

[01] New area of business: Bosch to develop components for hydrogen electrolysis

[02] New energy for sustainability with technology from Bosch

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New area of business: Bosch to develop components for hydrogen electrolysis

Technology for hydrogen generation expected to go into production in 2025

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- ▶ Bosch to develop the stack – the core component of an electrolyzer.
- ▶ Bosch to invest up to 500 million euros in this new area of business by the end of the decade.
- ▶ Stefan Hartung: “Our intention is to use Bosch technology to support the rapid expansion of hydrogen production in Europe.”

Stuttgart and Renningen, Germany – When it comes to green hydrogen, Bosch is stepping on the gas: in the interest of effective climate action, the company is planning not only to use this new fuel, but also to be one of the companies producing it. This is why Bosch is branching out into the development of components for electrolyzers, which use electrolysis to split water into hydrogen and oxygen. Ideally, the electricity for this purpose is generated from renewable sources such as wind or photovoltaic power, in which case the result is known as “green hydrogen.” “We cannot afford to delay climate action any longer, so we aim to use Bosch technology to support the rapid expansion of hydrogen production in Europe,” said Dr. Stefan Hartung, chairman of the board of management of Robert Bosch GmbH, at the presentation of the company’s [annual figures](#). “To do this, we will leverage our know-how in fuel-cell technology,” added Dr. Markus Heyn, member of the board of management of Bosch and chairman of the Mobility Solutions business sector. Drawing on this expertise, Bosch will assign the development of electrolyzer components to the Mobility Solutions business sector, investing up to 500 million euros in this venture by the end of the decade. In light of energy diversification, the move away from fossil fuels, and the need to reduce CO₂ emissions, demand for green hydrogen is growing rapidly – not only in energy-intensive industries such as steel, chemicals, and heavy-duty freight, but also in private real estate. According to the EU, demand is set to rise to some ten million metric tons a year by 2030. Bosch forecasts that the global market for electrolyzer components will increase

to a volume of around 14 billion euros over the same period, with Europe set to see the highest rates of growth. To help business and society reduce dependency on fossil fuels and harness new forms of energy, Bosch intends to invest some three billion euros in climate-neutral technology, such as electrification and hydrogen, over the next three years.

Bosch is to develop the stack – the core component of an electrolyzer

As in the fuel cell, the key component of an electrolyzer is a stack, which comprises several hundred individual cells connected in series. In each of these cells, electricity is used to split water into hydrogen and oxygen. This is the reverse of what takes place in a fuel cell, where electricity is generated by combining hydrogen and oxygen. In both cases, the chemical reaction is facilitated by means of a proton-exchange membrane (PEM). Bosch is collaborating with a number of partners to develop a way of combining the electrolyzer stack with a control unit, power electronics, and various sensors to create a “smart module.” With pilot plants scheduled to commence operation in the coming year, the company plans to supply these smart modules to manufacturers of electrolysis plants and industrial service providers from 2025 onward.

Using a simple process, Bosch will incorporate a number of these compact modules. They can then be used both in smaller units with capacity of up to ten megawatts and in gigawatt-rated onshore and offshore plants – whether in new-build projects or in existing plants for conversion to the production of green hydrogen. To maximize the efficiency of hydrogen production and extend the service life of the stack, the smart modules are to be connected to the Bosch cloud. At the same time, the use of a modular design for the electrolyzers is expected to make maintenance more flexible: any scheduled work will require the shutdown of certain sections of the plant only, instead of the entire facility. Bosch is also working on service concepts that will include the recycling of components in order to promote a circular economy.

Bosch can use its strengths in mass production and economies of scale

Unlike many of the electrolyzer components currently on the market, the Bosch smart modules will be mass produced. As such, the manufacturing operation will generate economies of scale. “Two key factors are involved in ramping up hydrogen production: speed and cost,” Heyn said. “This is where we can play to our strengths, thanks to our expertise in mass production and our automotive know-how.” Bosch is now planning to start volume production as quickly as possible at a number of European locations. These include Bamberg and Feuerbach (Germany), Tilburg (Netherlands), Linz (Austria), and České Budějovice (Czech Republic).

