Next Generation Solutions

THEIR CONTRIBUTION TO THE SUSTAINABILITY FOCUS AREAS

EVONIK
Leading Beyond Chemistry

Next Generation Solutions

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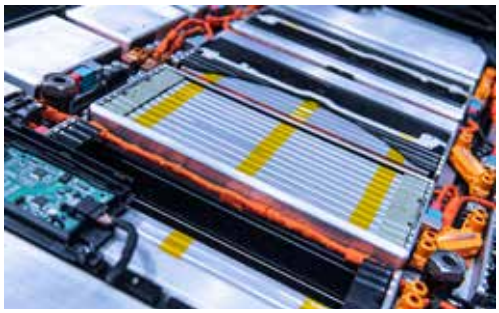


The intention of this brochure is to provide more detailed information on selected products and solutions with a clearly positive sustainability profile, i.e. our Evonik Next Generation Solutions (NGSs). Special attention is paid to the contribution of these NGSs to the four Sustainability Focus Areas (SFAs) – that bundle our contributions to a sustainable transformation – and describe their sustainability benefits (also referred to as their handprint).

After introducing the SFAs and the Evonik Portfolio Sustainability Assessment (PSA) methodology, the handprint evaluation of some NGSs is detailed. These assessments are evidence for a positive PSA score and allow a better understanding of the contribution of an NGS to one of the SFAs.

The brochure begins with a report on the greenhouse gas emission reductions of selected NGSs – so-called "avoided emissions"[1]. It then describes further NGSs and their associated benefits, paying special attention to their contribution to one of the four sustainability focus areas.

Where possible, a quantitative estimation of the handprint is given. Due to the profound interest in quantitative and precise information on handprints in some value chains and good data availability, several examples from automotive and food applications are described in this brochure.

[1] Until 2021, results and further information on "avoided emissions" have been reported in the Evonik carbon footprint brochure. Cf. https://corporate.evonik.com/Downloads/Corporate%20Responsibility/evonik_2022_ecf_2021_en.pdf

FIGHT CLIMATE CHANGE	DRIVE CIRCULARITY	SAFEGUARD ECOSYSTEMS	ENSURE HEALTH & WELLBEING

AVOIDED EMISSIONS THROUGH THE USE OF SELECTED EVONIK PRODUCTS

44.3
million tons CO_2e

quantified	quantification ongoing	quantification ongoing	quantification ongoing

Content

3 Handprint of selected Evonik's Next Generation Solutions (NGS) for the four Sustainability Focus Areas

Evonik's four Sustainability Focus Areas

1

Evonik's four Sustainability Focus Areas (SFAs)

Our contributions to sustainable transformation are bundled in the four Sustainability Focus Areas (SFAs):

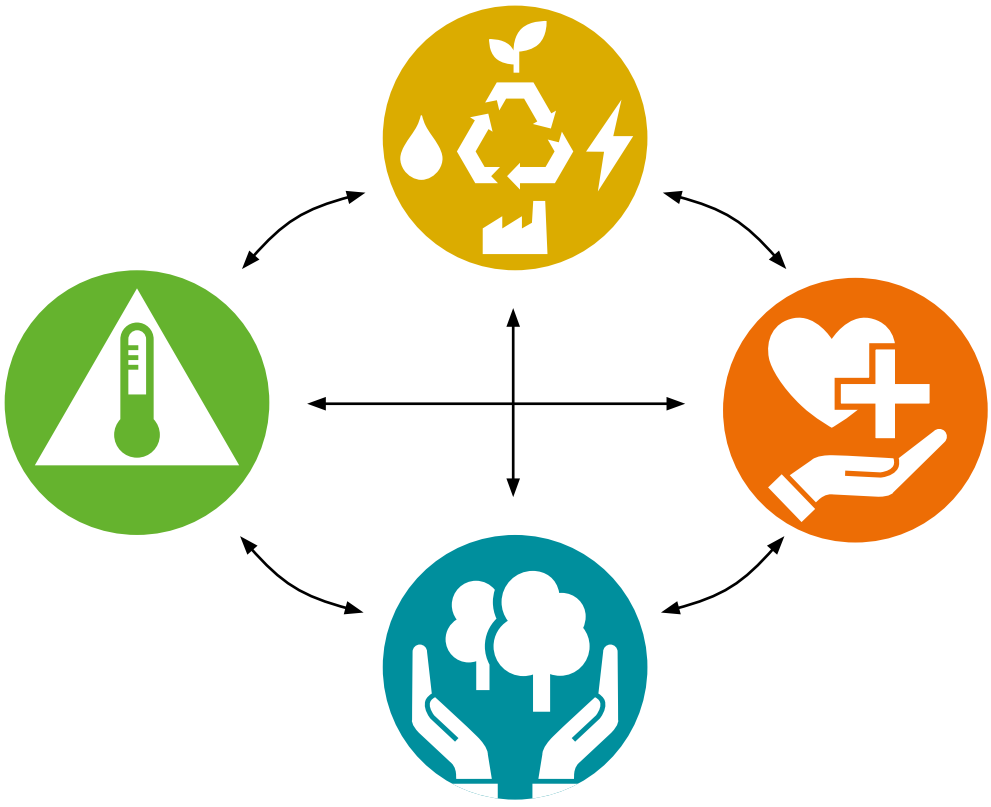
- Fight Climate Change
- Drive Circularity
- Safeguard Ecosystems and
- Ensure Health & Wellbeing.

Within each SFA, Evonik is working on reducing its ecological (and social) footprint and enhancing its handprint resulting from product application.

Each SFA addresses specific sustainability topics.

The following page summarizes our understanding and definition of each SFA, the topics addressed, as well as the relevant United Nations' Sustainable Development Goals (SDGs).

The relevance of each SFA for our business activities has been analyzed in order to define the current state of our impact and our next actions and ambitions.



FIGHT CLIMATE CHANGE

- Reduce Scope 1 and 2 greenhouse gases (GHG) reduction
- Reduce Scope 3 GHG
- Reduce Scope 1-3 carbon intensity
- Reduce specific energy use
- Increase share of renewable electricity
- Enable avoided emissions

DRIVE CIRCULARITY

- Increase share of circular raw materials[2]
- Enable resource reduction by process optimization, enhancing durability or other options for lifetime extension
- Enable or improve recycling (mechanical or chemical)

SAFEGUARD ECOSYSTEMS

- Establish water stewardship (focus on blue water consumption[3] reduction and water scarcity)
- Establish ecosystem stewardship (focus on land use)
- Access to bio-based raw materials which comply with environmental and social sustainability requirements
- Reduce eutrophication and acidification
- Reduce emissions and leaching of disputed chemicals, microplastic, and other persistent chemicals

ENSURE HEALTH & WELLBEING

- Reduce hazardous emissions
- Reduce hazardous solid waste
- Reduce sales with disputed chemicals
- Enable customers to replace disputed chemicals
- Enable reduced exposure to Volatile Organic Compounds (VOC) and microparticulate matter
- Grow number of patients or vulnerable consumers reached with health outcomes

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[2] There are three sources for circular feedstock: recycled feedstock (can come from fossil- or bio-based waste), bio-based feedstock, CO_2-based feedstock (could be produced using different technologies).

[3] Blue Water Consumption (BWC) refers to surface or groundwater that is either evaporated, incorporated into a product or taken from one water body and returned to another, or returned at different time.

1.1 FIGHT CLIMATE CHANGE

STATUS QUO

- We committed to science-based targets in 2022.
- Within the EAGER program[4] , 25% reduction of our scope 1&2 emissions by 2030 have been validated for technical feasibility with CapEx needs and OpEx effects and a positive business case. Main drivers are energy efficiency measures, electrification, exiting coal-based steam and electricity generation, and procurement of renewable electricity. We challenge our sites for reduction pathways in line with a 1.5 degree scenario.
- Completion of installation of an alternative steam and electricity generation in Marl in 2022, to terminate coal-based technology. Complete exit of coal has been postponed to respond to actual energy crisis in Germany
- We have responded to the energy crisis in Europe by reducing the demand for natural gas by 40% against the 2022 planning through intermediate measures in Germany
- Supplier engagement program started to reduce procured materials scope 3 emissions. Product Carbon Footprint guidelines launched within the Together for Sustainability (TfS) initiative to help suppliers to quantify and reduce carbon footprints.
- CDP Climate Change awarded Evonik a grade of A- in 2021
- Continuous dialogue with business lines and customers to increase the understanding of our product impacts and to quantify avoided emissions.

FIELDS OF ACTIONS & AMBITIONS

- Align the Next Generation Technologies roadmap with business lines and sites and integrate it into CapEx planning process.
- Better understand costs and availability of green raw materials and engage with our suppliers and customers to pass on these costs along the value chain.
- Intensify efforts to secure renewable electricity.
- Intensify dialogue with our customers and partners to avoid emissions along the value chain.

AWARD

CDP Climate Change awarded Evonik a grade of A- in 2021.

40%

We have reduced the natural gas demand in Germany by 40%.

[4] EAGER stands for the Evonik Assessment of Greenhouse Gas Emission Reduction started in 2022 to assess main CO_2-emitting sites and define a clear implementation plan with reduction measures.

1.2 DRIVE CIRCULARITY

STATUS QUO

- Around 10% of Evonik raw materials are bio-based.
- The Evonik Circular Plastics Program[5] is working on and highlighting significant contributions to the circular economy, specifically to increasing the recycling rate of plastics.
- Framework on how to assess circularity in PSA established in 2021 covering contributions to circular economy along the value chain like circular raw materials, resource reduction by e.g. higher durability, recycling, renature (describing a closed carbon loop with products that are 100% bio-based and 100% bio-degradable) or increased longevity by reuse/repurpose/repair/remanufacturing.
- This is informed by our active contribution to WBCSD's guidance on circularity assessment in PSA, which is currently under development.

FIELDS OF ACTIONS & AMBITIONS

- Improve tracking of circular raw materials and understanding for best use for alternative source.
- Combine increased share of circular raw materials with reliable supply.
- Create sufficient supply chain control (e.g. via partnerships or backintegration) for relevant raw materials.
- Select specialty technologies and business where circular economy is most material to deepen understanding of our impact downstream.
- The Evonik Global Circular Plastics program has an additional sales potential of €350 million per year from 2030.
- Apply circular chemistry principles in innovation.[6]

HARD FACT

Evonik Circular Plastics Program is working on increasing the rerecycling rate of plastics.

[5] https://corporate.evonik.com/en/sustainability/circular-plastic/
[6] Tom Keijer, Vincent Bakker, and J. Chris Slootweg: Circular Chemistry to enable a Circular Economy. Nature Chemistry, Volume 11, March 2019., 190-195. DOI: 10.1038/s41557-019-0226-9

1.3 SAFEGUARD ECOSYSTEMS

STATUS QUO

- > 70% of Evonik blue water consumption (BWC) results from the upstream value chain (i.e. fossil and bio-based raw materials). Biodiversity also has key relevance upstream.
- Bio-based and recycling based raw materials usually have a higher specific BWC than fossil ones, so a portfolio shift might result in an increase BWC.
- Water-intensive raw materials and processes have been identified as well as water stress sites.
- Biodiversity impact at sites is already known and monitored.
- CDP Water Security awarded Evonik a B in 2021.
- Evonik has been an active member of the RSPO since 2010.

AWARD

CDP Water Security awarded Evonik a grade B in 2021.

FIELDS OF ACTIONS & AMBITIONS

- A water stewardship approach needs to comprise raw materials and products. To achieve it, several actions need to be implemented: more systematic integration of water topics into business decisionmaking, intensifying dialogue with suppliers on water-related topics (e.g. on sourcing regions of purchased raw materials in order to assess potential water scarcity), initiating collective actions with key stakeholders from civil society, public authorities and public policy, engaging more with local communities in our areas of operation and, finally increasing transparency on water issues[7].
- Coherent management of greenhouse gas emissions reduction and blue water consumption is needed, especially for the transition towards circular raw materials.
- Biodiversity also needs to gain importance in supplier dialogue in relevant value chains. Following the LEAP Nature Risk Assessment Approach[8], the location of upstream operations needs to be identified in order to define how these activities interface with ecosystems. Dependencies and impacts can then be evaluated for the identified locations. Finally, material risks and opportunities can be discussed as well as existing mitigation approaches.
- Some Evonik products enable water savings and/or enhance biodiversity in their applications. This handprint will be further quantified in the near future.

70%

of Evonik BWC results from the upstream value chain

[7] according to the 6 principles defined by the CEO Water Mandate (https://ceowatermandate.org/)
[8] https://framework.tnfd.global/the-leap-nature-risk-assessment-process/

1.4 ENSURE HEALTH & WELLBEING

STATUS QUO

- We have established a software solution that allows us to link the product stewardship substance data with material data. Information is then consolidated on product and PARC level.
- In the PSA, signal category 1 uses relevant hazard information of the PARC together with the risk assessment of exposure and is the base for scoring.
- Hazard information including anticipated regulatory trends based on the European Chemicals Strategy for Sustainability (CSS) is used for portfolio review of risks, opportunities and follow-up actions.
- Assessment of the entire PARC portfolio for exposure to chemical safety concerns for our products and issues with disputed chemicals along the entire value chain. The overall exposure is less than 10% of our portfolio and is reflected in the ratings "Transitioner" or "Challenged" for the respective PARC.
- Our Health Care business is developing effective medication and treatments for a healthy life that minimize negative environmental impacts.

