Press release
Bosch Compact

Bosch Tech Day 2023: Bosch supplies technologies along the entire H_2 value chain
Solutions for the production and use of hydrogen

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- H_2 application: IVECO Heavy Duty FCEV suitable for many uses, all the way up to long hauls.
- H_2 production: Bosch is developing electrolysis stack and components for electrolyzers.
- H_2 storage: Bosch Rexroth has developed a drive solution for hydrogen compressors in hydrogen filling stations.

Stuttgart, Germany – Green hydrogen is indispensable for a climate-neutral world. Whether in transportation, buildings, or the manufacturing industry – it makes sense to use it in nearly every sector. Bosch is H_2 ready, and was an early mover in areas such as the development of fuel-cell technology. Along the entire hydrogen value chain, the company is developing technologies for the production, compression, storage, and use of hydrogen. At the Bosch Tech Day 2023, the company is providing some insights into its portfolio of products and services.

The exhibits on display at Bosch Tech Day 2023 in overview

PEM stack – hydrogen for climate-neutral transportation
The PEM fuel-cell stack is the heart of the mobile fuel-cell system. PEM stands for proton exchange membrane. The stack for mobile applications comprises many individual fuel cells. Depending on the output required, there can be several hundred of them. In these cells, hydrogen reacts with oxygen to produce electricity and water. The membrane inside a fuel cell prevents electricity from flowing between the anode and the cathode. At the same time, it also prevents the hydrogen from crossing over to the oxygen. The membrane is proton-conducting, and allows hydrogen ions to permeate. One of the technologies used when manufacturing the bipolar plates is high-speed laser welding – a process that only exists at Bosch. It is used to make 1,200 meters of welds in each stack hydrogen-tight. Bosch manufactures these stacks in its plants in

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Bamberg, Germany, and Wuxi, China. At the end of 2022, the stacks were ready for volume production. Others manufacturing sites are planned – for example, in the United States.

Service life of PEM fuel cells – anti-aging solutions

Over the course of their service life, fuel cells undergo an aging process: platinum particles and carbon supports oxidize and become degraded; platinum particles grow and catalyst layers become thinner. To solve this problem, Bosch researchers have developed a special coating that can mitigate these processes. In addition, systemic measures permit an operating strategy that avoids aging-relevant burdens such as high cell voltages, and will help further prolong the service life of PEM fuel cells to as much as 30,000 operating hours in the future. Moreover, certain aging effects can be reversed: in these cases, Bosch researchers have developed restorative processes.

Hydrogen engine – proven basis, but carbon neutral in operation

To power vehicles, hydrogen can be used not only in fuel cells, but in hydrogen engines as well. They are particularly suitable for heavy vehicles driving for protracted periods with especially heavy payloads – for long-haul freight and especially for construction and agricultural machinery. The engines and powertrains already available are a good basis for this, as many of the systems components in existing powertrain solutions can be transferred to the fundamental structure of the fuel, air-supply, and exhaust system. Bosch is developing two systems for hydrogen engines: port and direct injection of hydrogen. The injector for direct injection has to function without the lubrication provided by liquid fuel, and to open and close reliably roughly one billion times over a truck's service life. Apart from water, the only relevant waste product emitted by a hydrogen engine is nitrogen oxide. Using proven exhaust-gas treatment systems, this has no appreciable effect on air quality. The first production vehicles equipped with these engines are expected to appear on the roads in 2024.

Hydrogen tank – innovative, space-saving solution for passenger cars

Currently, the hydrogen for fuel-cell passenger cars is stored in large-volume carbon fiber-reinforced tanks at 700 bar. Bosch researchers have developed a tank with two new features. First, it comprises steel cylinders. Second, it is an underfloor tank, fitting into the space otherwise occupied by batteries. Externally, the system resembles conventional steel tanks. But hydrogen can cause steel to become brittle. As part of a publicly funded project, a prototype system has been created that fully complies with the demanding international rules for high-pressure tank systems. The tank's material gives it a cost advantage and makes it recyclable.