Bosch portfolio expansion will safeguard jobs

The ongoing transformation of the automotive sector presents a huge challenge for the industry as a whole. As ever, Bosch's response here is to innovate. In entering a new field of business – one that will add a nonautomotive wing to its mobility solutions business – the company is seizing the opportunity to further safeguard employment. In the coming years, this expansion into electrolyzer components is expected to create work for hundreds of associates. "In fact, we're doing three things at once," Heyn said. "We're making an important contribution ecologically, economically, and socially."

Bosch is working on mobile and stationary fuel cells

Bosch firmly believes in hydrogen as a future fuel, and is also working on both stationary and [mobile fuel cells](#). One intended use for the former is as small, on-site power plants for cities, data centers, shopping malls, business parks, and as charge spots for electric vehicles. Bosch plans to use mobile fuel cells to facilitate the climate-neutral shipping of goods and commodities, initially by truck. The company's portfolio of vehicle-related products in this field ranges from individual sensors to core components such as the [electric air compressor](#), the stack, and complete [fuel-cell modules](#). Production is expected to start this year.

Press photo: #174d8bb0

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Mobility Solutions is the largest Bosch Group business sector. It generated sales of 45.3 billion euros in 2021, and thus contributed 58 percent of total sales from operations. This makes the Bosch Group one of the leading automotive suppliers. The Mobility Solutions business sector pursues a vision of mobility that is safe, sustainable, and exciting, and combines the group's expertise in the domains of personalization, automation, electrification, and connectivity. For its customers, the outcome is integrated mobility solutions. The business sector's main areas of activity are injection technology and powertrain peripherals for internal-combustion engines, diverse solutions for powertrain electrification, vehicle safety systems, driver-assistance and automated functions, technology for user-friendly infotainment as well as vehicle-to-vehicle and vehicle-to-infrastructure communication, repair-shop concepts, and technology and services for the automotive aftermarket. Bosch is synonymous with important automotive innovations, such as electronic engine management, the ESP anti-skid system, and common-rail diesel technology.

The Bosch Group is a leading global supplier of technology and services. It employs roughly 402,600 associates worldwide (as of December 31, 2021). The company generated sales of 78.7 billion euros in 2021. Its operations are divided into four business sectors: Mobility Solutions, 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 440 subsidiary and regional companies in some 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 128 locations across the globe, Bosch employs some 76,100 associates in research and development, of which more than 38,000 are software engineers.

Additional information is available online at www.bosch.com, www.iot.bosch.com, www.bosch-press.com, [www.twitter.com/BoschPress](https://twitter.com/BoschPress).

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New energy for sustainability
– with technology from Bosch

Dr. Stefan Hartung,
chairman of the board of management, Robert Bosch GmbH,
together with
Filiz Albrecht, Dr. Christian Fischer, Dr. Markus Forschner,
Dr. Markus Heyn, and Rolf Najork,
members of the Bosch board of management,
at the annual press conference on May 4, 2022

Check against delivery.

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Ladies and gentlemen ...

... “Decoding tomorrow,” the theme of this year’s annual report, may sound slightly technical, yet it is also very optimistic. We stand by that. It refers to Bosch’s core message of making the world a better place with technology that is “Invented for life.” We may manufacture all manner of drive systems, but this is what drives us. Currently, however, matters of war and peace are overshadowing our day-to-day lives in a way we had, for decades, not thought possible. Where people are fighting to survive, our thoughts go out to them and we share their fears. Yet still we must not give up hope.

But what does the conflict in eastern Europe have to do with the threat of climate change? There is, in fact, a connection: we have to put our energy use on a broader footing. We need security of supply, and at the same time we have to open up new sources of energy. How is Bosch decoding this future task? We want to delve into this question in our annual press conference, to which I warmly welcome you in these somber times.

Dr. Stefan Hartung:

Electrification and green hydrogen – Bosch is opting for both

First, it’s worth taking a closer look at how the war affects climate action. My assessment is nuanced: in the short term, the acute conflict will slow progress in reducing carbon emissions, but in the long term, it will accelerate the technological transformation in Europe.

