We create chemistry

R&D Webcast
Circular Economy at BASF – Speech

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[Title Slide]

Ladies and gentlemen,

a warm welcome to this year's R&D Webcast.

I hope you will share my excitement for research in today's digital format. Research touches and improves all aspects of everyday life.

I've brought along a few everyday items: soap and detergent bottles. These show how we all consume resources and produce waste every day. But it is possible to do things differently: All of these items here were made with recycled plastics. And this is exactly what we are talking about today: the circular economy.

How can we keep raw materials circulating? How can we avoid waste, conserve resources and protect our environment? And how can we ensure that this is also economically viable?

With the circular economy, we decouple economic growth from resource consumption.

In some ways, we have been doing this for a long time: Our Verbund is a good example. In many areas of the chemical industry, however, production is still designed along linear value chains. The path to a circular economy will require enormous effort on our part.

And this is not the only challenge. In parallel, we are pursuing an energy transformation toward carbon neutrality. Ultimately, this means a carbon-neutral circular economy.

I am convinced that this is the way of the future. Our success in this area will have a direct effect on our future profitability and competitiveness.

[Slide: The European Green Deal]

With the European Green Deal, the E.U. aims to become carbon neutral by 2050. In our previous R&D Webcast in January 2019, I talked about how BASF wants to contribute to this goal with its Carbon Management Program.

The circular economy is another pillar of the European Green Deal and a key issue of the future – in society and in politics. Transitioning toward a circular economy will help to address our global resource and emission challenges. The European chemical industry sees itself at the center of this transformation.

As European Commission President Ursula von der Leyen put it: “The Green Deal is Europe’s man on the moon moment.” We are developing technologies to make this a success.

[Slide: BASF’s Circular Economy Program: Targets]

At BASF, we have long been conducting research on innovations to close material loops. We are currently pursuing more than 20 circular economy projects. The transformation to a circular economy affects all of our customer industries.

To drive forward the exceptionally ambitious transformation of our company, BASF has launched a Circular Economy Program. As part of this, we have set ourselves ambitious goals. BASF has committed to processing around 250,000 metric tons of recycled raw materials each year by 2025. And we will increase our sales with circular solutions to 17 billion euros by 2030. This is double the current figure! Sales of circular solutions include products that are based on renewable or recycled raw materials, close new material cycles or increase the resource efficiency and durability of products.

[Slide: BASF’s Circular Economy Program: Today’s focus]

To achieve these goals and close as many loops as possible, we are concentrating on three action areas:

- First: new feedstocks
- Second: new material cycles
- And third: new business models

“New feedstocks” means we will continuously increase our share of recycled and renewable raw materials.

“New material cycles” means that we will also need to consider recycling at the design stage for new materials.

And we are working on new product-specific material cycles.

Last but not least, we are developing new business models in which digitalization helps to conserve resources. One good example for this is smart farming with digital tools.

In today’s R&D Webcast, we will introduce some of our solutions for the first two action areas: new feedstocks and new material cycles.

Let’s begin with the feedstocks for our Production Verbund.

[Slide: Today’s recycling landscape for plastic waste]

Today, only one third of all plastic waste is mechanically recycled in Europe. Globally it is even less – only 20 percent.

The share of plastic waste that is sent to landfill or even ends up polluting the environment is a shocking 60 percent globally.

Chemical recycling does not play a noticeable role yet. It only accounts for 0.1 percent in Europe – and even less globally.

Due to the ever-growing volumes of plastic waste and given that plastics are a valuable resource, we must strive to keep as much as possible in the materials cycle.

But how can we do this? Let’s take a look at the plastics value chain.

[Slide: The plastics value chain]

Plastics are mainly produced from fossil raw materials such as naphtha. Naphtha is fed into a steam cracker, which produces olefins and aromatics that are then processed into polymers such as polystyrene, polyamide or polyethylene. These plastics have many advantages and are suited to a wide range of applications. However, at the end of their service life, they become plastic waste.

In Europe, two thirds of this plastic waste does not re-enter the value chain. This is where our ChemCycling™ project can make a difference!

