

We find solutions for the needs of today and tomorrow

Smart Materials
Division Spotlight Series 2021

June 24, 2021



Division Spotlight “Smart Materials”

Speakers of today’s event



Claus Rettig

President Smart Materials



Ralf Düssel

Head of High Performance Polymers



Gerd Löhden

Head of R&D Smart Materials

Smart Materials overview

Focused portfolio on environmentally friendly solutions

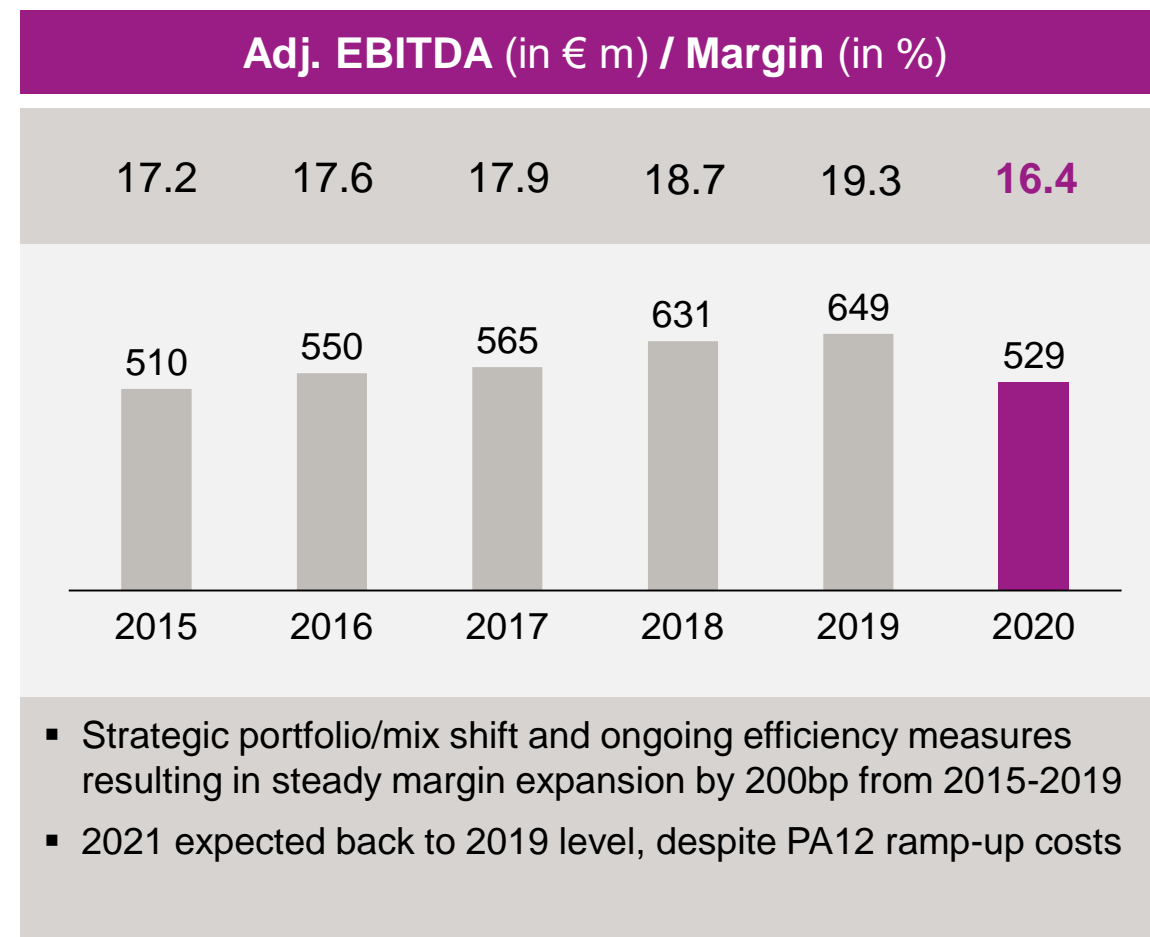
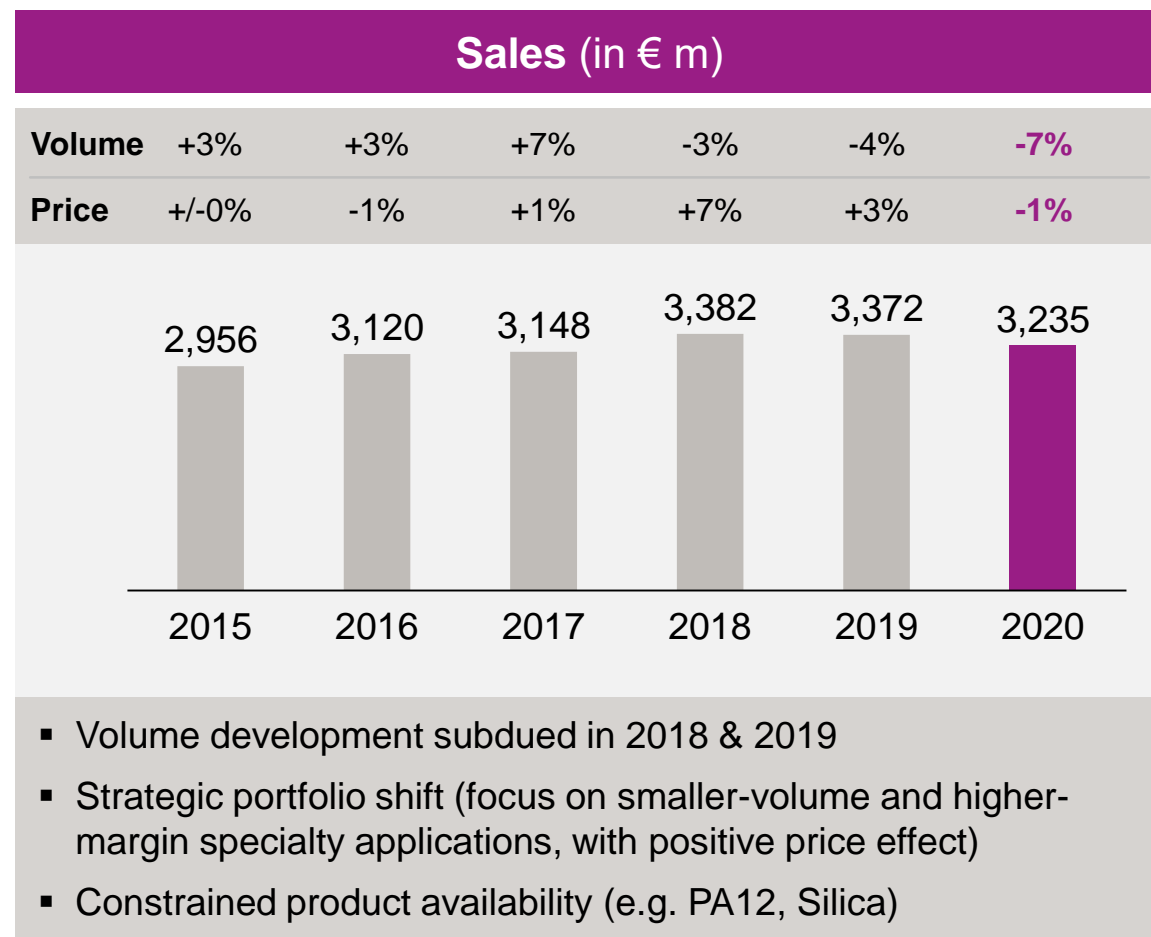
“We find solutions for the needs of today and tomorrow”

