



CEO Guide to the Circular Bioeconomy

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THE FUTURE **IS IN YOUR HANDS**

The circular bioeconomy is a **USD \$7.7 trillion¹ opportunity.**

While the global population has doubled over the last 50 years, resource extraction has tripled. 90% of biodiversity loss and water stress are caused by natural resource extraction and processing. **Unless we become more effective in how we harvest, process, use and reuse biological resources, we will be confronted with the catastrophic consequences of climate change, biodiversity loss and resource scarcity.**

The bioeconomy is the consumption of biological resources for the production of food and feed, products and energy.

Increasingly recognized as a way to deliver society's needs while responding to environmental challenges, the bioeconomy is a nature-based solution that enables more than 9 billion people to live well within the limits of the planet.

As decarbonization accelerates, the bioeconomy will become a much larger part of the global economy. To ensure we respond to the urgent calls to action for both climate and nature, it is essential that our future bioeconomy is circular, low-carbon and sustainable.

In a circular bioeconomy, biological resources are renewable, sustainably managed, recovered and reused as much as possible. Allocation of bio-based resources should be prioritized based on greatest societal needs, environmental benefits and value created.

We call for the shift towards a sustainable, low-carbon, circular bioeconomy to capture part of the USD \$7.7 trillion opportunity, while ensuring a healthy planet for generations to come.

¹ BCG Analysis: Estimated potential of circular bioeconomy for products, energy, food and feed waste in 2030 excl. consumed food and feed.

Source: [IPCC report](#), [Global Resource Outlook 2019](#), WBCSD, BCG analysis, Member companies

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FIVE URGENT ENVIRONMENTAL PRIORITIES, ONE COMMON SOLUTION

Climate change

We know that harnessing the power of natural climate solutions to improve decisions related to land use can provide at least 30% of what is needed to keep climate change under 2° C.

The Nature Conservancy²

Resource scarcity

Global resource use has more than tripled since 1970, and global material productivity has not improved in the last 20 years.

UN IRP⁶



Food loss & waste

Each year, one-third of all food produced in the world for human consumption never reached the consumer's table.

FAO⁵

Biodiversity loss

Without drastic action to conserve habitats, the rate of species extinction — already tens to hundreds of times higher than the average across the past ten million years — will only increase.

Nature³

Land use change

Land degradation negatively impacts 3.2 billion people, and represents an economic loss in the order of 10% of annual global gross product.

IPBES⁴

**THE CIRCULAR
BIOECONOMY
SOLUTIONS**



The circular bioeconomy is a solution to all five priorities

² [The Nature Conservancy. Natural Climate Solutions: Nature's Sleeping Giant.](#)

³ [Referencing IPBES Global Assessment Preview summary report.](#)

⁴ [IPBES. The assessment report on land degradation and restoration: summary for policymakers.](#)

⁵ [FAO. Food wastage footprint & climate change, 2011.](#)

⁶ [UN IRP. 2019 Global Resources Outlook: Implications for Business Leaders.](#)

THE CIRCULAR BIOECONOMY: A SYSTEM OF RESOURCES CRUCIAL FOR GROWTH

Tomorrow's economy depends on today's shift to the circular bioeconomy.

Our current economic model highly depends on finite resources such as fossil fuels, posing several business risks such as resource scarcity, climate change and supply chain disruptions. Our current model extracts 90 billion tonnes of resources annually of which 75% are fossil-based. This trend is further accelerated with fossil extraction growing at more than 20% while bio-based is only growing at 13% until 2030.

Currently representing 7% of today's economy, the circular bioeconomy is the shift away from fossil fuels and captures maximum value from biological resources.

The circular bioeconomy should be sustainable and low-carbon while meeting society's needs for food, products and energy. In a circular bioeconomy, biological resources should be renewable, sustainably managed, recovered and reused as much as possible. In doing so, it provides a solution to our greatest environmental challenges, including:

- Climate change
- Resource scarcity
- Food loss and waste
- Land use change
- Biodiversity loss



Recycling nutrients is a must to make farming more sustainable. We have to capture, recycle and re-use.