[Slide: New chemical recycling technology to increase the overall amount of plastic waste recycled]

Chemical recycling can significantly increase the overall recycling rate. It perfectly complements mechanical recycling.

In chemical recycling, plastic waste is pyrolized and converted into an oil. The polymer chains are chemically broken down into small molecules. The purified oil can be used in BASF’s Verbund. For example, it can be fed into a steam cracker – together with fossil raw materials.

The big advantage of chemical recycling: It can handle mixed and uncleaned plastic waste. These waste streams cannot be recycled mechanically and are mostly incinerated today.

One example is multi-layered food packaging. This has been developed to ensure that products remain fresh and prevent spoilage, while reducing the weight of the packaging. The individual layers cannot be separated for mechanical recycling. However, it is possible to chemically recycle this type of waste.

In addition, chemical recycling reduces the consumption of primary fossil resources. This helps avoid CO_2 emissions.

A life cycle assessment conducted on behalf of BASF concluded that pyrolysis of mixed plastic waste emits 50 percent less CO_2 than incineration. This study was reviewed by three independent experts.

When recycled and fossil feedstocks are used together, they are mixed and the recycled feedstock is not traceable. However, by applying the mass balance approach, it is possible to allocate the recycled feedstock to a specific customer product. The allocation is audited by a third party to ensure that this has been calculated properly.

This concept is widely accepted and is also used for products like green electricity. There is not a separate grid for green electrons, either!

In the chemical industry this is a new approach and it is essential for the circular economy. Together with BASF's chemcycled products, customers buy certificates that guarantee a certain share of recycled materials in the Production Verbund.

This concept has a huge benefit for our customers because it is a drop-in solution. The chemcycled products are indistinguishable from those manufactured from primary fossil feedstock. They are virgin-grade and suitable for use in all kinds of high-performance applications. Another aspect of sustainability is that existing plants can be used for this transformation.

The regulatory framework will determine whether the technology will become established in the waste industry. Authorities need to more widely adopt a technology-neutral definition of recycling. This would allow chemically recycled raw materials to count toward recycling targets, just as mechanically recycled raw materials do.

[Slide: The scale-up challenge: BASF collaborates with partners to supply its Verbund with pyrolysis oil]

We want to rapidly implement chemical recycling on a large scale. To achieve this, BASF is working with partners, such as the Norwegian company Quantafuel, the German company Pyrum Innovations and the Hungarian company New Energy.

But why is chemical recycling not yet established? Apart from regulatory hurdles, this is mainly due to technological challenges.

There are two main challenges here:

First of all, the pyrolysis process needs to work reliably on a large scale – regardless of the composition of the plastic waste. In this scale-up, new simulation tools enabled by BASF’s supercomputer will help – by reducing development time and the costs of reactor design and optimization.

Secondly, the pyrolysis oil needs to be very clean and of consistent quality. The chemical industry has very narrow specifications for raw materials. And so smart solutions for purifying the pyrolysis oil will be crucial.

[Slide: The purification challenge: Together with Quantafuel, BASF develops purification catalysts for their technology]

Many different types of plastics are required for a wide range of applications. The different chemical compositions of different polymers give them their useful properties.

Many plastics do not just contain carbon and hydrogen, but also other atoms, such as chlorine, nitrogen, oxygen or sulfur. These “heteroatoms” are marked in orange here on this slide. In a chemical plant they can cause corrosion, create safety risks or poison process catalysts. That’s why all heteroatoms in the plastic waste must be removed during the pyrolysis process.

Here, a BASF core competence comes into play: catalyst development. Together with Quantafuel, BASF is developing purification catalysts using our high-throughput testing laboratory at hte Gmbh in Heidelberg, Germany.

[Slide: Chemical recycling broadens BASF’s feedstock base and leverages the Verbund concept]

Why is BASF involved in chemical recycling anyway? After all, we no longer produce mass plastics for single-use applications!

However, the challenges around recycling concern us all. And BASF is particularly well positioned to make chemical recycling a reality.

Firstly, thanks to our backward integration, we are able to flexibilize our raw materials.

