tracing the identity of the reporting person – neither for the service provider nor IAV. Customers, suppliers and business partners can access the new portal via the compliance section on our website iav.com.

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Our Engineering – What We Develop Moves You Engineering

Passenger Cars and Vans

Chassis

- Axle systems
- Brakes and traction control systems
- Chassis control systems
- Steering systems and power-assisted steering
- Tank systems
- Testing and calibration
- Wheels and tires

Cockpit

- Cockpit concepts
- Cockpit electronics
- Instrument panel
- Operating concepts

Combustion Engine

- Charge motion
- Computation and simulation
- Diesel engine: thermodynamics and combustion
- Engine algorithm calibration
- Engine development and design
- Exhaust gas aftertreatment
- Exhaust gas recirculation (EGR)
- Gaseous-fuel engines
- Gasoline-engine thermodynamics and combustion processes
- Injection and fuel supply systems
- Mechanical system and endurance testing
- Supercharging

E-traction

- E-fleet operation
- Fuel cell systems
- HV energy management
- HV energy storage systems
- HV safety
- Powertrain electrification

Exterior

- Body structure – doors, flaps and lids
- Body styling parts and glazing
- Front-end and rear-end systems

Gaseous-Fuel Vehicles

- Concepts
- Dealerships
- Gaseous-fuel vehicle construction (CNG/LPG)

Hybrid

- Components
- Energy management
- Integration

Interior

- Audio and voice
- Insulation
- Interior / details
- Seat systems

Mobility

- Car2X
- Fleet support
- Mobile applications
- Mobility concepts
- Telematics solutions

Powertrain Concepts and Integration

- Energy management
- Powertrain concepts
- Powertrain integration
- Powertrain NVH
- Product data management
- Prototyping
- Thermal management

Powertrain Electronics

- Algorithm and software development
- Control unit hardware
- E-drive management
- OBD development
- Powertrain calibration
- Release and production support
- Sensors and actuators
- System architecture and powertrain design

Product Life Cycle

- Aftersales
- eDiscovery
- Quality assurance
- Software and IT systems

Transmissions

- Algorithm and software development
- Automatic transmissions
- Computation and simulation
- Concept development
- Continuously variable transmissions
- Design
- Dual-clutch transmissions
- Hybrid systems
- Mechanics and software testing
- Transmission control calibration
- Transmission geometry integration

Vehicle Electronics

- Antenna layout and integration
- Body electrics / electronics
- Electromagnetic compatibility
- Hardware and software development
- Light and vision
- Low-volume production vehicles
- Vehicle electric system

Vehicle Functions

- Air-conditioning
- Driver assist systems
- E/E architecture integration
- Energy management
- Functional safety
- Integral safety
- Overall vehicle validation
- Special-purpose vehicles
- Thermal management
- Vehicle concepts
- Vehicle NVH

Vehicle Safety

- Occupant safety, partner protection, restraint systems
- Overall vehicle crash testing
- Safety electronics

Commercial Vehicles and Working Machines

System Integration

- Functional E/E architecture
- LV bordnet
- ISO26262 & functional safety
- Cyber security
- Displays & HMI
- Powertrain electronics
- Calibration and diagnostics
- Exhaust aftertreatment
- Chassis
- Brakes & retarders
- Vehicle safety

Electric Commercial Vehicles

- BEV
- Fuel cell
- HV power supply
- Charging system

CO_2 Efficiency

- Fleet evaluation
- Aerodynamics
- Innovative engine concepts
- Hybrid solutions
- Transmissions
- ADAS & autonomous driving

Alternative Fuels

- H_2 combustion
- Gas engines
- E-fuels
- Injection systems
- Tank systems

Transport & Logistics

- Vehicle diagnostics
- Telematics and fleet management
- Apps

Energy Supply

- Autonomous energy supply
- Energy conservation
- Energy distribution
- Energy generation
- Energy storage

Methods and Test Facilities

Development Methods

- Design of Experiments (DoE)
- Model-based application
- Test bench automation

Project Management Office

- Coaching and training
- Methods and processes
- Project management and steering

Test Facilities and Laboratories

- Components
- Overall vehicle
- Overall system and subsystems

Quality Management

Product Solutions

- Electronic systems and components
- Development tools
- Vehicle retrofitting

Digitalization

- Competency development
- Business models
- Solutions
- Change management

We look forward to hearing from you!
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You can find out more about our unique range of expertise at: www.iav.com

Our Product Range

Please send us your inquiry to: engineering-tools@iav.com

IAV Cross
Injection Analyzer

IAV Cross is a powerful system for hydraulic measurement of injection valves. It is used when there is a need for diff erentiated investigations of injection procedures.

IAV Primero
Lambda Sensor Fault Simulator

IAV Primero supports the entire OBD development process: algorithm development, calibration, vehicle homologation (OBD demo).

IAV Auros
Automated Mobile Test Bench

IAV Auros is a fl exible, eff ective and low-cost test system which contains everything that is needed to test electric drives. The system converts all rooms with 63-amp power supply into potential high-voltage test benches.

IAV Meru
Knock Indication Systems

The most recent generation is available as IAV KIS4

IAV KIS4 is a measuring instrument for calculating, displaying and evaluating thermodynamic and knock-specific variables of combustion engines.

IAV Meru
Indication System

The most recent generation is available as IAV Indicar

IAV Indicar is a measuring instrument for calculation, display and evaluation of thermodynamic variables of combustion engines.

INCA-FLOW
Guided application and automation

The application tool INCA-FLOW supports project managers, function developers, software developers and application engineers by accelerating and improving the development process in the application. Expert knowledge is made available company-wide.