- One consideration relates to the impact on the oil and gas market, where the shock of the war in eastern Europe collided with an already difficult situation – difficult also in the wake of the recovery from the coronavirus crisis. Growing demand on the one hand, short supply and low capacity reserves on the other – that was the state of the oil and gas market even at the start of 2022. It is precisely this situation that has further intensified in step with the consequences of the war. Our concern right now is the security of energy supplies, and in many countries this is leading, at least temporarily, to a new “energy pragmatism.” In the longer term, however, oil and gas prices will certainly remain on a level that is high, if not very high.
- The other consideration relates to high fuel prices, which will make electrification more attractive, both for driving and for heating. This development will gain additional momentum as a result of consumers’ growing interest in alternative mobility solutions and energy sources. Policymakers could take this as their cue to act with a great deal more determination – whether in providing incentives to make existing buildings more energy efficient, or in massively expanding renewable power generation. The current crisis is rife with pitfalls – we don’t wish to downplay this fact. But in the long term, we are absolutely certain it will be a catalyst for decarbonization, both in our homes and on our roads.

Even this rough sketch of energy policy shows that, while it may be tempting to shift the focus away from climate action in times of international conflicts, there are good reasons to do just the opposite and to work on the technological conditions for mitigating global warming. We firmly believe that this is precisely what Bosch is capable of. The way we see it, we deliver technological solutions to this ecological problem.

In this sense, technology that is “Invented for life” is technology for more sustainability on the road, in buildings, and in factories. The presentations that follow will show how we are on the leading edge of this development. But before we get to them, I want to outline our strategy. For me, it is perfectly clear that if we really want to mitigate global warming, we have to be prepared to accept carbon-neutral technologies in every part of the economy. We still have to make some of these technologies available on competitive terms, and some will have to be developed completely from scratch. To achieve this, we are taking a two-pronged approach.

First, we are opting for electrification. Assuming it uses green electricity, this is the fastest route to climate neutrality. Bosch has solutions for this – both heat pumps for buildings and electrical powertrain systems for vehicles. We are investing in both, and growing faster than the market in both. One figure illustrates our dynamic progress here: In 2021, our orders relating to electromobility exceeded ten billion euros for the first time.

Second, we are opting for hydrogen and developing the applications for it. Green hydrogen is essential if we want to make our world climate neutral. Contrary to what some people believe, hydrogen is by no means something that only the steel and chemicals industries need. It makes sense to use it in nearly every sector – whether in buildings as a replacement for natural gas, or in order to wean trucks and machinery off diesel. Technologically, there is nothing to prevent this. As a green fuel, hydrogen can be easily transported and imported. It will be up to the markets to find economical solutions for its distribution. In every sector, using hydrogen helps mitigate global warming. As we see it, far-sighted industrial policy is about setting the right priorities for

applications, but not excluding any sector from using hydrogen. On the contrary, all sectors should be made ready for it. In concrete terms, this means establishing filling-station infrastructure for hydrogen-powered vehicles and incentivizing hydrogen-ready gas-fired boilers, also in hybrid systems that are combined with a heat pump. Bosch wants not only to use hydrogen technology, but also to be one of the companies manufacturing it. That's why we will enter the components business for hydrogen electrolysis by mid-decade. We have a broad basis from which to develop hydrogen technologies, and we are currently ramping up our investments in our core plants. For us, new energy for climate action is also a social mission.

Everything we do supports the European Union's Green Deal. At the same time, however, we are aware of what is happening in other regions of the world. We have noted that the Japanese ministry of industry has set its long-term focus on synthetic fuels as well. We see that traditional oil-producing countries are well placed to diversify and become carbon neutral – with abundant local solar energy to produce green hydrogen inexpensively. The hydrogen economy will happen globally, and Bosch must be open to all scenarios.