FIELDS OF ACTIONS & AMBITIONS

- Coherent and forward-looking management of risks and opportunities is needed driven by chemical safety regulations and stakeholder ambitions around the use and substitution of specific chemicals by establishing a consistent data structure for substances, materials, products and PARCs and the consideration of future requirements.
- Alignment within the chemical sector and along WBCSD pathways to incorporate CSS legislation into the PSA as it becomes clearer.
- Better understand the health impact of enabling alternative, more effective pharma therapies.

HARD FACT

Our Health Care business is developing medication and treatments for a healthy life that minimizie negative environmental impacts.

Evonik sustainability analysis

2

Evonik sustainability analysis

2.1 METHODOLOGY

Our sustainability analysis is closely based on the principles and content of the WBCSD Portfolio Sustainability Assessments (PSA)[9]. The framework for the sustainability analysis comprises the five process steps illustrated on the next page.

The unit of assessment is defined as a so-called product-application-region-combination (PARC). PARCs group combinations of products, applications and regions for which sustainability performance – in terms of both favorable and unfavorable sustainability signals – is similar. Sustainability signals relate to material ecological or social aspects along the value chain, from the supply chain through production and subsequent use to end of life.

The PSA methodology describes the signal categories (SCs) of specific relevance for the chemical industry:

1. Chemical hazard and exposure across the life cycle (SC 1)
2. Global regulatory trends (SC 2)
3. Sustainability ambitions in the value chain (SC 3)
4. Authoritative ecolabels (SC 4)
5. Sustainability performance compared to alternative solutions (SC 5)

Evonik follows this approach and evaluates the signal categories 1 to 5 to determine the sustainability performance of our portfolio.

The findings are used in a structured overall evaluation of the PARC's sustainability performance, resulting in allocation to the performance category:

- A++ (LEADER)
- A+ (DRIVER)
- B (PERFORMER)
- C- (TRANSITIONER)
- C-- (CHALLENGED)

Equal weight is given to all material signals; negative signals are not offset by positive signals.

Together, the categories "Leader" and "Driver" cover the Next Generation Solutions. Results of the PSA are published yearly in the Evonik sustainability report.[10] In 2020, Evonik generated 37% of sales with NGSs.

Our goal is to make NGSs grow beyond 50% by 2030, through existing NGSs, new sales from innovations, and from exiting "Challenged" and "Transitioner" product or replacing them with new formulations.

[9] https://www.wbcsd.org/Programs/Circular-Economy/Resources/Chemical-Industry-Methodology-for-Portfolio-Sustainability-Assessments
[10] https://corporate.evonik.com/en/investor-relations/reports

A++ (LEADER)

A++ indicates PARCs that take the lead in meeting the standards for sustainable business defined by Evonik's stakeholders and our impact. PARCs in the A++ category fully meet the requirements. They do not show any material negative signals. Moreover, material strong positive signals have been identified in one or more signal categories.

A+ (DRIVER)

A+ indicates PARCs that are at an advanced stage of meeting the standards for sustainable business set by Evonik's stakeholders and our impact. PARCs in the A+ category meet almost all the requirements. They do not show any material negative signals. Unlike those in the A++ category, however, only material weak positive signals were identified for one or more signal categories.

B (PERFORMER)

B indicates PARCs with a neutral position regarding meeting the standards for sustainable business defined by Evonik's stakeholders and our impact. For PARCs in this category, neither material negative nor material positive signals have been identified.

C- (TRANSITIONER)

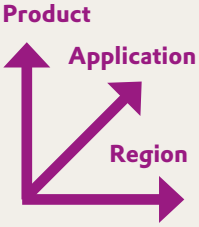
C- indicates PARCs that show room for improvement in meeting the standards for sustainable business defined by Evonik's stakeholders and our impact. They do not yet meet these requirements. Material weak negative signals were identified, but no material strong negative ones, for one or more signal categories.

C-- (CHALLENGED)

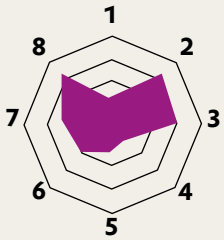
C-- indicates PARCs that do not satisfactorily apply the standards for sustainable business set by Evonik's stakeholders and our impact. PARCs in the C-- category do not meet these requirements. Moreover, they have material strong negative signals in one or more signal categories.

1 **Defining objectives, scope and process**

2 **Defining assessment segments**

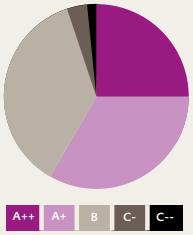


3 **Detecting market signals**



4 **Categorizing the portfolio**

5 **Reporting and using results**



2.2 CONTRIBUTION OF PARCS TO SFAS

Within the PSA, each PARC is attributed to one of the four SFAs. This choice is determined by which topic is most material for the product and its application.

The contribution of the PARC (footprint as well as handprint) to the SFA is assessed in SC 5 using the following KPIs:

FIGHT CLIMATE CHANGE

- Greenhouse gas emissions in kg CO_2e and avoided emissions

DRIVE CIRCULARITY

- Generated waste (kg)
- Resources used/saved (kg)
- Recovery potential (%)
- Amount of circular raw materials purchased (kg)

SAFEGUARD ECOSYSTEMS

- Blue water consumption (m^3) and water scarcity footprint[11]
- Land use (ha)[12]
- Depending on application:
  - improved marine biodiversity,
  - reduced eutrophication,
  - reduced acidification, etc.

ENSURE HEALTH & WELLBEING

- Reduced exposure to VOC or microparticulate matter
- Reduced exposure to disputed chemicals
- Number of patients or vulnerable consumers reached with positive health outcomes

[11] Water scarcity footprint is a indicator of the water consumed weighted with a local water scarcity index i.e. an index that characterize water stress for a specific area and time

[12] Land use is selected as KPI as it is a main driver of biodiversity change. Evonik is engaged in the development of a biodiversity footprint that could be used as a new KPI.

Handprint of selected Evonik's Next Generation Solutions

3

Handprint of selected Evonik's Next Generation Solutions (NGSs) for the four Sustainability Focus Areas

We define handprint as positive sustainability impacts that Evonik products enable along the value chain compared with other established products and applications on the market, especially in customer application. These products make a relevant contribution to a direct (measurable) improvement regarding one or more environmental and/or social indicators. This is reflected in a strong or weak positive rating in the PSA's SC 5 (environmental and social performance compared to alternative solutions).

This handprint reflects the material sustainability ambitions addressed in SC 3 that the PARC is delivering on. During the annually conducted PSA, special attention is paid to revising the market reference as it might quickly evolve over time or the Evonik solution might even become the market reference itself (and would consequently have no more handprint as defined for the SC 5).

A handprint can be assessed qualitatively or (semi-) quantitatively. Our goal is to increase the number of quantitative analyses, to gain deeper knowledge of our product benefits and transparency.

The NGSs selected to calculate avoided greenhouse gas emissions – following the "Avoiding Greenhouse Gas Emissions" guidelines published jointly by the World Business Council for Sustainable Development (WBCSD) and the International Council of Chemical Associations (ICCA)[13] – have precise use phase knowledge and key parameters and assumptions have been verified by an external auditor. As good data availability (including beyond Evonik's company gates) allows for reasonable quantification, several examples presented here refer to the automotive value chain. Moreover, strong pressure to generate sustainability data is observed in those value chains. Insights on the solutions' benefits and the associated impact assessments are described in Section 3.1.

Although there are no assessment rules for quantification beyond avoided greenhouse gas emissions, our intention is to describe our handprint comprehensively for impact categories relevant to SC 5 in the PSA – such as water or land savings or any other topic relevant in the context of the four SFAs. Thus, Section 3.2 elaborates on further NGSs and their handprint within the different SFAs.

While only a few handprint studies have been externally validated, most of these quantitative or semi-quantitative assessments (e.g. "X% reduction of GHG") are based on internal knowledge and expertise as well as general comparison between our products and their alternative.

For the NGSs with a handprint related to circularity and health, impacts are only described qualitatively as the metrics are still under development.

Nevertheless, we are currently working on the further quantification of handprints for the SFAs "Drive Circularity" and "Safeguard Ecosystems" and our intention is to report in the future absolute avoided water (or waste) from products' application alongside avoided greenhouse gas emissions.

[13] World Business Council for Sustainable Development (WBCSD) and International Council of Chemical Associations (ICCA), Avoiding Greenhouse Gas Emissions - Guidelines: Accounting for and Reporting Greenhouse Gas (GHG) Emissions Avoided along the Value Chain based on Comparative Studies, Version 2, December 2017

44.3

million metric tons CO_2e
were avoided in 2022.

3.1 REDUCTION IN GREENHOUSE GAS EMISSIONS THROUGH APPLYING EVONIK'S NGS (AVOIDED EMISSIONS)

Evonik offers a variety of products enabling greenhouse gas emission reductions over the life cycle of their application compared to using conventional alternatives. This section presents selected Next Generation Solutions (NGSs) that enable greenhouse gas emissions savings.

Assessments of avoided greenhouse gas emissions of products and their applications follow the recommendations given in the "Avoiding Greenhouse Gas Emissions" guidelines. The internal Evonik life cycle management team works in close cooperation with experts from the responsible business lines and performs life cycle assessments (LCAs) in accordance with the requirements of DIN ISO 14040 ff. Greenhouse gas emission savings are calculated on the basis of the life cycle emissions of applications of selected Evonik products compared to conventional alternatives. Both the emission-saving product and the reference solution must deliver the same function to the user and be used for the same application.

Additionally, the reference solution must be available on the market, interchangeable for the typical customer in the selected market, and as similar as possible to the emission-saving product in terms of data quality, methodology, and assumptions. The simplified calculation methodology as mentioned in the "Avoiding Greenhouse Gas Emissions" guidelines is applied, so that identical steps and corresponding emissions over the life cycle for the reference and Evonik solution are excluded from assessments.
This approach has no impact on the final amount of calculated greenhouse gas emission reductions.

The avoided emissions reported here result from applying the following six Evonik solutions:

- green tire technology,
- amino acids in animal feed,
- improved hydraulic fluids,
- hydrogen peroxide to propylene oxide (HPPO) process,
- POLYVEST® in green tire tread compounds and
- fumed metal oxides in lithiumion batteries.

Within the sustainability analysis, it has been checked that the selected PARCs are rated as Next Generation Solutions so that these products do not reveal any negative signals.

In 2022, the use of the six selected Evonik Next Generation Solutions result in the avoidance of 44.3 million metric tons CO_2e[14]. These 44.3 million metric tons CO_2e reflect the total savings of the selected applications enabled by the amounts of the six Evonik solutions sold in 2022.

Each NGS provides a measurable improvement over the life cycle and the associated Evonik products have either a fundamental, extensive, or at least a substantial contribution to reducing greenhouse gas emissions compared to conventional alternatives[15].

[14] Avoided emissions results have been calculated using forecast sales volumes for 2022. They were verified within the scope of our auditors' limited assurance engagement of the 2022 sustainability report.
[15] The significance contribution of chemical products to value chain avoided emissions is described in the WBCSD "Avoided Emissions" Guideline.

GREEN TIRE TECHNOLOGY

The rubber compounds in tires have a major impact on the characteristics of the tire performance. Organic and inorganic components determine the performance of the tread compound that is in contact with the road surface.

Such treads typically contain about 35% reinforcing filler, which is a key ingredient in the rubber compound to reach the desired properties. Instead of carbon black, silica can be used as filler. Bifunctional organic silicon compounds – called organosilanes – serve as coupling agents that connect silica and rubber.

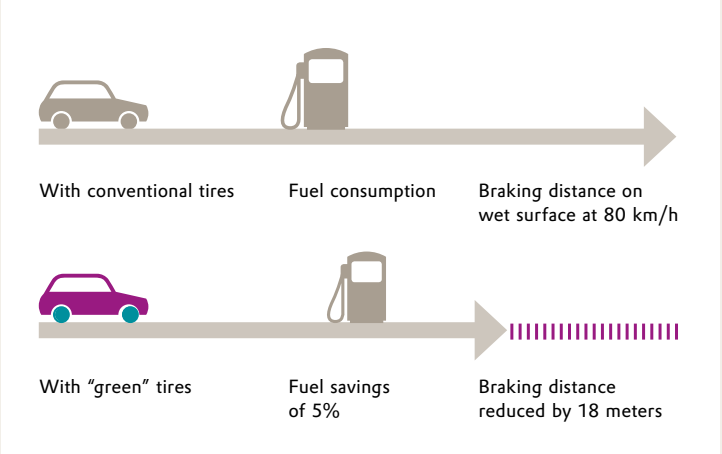
In contrast to conventional carbon black as filler, the use of the silica/silane system allows an expansion of the "magic triangle" of tire performance (see **Figure 1**).