Two strong technology platforms	 Sales: €2,315 m Inorganics		 Sales: €920 m Polymers	
Growth highlights	 Future Mobility (e.g. PA12, Silica, Battery Materials)			
FY 2020 financials	 Eco-Solutions (e.g. Active Oxygens, Membranes, Catalysts)			
	 Margin ¹ : 16%	 Sales: €3,235 m	 ROCE: 6%	

1. Adjusted EBITDA margin

Our financial track record

Margin expansion by 200bp within 5 years



We are “smart(er)” since...

... we develop innovative solutions

Rohacell

PMI¹-based structural foam at the core of lightweight high-performance fiber composites for demanding aerospace applications



Anion Exchange Membrane (AEM)

Ion-conducting membranes for water electrolysis in alkaline conditions – the more efficient way to green hydrogen



... we tailor our solutions to the customers' needs



>100 individual Silica grades to solve our customers' challenges



High performance polymers:
~500 customer/application-specific products



Specialized polymer powders for 3D printing process allowing for series production of complex and individualized products

... we help our customers with individual know-how and services

840 employees in product, application and process development

Service teams for equipment, installation and full start-up support (e.g. to ensure dosing accuracy for Peracetic Acid in poultry anti-microbial interventions)

80 years of catalysts development expertise

External partners contributing in close cooperation to technology development

1. Polymethacrylimide.

Why are we smarter?

Tailor-made solutions as the smart answer for our customers



“We have been successfully and jointly working with Evonik on PA12 system solutions for decades for the Automotive industry and appreciate the innovative power of Evonik - fulfilling the fast disruptive change within the automotive industry and rising technical demands to strengthen PA12 usage also in the new mobility sector in the future, e.g. in battery cooling system solutions.”

*Mr. Heyang Wang, General Manager,
Chinaust Automotive, Greater China*

Why are we smarter?

Tailor-made solutions as the smart answer for our customers



“As we work with leaders of the consumer goods industry to disrupt markets and accelerate the mass production of breakthrough applications, we are proud of our long-standing partnership with Evonik. Together the advanced capabilities of our Multi Jet Fusion platform along with the Evonik/HP co-branded thermoplastic amide (TPA) enables the production of personalized midsoles for athletic shoes that deliver a flexible, lightweight, high-performance experience for consumers. We are excited to push the limits of innovation for footwear and beyond through this collaboration.”

Ed Ponomarev, Vice President HP Personalization and 3D Printing, USA

Why are we smarter?

Tailor-made solutions as the smart answer for our customers



“We developed the dishwasher basket coating jointly with Evonik more than 30 years ago. We grew together in a long-term partnership with this application. Today we are one of world’s leading companies in dishwasher basket production and we are using Vestosint[®], the most important coating material for this application for long-lasting dishwasher products with high quality for major OEMs in the appliance industry.”

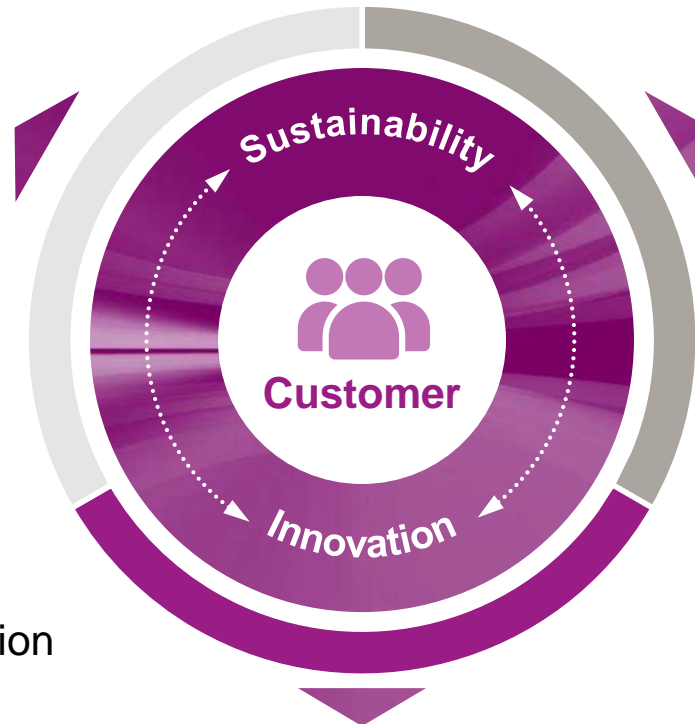
Joachim Schnee, CEO Josef Schnee, Wehingen, Germany

Our strategic pillars

Growth – Excellence – Leadership with the customer always in the center

- Develop our Growth Fields
“Future Mobility” and “Eco Solutions”
- Expand specialty applications
- Regional expansion into Asia
- Leverage acquisitions
and continue selective M&A