Last but not least, digitalization also has a special role to play in sustainability. Bosch solutions such as the smart home energy manager and the connected manufacturing energy platform are two good examples, and they will be addressed in more detail later. In all our business sectors, we are focusing on both connectivity and artificial intelligence. We turned our attention to these before others did. Over the next three years, we will be investing another ten billion euros in digitally transforming our business. In other words, we are devoting more and more energy to the interplay between the internet of things and artificial

intelligence. When software-defined cars make their driverless and accident-free way through traffic, it will be with Bosch on board and in the cloud. To make this happen, we are developing platforms and functions in equal measure. Artificial intelligence is progressing faster than expected. Our new wafer fab in Dresden is a prime example. The AI-based quality approval system in place there helps us save time and money, reducing local startup costs by nearly 100 million euros. At our company locations, we are already “decoding tomorrow.”

We will be taking a much closer look at digitalization at events later in the year, such as the Bosch Connected World in November. At today’s annual press conference, however, our main theme is energy. It crops up in all my colleagues’ presentations, be they about buildings, industry, or transportation. But before we turn to them, Markus Forschner will take a look at the business situation ...

Dr. Markus Forschner:

2021 brought to a successful close – growing pressure on result

Given present developments, I will be devoting a lot of my attention today to the current business year. The impact of the war in Ukraine, including the subsequent ongoing increases in raw materials prices, will affect us as well. As yet, however, our business figures reflect this development only to a limited extent.

As was highlighted when the preliminary business figures were presented in February, we rose well to the challenges of 2021. We were able to grow Bosch Group sales by 10.1 percent, to 78.7 billion euros, and increase our EBIT from operations by more than 50 percent, to 3.2 billion euros. We thus improved our EBIT margin from operations

to 4 percent, compared with 2.8 percent in the previous year. We achieved all this despite the ongoing coronavirus pandemic, continued supply bottlenecks for semiconductors, and raw materials prices that were already significantly higher. In addition to our good sales figures, our extensive cost-cutting measures have also paid off.

All business sectors contributed to our positive financial result last year. Mobility Solutions increased sales by 7.6 percent. In addition, following the previous year's loss, the business sector returned to a slightly positive result with an EBIT margin from operations of 0.7 percent. But while we have made good progress here, we cannot be satisfied with such a margin. Even in 2021, there was a lot of pressure on result from the increased costs for chips, raw materials, and logistics. Moreover, the Mobility Solutions business sector is particularly exposed to chip shortages and is having to prepare for profound changes in mobility. These changes will continue to require significant adjustment-related cost; at the same time, we are making substantial upfront investments in electromobility and automated driving.

The Industrial Technology and Consumer Goods business sectors were particularly successful. Industrial Technology benefited from the recovery of key mechanical engineering markets, achieving sales growth of 18.9 percent and an EBIT margin of 8.4 percent. After a strong showing last year, Consumer Goods was able to further increase its sales by 12.7 percent, and again achieved a double-digit margin from operations, at 10.2 percent. Energy and Building Technology also performed well, with a 7.8 percent increase in sales and an improved margin of 5.1 percent. This is due in part to our success with climate-friendly heating technology. My colleagues will address key strategic focal points shortly.

The positive financial result is also reflected in the development of headcount. As of December 31, 2021, the Bosch Group employed more than 402,000 people worldwide – some 7,600 more than the previous year. Headcount increased in all three major regions, and remained stable in Germany at more than 131,000. In research and development, headcount grew by roughly 3,000 to more than 76,000 associates.

I would like to mention a few more numbers that underscore our orientation to the future, as well as our sound financial position. Research and development cost rose to 6.1 billion euros, compared with 5.9 billion euros in the previous year, and capital expenditure increased to 3.9 billion euros, compared with 3.3 billion euros. Research and development cost focused on electromobility and driver assistance systems, as well as on electrification in industry and heating technology. Special mention should be made here of the new wafer fab we opened in Dresden last year. Thanks to improved result, our equity ratio rose 1.3 points to 45.3 percent. Further details can be found in our annual report, which is completely electronic for the first time – with user-friendly navigation options in the PDF.

