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Speech

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Driving sustainability with microorganisms

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The spoken word applies.

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Good afternoon, ladies and gentlemen,

Thank you for joining today's event. We have put together an exciting program to show you what BASF researchers are up to.

(Slide 2: Multiple challenges ahead)

Our actions revolve around sustainability. It is at the core of our strategy. Sustainability and innovation go hand in hand at BASF. The picture you see here shows what we are facing in the chemical industry: rough seas. The crew must give its all. We must stay on course.

This means: Energy-intensive companies such as BASF must reconfigure their energy supplies and respond to soaring energy costs. In addition, governments worldwide have adopted ambitious climate targets and the European Union is setting a new framework for chemicals with its Chemicals Strategy for Sustainability.

BASF is facing many challenges at once: Our production must become climate-neutral; we must create a circular economy, scrutinize many of our products and achieve the digital transformation. And all of this in the middle of an unprecedented energy crisis and soaring inflation in Europe.

Yet, I also want to state very clearly: Our company is taking on this enormous task. And, though there is cause for concern, we also see enormous opportunities for a sustainable future. It is clear what is needed: Only with innovations and a competitive industry can we stay on course in these stormy times.

(Slide 3: Continuous commitment to sustainability)

We are well equipped to navigate safely in these conditions. We know our strengths, and we have the ability to transform. It helps us that sustainability has been a topic for BASF since long before the European Green Deal. Sustainability has been our guiding principle for 27 years. Since 2011, it has been anchored in our corporate purpose: "We create chemistry for a sustainable future."

Let me prove that with some figures: Between 1990 and 2018, we reduced our greenhouse gas emissions by half, while our production doubled. And we continue to be ambitious: We are firmly committed to being a pioneer in the chemical industry. By the year 2030, we want to reduce our global CO_2 emissions by 25 percent compared to 2018. By 2050, our goal is net zero emissions. We are in the process

of transitioning to renewable energy sources. As one of our first steps, we are building a 1.5-gigawatt wind farm in the North Sea off the coast of the Netherlands together with Vattenfall and Allianz. It is slated to fully start up in 2023 and will be the world's largest offshore wind farm. We need huge amounts of renewable energy to electrify our energy-intensive processes, for example. But I will come back to this later.

Our circular economy program is also ambitious. By 2025, we want to process around 250,000 metric tons of recycled raw materials annually. And we want to double our sales generated with circular economy solutions by 2030. One contributor to this will be the ChemCycling™ method. As you can see, we have big plans – and we are already making good progress.

(Slide 4: Our global innovation setup benefits our customers and supports the transformation towards sustainability)

For these challenging tasks, we need the best team. In the past few years, we brought our research and development units closer together so that we are even better able to adapt to the market. We concluded this process this year and realigned our global research activities.

Ladies and gentlemen, I would like to mention three key elements of this realignment:

First: Business- and application-oriented research units are now embedded in the operating divisions. They are closer to our customers and thus even better able to cater to their needs. This further shortens the time-to-market for new products and accelerates BASF's organic growth.

Second: Research activities that are relevant for multiple operating divisions have been bundled into a central research division. This unit remains globally organized, with research centers in Europe, North America and Asia Pacific. Together with the development units in our operating divisions, it forms the core of our global Know-How Verbund.

And third: The central research unit brings external knowledge into BASF. Our global network of top universities, research institutes and partner companies gives us direct access to external scientific expertise, talented people and new technologies.

The transformation of our research structure is now complete. With its innovative strength, our new setup supports us on our journey to even greater sustainability.

(Slide 5: We operate the industry-leading innovation platform: Facts and figures 2021)

We are proud of our R&D platform. Let me give you a few figures for 2021. Worldwide, we have around 10,000 employees in research and development. As in the past few years, we invested somewhat more than €2 billion. We invest to develop new sustainable products but also to enter new fields of technology, such as the recycling of battery materials. Developing our competencies is an ongoing task for us. For example, when it comes to generating CO_2-free hydrogen or using digital tools more effectively.

And our work pays off: We generated sales of over €11 billion with BASF products launched on the market in the past five years that stemmed from R&D activities. Within the chemical industry, we have a leading position in terms of the number and the quality of our patents. I am especially happy that in 2021, 45 percent of our patent applications were related to inventions with a special focus on sustainability – and this trend is growing. And in the long term, too, we want to increase our sales and earnings in particular with new and improved products that make a significant contribution to sustainability.

(Slide 6: Driving sustainability – a value chain perspective)

But there is more than just our new products: The research projects our global R&D team is working on today affect all steps of our value chain. We are also thinking about new raw materials and new processes. With the resulting advantages, we want to support and strengthen our customers. I will give you a concrete example in a moment.