IVECO Heavy Duty FCEV – hydrogen-powered truck for Europe

The IVECO Heavy Duty FCEV (fuel cell-electric vehicle) is a hydrogen-powered semi for the European market. With its fuel cell-electric powertrain, and in combination with green hydrogen, the semi emits zero emissions locally. With a payload of roughly 70 kilograms of hydrogen, the truck can drive up to 800 kilometers without refueling. It currently takes roughly 20 minutes to refuel. This makes the IVECO Heavy Duty FCEV suitable for many uses, all the way up to long hauls.

eDistance Truck – Bosch technology for climate-neutral trucks

Bosch offers various powertrain solutions for long-haul trucks. These include fuel cell-electric, battery-electric, and hybrid powertrains. The heavier the payload and the longer the route, the more the fuel-cell powertrain comes into its own, with short refueling stops and a long range. If the hydrogen used comes from renewable sources, then the fuel cell's operation is also climate neutral. Bosch offers individual components for the electrical powertrain, the fuel cell, and H_2 storage systems, as well as the complete fuel-cell power module. This module, the FCPM, is scalable and, apart from the stack, combines all the submodules for hydrogen supply, air supply, and current draw. A complex system has been reduced to an easy-to-integrate solution.

Hydrogen filling stations – drive solutions for compressing H_2

To be able to refuel vehicles with hydrogen quickly and simply, the gas has to be compressed to as much as 900 bar. Compressors featuring efficient and low-maintenance Bosch Rexroth drives will play a significant role in the establishment of a hydrogen infrastructure. For example, Bosch Rexroth and Maximator Hydrogen have developed a solution for the efficient compression of hydrogen for filling stations, storage tanks, and pipelines. Maximator Hydrogen plans to manufacture some 4,000 compressor systems by 2030. For the energy-efficient operation of hydrogen compressors, Bosch Rexroth offers a low-maintenance, scalable systems solution. Scalable drive units with ratings currently up to 250 kilowatts offer filling station operators an affordable way into hydrogen technology. The new container-based compressors can potentially reduce total cost of ownership by half compared with the commercially available alternatives.

Stack and smart electrolysis module – Technology for H_2 electrolyzers

Bosch not only plans to use hydrogen, but also to provide smart technology for its production. For this purpose, Bosch is developing the electrolysis stack, the central element of an electrolyzer. The stack comprises more than 100 electrolysis cells that use electricity to split water into oxygen and hydrogen. It is designed for an output of 1.25 megawatts. That is equivalent to the

production of 23 kilograms of H_2 per hour. On the hydrogen side, the resulting pressure is more than 30 bar. The Bosch electrolysis stack is suitable for use in smaller-scale plants producing 1 megawatt and more, all the way up to large, gigawatt-scale plants. It is expected to be market-ready from 2025. First pilot projects with customers are in preparation and will start next year. In addition, Bosch is planning to combine the electrolyzer stack with a control unit, power electronics, and various sensors to create a "smart electrolysis module." These elements are designed to be compatible and save space, and optimize systems efficiency, reliability, installation, and setup.

Solid oxide fuel-cell system – demand-driven power generation

Bosch solid-oxide fuel-cell (SOFC) systems are distributed power plants that can be used in commercial buildings, industrial plants, and computing centers. An SOFC system generates a power output of 100 kilowatts, and depending on power requirements, several systems can be combined for megawatt-scale output. An SOFC system uses conventional fuels (biomethane or natural gas; in the future also hydrogen) to generate heat and power. It achieves as much as 90 percent overall efficiency. Expertise in functional ceramics can be used when manufacturing these stationary fuel-cell stacks – expertise that was developed when manufacturing lambda sensors for vehicles. They are expected to be ready for production by the middle of the decade.

Recycling platinum from fuel-cell stacks

The manufacture of PEM fuel-cell stacks requires valuable raw materials such as platinum. This process can be made far more sustainable and economical if the platinum is recovered from end-of-life stacks. For this purpose, Bosch has developed novel contract models that secure the company the right to repurchase stacks for mobile applications. This creates predictable and stable supply chains and improved availability of resources, and also significantly reduces carbon emissions. In addition, Bosch researchers have developed solutions that use chemical processes to recover platinum in a more eco-friendly way. For these processes, it has filed for more than 20 patent families. But resource conservation doesn't just start at the end of the product life cycle even during operation, it is planned to use digital twins to monitor the service life and function of the components in electrolyzers and fuel cells in mobile and stationary applications. This allows maintenance, repair, and recycling to be planned in advance.