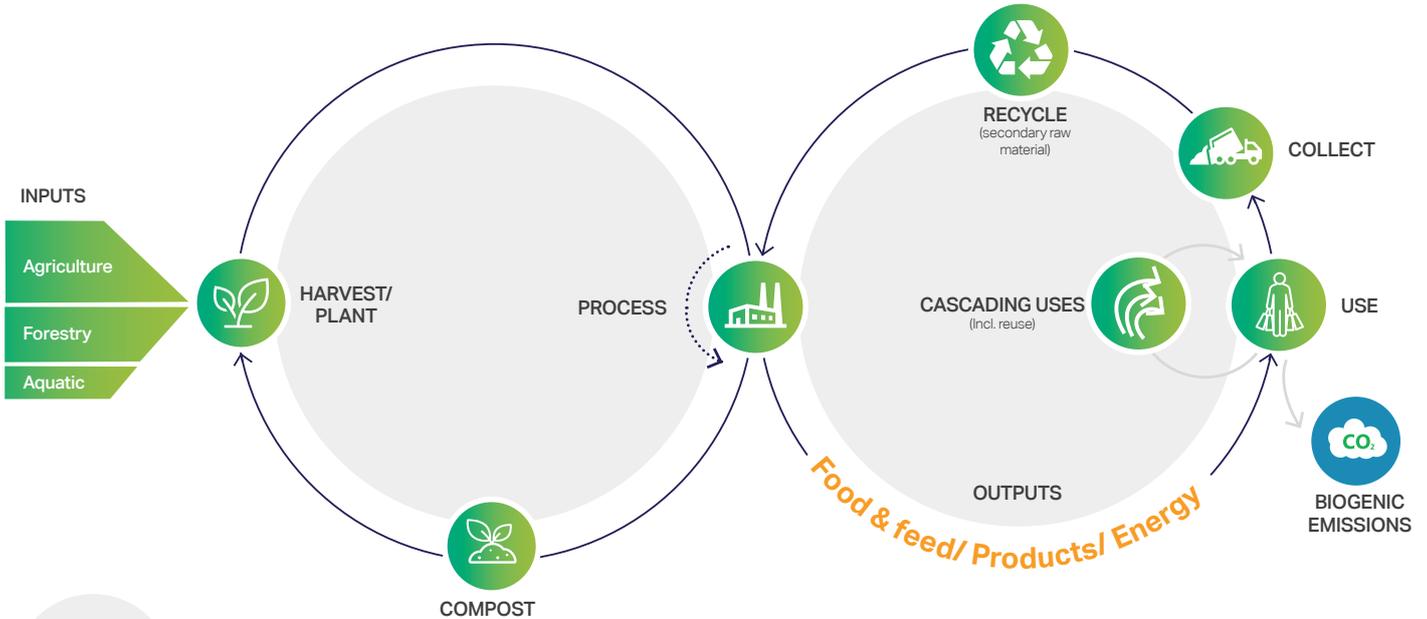
Svein Tore Holsether
President & CEO, Yara



Source: [Eurostat](#); [OECD report 2018](#); [Circular Gap report 2019](#); [WU Vienna](#); WBCSD; BCG analysis, Member companies

Harvested biomass is processed to become food and feed, products and energy. After use, those resources

are collected, recycled and either reprocessed into products or energy or composted.