(Slide 7: A conventional chemical value chain…)

In the chemical industry, we need raw materials – and a lot of energy! Let’s look at the traditional linear value chain, as we know it today. Our raw materials are largely fossil-based. The main ones are naphtha – a crude oil distillate – and natural gas. We use them to produce chemical products in our Production Verbund. In the first stage of the value chain, we form small and simple chemical molecules from these feedstocks, primarily ethylene, propylene and acetylene. These are like a set of

building blocks, which we use to produce various and increasingly complex derivatives for our customers.

Today, recycling of our products is not widely used, it is mainly limited to mechanical recycling of plastic waste. In this case, though, the structure of the polymers remains intact and cannot be used in our building-block principle.

(Slide 8: ... and the result of a sustainable transformation)

So how do we tackle the desired transformation? Where do we get the large volumes of renewable energy necessary for climate-friendly chemistry? How do we replace fossil feedstock with renewable raw materials? These are critical questions.

We cannot entirely predict what our raw material mix will look like in 2050. However, one thing is already clear: Our raw material base will still contain carbon – because our world and our products are based on carbon. So, while decarbonizing energy inputs is possible in principle – with wind or solar energy – it is impossible to fully decarbonize products.

But we can replace some of the fossil feedstock with renewable raw materials. So-called bio-naphtha is produced, for example, by converting renewable raw materials such as native plant oils or used cooking oil.

We want to source another portion of our feedstock by closing material loops. To do this, we need partners to supply us with sustainable sources of hydrocarbon compounds. Waste is transformed into valuable raw materials, which must be collected by the waste industry and sorted. This will also require that consumers become more aware of the value of waste separation. Products must have the right properties to be suitable for chemical recycling.

Many of the technologies that will enable a climate-neutral society in 2050 have not yet been invented. When we make decisions today about the best technology currently available in order to make rapid progress, we should never completely rule out alternative technology concepts. Being open to and supportive of innovations and technologies are essential for a successful transformation.

(Slide 9: Feedstock: Battery recycling)

Ladies and gentlemen, let us move from the future to the present: I would now like to show you a specific example of how we will soon be able to supplement our raw

material mix thanks to recycling. I am talking about cathode active materials for batteries. In this area, BASF has built up a strong market position with a broad portfolio of cathode materials for the automotive industry.

Now, our researchers have developed a process to recover lithium, nickel, cobalt and manganese with high yield from end-of-life lithium-ion batteries or production scrap. We can thus further reduce the carbon footprint of electric vehicles and meet the strict requirements of the EU's Batteries Regulation.

To transition this process from the lab to the factory and to optimize the technology, we are currently building a prototype plant at our Schwarzheide site in Germany. The metals we recover via battery recycling will be used to produce new cathode materials. This circular model will support our customers throughout the entire value chain and will reduce the need for primary metal from mining operations.

(Slide 10: Process: From idea to commercialization)

I just showed you how we can expand our raw material base with recycling. Here is another lever for greater sustainability – at the process level. I talked about how our products are developed using a building-block principle. Our steam crackers play an important role here. Inside these crackers, naphtha is heated to 850 degrees Celsius in the presence of steam. This breaks down the long carbon chains into smaller components for our chemical value chains. Until now, we have been heating our cracker furnaces with gas, which produces around 1 metric ton of CO_2 per ton of olefin.

In the future, we want to heat the furnaces with renewable electricity. With our development partners SABIC and Linde, we have developed the world's first electrical heating concept for steam crackers. We thus have the potential to reduce the CO_2 emissions of one of the chemical industry's most energy-intensive production processes – by at least 90 percent compared to traditional processes! This is a true technological leap. Our eFurnace demonstration plant in Ludwigshafen will start up already next year. It will be fully integrated into one of the existing steam crackers at our Verbund site.

Policymakers also support our approach to climate neutrality, as evidenced by the project funding provided by the German Ministry for Economic Affairs and Climate Action.

However, as you can imagine, we will need to bring a huge volume of renewable electricity to Ludwigshafen for this new technology – reliably and at competitive prices. We are laying the groundwork with our investment in wind farms. However, much will depend on the speed of the energy transformation in Germany and in particular on the rapid expansion of the electricity grid.

(Slide 11: Product: Create additional value for our customers)

Now let's look at the product level, and at how we are proceeding on our path towards lower emissions. If we use green electricity, low-carbon generated steam and renewable raw materials, and our processes are highly efficient, we can offer our customers net-zero products and products with a smaller product carbon footprint (PCF).

I would like to highlight the mass balance approach. We cannot trace every single carbon atom in our complex Production Verbund. However, with this approach, we can allocate the share of bio-based raw materials or of those from ChemCycling processes to specific sales products according to a certified method. It is already being used for many BASF products. What does this mean for our customers? They can stand out from the competition by improving their carbon footprints or by conserving fossil resources. We expect that consumers will drive growing demand for such products because they want to make a personal contribution to lowering emissions. Therefore, we want to be one of the first companies to offer industrial-scale volumes of as many products as possible with a reduced carbon footprint.