Growth



Excellence

- Digitalization and
Artificial Intelligence
as key enabler for value creation
- Supply Chain Excellence:
Simplify the way to operate

- Increase diversity and globalize organization
- Foster organizational agility
- Push entrepreneurial spirit

Leadership



Sustainability: In the DNA of Smart Materials

Evonik focus areas covered by smart solutions

Evonik's four "Sustainability Focus Areas"

Fight Climate Change



Materials for Li-Ion-Batteries



- Nanostructured high-quality metal oxide and silicon particles improve safety, lifetime and energy density
- Metal oxides extend cathode lifetime by ~50%

Drive Circularity



Excel® technology for catalysts



- Rejuvenation of catalysts avoids waste and reduces CO₂ by >50%
- Excel® technology to reduce the CO₂ footprint of hydro-processing in refineries

Safeguard Ecosystems



Biogas membrane



- Superior biogas upgrading with hollow-fiber membranes
- Superior methane efficiency and low methane slip

Ensure Health & Well-being



Active Oxygens for food safety



- Environmentally friendly oxidizer for food sanitation meeting stricter governmental regulations
- Hydrogen peroxide purified and diluted to various concentrations



Innovation: R&D as one of our key growth drivers

Strategy, focus and global setup

Innovation approach

1. Solutions developed with key customers in close partnerships, e.g.



2. Two strong technology platforms

Inorganics

Polymers

3. Further strengthen our presence in Asia

4. Two innovation growth fields at the core



Additive Manufacturing



Membranes

Key facts

€132 m

R&D budget

~4% of sales

13 R&D sites

3 in NAFTA
6 in Europe
4 in Asia

840

employees
in product, application
and process
development

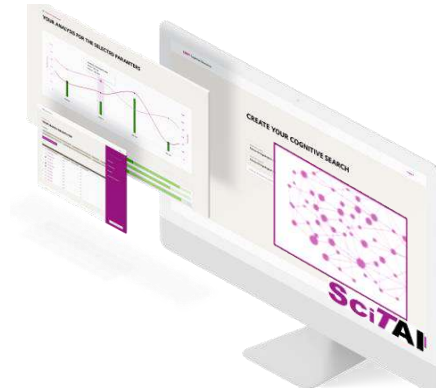


Excellence: Reinventing R&D with Artificial Intelligence

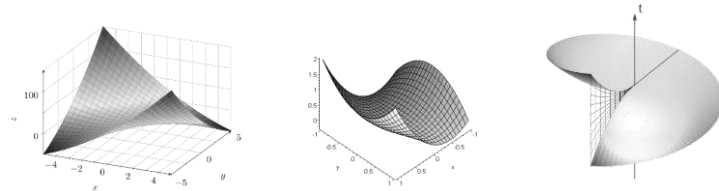
20 years of experience in PA12 transferred into high-speed AI solution

SciTAI

Scientific-
Technical Support by
Artificial
Intelligence



20 years of research work and data in PA12 compound development now digitally available



- Prediction of material properties by means of artificial intelligence
- Modeling on IBM technology