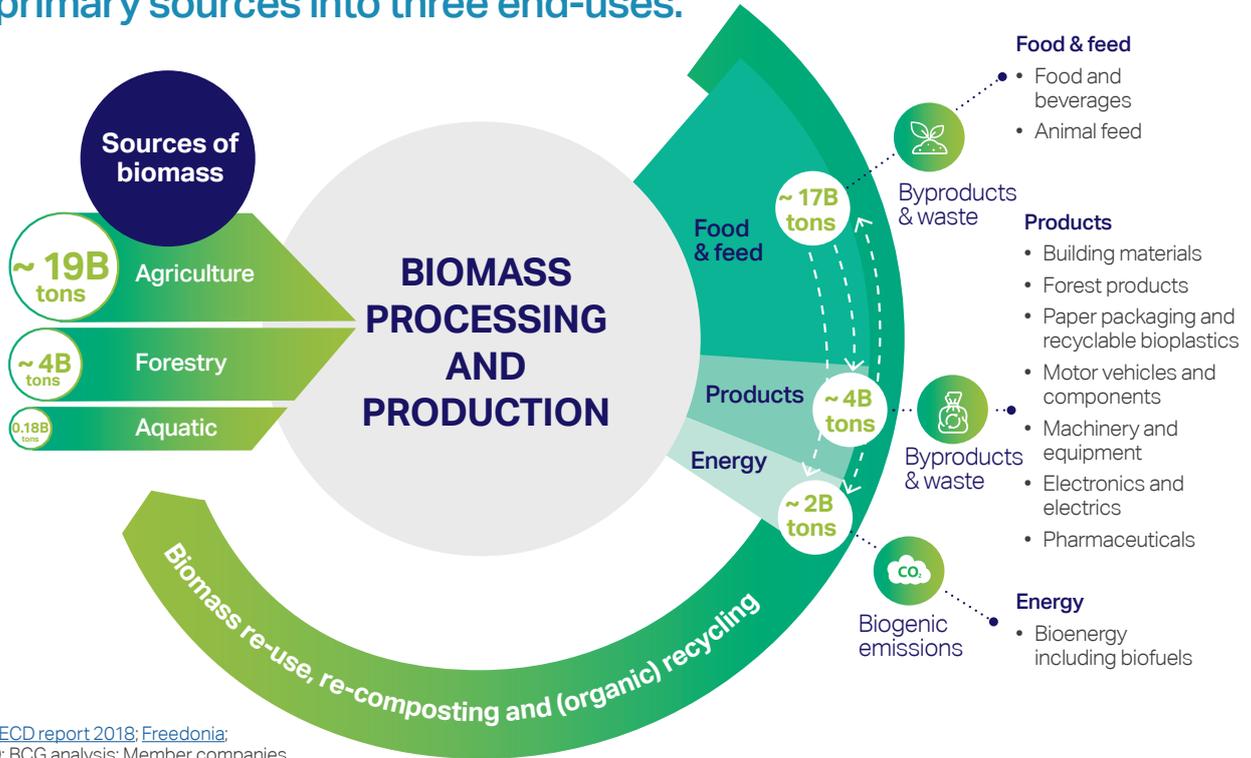
WBCSD PROGRAMS

FOOD & NATURE
Forest Solutions Group, Fresh, Climate Smart Agriculture, Food Loss & Waste

CIRCULAR ECONOMY
Factor 10

THE CIRCULAR BIOECONOMY

Biomass, the foundation of the bioeconomy, flows from three primary sources into three end-uses.



Source: Eurostat; OECD report 2018; Freedonia; WU Vienna; WBCSD; BCG analysis; Member companies.



Combining bio-based fragrance ingredients with the expertise, creativity and passion of our people is how we deliver more sustainable products, satisfying the growing market demands while protecting the planet.

Andreas Fibig
Chairman & CEO, IFF



BUSINESS CASE: THE CIRCULAR BIOECONOMY UNLOCKS MULTIPLE OPPORTUNITIES

Moving towards the circular bioeconomy makes business sense.

ENTER NEW MARKETS AND CUSTOMER SEGMENTS: The circular bioeconomy can help improve **financial performance** and company growth rates by e.g., creating **new markets**, accessing **new customer segments**, sourcing responsibly and enabling **new value chains**.



MITIGATE REGULATORY AND SOCIETAL RISKS: Companies can actively **reduce regulatory risks** of upcoming regulations in areas such as climate change or waste management. Companies can **be at the vanguard** in societal shifts towards material bans or investors' demand.

PROVIDE COMPETITIVE ADVANTAGE: Companies can do business with less environmental impact. This will give competitive advantage, **attract and retain talents and new customers**.



Resins Discovery® by DSM

Plant-based paint resins used for walls, flooring and furniture for healthy homes. Decreased carbon footprint by 34% as compared to oil-based resins, up to 49% renewable material content, aiming at 100% and thus, fully circular in the future.



Design & Consultancy
for natural and
built assets

Construction of Arcadis, Holland Casino Venlo by MVSA Architects

Circular design based on biomimicry and structure of plants. Reusable and bio-based materials e.g., hemp fibers for insulation, and bio-based asphalt and wooden beams provide energy neutrality and cost-effective sustainability.