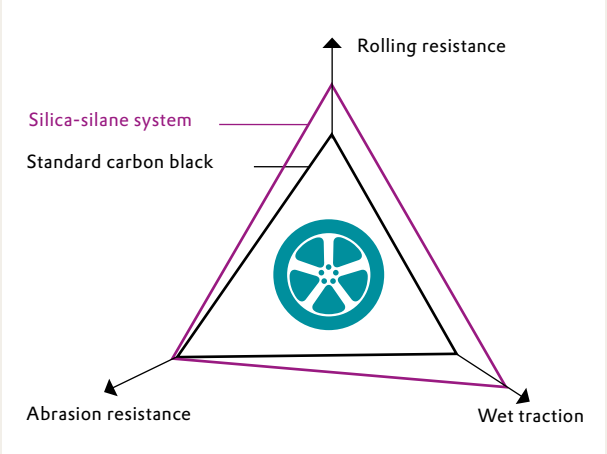
Rolling resistance and wet traction are improved without significantly affecting abrasion and therefore the service life of the tire. These improvements result in significantly lower fuel consumption for end users and therefore in reduced greenhouse gas emissions.

Carbon black filled tires still dominate the global market. As the Green Tire technology has penetrated the European and parts of the Asian (Japan and South Korea) market, the advantage is only claimed for the rest of the world where carbon black tires still prevail.

Evonik's silica/silane system for Green Tires is a Next Generation Solution. Compared to conventional car tires using carbon black as filler, the use of the silica/silane system and a certain polymer blend (solution styrene butadiene rubber (S-SBR) and butadiene rubber (BR)) – known as Green Tire technology – can achieve significant fuel savings and improved wet grip without impacting abrasion resistance (see **Figure 1**).

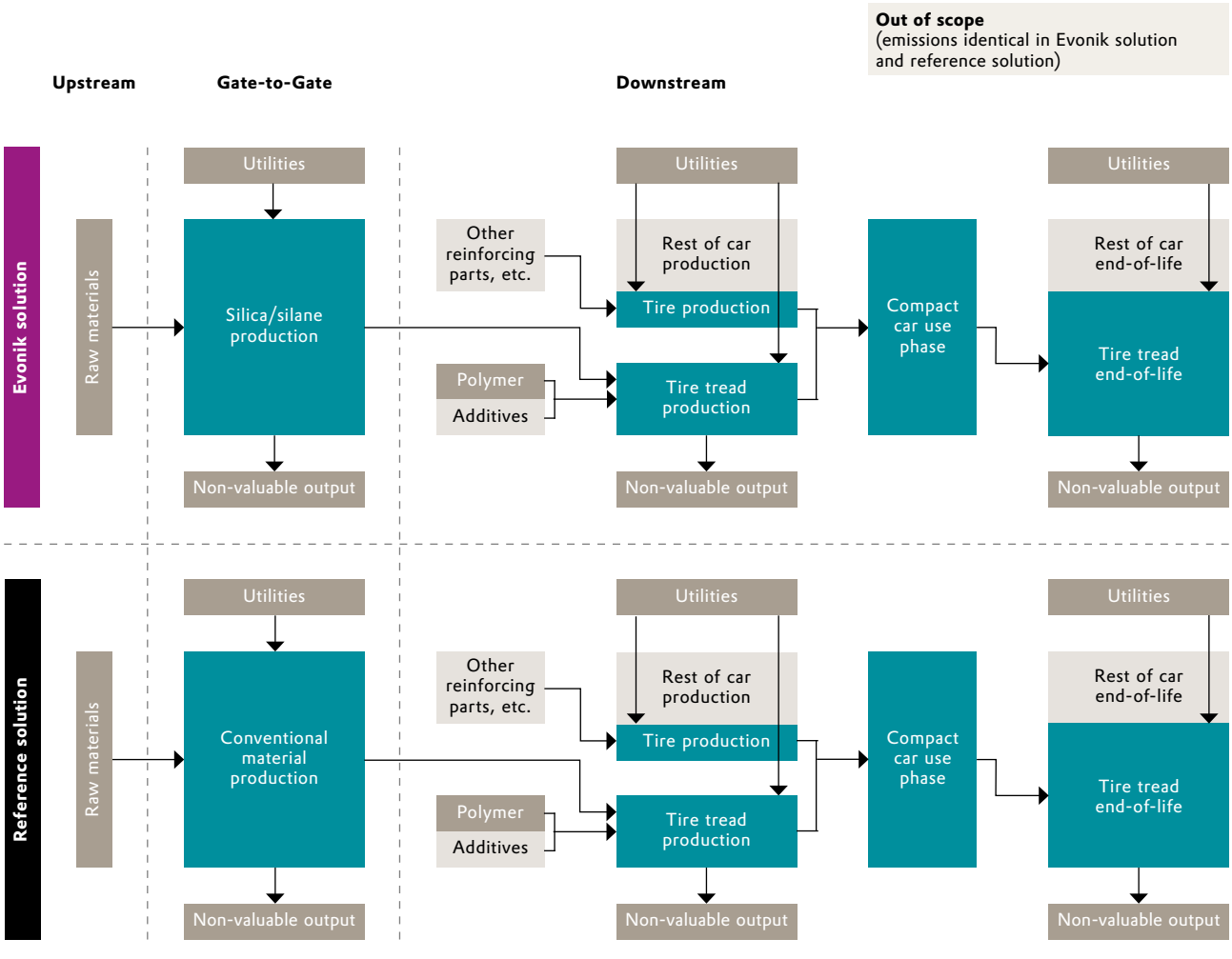
Figure 1
The expanded "Magic Triangle" and impact on fuel consumption reveal the Green Tire technology's benefit





Next Generation Solution	Silica-silane systems in a specific rubber blend (S-SBR, BR) as a tread component in region Americas/East Europe & Turkey/ Asia without Japan & South Korea for the Green Tire technology.
Reference solution(s)	Carbon black tire: Carbon black as filler material and emulsion styrene butadiene rubber (E-SBR) as tread component.
Functional unit	The use of silica-silane and rubber compound (S-SBR, BR) or carbon black and E-SBR as components in a compact car tire over 150,000 km.
Boundaries	Cradle-to-grave. Life cycle steps considered in calculations are shown in Figure 2.
Main parameters and assumptions	The respectively required volumes of tread components for the distance of 150,000 km have been determined. A passenger car EURO 6 with its corresponding fuel consumption was assumed. Same type of vehicle and tires in each region. Field test data and statistics on fuel consumption and savings were considered.
Background information on the assessment	The life cycle assessment was completed and certified in 2015. In 2022 the LCA for the Silica production was updated using 2021 production data. With the recent update, the differentiation and regionalization between different Silica grades was increased. Each Silica grade which is used for the Green Tire technology is now covered by a site/region specific LCA. This means that we now use several different Silica LCAs depending on the region where the Green Tires compete against the carbon black tires and the grades which are typically used in the region. The global amount sold of the corresponding Evonik solutions in 2022 (Q1-Q3 and forecast Q4) was used to calculate the total savings.

Figure 2
Overview of life cycle steps considered in the comparative analysis of greenhouse gas emission reductions through the use of the Green Tire technology



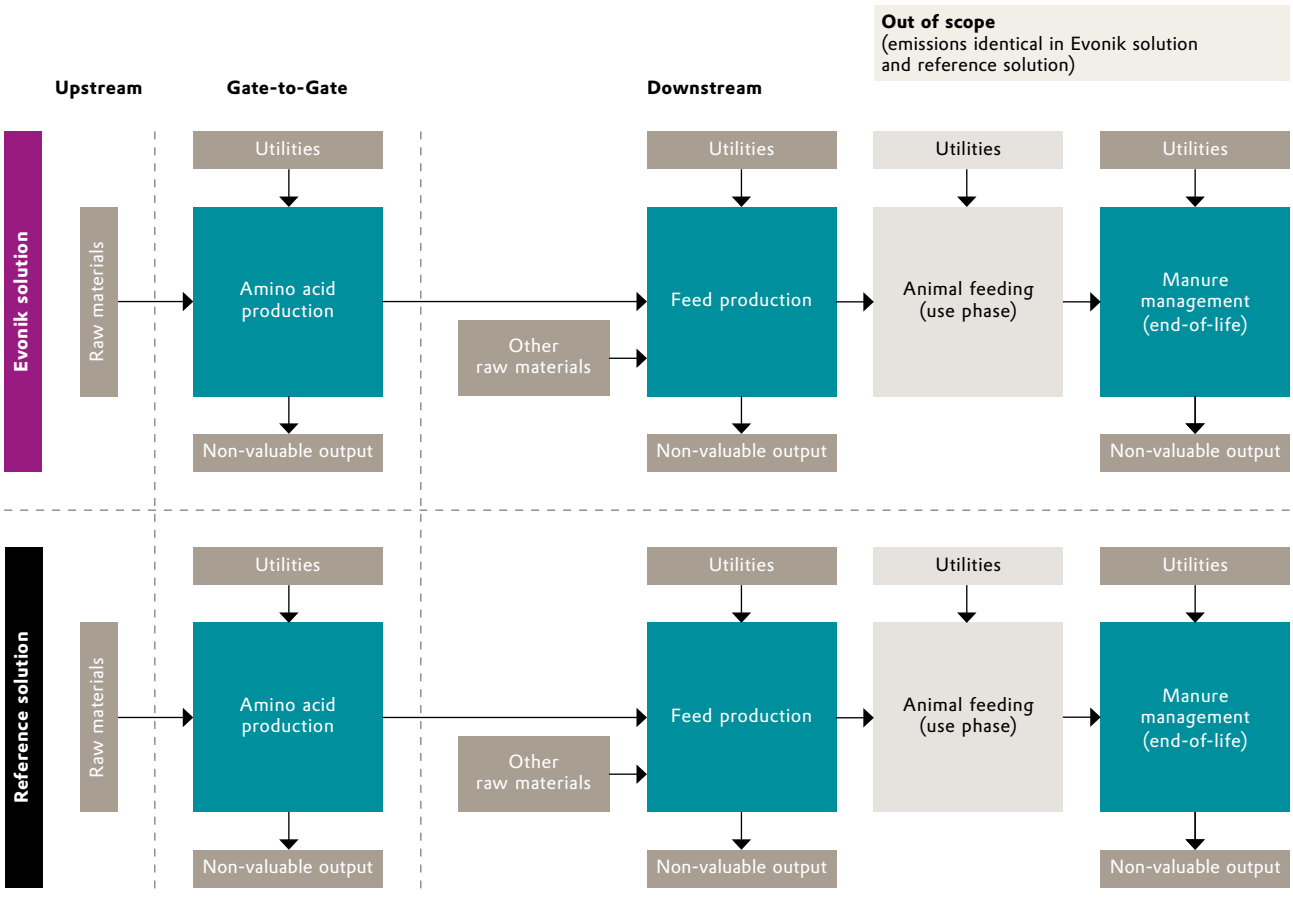
AMINO ACIDS IN ANIMAL FEED

Animal feed is specifically formulated to meet the physiological and nutritional needs of animals, and in particular the necessary requirements of essential amino acids. A lack of certain amino acids in animal feed can be compensated either by adding a higher percentage of protein-rich feed components such as oil seed, or by fortifying the feed with essential amino acids. Supplementing animal feed with essential amino acids allows for the substitution of high-protein ingredients which are associated with high emissions and requirements on land and water resources.

Potentially, higher feed conversion rates can even allow for an absolute reduction in feed demand. Furthermore, feed supplementation with these essential amino acids reduces the crude protein content of the diet. Hence nitrogen emissions such as ammonia and laughing gas resulting from the manure management are diminished.

Next Generation Solution	Feed mix with a balanced amino acid profile based on Evonik recommendations (including MetAMINO®, Biolys®, ThreAMINO®, TrypAMINO®, and ValAMINO®), representing "best practice" for diets with low protein levels. In South America, North Asia, and South Asia the application of these amino acids for all pig, broiler and layers has been rated as Next Generation Solution. In Europe and North America only the application in layers diets has been classified as a Next Generation Solution, therefore, application in pig and broiler diets have been excluded from the calculation.
Reference solution(s)	Feed mix with an amino acid supplementation customary in the respective regional market. Such a feed mix usually contains less, and different, amino acid supplementation.
Functional unit	The functional unit and the reference flow have been defined as one ton of live weight or, in the case of feeding laying hens, one ton of eggs.
Boundaries	Cradle-to-grave Life cycle steps considered in calculations are shown in Figure 3.
Main parameters and assumptions	The composition of the feed mixes and the animals' nutritional demands per functional unit relate to 2019. Feeding of pigs, broilers and laying hens has been covered in the study. The composition of the feed mixes, the animals' nutritional demand and (as far as possible concerning data availability) the regional origin of feed materials has been adapted to the regions Europe, North America, South America, North Asia and South Asia, respectively. As a conservative assumption, an identical feed conversion rate between the Evonik solution and reference solution (per region) has been considered.
Background information on the assessment	The global forecasted sales volumes for amino acids supplied by Evonik to the feed industry in 2022 have been used to calculate total savings (excluding sales to the pig and broiler industry in Europe and North America). Regional sales volumes have been aligned with the respective regional emission avoidance. The considered amino acids are: MetAMINO®, Biolys®, ThreAMINO®, TrypAMINO®, and ValAMINO®.