Now for some remarks on the 2022 business year. Bosch Group sales are up 5.2 percent for the first three months of the year. The Mobility Solutions business sector has posted an increase of 4.8 percent. Two business sectors have grown by double digits: Industrial Technology, at 14.4 percent, and Energy and Building Technology, at 11.7 percent. We have achieved 1.7 percent growth in Consumer Goods. Growth is leveling off in consumer goods for homes and gardens, where changes in consumer focus during the coronavirus pandemic led to particularly high demand. From a regional perspective, sales in the first quarter

have grown particularly in Asia Pacific and the Americas, while stagnating on their previous-year level in Europe.

Any estimates for the year as a whole are bound up with considerable uncertainties. We, too, have already significantly lowered our expectations for business activity. We now expect to see global economic growth of 3½ percent in 2022, compared with the 4¼ percent stated in the annual report. In addition, the annual report's forecast for automotive manufacturing of some 88 million vehicles worldwide, and thus an increase of 9 percent, probably won't be met. The reasons for this are the resurgence in adverse effects from the coronavirus pandemic in China and the ongoing chip shortages.

In light of the current circumstances, it is difficult to forecast Bosch Group sales and result for 2022 as a whole. Besides the uncertainty as to how the situation in Ukraine will develop and what its impact will be going forward, it is currently unclear what consequences the new lockdowns in China will have for economic development. At present, we expect to exceed the 6 percent sales growth forecast in our annual report. One contributing factor we are currently seeing is the sales-boosting effect of prices and exchange-rate movements.

But despite the expected sales increases, it is unlikely we will fully achieve our target of an EBIT margin on a par with the previous year. It should be in the range of 3 to 4 percent. However, it is not yet possible to precisely quantify the earnings impact of the loss of business in Russia. As you know, our deliveries to Russia have largely come to a halt due to the sanctions, and most of our business with Russian customers and in Russia has been suspended. In addition, the burden on our

result is growing considerably due to steep increases in the cost of energy, raw materials, and logistics.

The current cost pressure is immense, especially in the Mobility Solutions business sector. It's not just automakers that have to pass on price increases, but especially suppliers such as us as well. To explain the enormous cost pressure relating to raw materials, let me give you the example of the indexed development of flat and round steel, two materials that are very important for us. As you can see, their prices have approximately tripled since 2020. After a slight temporary decrease, they have been given an extra boost by the Ukraine crisis. The strained supply situation is being made significantly more tense by the key role Russia plays in supplying raw materials, particularly to Europe. This means we must prepare for continued high prices and very volatile markets.

These increases in the prices of raw materials aren't making it easy for governments, central banks, or companies to ensure economic stability. They are also likely to have a negative impact on consumer behavior. While demand will likely remain relatively stable in 2022, we have to prepare for a slowdown in 2023. Nonetheless, as a company, we are confident that Bosch will rise to the challenge of this difficult phase as well. What's important here is that we have pioneering products and a clear long-term strategic focus. On the topic of sustainability, I would like to turn the floor over to Filiz Albrecht.

Filiz Albrecht:

Sustainability has become a core business responsibility

Gone are the days, ladies and gentlemen, when sustainability seemed a nice-to-have addition to ongoing business. It has become a must-have and a core business responsibility, and that's a good thing. This change is also being driven by increasing regulation, not only under the EU's Green Deal but also under Germany's Supply Chain Due Diligence Act. Three years ago at this press conference, we presented our goal of making Bosch – with its 400 locations worldwide – carbon neutral. In 2020, we achieved this goal, becoming the first global industrial enterprise to do so. We did it voluntarily, just like the introduction of the 8-hour workday in our plants more than 100 years earlier. Now as then, it appears that regulations are catching up with corporate responsibility.

Our responsibility continues to encompass the trio of economic, social, and ecological concerns. It's not easy to keep these three things in balance. In times of change, social responsibility means taking as many associates as possible with us into new areas of business. We do this with reskilling and company-wide job placement platforms. This measure alone has meant we were able to help 1,400 associates in our powertrain operations take on new jobs in fields such as software and electromobility. Unconventional location-policy decisions also help in this regard: it is not on greenfield sites that we are developing climate-neutral technology, but instead primarily at locations that previously produced combustion systems. In this way, nearly 2,300 associates will be working on mobile and stationary fuel cells by the end of the year – and we filled 90 percent of these positions internally. This is

transformation “made by Bosch” – as is the way we will be taking on 10,000 new software engineers worldwide this year.