* Estimated potential of circular bioeconomy for products, energy, food and feed waste in 2030 excl. consumed food and feed.



The circular
bioeconomy
represents

USD \$7.7 tn*

business
opportunity
until 2030

THE CIRCULAR BIOECONOMY:

The USD \$7.7 trillion opportunity in the circular bioeconomy spreads across industries.

The table below shows the size of the prize for each industry (in USD \$B), in 2018 and 2030, based on BCG analysis.

	Bioenergy & biofuels	Food & feed waste ⁷	Pharmaceuticals	Textiles & wearing apparel	Building materials & construction
2018	150	2,300	250	400	350
2030	200	2,600	750	700	700
MARKET SIZE (IN USD \$ BILLION)	<ul style="list-style-type: none"> • Solid bioenergy incl. wood pellets (from by-products) • Liquid biofuels incl. biodiesel, biomethane, cellulosic ethanol, renewable "drop-in" fuels 	<ul style="list-style-type: none"> • Waste repurposing • Organic nutrient upcycling • Silk, satin and viscose-like fabric from orange peel 	<ul style="list-style-type: none"> • Vaccines from medicinal plants & herbs • Cancer treatment synthesized from plant substances • Blockchain technology to produce protein-based medication 	<ul style="list-style-type: none"> • High-tech fibers • Fibers made from biomass or biowaste • Plant tanning agents • Compostable textiles • Compostable lyocell, modal 	<ul style="list-style-type: none"> • Circular wooden structures • Composites reinforced with natural fibers • De-commissionable bio-based insulation materials

Source: WBCSD, BCG analysis, Member companies

Note: Striving for food loss and waste reduction needs to be the ultimate objective, yet repurposing and recycling is aspired for non-used food & feed

⁷ USD \$2.3 trillion is estimated higher than existing food loss and waste calculations as it also includes feed and the valorization of all losses and wastes.

					TOTAL ⁸
Packaging	Motor vehicles & components	Other forest products	Electronics & electrical products	Machinery & equipment	Total circular bioeconomy ⁹
400	250	150	100	50	USD \$5.750
550	550	200	200	100	USD \$7.650
<ul style="list-style-type: none"> • Recyclable flexible packaging paper & paper board • Paper packaging replacing plastics (e.g., packaging board for beverages) • Recyclable bioplastics • Biodegradable starch blends and plastics 	<ul style="list-style-type: none"> • Natural fibers for car parts • Compostable interior lining based on bioplastics • Tires based on dandelion in closed loop system 	<ul style="list-style-type: none"> • Bio lubricants • Enzyme-based additives 	<ul style="list-style-type: none"> • Recyclable bioplastics • Polymers reinforced by natural fibers • Bio-based casings • Lignin for recyclable battery parts 	<ul style="list-style-type: none"> • Bioprocess engineering • Agricultural engineering 	

⁸ Gap between total market sized and summed up market size is explained by "other products and industries not outlined in this double page"

⁹ excl. consumed food and feed



As resources become scarcer and demand from growing economies increases, a circular economy becomes essential. Innovation, in products, process and partnerships is core to sustainable economic growth and a major portion of our client work. The circular bioeconomy will be a key contributor to a more sustainable, circular global economy.

Rich Lesser
CEO, BCG





The chemical industry is central to solutions for global challenges such as climate change and resource scarcity. Bio-based chemical products and solutions can contribute greatly to a more sustainable, low-carbon circular bio-economy.