Secondly, we can leverage our Verbund. We manufacture around 45,000 sales products from only a small number of raw materials.

The third component is our mass balance concept. BASF has ten years’ experience with certified mass balance approaches.

Finally, we are experts in high-temperature and high-pressure processes, and catalyst development is one of our strengths. BASF has the know-how to further develop and support the scaling up of this new and exciting pyrolysis technology.

[Slide: Next steps in BASF's chemical recycling partnerships]

BASF started the ChemCycling™ project in 2018. In a pilot phase, we fed some batches of pyrolysis oil into the Verbund. We manufactured a small range of prototypes with customers, for example, laundry detergent bottles, cheese packaging, refrigerator components and insulation boxes.

In October 2019, we announced a partnership with Quantafuel, including a BASF investment of 20 million euros. Quantafuel's first commercial-scale pyrolysis plant in Skive, Denmark, is currently ramping up regular production. At the same time, we are already working on the second generation in the laboratory. Next year, Quantafuel and BASF will start up a pilot plant in Kristiansund, Norway.

In 2020, the first commercial volumes of high-performance plastics from recycled feedstock were sold to pioneering customers. We also established further partnerships with Pyrum Innovations and New Energy to broaden our feedstock base.

We invested 16 million euros into Pyrum to support the expansion of their pyrolysis plant and the roll-out of the technology. Pyrum's pyrolysis plant can currently process up to 10,000 tons of waste tires per year. Waste tires are another completely new feedstock for the chemical industry.

We will utilize most of the pyrolysis oil and process it into new chemical products. BASF and Pyrum anticipate that production capacities of up to 100,000 tons of pyrolysis oil derived from waste tires could be built up within the coming years together with additional partners.

New Energy will supply BASF with up to 4,000 metric tons of pyrolysis oil per year derived from waste tires. We are also working on a joint feasibility study to convert other plastic waste streams.

[Slide: Bio-based products across the portfolio further broaden BASF's feedstock base]

Fossil raw materials are not the only possible feedstocks. We started introducing alternative feedstocks about 10 years ago – using bio-based raw materials and the biomass balance concept.

With our Circular Economy Program, we also want to increase the volume of renewable raw materials from sustainable sources.

In a wide variety of businesses, BASF has already developed products based on renewable raw materials. You can see examples from all BASF segments on this slide. All these examples are important and valuable for our customers. However, none of them can be scaled up as efficiently as chemical recycling in combination with the mass balance concept.

[Slide: BASF's Circular Economy Program: New Material Cycles]

Now, I would like to introduce the second action area of our Circular Economy Program: new material cycles.

Here, we focus on product-specific recycling loops. Important examples are the mechanical recycling of plastics and the recycling of battery materials.

[Slide: Established mechanical recycling loop for plastics]

The mechanical recycling of plastics is a success story. 50 million metric tons of used plastics are reprocessed globally – a remarkable achievement and the result of heavy investment.

However, mechanical recycling has limitations: It requires clean mono-material streams. This is crucial because the chemical structure remains unchanged. It is a polymer-to-polymer process.

Furthermore, mechanically recycled plastics do not generally have the same quality as new plastics. This is due to impurities. The thermal and mechanical stress during the recycling process damages the polymer chains. Consequently, the performance of recycled plastics is lower and often fluctuating. This is problematic in demanding applications, where strict quality and hygiene requirements must be met, such as in food packaging.

[Slide: Mechanical recycling – a fast-growing market enabled by innovative additives]

Despite these limitations, there is ample room for growth in mechanical recycling. The use of tailor-made additives can improve the properties of recycled plastics. BASF is developing these additive solutions to help create more value from recycled content and in this way, increase the circularity of plastics.

Together with optimized waste management and improved sorting technologies, additives will play a central role in mechanical recycling. This will allow for a higher proportion of plastics to be reused.

We expect the production of plastics from mechanical recycling to almost triple by 2030, driven by improved technologies and regulation. This corresponds to growth of around 10 percent per year.

As the market leader for plastic additives, we are expanding our broad portfolio. It will include new additive solutions specifically optimized for mechanical recycling. This allows us to participate in this growth and to become the leading supplier of plastic additives in this area as well.