Ecological responsibility also begins at home. For example, we have significantly enhanced the quality of our carbon neutrality across our global network of locations. In other words, we are relying on ever fewer carbon offsets. Since 2019, we have initiated 3,000 projects that boost energy efficiency at our locations. Thanks to these projects, we have already realized one-third of the energy savings we set out to achieve by the end of the decade.

And we’re moving just as quickly in addressing climate action along our supply chains. To this end, we agreed with the Science Based Targets initiative on a binding target for the current decade. We’re on our way to achieving this target: while making our own business carbon neutral was in itself a big step, we are now reducing our carbon footprint by twice as much each year, from our suppliers to our customers. Our purchasing department is working to make this happen, as is every one of our divisions. There are three levers over which we have immediate control: first, more circular economy; second, more energy efficiency in our existing products; and third, shifting our product portfolio toward climate-neutral products. Climate action isn’t something we aim to do alongside or on top of our business – we are making it our business. Christian Fischer will now talk more about this.

Dr. Christian Fischer:

More than one way to transition to alternative heating in buildings

Bosch Thermotechnology is a clear example of how aggressively we are developing our portfolio in response to the challenges of climate change, as well as of how crucial it is that we develop a range of answers. It is well known that more than one-third of carbon emissions comes from buildings, so climate action has to take place in people's homes as well. The German government has set an ambitious goal for this: by 2024, it wants 65 percent of new heating systems to be powered by renewables. Bosch can help realize this goal, but here, too, there is more than one path forward.

Whether in buildings or on the road, we embrace the principle of “electrification first.” In concrete terms, this means that the transition to alternative heating starts with the heat pump, ideally powered by green electricity. Market developments are clearly pointing in this direction. This year, the value of the heat-pump market in Europe has caught up with that of the gas-fired boiler market. It will expand by an annual 15 to 20 percent between now and 2025, and we want to grow at twice that rate – by between 30 and 40 percent, in other words. To achieve this, over the last four years we have invested 400 million euros, and we will invest an additional 300 million euros by mid-decade. Investment gives rise to innovation. We have developed a solution for integrating heat pumps into home energy management and thus also for running them in partial-load mode as needed. This lowers both electricity consumption and noise, making it easier to live with the transition to alternative heating.

But a nuanced view is needed here. Heat pumps pay off especially in new buildings, but 70 percent of all houses in Germany are more than 50 years old. So how can we ensure that existing buildings make the transition to alternative heating? Tearing down and rebuilding entire neighborhoods can't be the answer, but switching from natural gas heating systems to hydrogen can. Fortunately, the gas network in many European countries is already hydrogen-ready – in Germany, that is true of 96 percent of all pipelines. Still, equipment will need to be prepared in time for the transition. The United Kingdom is a role model in this regard. There, new gas-fired boilers have to be hydrogen-ready as early as 2026. In early 2023, a large-scale field test involving 300 hydrogen heating systems will launch in Scotland, and one in every two of those will be a Bosch system. We are setting the pace for the transition to alternative heating in every way we can.

We are bringing not just new energy sources into homes but also energy efficiency. We're doing this with a large portfolio of home appliances that conserve resources, as well as with the energy manager for smart homes, which enables smart distribution of, say, solar energy to the washing machine, the heat pump, or the battery storage unit. This lowers electricity costs by nearly 60 percent. The energy and cost-efficiency equation is also helping climate action gain traction in commercial buildings. The savings are considerable: for example, our solutions have helped us lower the annual energy costs at the Robert Bosch Hospital by as much as 1.3 million euros. Not least, this extra efficiency is made possible by connecting and integrating building systems – it's a telling sign that two out of three invitations to tender in building technology today relate to integrated projects. Bosch is growing faster than the market – also through acquisitions. Most recently, we acquired Hörburger, a specialist in building automation. At the same time, this is

bringing us closer to our goal of increasing the share of regularly recurring revenues from services. After all, services already account for almost half of all sales in the building systems business. So our strategic objectives – helping shape climate action with technology and expanding our service business – complement each other. And with that, I turn the floor over to Rolf Najork.