Hans Bohnen
Executive Committee Member,
Clariant

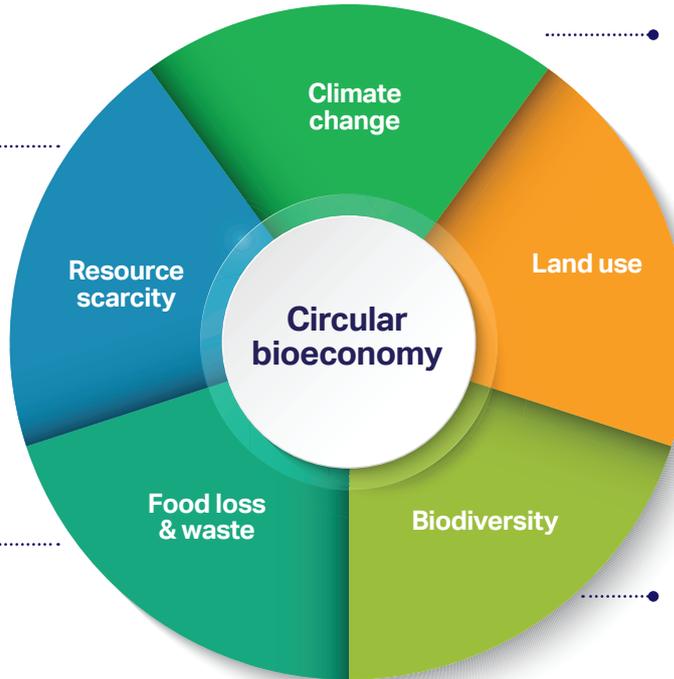
THE CIRCULAR BIOECONOMY

A solution to today's greatest environmental challenges.

The circular bioeconomy alleviates resource supply risks by shifting from fossil-fuel and non-renewable resources towards sustainable, renewable biomass.



Production and use of food and feed is smarter, minimize waste generated. Any waste and by-products should be recovered and used as products or energy.



A circular bioeconomy contributes to the Paris Agreement by **reducing fossil-fuel consumption, reusing biomass over multiple life cycles** and eventually serving as alternative fuel for energy-intensive industries.



Biomass serves many functions over multiple lifetimes, maximizing value created and **relieving pressure on land**.



Production and harvesting of biomass is sustainable and regenerative, promoting biodiversity and contributing to the Convention on Biological Diversity.

CIRCULAR BIOECONOMY TRADEOFFS

When transitioning to a circular bioeconomy, companies can face various trade-offs. We identified five main tradeoffs and provided recommendations to address them.

What are the tradeoffs?

EXAMPLES IN WHICH TRADEOFF DISCUSSIONS CAN ARISE



CHEMICALS

What effect does the product life cycle have on the climate and carbon emission?

Estimate energy consumption for production of bio-based, biodegradable plastics as compared to conventional plastics



BIOFUELS

How much land is used during the process?

Assess total land required for biofuel production



CONSTRUCTION

How does the built infrastructure impact biodiversity?

Reduce the building's environmental footprint by sourcing materials from sustainably managed forests and recovered resources



TEXTILES

How much water is consumed?

Compare water consumption during cotton cultivation versus polyester processing for textile production



FOOD & FEED

Could the circular bioeconomy compete with food supplies?

A sustainable circular bioeconomy should prioritize the use of secondary biomass and byproducts, minimizing competition with nourishment need

THE CIRCULAR BIOECONOMY LEADS TO INNOVATION ACROSS THE WHOLE VALUE CHAIN

AGRITECH RESEARCH



Syngenta offers AFLA-GUARD®, a natural biocontrol product derived from a non-toxic fungus. When applied, the product significantly reduces aflatoxin contamination levels to help improve productivity and marketability of corn and peanuts. The product protects crops from harmful fungi, improves crop quality, reduces soil and water contamination, enhances agricultural biodiversity and makes the food safer for consumers.

BIO-BASED FRAGRANCES



Catalogue of over 1,500 renewable ingredients, derived from a variety of bio-based sources from natural oils to waste streams from the paper industry, enable IFF to continue to develop its innovative portfolio of circular scents. This also helps reduce the carbon footprint of its supply chain and insulate IFF from petrochemical supply disruptions.