Figure 3
Overview of life cycle steps considered in the comparative analysis of greenhouse gas emission reductions through the use of amino acids in animal feed



IMPROVED HYDRAULIC FLUIDS

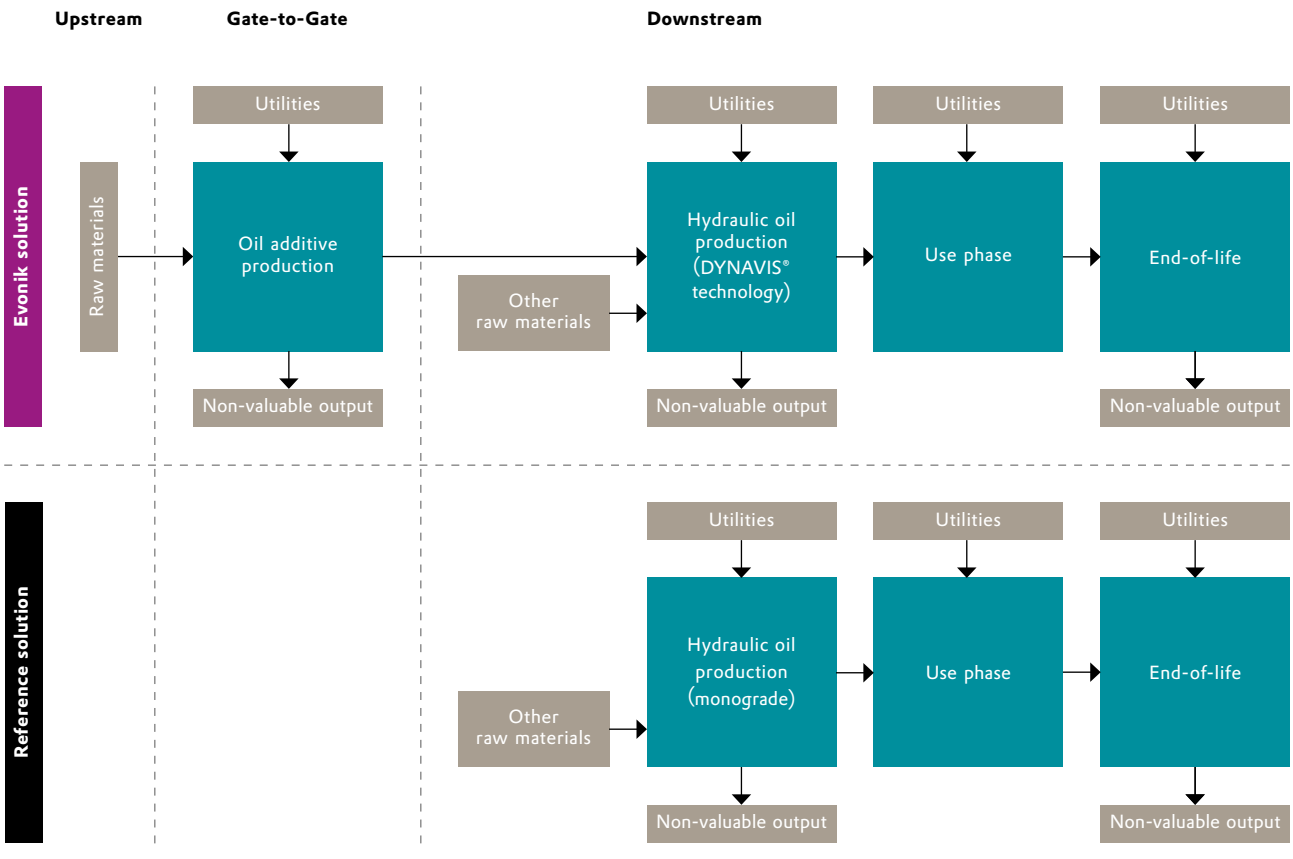
In hydraulic construction equipment, fluid viscosity must be high enough to protect the moving parts and to guarantee high pump efficiency over extended oil drain intervals. However, as fluid moves dynamically through the system, it heats up under demanding conditions and viscosity of the oil drops down resulting in volumetric losses in the pump.

Hydraulic fluids formulated with DYNAVIS® technology save energy in almost all hydraulic applications. The foundation of DYNAVIS® technology are the highly shear stable viscosity index improvers from Evonik that go by the tradename VISCOPLEX®. Increasing the shear stability and viscosity index of a hydraulic fluid balances volumetric with mechanical efficiencies and expands the temperature operating window for hydraulic systems.

The stable viscosity over a broad temperature range allows the use of one ISO grade lower than the monograde recommended by the oil manufacturer. This reduces hydromechanical losses in the entire system and the higher viscosity index avoids internal leakage at the pump. Depending on the specific situation, energy savings of up to 15% have been measured. Based on years of intensive R&D and meticulously designed field test trials, hydraulic equipment operating with fluids formulated with DYNAVIS® technology have credibly demonstrated their potential to achieve more hydraulic power under full load conditions, lower fuel consumption, faster response to operator control and reduced peak temperatures due to higher system efficiency.

Next Generation Solution	DYNAVIS® technology in hydraulic fluids of hydraulic construction machinery *globally*.
Reference solution(s)	Conventional hydraulic oils without DYNAVIS® technology (monograde).
Functional unit	Operation of a hydraulic construction machine moving 1 million metric tons of mass over a defined distance.
Boundaries	Cradle-to-grave Life cycle steps considered in calculations are shown in Figure 4. Identical emissions for the Evonik and the reference solution that are e.g. caused during the production of excavators are not considered.
Main parameters and assumptions	All hydraulic fluids have been used in field tests in a mid-sized excavator. While the oil drain interval of the monograde fluid is 2,000 hours, the other three fluids need to be changed after 4,500 hours. Furthermore, fuel consumption decreases by 5% to 15%.
Background information on the assessment	The model is mainly based on data from Europe. The reference year is 2021. Savings refer to the global use of DYNAVIS® technology. The global amount sold of the corresponding Evonik oil additives to the hydraulic oil industry in 2022 (Q1 - Q3 and forecast Q4) has been used to calculate the total savings.

Figure 4
Overview of life cycle steps considered in the comparative analysis of greenhouse gas emission reductions through the use of improved hydraulic oils



HYDROGEN PEROXIDE TO PROPYLENE OXIDE (HPPO) PROCESS

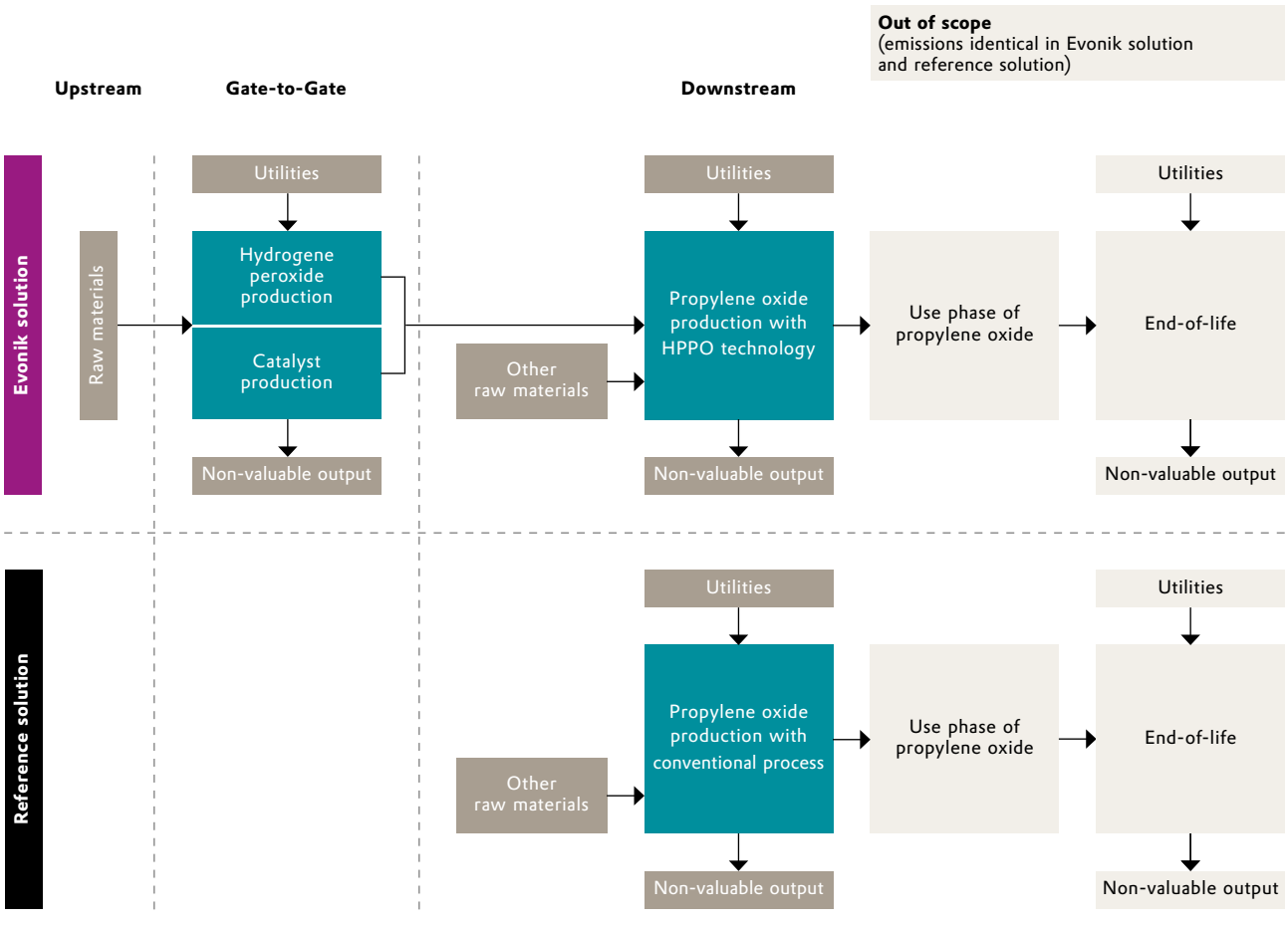
Propylene oxide (PO) is an important intermediate in the production of polyurethane — a highly in-demand chemical necessary for the foam used in everyday items like seat cushions, sport shoes, insulating materials, and more. The problem is that conventional production processes for PO tend to generate large quantities of co-products and consume a great deal of resources. Evonik and thyssenkrupp Industrial Solutions (tkIS) have therefore developed an alternative process that is more efficient and more environmentally friendly. Known as HPPO, from "hydrogen peroxide to propylene oxide," this technology involves the direct synthesis of PO from hydrogen peroxide (H_2O_2). The process uses far fewer resources than conventional methods, while generating only water as a co-product.

As industries around the world develop increasing sustainability ambitions, face stricter environmental regulations, and are keener than ever on lowering their investment costs, HPPO is becoming a highly attractive technology for PO production.

Evonik and tkIS supply PO producers with the license and know-how for HPPO plants. In addition, Evonik provides the necessary amounts of hydrogen peroxide through the construction of on-site hydrogen peroxide megaplants. The titanium silicalite-1 (TS-1) catalyst used for the HPPO process was also custom-made by Evonik. In addition, Evonik and tkIS work together with producers on-site on the planning, construction, and commissioning of the plants.

Next Generation Solution	HPPO process for environmentally friendly propylene oxide (PO) production as raw material for different polyurethane (PU) applications.
Reference solution(s)	Conventional processes for PO production as raw material for different PU applications.
Functional unit	Production of one ton of propylene oxide (which can e.g. be processed to polyether polyols and used as PU foam in insulation materials).
Boundaries	Cradle-to-grave Life cycle steps considered in calculations are shown in Figure 5.
Main parameters and assumptions	The cases of South Korea and China have been analyzed separately. The propylene oxide/styrene monomer (PO/SM) and cumene (CuPO) process are considered as competitive routes in South Korea according to their production shares while for China, the chlorohydrin process is considered as reference as being the dominant solution to be substituted.
Background information on the assessment	Comparative life cycle assessments have been performed with license agreement data and market report data in 2020. The 2022 sales volume (Q 1- Q3 and forecast Q4) of H_2O_2 to the HPPO production sites and corresponding production amounts of PO have been considered for calculating total savings.