Manufacturing and testing technology - how fuel cells are made

Bosch Manufacturing Solutions, the company's special-purpose machinery unit, supplies advanced manufacturing equipment and testing technology for fuel-cell manufacturing – from individual components to complete systems. In total, more than 50 percent of the required manufacturing equipment comes from Bosch itself. For example, the test benches in Feuerbach were developed by the Homburg-based Bosch subsidiary Moehwald. When testing stacks and systems, natural conditions are simulated for the end-of-line functional test, where the PEM fuel cells are put through their paces. Here, gas composition, temperature, pressure, and humidity are the same as in the actual vehicle.

H_2-ready industrial boiler – climate-neutral heating and process heat

With its futureproof industrial boiler systems, Bosch helps manufacturing countries worldwide reduce their energy costs and reach their sustainability targets – all the way to making their heat processes climate neutral. Industry is responsible for roughly one-fifth of global carbon emissions, part of which come from the generation of steam, heat, and hot water. Hydrogen and green electricity have huge potential for industrial heating and process heat. Bosch steam and heat generators can be operated flexibly on 100 percent green hydrogen, green electricity, or biofuels. Many legacy systems have already been prepared for an upgrade to renewable fuels. Hybrid boiler systems are a further promising technology. With a design featuring an electric heating element and a burner, different fuels can be used at the same time, such as green electricity and hydrogen. That means greater flexibility, security of supply, and independence of fossil fuels. First pilot systems went into operation in 2022, and are already avoiding carbon emissions equivalent to the average emissions of more than 4,500 households.

H_2-ready boilers – technology-neutral solution for climate-friendly heating

Bosch H_2-ready boilers can initially be run on natural gas, and then easily converted to hydrogen when it becomes available. An admixture of 20 percent hydrogen to grid gas is also possible without any refitting. Once 100 percent hydrogen becomes available, expert installers can convert the H_2-ready boilers to 100 percent hydrogen operation within roughly one hour. Only a few components, such as the burner, have to be replaced. An H_2-ready boiler takes up very little room. This makes them an attractive alternative for legacy buildings where space is restricted.

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The Bosch Group is a leading global supplier of technology and services. It employs roughly 421,000 associates worldwide (as of December 31, 2022). The company generated sales of 88.2 billion euros in 2022. Its operations are divided into four business sectors: Mobility, Industrial Technology, Consumer Goods, and Energy and Building Technology. As a leading IoT provider, Bosch offers innovative solutions for smart homes, Industry 4.0, and connected mobility. Bosch is pursuing a vision of mobility that is sustainable, safe, and exciting. It uses its expertise in sensor technology, software, and services, as well as its own IoT cloud, to offer its customers connected, cross-domain solutions from a single source. The Bosch Group's strategic objective is to facilitate connected living with products and solutions that either contain artificial intelligence (AI) or have been developed or manufactured with its help. Bosch improves quality of life worldwide with products and services that are innovative and spark enthusiasm. In short, Bosch creates technology that is "Invented for life." The Bosch Group comprises Robert Bosch GmbH and its roughly 470 subsidiary and regional companies in over 60 countries. Including sales and service partners, Bosch's global manufacturing, engineering, and sales network covers nearly every country in the world. With its more than 400 locations worldwide, the Bosch Group has been carbon neutral since the first quarter of 2020. The basis for the company's future growth is its innovative strength. At 136 locations across the globe, Bosch employs some 85,500 associates in research and development, of which nearly 44,000 are software engineers.

The company was set up in Stuttgart in 1886 by Robert Bosch (1861–1942) as "Workshop for Precision Mechanics and Electrical Engineering." The special ownership structure of Robert Bosch GmbH guarantees the entrepreneurial freedom of the Bosch Group, making it possible for the company to plan over the long term and to undertake significant upfront investments in the safeguarding of its future. Ninety-four percent of the share capital of Robert Bosch GmbH is held by Robert Bosch Stiftung GmbH, a charitable foundation. The remaining shares are held by Robert Bosch GmbH and by a corporation owned by the Bosch family. The majority of voting rights are held by Robert Bosch Industrietreuhand KG, an industrial trust. The entrepreneurial ownership functions are carried out by the trust.

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