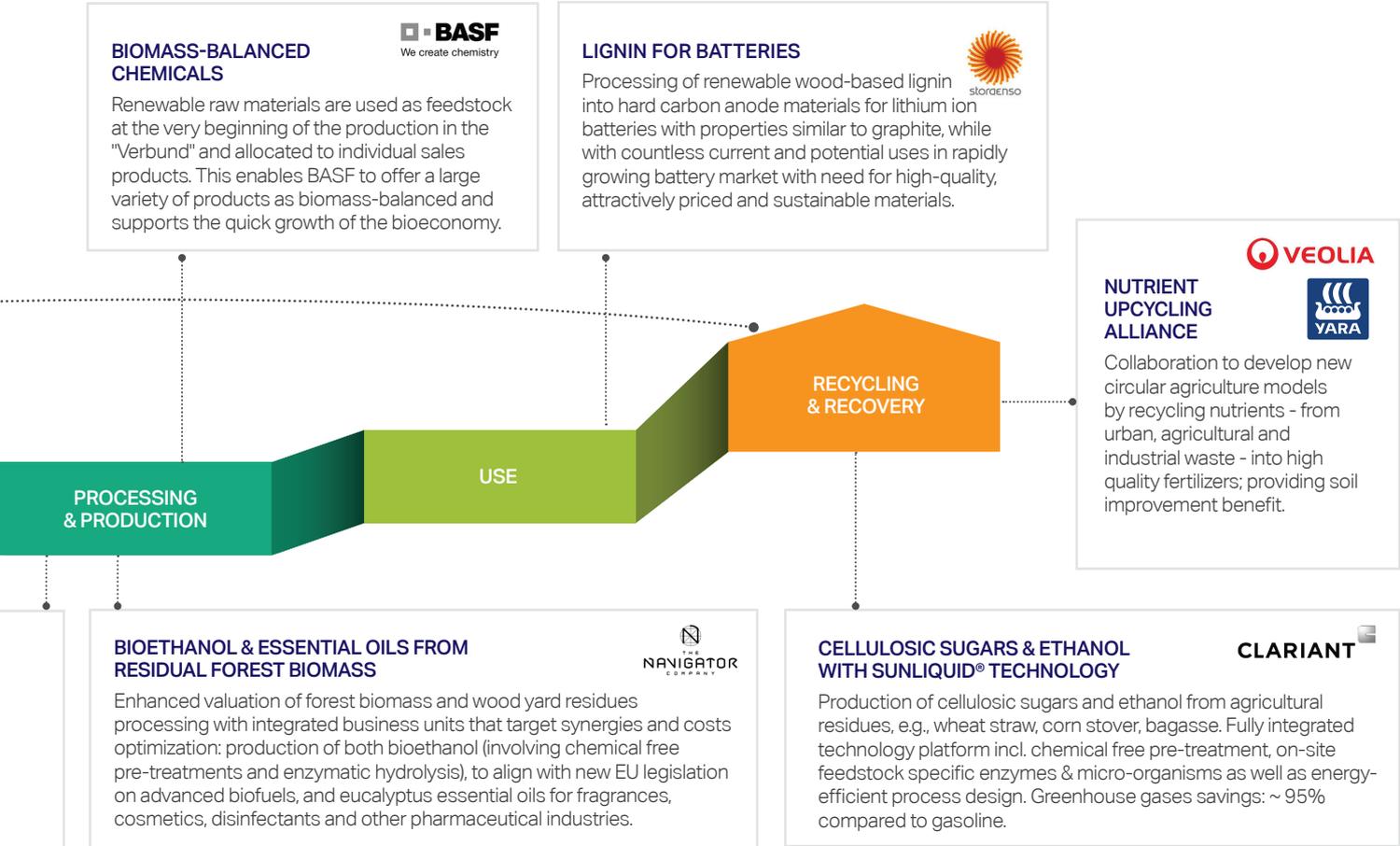
DESIGN & INNOVATION

GROWING, DEVELOPMENT & SOURCING



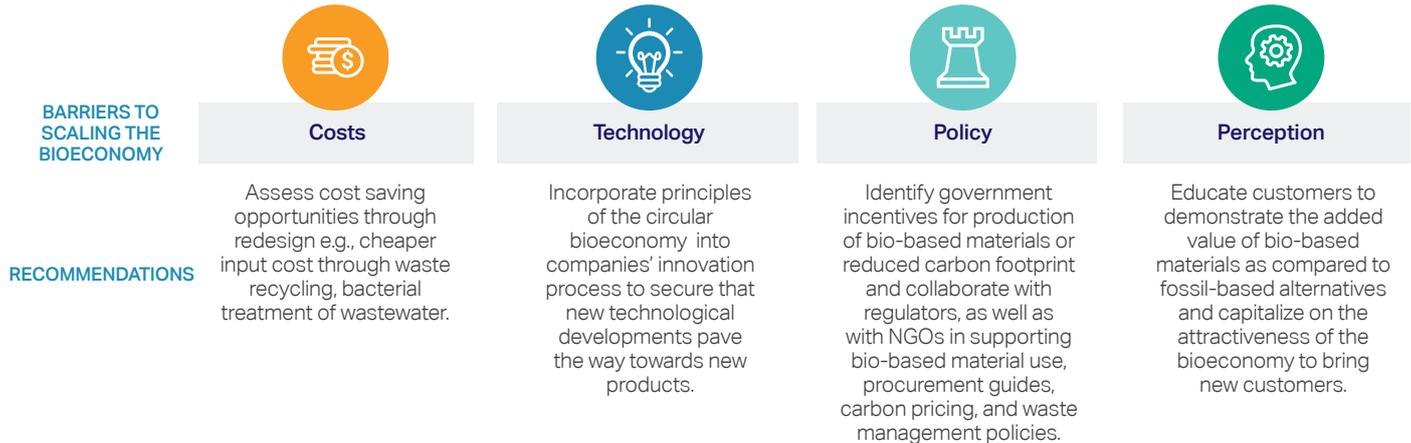
CONVERSION INTO BIOREFINERY

Eni has given new life to its Venice refinery (Italy) making it the world's first example of a conversion of a conventional refinery into a biorefinery. The plant is now able to process vegetable oil, animal fats, non-edible oils and residues coming from other industrial processes (e.g. from used oils, animal fats, cosmetic industry and from bioplastic production) into high-quality biofuels. Used cooking oils (UCOs) usually make up 25% of the feedstock, but they can be increased to as much as 50%.



CURRENT BARRIERS TO SCALING THE CIRCULAR BIOECONOMY

When transitioning to a circular bioeconomy, companies face cost, technology, policy and perception challenges.





Energy transition requires a change of habits. This means also building new demand models and deploying new technologies to obtain new products and energy from biomasses and waste.



Claudio Descalzi
CEO, Eni



FOUR HIGH-LEVEL ACTION POINTS TO GET YOUR COMPANY STARTED IN THE CIRCULAR BIOECONOMY

1 Identify entry point

Set clear targets and identify processes and products which are suited for circular bioeconomy

2 Evaluate sustainability trade-offs

Conduct assessments that support the evaluation of sustainability trade-offs (e.g., life cycle assessment)

3 Collaborate

Collaborate and find partners to turn waste streams into value streams. Working with all value chain partners, from sourcing, to product design, to policy makers and consumers

4 Start small, then scale

Start to develop new product innovations with clear business cases that pave the way for disruptive business models and bring your customers to the circular bioeconomy