Figure 5
Overview of life cycle steps considered in the comparative analysis of greenhouse gas emission reductions through the use of the HPPO process



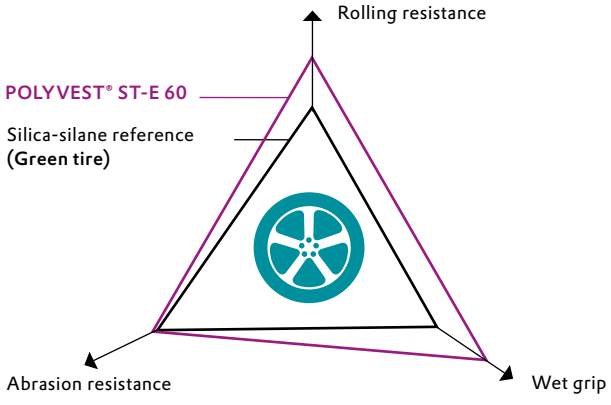
POLYVEST® IN GREEN TIRE TREAD COMPOUNDS

POLYVEST® ST-E 60 is a new generation of silane functional rubber additives. It is used in green tire tread compounds to improve the homogenous dispersion of silica particles in the rubber matrix as well as to act as a reactive plasticizer decreasing the viscosity of the compound. It combines the advantages of liquid rubbers and functional silanes. Due to its rubber-based nature it exhibits a natural fit and excellent compatibility with the rubber matrix of tire tread compounds.

As a dual functional material POLYVEST® ST-E 60 forms strong chemical bonds with filler and matrix to create a stable and long-lasting network.

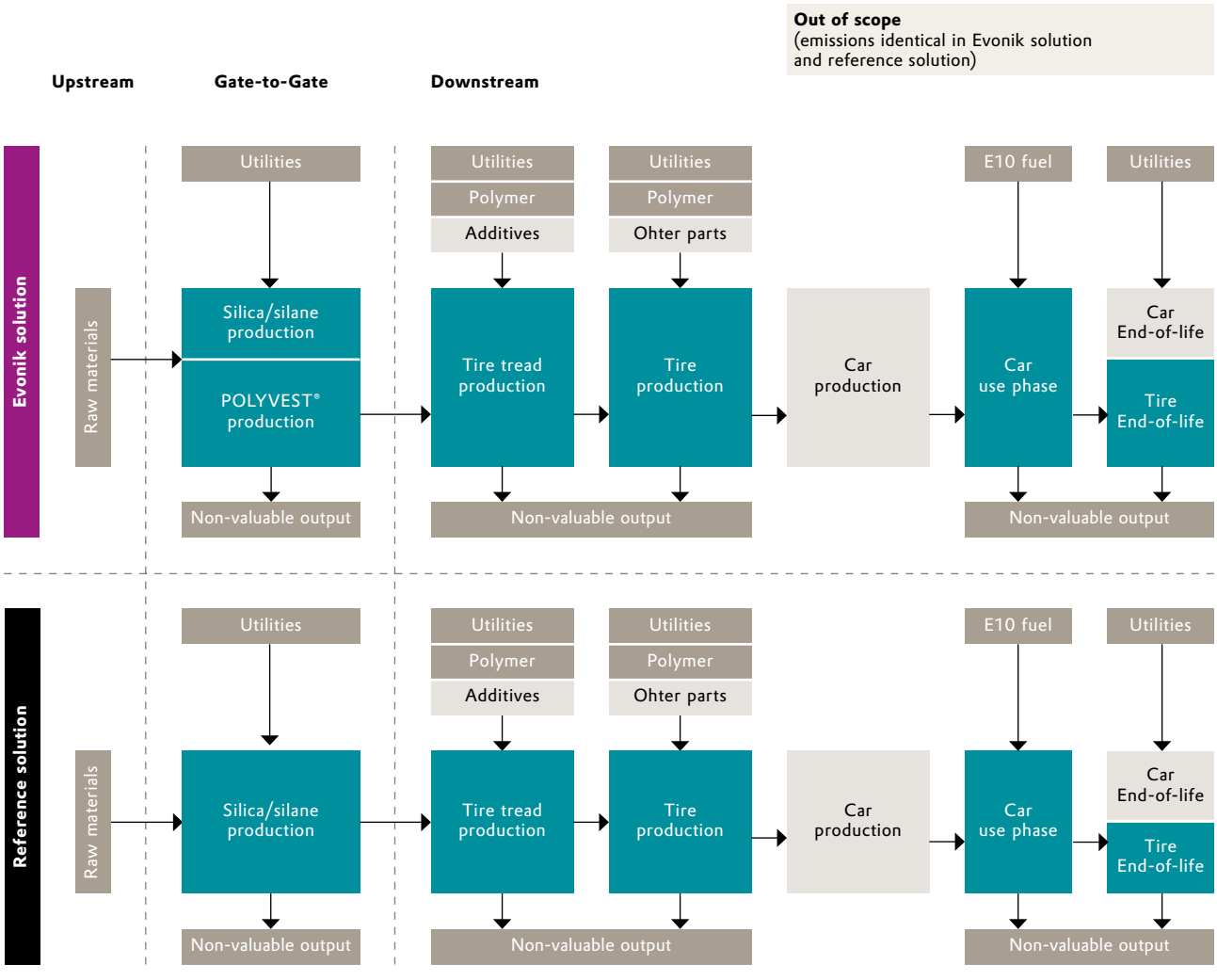
If not using POLYVEST® ST-E 60, the standard plasticizer in tire treads is TDAE oil. This process oil does not chemically react with the system, leading to migration onto the surface and consequently a decrease in tire performance over time. With POLYVEST® ST-E 60 the migration effect can be overcome, increasing the durability of a tire.
In combination with the silica/silane system, POLYVEST® ST-E 60 enables further improvement of key performance indicators of green tire tread compounds such as rolling resistance, abrasion resistance, and wet grip (see **Figure 6**). This effectively leads not only to improved fuel efficiency, resulting in less greenhouse gas emissions, but also to enhanced driving safety.

Figure 6
The expanded "Magic Triangle" for POLYVEST® in green tire tread compounds



Next Generation Solution	POLYVEST® ST-E 60 as additive for green tire treads.
Reference solution(s)	Standard green tire (silica/silane system in rubber blend).
Functional unit	150,000 km driven by compact car.
Boundaries	Cradle-to-grave. Life cycle steps considered in calculations are shown in Figure 7.
Main parameters and assumptions	Euro 6 car compact class consuming E10 fuel. Lifetime of 50,000 km for all tire types. Compound formulations for tire treads (expert interview). 1.5% fuel savings by POLYVEST® green tire technology (field test data).
Background information on the assessment	The product LCAs for POLYVEST® HT and POLYVEST® ST-E 60 have been performed in 2022 with 2021 production data. Based on compound formulations from our experts, the required amount of product for the tire treads has been determined. For tire production and end-of-life, the existing green tire model has been used. The use phase has been modeled according to the existing model with additional data on fuel savings by POLYVEST®. The amount sold for the tire application in 2022 (Q1 - Q3 and forecast Q4) has been used to calculate total savings.

Figure 7
Overview of life cycle steps considered in the comparative analysis of greenhouse gas emission reductions through the use of POLYVEST® in green tire tread compounds.



FUMED METAL OXIDES IN LITHIUM-ION BATTERIES

The global shift to electric mobility is key to reducing greenhouse gas emissions and air pollution from road traffic. Batteries that are powerful yet safe, with quicker charging times and extended driving ranges, are essential for the acceptance of electric vehicles. However, their high energy density puts increased strain on the battery materials and demands better technology development.

High-quality metal oxides from Evonik are used as additives in Li-ion batteries (LIB) to increase their performance, service life ,and safety. AEROXIDE® fumed alumina and fumed titania are produced by flame hydrolysis and consist of nanostructured aggregates with mean aggregate sizes of approx. 100 nm. The white powder provides a very narrow particle size distribution and exhibits high chemical purity. As dry coating on the surface of cathode materials AEROXIDE® acts as a defined cathode electrolyte interface (CEI). It prevents undesired reactions and makes batteries last longer. This increases the service life of a Li-ion battery significantly by about 50%.

With longer lasting Li-ion batteries, fewer newly produced batteries are required to meet market demand.

The production of Li-ion batteries itself is very energy intensive and causes a lot of greenhouse gas emissions as well as the raw material production and supply.

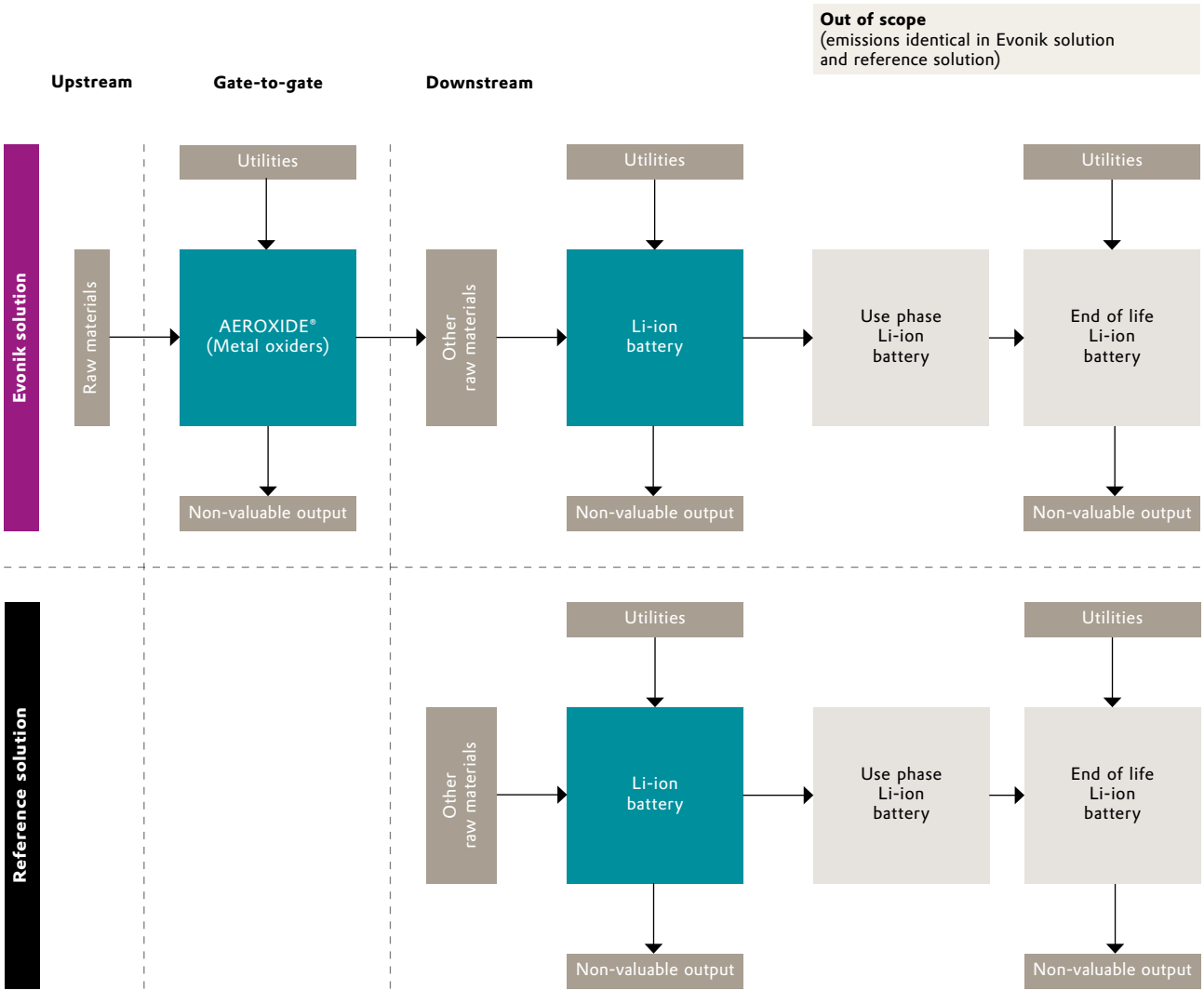
By increasing the battery lifetime and consequently reducing battery production, the Evonik solution avoids the emission of greenhouse gas.

Applications of AEROXIDE® in Li-ion batteries:

- Protective dry coating for cathode materials
- High performance LIB separator coating
- Nanostructured ceramic fillers inside separators
- Additive for electrolyte immobilization (gel polymer type)

Next Generation Solution	AEROXIDE® fumed metal oxides increase the performance, service life and safety of batteries.
Reference solution(s)	No use.
Functional unit	Electric vehicle Li-ion battery with a capacity of 100 kWh.
Boundaries	Cradle-to-grave Life cycle steps considered in calculations are shown in Figure 8.
Main parameters and assumptions	Literature value for greenhouse gas emissions of battery production has been used. A battery capacity of 100 kWh has been assumed. The Evonik solution increases the battery lifetime by 50%.
Background information on the assessment	The underlying life cycle assessments of the Evonik products have been conducted in 2022 and are based on production data from 2021. The LCA covers the global production of fumed metal oxides with separate LCAs for each production site. The global amount sold of the corresponding Evonik solutions in 2022 (Q1 - Q3 and forecast Q4) has been used to calculate total savings.

Figure 8
Overview of life cycle steps considered in the comparative analysis of greenhouse gas emission reductions through the use of AEROXIDE® fumed metal in batteries.