[Slide: Innovative stabilizers enable mechanical recycling]

A very well-established mechanical recycling system is the one for PET bottles. You are all familiar with that one.

However, what you might not know is that the quality of the plastic deteriorates with each recycling cycle and the lifespan is limited. PET tends to yellow or grey when recycled. This illustrates that mechanical recycling loops are not endless.

Technical solutions are required to improve the quality of recycled plastics and to increase the number of recycling loops. Our researchers are developing additives that can specifically stabilize recycled plastics and improve their properties.

If innovative stabilizers are added during the production of the recyclate, discoloration can be completely prevented. This enables the use of recycled plastics in applications of equal or even higher value.

[Slide: Innovative compatibilizers enable higher recycling rates]

Another major challenge in mechanical recycling is purity. Sorting and separating plastics is not trivial, and it is expensive. It does not always work perfectly – despite all the technical progress that has been made.

A good example here is again PET recycling: Who of you removes the bottle cap before you dispose of the bottle?

The cap is mainly made from polypropylene, while the bottle is made from PET. Unfortunately, most polymers do not mix well due to their different chemical compositions. It is like mixing oil with water – creating droplets.

On this slide you can see microscope images of such a sample of mixed polymers. The droplets in the upper picture are clearly visible. In plastics, they cause brittleness and poor material quality.

By adding a compatibilizer, the mixture becomes more homogeneous and more stable. This can be seen on the picture at the bottom.

Compatibilizers are surface-active molecules, like modern detergents. They act as an adhesive between the two domains and improve the mechanical strength of the recycled material.

Compatibilizers enable higher recycling rates and improve the economics of mechanical recycling.

[Slide: Footprint of key battery materials]

Now, I would like to move on to another important area of R&D for new material cycles.

By the year 2030, more than 7 million electric cars will be registered in Germany alone. At the same time, the raw materials for producing key vehicle components are limited. Moreover, sourcing these materials often has a substantial environmental impact.

At the heart of an electric car is the battery, and at the heart of the battery are the electrodes. The anode is made of graphite, and the cathode contains the valuable metals cobalt, nickel and lithium.

Mining 1 kilogram of class 1 nickel, for example, requires more than 100 kilograms of drinking water. Lithium even requires more than 270 kilograms of drinking water. Therefore, it is imperative that metals are recovered as fully as possible.

BASF supports the European Commission’s goal of establishing a sustainable network for batteries here in Europe. To achieve this, we urgently need solutions to recover the valuable raw materials from used batteries – in an economical and environmentally sound way.

In the following, I will show you how we are helping to close the loop in the battery value chain.

[Slide: The new value chain for electric vehicles – recycling closes the loop]

To build up a circular economy, the used battery packs must be collected, disassembled and processed. The resulting so-called “black mass” plays an important role as an intermediate product.

To create a circular economy for battery materials, the two crucial steps of collection and metal extraction must be sustainable and economically viable.

[Slide: Processing “black mass” – comparison of main technologies]

After disassembling the battery packs, the battery cells are shredded and sorted. Steel, copper and aluminum can directly be sent for recycling. The remaining black mass contains the active electrode materials: cobalt, nickel, manganese, lithium and graphite. The black mass also contains a range of impurities.

The valuable metals have to be extracted from the black mass in chemical process steps. There are two fundamentally different approaches here: pyrometallurgy and hydrometallurgy.

In pyrometallurgy, the black mass is placed in a smelter and heated to around 1,500 degrees Celsius. The battery graphite burns in the process and supplies parts of the required energy – with significant CO_2 emissions. The noble metals copper, nickel and cobalt form a rather clean alloy, which can then be separated into the individual metals. The less noble metals, including lithium, are separated with additives – as a slag. It is technically possible to extract the valuable resource lithium from the slag, but only at high cost.

Hydrometallurgy works with aqueous solutions at low temperatures. Copper, nickel, cobalt and lithium can all be recycled in this way. However, the process involves many steps, which is always capital-intensive. Plus, a whole range of by-products are formed. For example, for every ton of lithium, at least 10 tons of sodium sulfate waste are produced. This is where our research comes in.