We have to move our economy from linear to circular to meet society's needs within the limits of the planet. Fostering the bioeconomy is an essential contribution to this end. That's why BASF is innovating to use sustainable renewable raw materials and to close the loops in our value chains.

Martin Bruder Müller
CEO, BASF



BE PART OF THE CHANGE



BE PART OF **THE CHANGE**

Get engaged in the circular bioeconomy work at WBCSD

Factor 10

Factor10 is WBCSD's circular economy project. It brings companies together to reinvent how business finds, uses and disposes of the resources and materials that make up global trade. It is the global business collaboration delivering innovative, scalable solutions for the circular economy.

<https://www.wbcd.org/Programs/Circular-Economy/Factor-10>

Forest Solutions Group (FSG)

WBCSD's Forest Solutions Group (FSG) is the global platform for the forest sector value chain to build and share business solutions to lead sustainable development in the forest products sector. FSG's mission is to advance the bio-economy and a thriving forest sector that sustains healthy productive forests and people's well-being.

<https://www.wbcd.org/Sector-Projects/Forest-Solutions-Group>

Food & Nature

Projects in our Food & Nature Program develop solutions to address key challenges of food & land use systems: food and nutrition security, smallholder livelihoods, natural resource efficiency, including water management, climate change impact and adaptation - using comprehensive approaches and new technologies.

<https://www.wbcd.org/Programs/Food-Land-Water>



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