Further Next Generation Solutions

This section gives a few examples of NGSs and describes their contribution to one of the four SFAs qualitatively or quantitatively as well as their handprint.

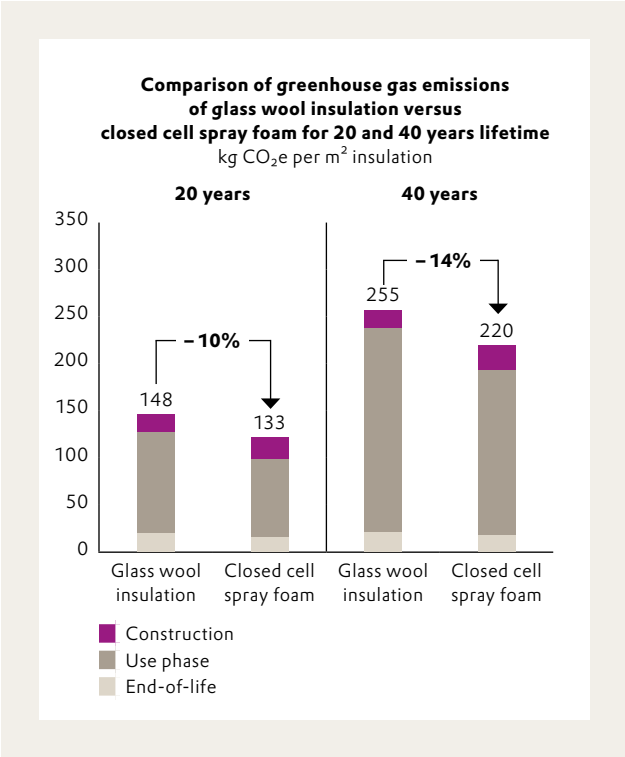

DRIVE
CIRCULARITY
SAFEGUARD
ECOSYSTEMS

INSULATION SPRAY FOAM

Heating is the biggest energy guzzler in residential buildings and is responsible for 60% of greenhouse gas emissions. Improved insulation is key for CO_2 reduction. Spray foam allows efficient insulation of buildings as it fills any shape and penetrates even narrow gaps. In the USA, spray foam is well established with an overall greenhouse gas saving potential of around 180 million tons. To produce spray foam, blowing agents are needed. Third generation blowing agents exhibit high global warming potential. Evonik additives (silicone and non-silicone) support the introduction of 4th generation blowing agents with a much-reduced carbon footprint, while maintaining the optimum insulating performance of spray foam.

In the PSA, the related PARCs "insulation foam silicone" and "insulation foam non-silicone" are rated as NGSs. They fully address stakeholders' ambitions (SC 3) in the building value chain regarding reducing GHG emissions from buildings, better insulation properties, reduced VOC emissions and building steadfastness. This results in a positive environmental impact when Evonik additives are used over market standard (mineral wool or wood fibers). Indeed, besides lower energy building consumption and lower GHG emissions, the Evonik additives used in 4th generation blowing agents increase the longevity of buildings and consequently lower resource consumption. This handprint has been validated by an LCA, performed by our in-house experts for a functional unit of one m^2 of an outer wall for a house in Minnesota.

It has been calculated that between 10 and 14% greenhouse gas emissions savings can be realized by using spray foam with 4th generation blowing agents instead of glass wool insulation. Savings depend on duration of use phase, as spray foam has initially slightly higher emissions during construction but is more effective as insulation (i.e. use phase). Additionally, spray foam fills other gaps resulting in air sealing of the building, which is not included in the calculations: Air filtration might cause up to 40% energy loss in buildings[16] (which would result in a greenhouse gas savings increase of up to 36% over a 40-year life-time). Current limitations of the LCA are that results are regionally and use-phase dependent (greenhouse gas savings increase with cooler climate and longer use phases) and being only applicable for closed cell spray foam.



[16] https://www.whysprayfoam.org/benefits-of-spray-foam/efficiency

HYDRAULIC FLUIDS FOR STATIONARY EQUIPMENT

In hydraulic manufacturing systems, the operating conditions can vary from highly dynamic to less dynamic flow patterns of the hydraulic fluid. In all cases the fluid needs to protect the equipment from wear and corrosion and to efficiently transmit power.

The right viscosity of oil under operating conditions in hydraulic pumps, motors, and actuators is crucial for high equipment efficiency. Hydraulic fluids formulated with DYNAVIS® technology are based on highly shear stable viscosity index improvers VISCOPLEX® from EVONIK, that allow fluids to maintain the desired viscosity under shear and over an extended temperature operating window. This technology results in more powerful machinery with reduced internal leakage, less hydro-dynamic friction and reduced cooling demand. Lower oil peak temperatures potentially enable longer oil drain intervals.

In the PSA, this product application has been considered within the PARC "Viscosity modifiers for hydraulic fluids in manufacturing" and rated as an NGS because it positively addresses stakeholders' ambitions (SC 3) regarding productivity and energy efficiency. It also has a positive environmental impact (SC 5) compared to conventional hydraulic oils without DYNAVIS® technology (i.e. mono-grade). Intensive R&D and numerous field trials have proven that DYNAVIS® technology allows manufacturing systems to work up to ten% more efficiently. For example, plastic injection molding equipment benefits with two to six% reduced energy consumption in the hydraulic system and overall lower GHG emissions. The handprint has been quantified through an LCA conducted by our in-house experts from the LCM group. Using a better oil, based on DYNAVIS® technology at the next scheduled maintenance, is an easy option for reducing energy demand in any hydraulic manufacturing plant.

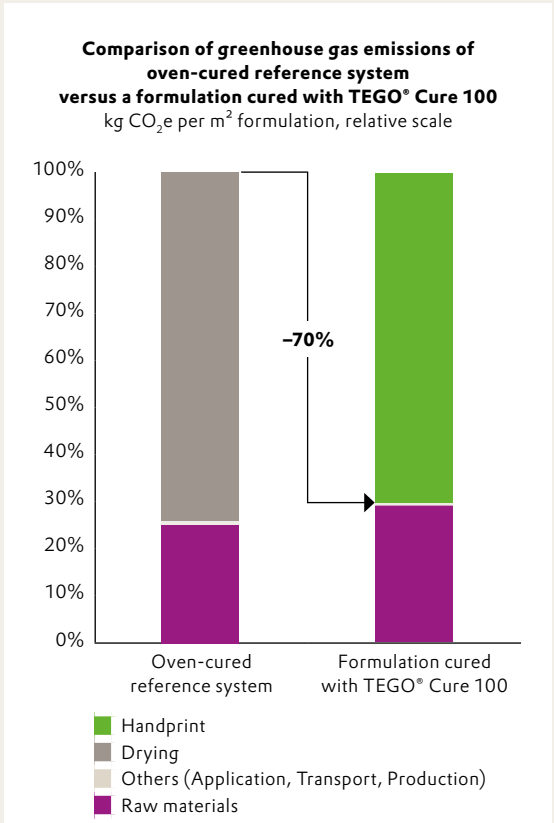
TEGO® CORROSION PROTECTION

The product TEGO® Cure 100 is a reactive ambient-curing siloxane resin, pre-catalyzed with amines, for use as a hardener. It is suitable for all kinds of compatible silicone and silicone hybrid resins. This product is allocated to the PARC "Tego corrosion protection – low VOC" and is rated as an NGS.

State-of-the art technologies in the area of high temperature resistant coatings are solvent-bone silicone resin coatings, which need to be cured in the oven at high temperatures, e.g. 250°C for 30 minutes. The curing step is very ineffective, as high quantities of steel as the main substrate for high temperature coatings also have to be heated up.

By using TEGO® Cure 100, it is possible to avoid energy intensive curing step, as coatings based on TEGO® Cure 100 as hardener cure at room temperature. Thus, TEGO® Cure 100 contributes to the SFA "Fight Climate Change". It addresses positively stakeholders' ambitions (SC 3) regarding reduced energy consumption and has a significant positive environmental impact in comparison to the market reference (SC 5).

The handprint is quantified via an LCA which has been conducted by our in-house experts from the LCM group. The functional unit is one m^2 coated surface and system boundary is cradle-to-application. The handprint is quantified in CO_2e of the Evonik solution compared to the market reference, which is an oven-cured silicone resin coating. Compared to the benchmark it is possible to achieve savings of up to 70% in greenhouse gas emissions compared to the market reference, driven by avoiding oven curing step.



SILICA IN FOOD AND FEED APPLICATIONS

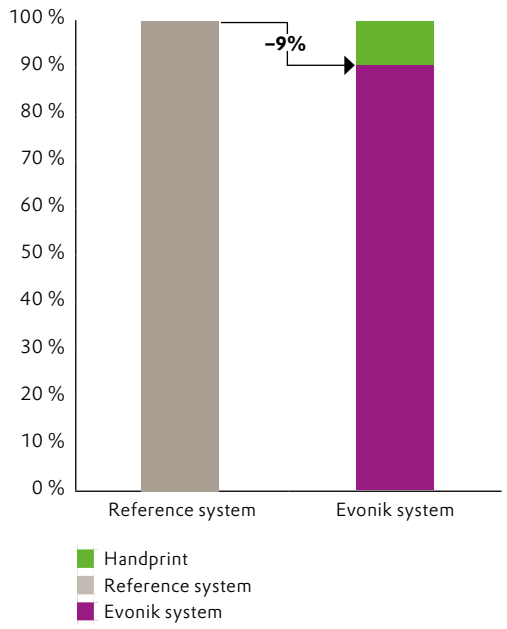
Silica in food and feed applications is used to improve the production of powdered foods and feeds. These silica products are part of the PARCs "silica in food" and "silica in feed" and those are rated as NGSs.

Caking can be a cause of food and feed losses when processing and storing powdered foods such as milk powders, non-dairy creamers, spices and seasoning blends or feed products (e.g. milk replacers, hydrolyzed proteins, minerals/vitamins). When spray-drying dairy products, for example, about 10 to 25% of the raw material can be lost. Caking, clumping and stickiness also affect the quality of ingredients and impede their processing. Moreover, wall deposit in a spray dryer may present a safety issue as it could oxidize or even combust. Silica for food production (i.e. AEROSIL® fumed silica, SIPERNAT® and ZEOFREE® specialty silica from Evonik) contribute to the efficient processing of food powders because they reduce caking in spray dryers and prevent clogging of pipes. The main benefit is that less of the valuable raw material is lost as production waste. Through improving the efficiency and output of food and feed processing, Greenhouse gas emissions are avoided.

Thus, silica in food and feed applications contributes to the SFA "Fight Climate Change".

It addresses positively stakeholders' ambitions (SC 3) regarding reduced energy consumption and has a significant positive environmental impact in comparison to the market reference (SC 5). The handprint is quantified through an LCA conducted by our in-house experts from the LCM group. The functional unit is one kg of milk powder and the system boundary is cradle-to-application. The handprint is quantified in CO_2e of the Evonik solution compared to the reference which is the production of milk powder without silica processing aid. Compared to this market reference, it is possible to achieve savings of 9% in greenhouse gas emissions, driven by the avoided product losses during processing. Only very small amounts of silica are required to achieve significant improvement.

Comparison of greenhouse gas emissions of milk powder produced without the use of processing aid (Reference system) versus milk powder produced with silica processing aid (Evonik system)
kg CO_2e per kg milk powder, relative scale



LINERLESS RELEASE COATING

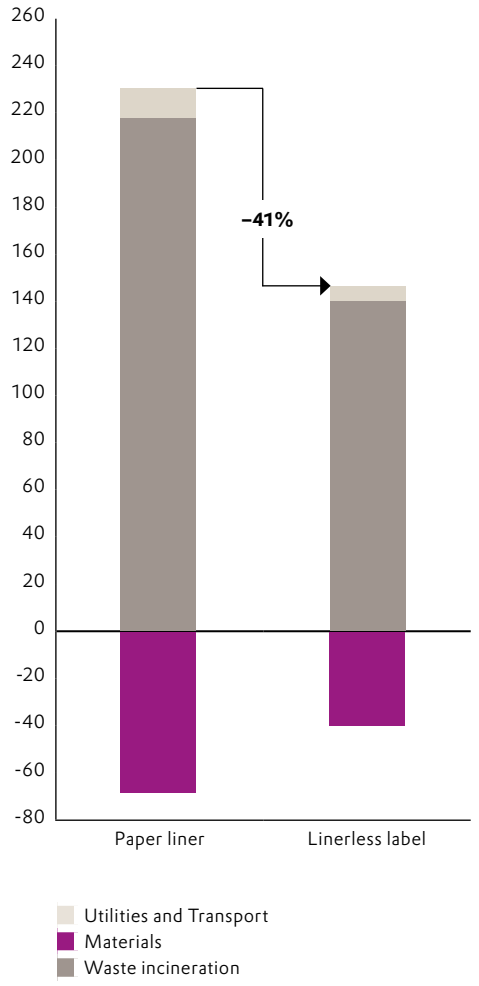
In recent years, interest in linerless labels has increased enormously. Here, the labels no longer stick to a release liner, but are wound directly into a roll, like adhesive tape. A silicone-based release coating ensures that the individual windings separate cleanly, quickly and without any residue before further processing or labelling. The very robust free radical curing mechanism of TEGO® RC silicones can be key to linerless label application on a wide variety of paper and filmic surfaces.