[Slide: New BASF process scheme avoids waste]

Our work is based on hydrometallurgy, but with an important innovation: We extract the lithium first.

Our process consists of two steps:

In the first step, we directly extract lithium from the black mass as a hydroxide, which is what we want. Lithium hydroxide is the lithium compound used to produce battery materials.

Today, hydrometallurgy only yields lithium carbonate, which later has to be converted into the hydroxide. Our idea delivers high yields, significantly cuts costs and avoids large amounts of undesired by-products.

In the second step, nickel and cobalt can now be extracted. This second step could directly be coupled with existing metal refineries, saving investment costs.

Overall, the new BASF process will reduce the environmental footprint of lithium recycling and make the process chain more flexible.

[Slide: Next steps in closing the loop in battery materials]

Let me summarize: Efficient lithium recycling is crucial for a reliable circular economy in electromobility. Our innovative process will reduce the CO_2 footprint of lithium recycling and enable it to be combined with existing value chains.

What are our next steps? We have successfully completed the laboratory phase, and are currently in the scale-up phase. The first successful pilot tests were conducted in 2020. We are designing a pilot plant, integrated into our production in Schwarzheide. We would like to put this pilot plant into operation in 2022.

[Slide: BASF's Circular Economy Program]

Ladies and Gentlemen,

I hope you enjoyed gaining some insights into important projects in BASF's Circular Economy Program.

Let me now spend a few more minutes on the third area of development – new business models and how we intend to monetize this transformation.

[Slide: Product Carbon Footprints create transparency for customers]

Many of our customers aim to reduce their CO_2 footprint. To truly support them, the industry needs a new level of transparency for its raw materials and processes.

We recently announced that by the end of 2021, we will be the first chemical company to provide our customers with a carbon footprint for our 45,000 sales products. With our proprietary digital solution, we will be able to determine the overall CO_2 emissions for each individual sales product.

The product carbon footprint will be reported as CO_2 units per metric ton of product. It will include all emissions that occur until the product leaves the factory gate, meaning scope 1, scope 2 and scope 3 emissions. BASF’s customers have shown great interest in this innovative tool and the resulting transparency.

Sustainability and digitalization are core elements of our corporate strategy. Calculating the product carbon footprint brings these two elements together.

With this innovative solution, BASF is once again a front-runner when it comes to sustainability and additional customer benefits.

[Slide: Profitable growth with transformation – based on resource efficiency of the Verbund and the Mass Balance concept]

We are talking about new business opportunities here. In a few years, BASF will command an entire toolbox including:

- renewable feedstock under the biomass balance approach,
- recycled feedstock through ChemCycling™ technology,
- green or turquoise hydrogen from electrolysis or methane pyrolysis,
- renewable energy sources,

- and, last but not least, the necessary transparency on footprints and reduction potentials.

This toolbox will enable us to support our customers with sustainable solutions. It will allow us to differentiate from competitors. It is clear, however, that incremental, specific CO_2 reductions have their price for customers and consumers.

At the same time, lower-emission products have higher growth rates. This is why we are convinced that the transformation toward a low-carbon and circular economy will create opportunities for BASF's profitable growth.

[Slide: Circular Economy and Carbon Management Programs – BASF's way to drive sustainability]

Ladies and gentlemen,

To conclude, I would like to address our Carbon Management Program once again.

With the Green Deal, the E.U. has the ambitious goal of being climate-neutral by 2050. BASF has taken a clear position with its corporate strategy: We have committed ourselves to climate-neutral growth until 2030.

This means that we will further reduce specific CO_2 emissions per kilogram of sales product – by an average of around one-third. In addition, we are developing fundamentally new technologies to reduce emissions even further.

The Carbon Management Program and the Circular Economy Program enable us to support our customers with tailor-made innovations – all the way to carbon neutrality. These innovations drive BASF's sustainable growth.

And this depends on excellent R&D with creative, highly motivated employees. That is exactly what we have at BASF. Innovations have made BASF successful. And with innovations, we will continue to be successful in the future.

Thank you very much!