The scope of this concept already includes everything from insulation materials to sneakers, from appliances to textiles. In these cases, the reduction of the carbon footprint and thus the benefit for our customers and end consumers is already significant – as you can see from the numbers.

(Slide 12: Driving sustainability with microorganisms)

And we have not yet fully exploited our potential. Thanks to white biotechnology, we have another tool that enables us to become even more sustainable at the three levels of our value chain that I mentioned earlier. White biotechnology is nature's toolbox: Just think about the centuries-old processes to make bread, cheese, wine and beer – all of which use the power of microorganisms. Louis Pasteur once said: "The role of the infinitely small in nature is infinitely great." With this finding, he paved the way for modern biotechnology. We say: Small but powerful!

And our researchers are taking advantage of this. When it comes to raw material sources, white biotechnology gives us maximum flexibility. Our tailor-made microorganisms can handle fossil, renewable or recycled material streams, either pure or mixed. They allow us to produce some products in a much gentler and more environmentally friendly way than traditional chemical processes – at room temperature and at normal pressure, often in an aqueous medium. Using fermentation or bio-catalysis, we also have access to entirely new products that otherwise would not be simple to synthesize.

(Slide 13: Microorganisms produce molecules)

Ladies and gentlemen, let's go into more detail. Perhaps you remember the concept of anabolism from your school biology lessons. It is the metabolic process that builds larger molecules. The opposite process is catabolism, which breaks down molecules. Microorganisms help us in both respects. Let's start with the anabolic, or building process: In nature, with the help of their enzymes, microorganisms catalyze the formation of a large number of molecules. We can use this ability to produce a wide variety of products: from simpler structures such as ethanol and lactic acid to very complex structures such as vitamin B_2, aroma chemicals or crop protection products. Microbes can use a large number of starting materials to do this, ranging from glucose to carbon monoxide or carbon dioxide.

(Slide 14: Microorganisms digest molecules)

In catabolic processes, microorganisms break down complex organic compounds into simple molecules. In nature, they are responsible for degrading dead material, such as the leaves on trees. Nature's cycle is nearly perfect. It produces energy, water, CO_2 and biomass. How can we take advantage of this? By offering synthetic substrates and copying the natural process of biodegradation. If polymers and functional materials have the right structure for biodegradation, microbes can also digest them and turn them into energy, water, CO_2 and biomass. Microbes live in communities, either in natural habitats such as soil or in "technical systems" such as compost or wastewater treatment facilities. For us, it is essential to understand both the natural and technical systems in order to design new chemical structures that are completely biodegradable in a short period of time.

(Slide 15: Biotechnology and biodegradability broaden BASF's capability to shape a sustainable future)

For us as a chemical company, there are therefore many good reasons to expand our competencies in the field of biotechnology. I also want to illustrate this with a few figures. In five of our six BASF segments – Chemicals, Materials, Industrial Solutions, Nutrition & Care and Agricultural Solutions – we already produce more than 3,000 products that we associate with biotechnology or biodegradability. For today's event, we calculated that we generated more than €3.5 billion in sales with these products in 2021. And the trend is rising. We expect that growth in the coming years will be above that of the chemical market – a good reason to strengthen our R&D activities in this area!

(Slide 16: Today's topics)

As you can see: Microorganisms also have an increasing economic impact. Their abilities are diverse and exciting. We are now happy to show you in detail how white biotechnology – the technology with microorganisms – is becoming an increasingly important piece of the puzzle for our chemical industry. Later, we will explain how BASF and its partner firm LanzaTech are working together to produce chemicals from alternative carbon sources. And, in our third presentation, we will show how newly gained knowledge in the field of biodegradability can make an important contribution to developing sustainable products.

(Slide 17: To successfully meet the challenges of today's world… we rely on innovative minds, partnerships, and cooperation)

Before we get to the research presentations, ladies and gentlemen, I would like to repeat the message I started out with: The chemical industry is facing unprecedented challenges. But in our long history at BASF, we have proven again and again that we emerge even stronger from challenging times. The key to this is our innovative strength.

Society will only achieve the transformation to climate neutrality with innovative solutions based on chemistry and neighboring disciplines. The transformation will be impossible without our industry. And I know we can count on our creative and dedicated BASF team. However, we also need alliances. We must work together – with all players in industry, science, politics and society. And across all borders – in Germany, Europe and the world. Alliances between companies and legislators are

especially important because we need good framework conditions underpinning our actions. It is essential that we all work together to remain competitive, strong and successful.

And now I’m looking forward to your questions.