Thus, linerless labels are already being used effectively in numerous applications, from health and beauty, food, and beverage to postage and logistics. Linerless labels are especially suitable for use as thermal labels for variable print information. Likewise, prime labels can also be produced. Wrap-around labels in particular are rapidly growing in food packaging.

In the self-adhesive label market, the PARC "linerless release coating" is rated as an NGS as it fully addresses stakeholders' ambitions regarding reduced energy and material consumption as well as waste production (SC 3) and has clear environmental benefit compared to conventional self-adhesive labels. Indeed, linerless labels offer clear advantages for the labelling process (more efficient and flexible) and produce less waste and a greenhouse gas reduction in production, logistics and disposal. With conventional self-adhesive labels, the liner accounts for up to 40% of the weight and is therefore also a major driver in the overall cost of materials. After the labelling process, the liner just becomes very expensive waste. With our solution, 29 billion m^2 of release liner waste could be avoided worldwide. Although in the EU about 35% of the total waste of release liner material is fed back into recycling processes, a large part of high-quality and costly cellulose paper still ends up in landfills or incineration, further adding to the waste problem. Linerless labels clearly play a key role in a more circular economy. When using linerless labels, the converter as well as the user do not generate wastes anymore, that they would need to take care of in terms of collecting and disposing or sometimes even paying fees.

The handprint has been quantified by a cradle-to-grave LCA, performed by our in-house experts for a functional unit of 1,000m^2 label. The potential for avoiding waste has also been translated into greenhouse gas emissions avoided along the life cycle: Around 67.2 kg of CO_2e can be saved compared to a standard label, which equates to a saving of 41%.

Comparison of greenhouse gas emissions over the life-time of a standard label versus a linerless label
kg CO_2e per 1,000 m^2 label, relative scale

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EVONIK'S EXCEL® REJUVENATION

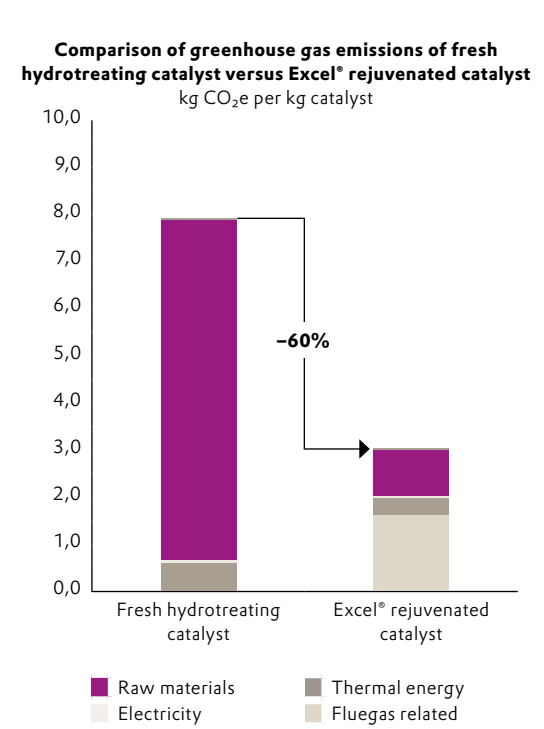
Evonik's Excel® rejuvenation process is a step beyond regeneration. It offers a means for restoring spent catalyst and gives refiners an excellent alternative to fresh catalyst in a wide range of hydrotreating applications from naphtha to heavy gas oil.

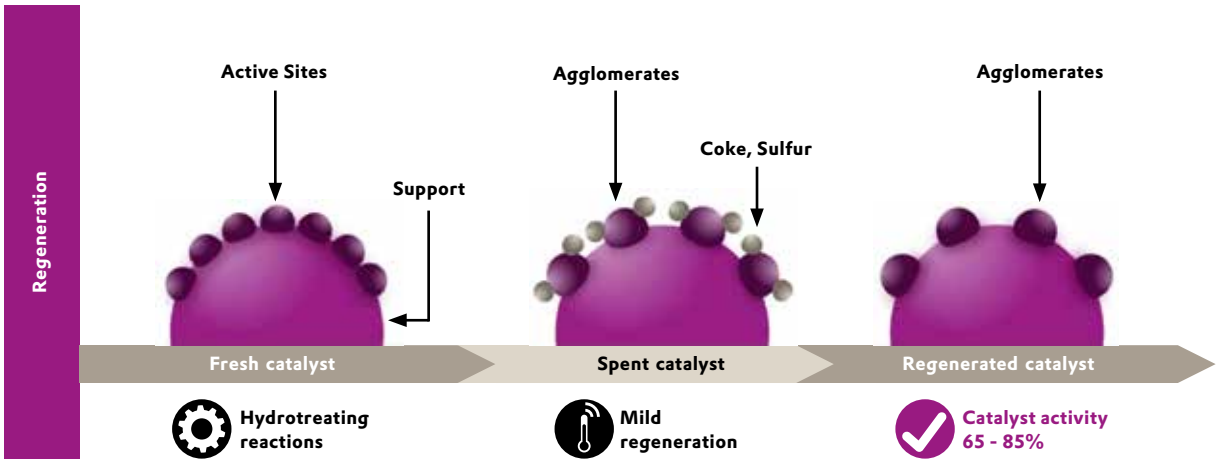
Prior the rejuvenation step, the spent catalyst is regenerated under oxidative atmosphere to remove both coke and sulfur. Then a chemical treatment is carried out to remove activity inhibitors, redisperse metals and restore active sites for maximum activity.

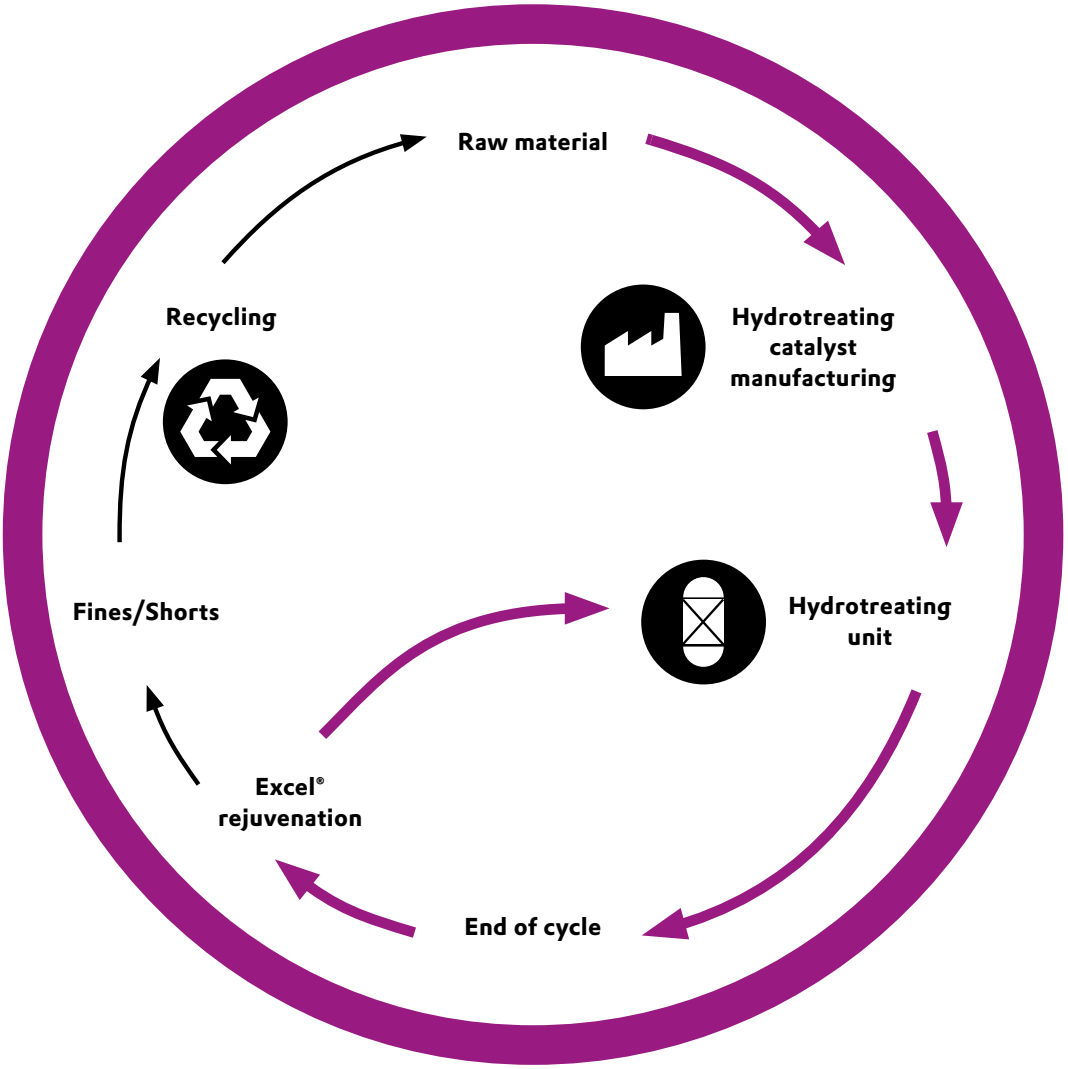
The Excel® technology rejuvenates catalysts and consequently helps avoiding wastes and reducing the CO_2 emissions compared to a fresh catalyst production for refiners (lower use of virgin raw materials and lower energy consumption for processing). Thus, it makes an active contribution to circular economy by maximizing catalyst reuse & minimizing catalysts wastes.

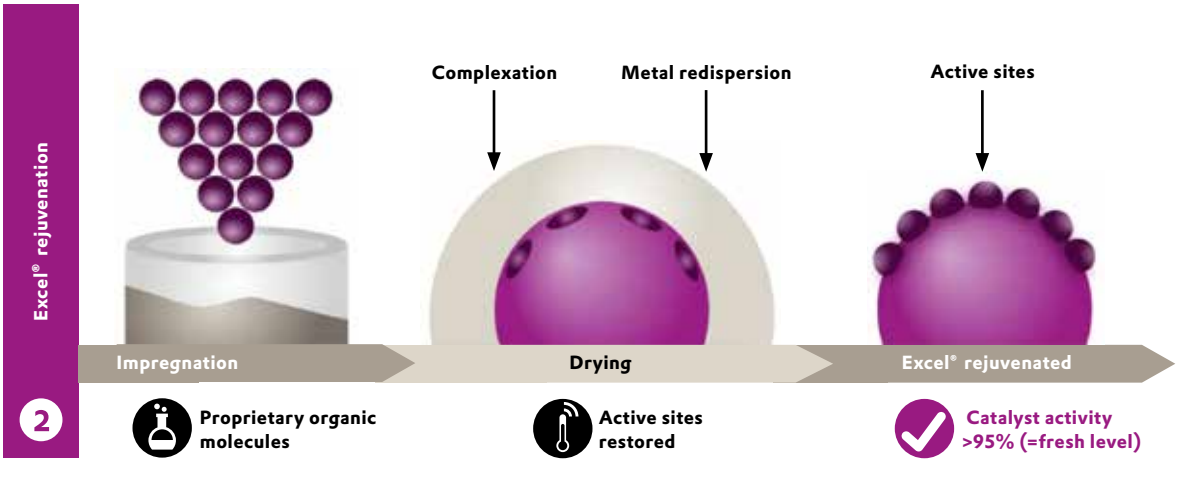
In the PSA, the PARC "Hydrotreating regeneration/ rejuvenation" is rated as an NGS as it addresses stakeholders' ambitions (SC 3) regarding the commitments in greenhouse gases emissions and wastes reductions.

Indeed, clear commitments have recently been forthcoming from our refining customers regarding reductions in Scope 1 and 2 emissions, sometimes including Scope 3 emissions and waste reduction initiatives. The environmental advantage of the Excel® technology (SC 5) has been confirmed by a cradle-to-gate LCA, performed by our in-house experts and comparing the rejuvenating technology with current market reference (i.e. virgin catalyst). The functional unit is 1 kg of rejuvenated catalyst, functionally equivalent to virgin catalyst. The analyze shows that the Evonik technology enables a reduction of greenhouse gas emissions and wastes by about 60% thanks to the rejuvenation technology.






Raw material
Hydrotreating catalyst manufacturing
Hydrotreating unit
End of cycle
Excel® rejuvenation
Fines/Shorts
Recycling


Excel® rejuvenation
2
Complexation
Metal redispersion
Active sites
Impregnation
Drying
Excel® rejuvenated
Proprietary organic molecules
Active sites restored
Catalyst activity >95% (=fresh level)

AMINO ACIDS SUPPLEMENTS FOR ANIMAL FEED

In the Animal nutrition business line, several PARCs have been created in relation to feed additives (e.g. MetAMINO, Biolys, ThreAMINO, etc.) depending on the type of animal fed (poultry, swine) and the farming region. The PARCs relating to amino acids for broilers and pigs in emerging and developing countries as well as the PARCs relating to layers have been rated as NGSs and have a positive score in SC 3 and 5 because of their addressed ambition to make agriculture more efficient by producing more with fewer resources and because of their positive environmental impact.