Rolf Najork:

Industrial technology is driving electrification

It is precisely in industrial manufacturing, where rationalization originated, that it has to prove possible to combine economic and ecological objectives. The energy and cost-efficiency equation is, in fact, driving climate action in factories – and digitalization is a crucial element here as well. Thanks to connected energy management alone, we are reducing the annual energy consumption of our manufacturing operations by an average of 5 percent. The Energy Platform from our Industry 4.0 portfolio is already in use in 80 customer projects and at 120 Bosch locations. Adding artificial intelligence generates even more efficiency. For instance, our plant in Changsha, China, developed an AI-controlled energy management system that enabled it to reduce its annual energy consumption by 18 percent. That's reason enough for the World Economic Forum to honor Changsha as a global lighthouse for Industry 4.0.

We are also embracing electrification in our industrial technology. It is especially in the kind of mobile machinery used in ports, on construction sites, and in mining that we are seeing a trend toward this. Such applications will see stricter emissions and noise regulations, and will require robust technology that is “Invented for life.” Bosch Rexroth, the

global market leader in mobile hydraulics, will already begin expanding its portfolio this year to include electrical components for drives and operating gear. This will make it possible to electrify both the driving and the buckets of excavators, to name just one example. This eLion product range will comprise 80 motor options based on different nominal sizes graded according to torque and speed – the broadest offering in the industry. This, too, shows what is typical of Bosch. Our strength lies in the combination of different strengths: experience in electrical solutions for industry, industry-specific knowledge in off-highway equipment, and expertise in electromobility. We expect 30 percent of mobile machinery to be electrified by 2030. This translates into an additional market volume for high-voltage systems worth 1.5 billion euros. Here, too, our new product portfolio puts us at the forefront.

Finally, we are advancing electric driving on the road through our industry technology. In a project unit with VW, we are working to establish a company that will equip battery-cell factories in Europe. Our common objective is to be the cost and technology leader in systems for the volume production of batteries. With our experience in factory automation, we see potential for greater productivity in core processes, such as in cell assembly. We are contributing the full spectrum of our industry technology expertise: drive and control technology, assembly and process technology, and software for Industry 4.0. We already offer solutions for the production and recycling of battery modules and packs. Providing technology for battery-cell manufacturing will round out this portfolio. And we can expect strong demand – with a cumulative market volume of 50 billion euros worldwide by 2030. More than 30 new cell factories are currently being planned in Europe alone, six of them at VW. No other segment in the plant and mechanical engineering sector currently has greater prospects for growth. Bosch is

driving electromobility from two sides: not only as an automotive supplier, but also as a supplier of factory equipment. Markus Heyn will now talk more about electric driving.

Dr. Markus Heyn:

Alternative mobility also means electromobility plus fuel cells

Starting in 2035, new cars in Europe will no longer be allowed to emit CO₂. By including this requirement in its Green Deal, the EU is providing a decisive boost to the electrification of road traffic. It comes at a time when the automotive industry is experiencing extremely high economic pressure. In percentage terms, automaker's retail prices for new vehicles have increased on average by a high single-digit figure. The price of new electric cars, for example, has risen by just under 8 percent in the past two months alone. And Bosch will also have to pass on to its customers the costs for raw materials, chips, and logistics – which have again risen considerably. My colleague Markus Forschner has already made this perfectly clear. Only then can we continue to operate our automotive supply business at a profit.

At least the market for electric vehicles is gaining momentum. All automakers are eager to secure the greatest possible share of this market. Bosch sees itself as the number one supplier for electrical powertrains on the road as well. We are doing all we can to make electromobility even more practicable.

For example, we are keeping the powertrain, including the battery, at the right temperature and providing the necessary climate comfort in the passenger compartment – intelligent thermal management alone increases electric driving range by 25 percent. It accounts for around

four times more value creation in electric vehicles than in diesel- or gasoline-powered ones. To this end, Bosch has developed a pre-integrated solution: the flexible thermal unit, or FTU. This solution significantly reduces system costs and complexity: fewer parts, fewer assembly steps, fewer coolant lines, and thus less coolant weight. With the FTU alone, we are tapping into a market that will reach a volume of 3.5 billion euros by the end of the decade.