IAV Engine
Design and optimization of the engine mechanics

IAV Engine is an integrated tool for holistic design and optimization of mechanical drives in the powertrain.

IAV Teslin
Efficient and automated reporting

IAV Teslin is a high-performance tool for the consistent reporting of endurance runs. It accompanies the entire reporting process from data acquisition to visualization and automated reporting.

IAV Barito
Application of battery models

The IAV Barito tool has been developed for the parameterization of battery models. It maps the entire workflow and is part of the tool chain developed by IAV for electric drivetrains.

IAV Kasai
Model-based application

in the currently available release as IAV EasyDoE

Design of Experiments (DoE) is a method that facilitates the efficient parameterization of engine control units. With the software, the user can perform a complete DoE as well as parameterization and optimization.

IAV Macara
Editing, validation and visualization of application parameters

With IAV Macara, application data can be visualized, compared, merged and regenerated.

IAV White
Making connections in data tangible

IAV White visualizes large volumes of data in real time (BigData). This makes it possible to carry out evaluations intuitively and easily and to understand relationships.

IAV Tronador
A look inside the control unit

IAV Tronador presents the most important information on an ECU directly in the function documentation. The presentation options range from simple display of static adjustment variables through to interactive analysis of measurement data.

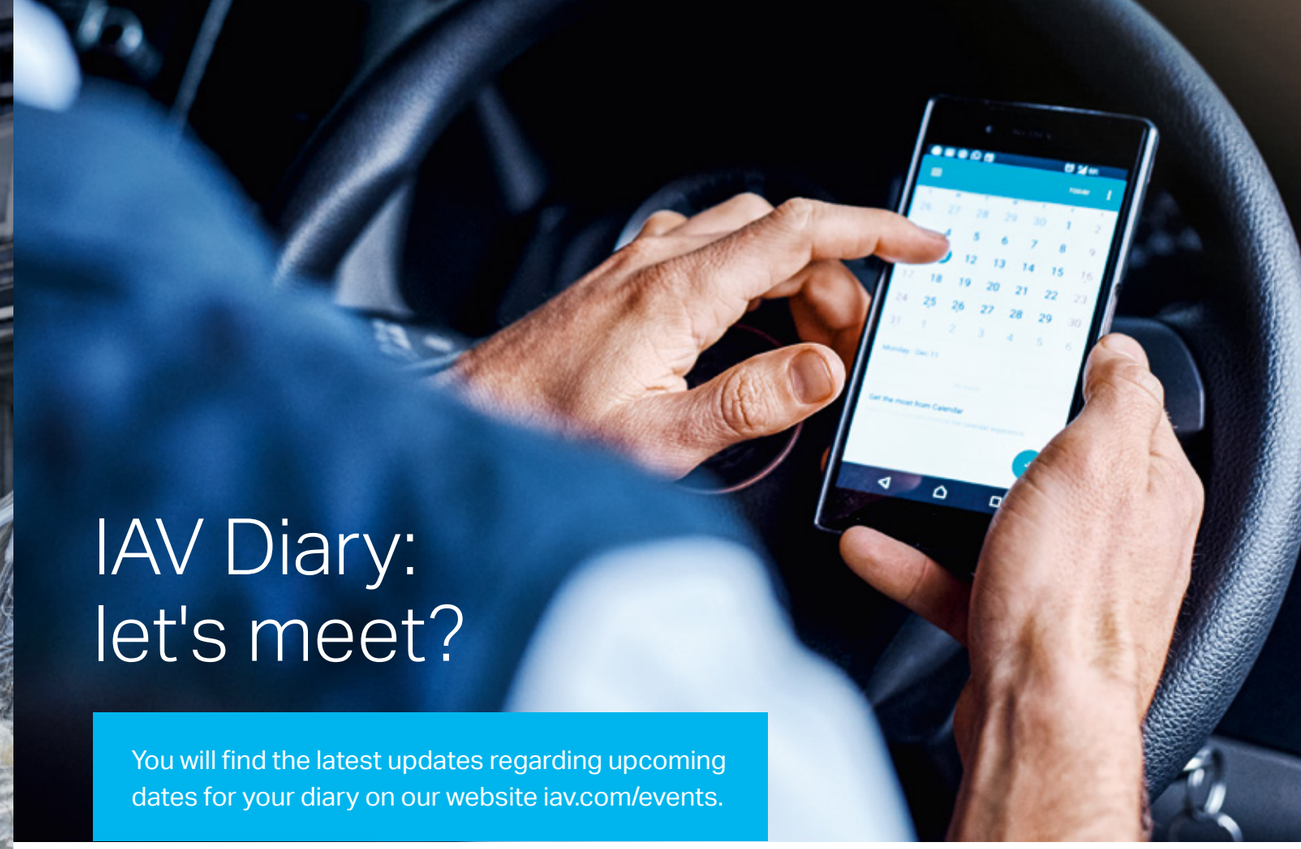
IAV Mara
Automated measurement data analysis

IAV Mara is used to search for and flexibly analyze measurement data. Complex analyses and visualizations can be configured according to individual requirements without any programming knowledge. Recurring tasks can be automated and calculated using distributed computing on cloud-based systems.

IAV Flexmore
List comparison, processing and analysis

IAV Flexmore provides an overview of different list information quickly and with little effort, so that it can be easily analyzed and processed.

Product by IAV



IAV Diary: let's meet?

You will find the latest updates regarding upcoming dates for your diary on our website iav.com/events.

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