Amino acids supplements used in animal feed have already been described in the Section 3.1.2 regarding their potential to reduce greenhouse gas emissions in livestock production. Additionally, an important material topic for the agriculture value chain is the protection of the ecosystems.

Feed supplements enable a reduction of the amount of feed needed to supply the essential nutrients that animal require and consequently a reduction in land, fertilizer and freshwater use to produce animals. They also reduce the amount of nitrogen excreted by the animals in manure, which helps reduce harmful nutrient pollution.

This handprint has been validated by a life cycle assessment and certified by TÜV Rheinland. The functional unit is one ton animal live weight. For example, compared to the industry standard diet, the use of Evonik-recommended amino acid supplementation in layer hen feed can reduce the eutrophication potential of egg production in Europe by 12% and in China by 19%.

VERAMARIS ALGAE OIL

Veramaris was launched in 2018 as an equal joint venture of DSM and Evonik and offers a solution for the reliable and sustainable supply of omega-3, produced from natural marine algae on an industrial scale and via a fermentation process.

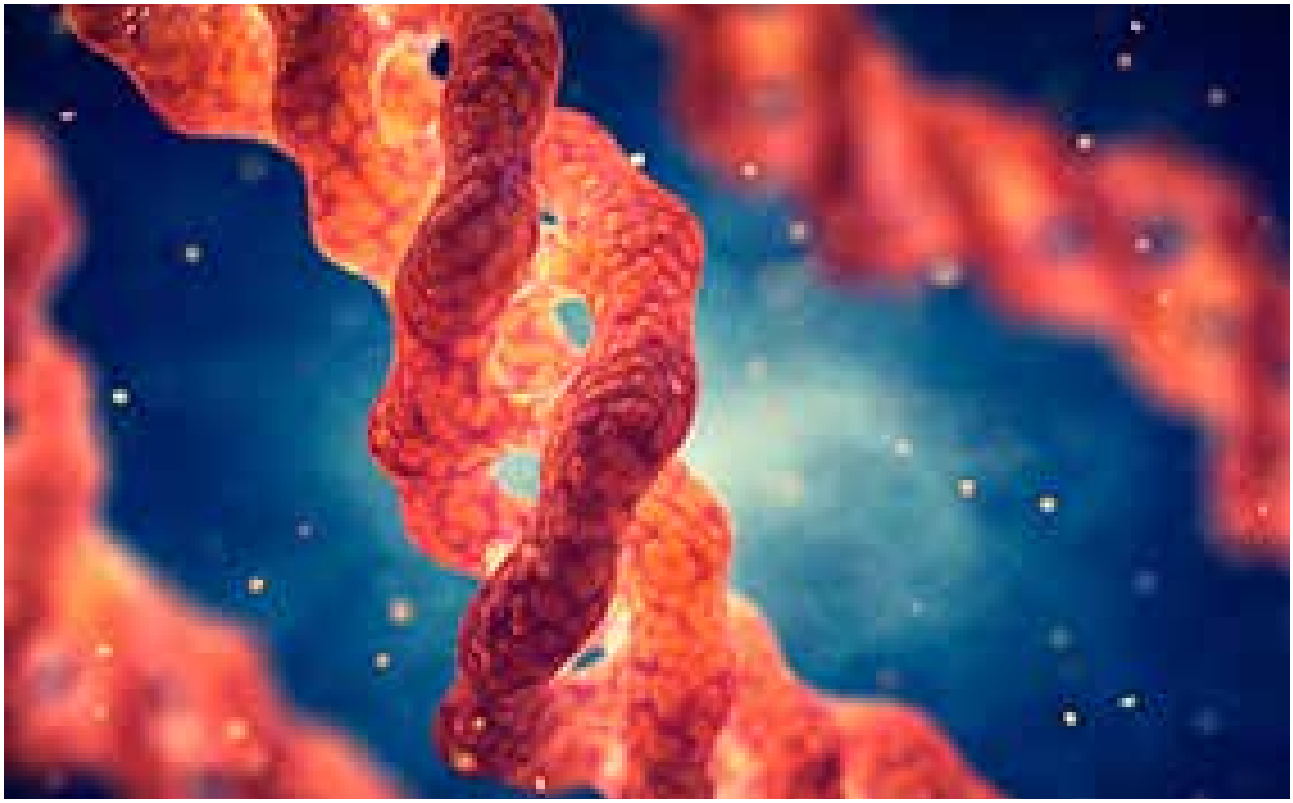
In aquaculture, omega-3 must be added to feed while wild fish obtain their omega-3 from the natural food chain. Until recently, fish oil and fish meal from wild fish stocks were the sole source of omega-3 fatty acids. However, these fish stocks are often overfished. Veramaris algae oil enables independence from marine resources, consequently reducing the pressure on marine ecosystems. The PARC relating to Veramaris has been rated as an NGS as it addresses positively stakeholders' ambitions in the aquaculture value chain (SC 3) regarding the reduction of the amount of unsustainable fish oil used in farmed fish and thus has a positive environmental impact on marine biodiversity.

To quantify the handprint of the Veramaris algae oil, a LCA study[17] has been conducted for salmon farming (the functional unit being one ton salmon live-weight) and new impact categories relevant to marine environment have been developed together with a leading international research institute. One of these new metrics is the primary production of photosynthetic carbon (PPR) which reflects the disturbance of ecosystem flows when fish is used as feed in the form of fish oil and meal. The LCA study and the new metrics have been validated by third-party reviewers. The study shows that when replacing fish oil in the salmon diet with Veramaris algae oil, the PPR can be reduced by 45%.

Moreover, it has been determined that 1 ton of Veramaris algal oil yields the same amount of omega-3 fatty acids as 60 ton of forage fish.

[17] Veramaris (2016): Comparative Life cycle assessment of Algal Oil containing EPA/DHA as feed ingredient for salmon aquaculture, (2016)

VECOLLAN® –EVONIK'S NON-ANIMAL-DERIVED COLLAGEN FOR MEDICAL DEVICE APPLICATIONS



Collagen is a protein found in bones, muscles, skin, and tendons. It forms a scaffold to provide strength and structure. Evonik has developed Vecollan®, a highly pure and soluble collagen that is produced via fermentation-based processes without the need for animal-derived materials. This advanced recombinant collagen platform leverages Evonik's biotechnology platform using raw materials and products that are 100% biodegradable. In the PSA, this product is considered in the PARC "Biomaterials collagen", is rated as an NGS for several reasons and contributes directly to the "Ensure Health & Wellbeing" focus area.

Conventionally, collagen used in life sciences and pharmaceutical applications is animal-derived from young cattle. In addition to the high environmental impact of cattle production, this collagen is associated with batch-to-batch variability, potential transmission of diseases or pathogens, adverse immunogenic or allergic reactions, and non-sustainable sourcing methods.

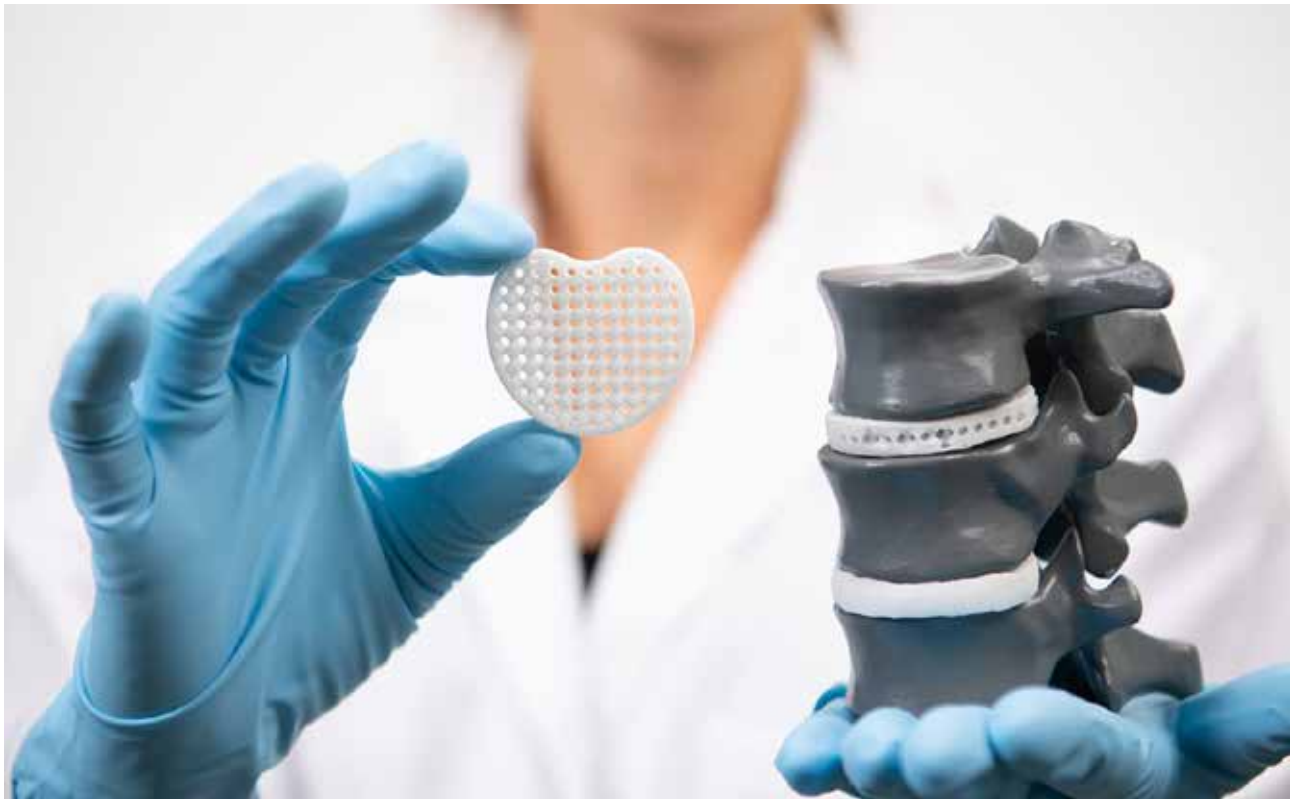
As a natureidentical material, Vecollan® is a highly pure form of collagen that is produced under precisely controlled conditions.

Vecollan® is compatible with other cross-linking technologies such as 3D-scaffolds, and injectable and bio-responsive hydrogels. No ecotoxicity, immunotoxicity and cytotoxicity products are used in the manufacturing of Vecollan®.

In terms of health and wellbeing, there are numerous societal benefits of non-animal-derived collagen. These include reduced allergic reactions due to non-immunogenic and low inflammatory responses, reduced rejection of medical devices by the body thanks to high biocompatibility, increased patient safety, and improved product efficacy. Vecollan® is also highly soluble, which makes it suitable for use in new biomedical solutions in surgery and tissue regeneration. Finally, Vecollan® is suitable for patients who for religious or ethical reasons do not consume animal-based medications.

Consequently, this PARC fully addresses stakeholders' ambitions in this value chain (SC 3) and has a significant social benefit in comparison to animal-derived collagen (SC 5).

HEALTHCARE BIOMATERIALS FOR MEDICAL DEVICES



The RESOMER® portfolio of biodegradable materials offers a broad range of standard, custom and specialized products for use with medical implant devices. Our RESOMER® polymers are designed to enhance the safety, biocompatibility and functional performance of medical implants across a range of application areas including orthopedics, wound healing and cardiovascular care. In the PSA, they are regarded as the PARC "surgical materials" that is rated as an NGS. Indeed, this PARC addresses stakeholders' ambitions positively (SC 3) regarding biodegradability and better patients' recovery in comparison to other metals and non-biodegradable materials and polymers used in the same surgical interventions.

The 100% bioresorbable RESOMER® polymers are completely metabolized by the body and are available in different forms. These include filaments, powders and granulates that can enable the 3D printing of high-resolution bioresorbable medical implants. Customization options are available for the architecture and microstructure to enable the polymerization of medical devices. For increased mechanical strength and rapid degradation, we also manufacture RESOMER® composites with distinct osteoconductive properties. These enhance the performance of medical applications such as suture anchors, interference screws and dental devices for faster patient healing and recovery.

RESOMER® biodegradable polymers support the Ensure Health & Wellbeing focus area because they can be engineered to match the specific needs of the target application. As a result, they have the precise strength, elasticity, mechanical, and chemical properties needed. Controlled release of active pharmaceutical ingredients ranging from one month to more than four years can also be fine-tuned. This enables faster recovery times, as patients' medications do not have to be taken so frequently, and there is reduced risk of overdosing. Personalized 3D-printed implants that can biodegrade over a period of time also enable the body to heal naturally, ensure patient compliance and faster recovery times. This positive health outcome is addressed in SC 5 by the elimination of the need, in some cases, for a second surgery and in reducing risks of chronic inflammation associated with permanent implants.

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