In addition, we are making good progress in electromobility on both of the key technological paths.

- The first is Bosch's growth in the battery-electric mobility business. Since 2018, we have acquired 170 commercial projects – 60 of those in 2021 alone. The market is seeing strong growth, and ours is even stronger. Our unit sales are increasing annually at double-digit rates. In 2025, our sales will surpass the five billion euro mark, with components for purely electric cars accounting for 70 percent by then. Our capital expenditure remains on a high level – the figure for this year is more than 500 million euros.
- The other path will open up once Bosch launches its electromobility based on fuel cells. Specifically, we will start production of fuel-cell powertrains for trucks this year. Our technology already completed a good 100,000 test kilometers in 2021, driven by Chinese prototypes. Our Bamberg plant in Germany will start producing fuel-cell stacks in 2022. By the middle of the decade, we aim to be producing stacks with a gigawatt output at that site – our gigafactory, if you will. To this end, assembly of the complete fuel-cell system will begin in Stuttgart-Feuerbach in 2023, with some components also being supplied from Homburg. This cooperation clearly shows that our core plants are generating innovations.

The Wuxi location, which serves our Chinese customers, will also be involved. By 2030, it should cost no more to operate a fuel-cell truck than a diesel – that's our goal. We have the necessary expertise in commercialization to achieve this, such as a process that exists only at Bosch: high-speed laser welding, to make 1,000 meters of hydrogen-impermeable weld seams per stack. Major capital expenditure will also be required. We have increased ours once again, to nearly one billion euros between 2021 and 2024.

But that's not all. In the same period, we will invest half a billion euros in stationary fuel-cell technology. So Bosch is positioning itself broadly here as well – we are thinking beyond mobility. Stationary fuel cells are typically used in micro power plants, or to supply electricity to data centers or city districts. For these cells as well, production is being ramped up in our core plants – in Bamberg, Homburg, and Wernau. We plan to launch stationary fuel cells on the market in 2024. In order to tap the Chinese market, we are also planning a joint venture with our partners Ceres Power and Weichai. We expect the global market to be worth 20 billion euros by 2030, and have a good chance of becoming one of the top three providers. With that, I turn the floor back over to Stefan Hartung.

Dr. Stefan Hartung:

Three billion euros for climate-neutral technology

Ladies and gentlemen, we are coming to the close of our presentation. A sustainable way of life is coming – it has to come. With dependence on fossil fuels being exploited in international conflicts, we must now work with even more determination to do what our planet requires of

us: to diversify our energy use. Bosch is pursuing this in all its business sectors, both as a transition to alternative heating and a transition to alternative mobility. Our strategic imperative – technology that is “Invented for life” – also means making life with this transition as easy as possible. For instance, we are launching a connected wallbox that lets users control electric vehicle charging at home with an app. It can also be integrated into the smart home energy manager.

In addition, Bosch wouldn't be Bosch if we were to leave a promising development untouched. That's why we're also working on hydrogen engines for heavy trucks. And as mentioned earlier, we want to use our technology not least to support the expansion of hydrogen production in Europe. We will supply the stack – the core of the hydrogen electrolysis system – which combines with the power electronics, sensors, and control unit to form a smart module. Our development is aimed at the market for electrolyzer components, which we expect to be worth 14 billion euros worldwide by 2030. We plan to invest nearly 500 million euros in this area by the end of the decade, half of it by the time of market launch, which we are planning for 2025. Altogether, our upfront investments in technologies aimed at climate neutrality total a good three billion euros over three years. No other company can match the way we are diversifying with these kinds of technologies. Yet for all this diversification, our strategy can be summed up in one sentence: We're already well underway with electricity-based solutions, and hydrogen-based ones will pick up speed as well. That isn't to say that we won't have to invent a few technologies along the way, or that a few other technologies aren't still too costly. But technologically, we mustn't make the mistake of restricting ourselves to the solutions that are already in use today. Electrification and green hydrogen: we'll need both if we are to live sustainably on our blue planet.