Quality	Speed	Cost

- Customized solutions
- Accelerated development by 20% - 40%



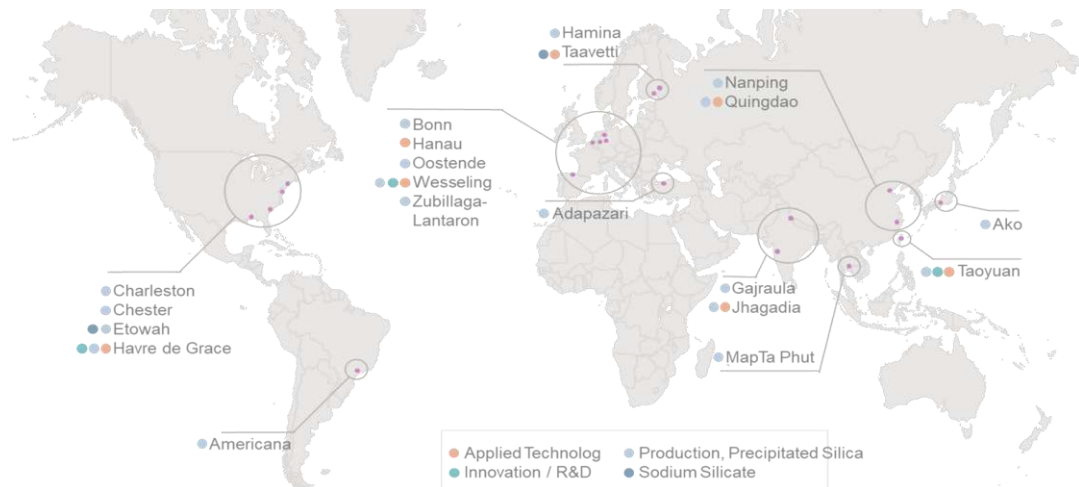
Unique partnership with MIT-IBM Watson AI Lab to explore upcoming digital technologies



Excellence: „Silica Network Optimization“

Identification of weaker sites and optimizing the overall network

Precipitated Silica Production Network



Implementation of AI tool

- for better **decision-making** on investments or greenfield options
- to systematically **benchmark** and optimize **costs** of each plant towards **network optimum**
- to identify and **mothball weaker sites** in the network

Project benefits

Profitability

Reduction of costs for production, transportation and warehousing
...resulting in low-double-digit € m savings

Asset utilization

Improved utilization of 18 assets¹ with high synergy level (6 added by Huber acquisition)

Sustainability

Reduction of transport costs
...resulting in a lower CO₂ footprint

Next step:

Potential check on roll-out to further Evonik platforms

1. Total number of sites: 18 for precipitated silica, 8 for fumed silica



Growth: Portfolio shift towards specialty applications accelerated

Both organically and inorganically

Expand share of specialty applications via ...

Targeted acquisitions

PeroxyChem



- Share of H₂O₂ specialty business increasing from ~50% to ~65%
- Resilience proven by stable earnings in FY 2020

Porocel



- Strengthen exposure towards sustainability and circular economy
- Higher share of Catalysts in Smart Materials portfolio

Own R&D

ROHACRYL™







- New performance foam addressing high potential for composite applications
- Trend toward increasingly longer wind turbine blades

Silica/Silane



- First Silica/Silane system for natural-rubber-based truck tires
- Pilot plant quantities available Q1/2022

Growth: Focus on attractive markets with smart solutions

Main end-markets served ¹	Product examples	Growth ²	Customer needs	Growth fields
Automotive/ Transportation (~20%) 	<ul style="list-style-type: none"> ▪ Silica for low rolling tires ▪ Battery additives ▪ Polymer - Lightweight composites ▪ Advanced adhesives & sealants solutions 	5%	<ul style="list-style-type: none"> ▪ Reduction of emissions ▪ Shift to electrification ▪ Lightweight design 	Deep dive 1 Future Mobility
Chemicals, Oil & Gas (~15%) 	<ul style="list-style-type: none"> ▪ Adsorbents & catalysts ▪ Silica for Silicones ▪ H₂O₂ for HPPO 	4%	<ul style="list-style-type: none"> ▪ Saving resources ▪ Environment-friendly processes ▪ Stricter regulations ▪ Energy efficiency ▪ Life-time extension 	Deep dive 2 Eco-Solutions
Environmental (~20%) 	<ul style="list-style-type: none"> ▪ Biogas membranes ▪ Green catalysts ▪ PAA waste-water treatment 	6%		
Consumer Goods (~10%) 	<ul style="list-style-type: none"> ▪ H₂O₂ for electronics 	7%		

“We offer the smart solutions for the needs of today and tomorrow”

1. Share of Smart Materials total sales 2020 (not displayed Personal Care with 15% and Others with 10%) 2. End-market growth rates CAGR 2021-2026 (not displayed: Personal Care with 4% and Construction with 4-5%, Others)

Future Mobility

Division Spotlight Series 2021

24 June 2021

Ralf Düssel & Gerd Löhden

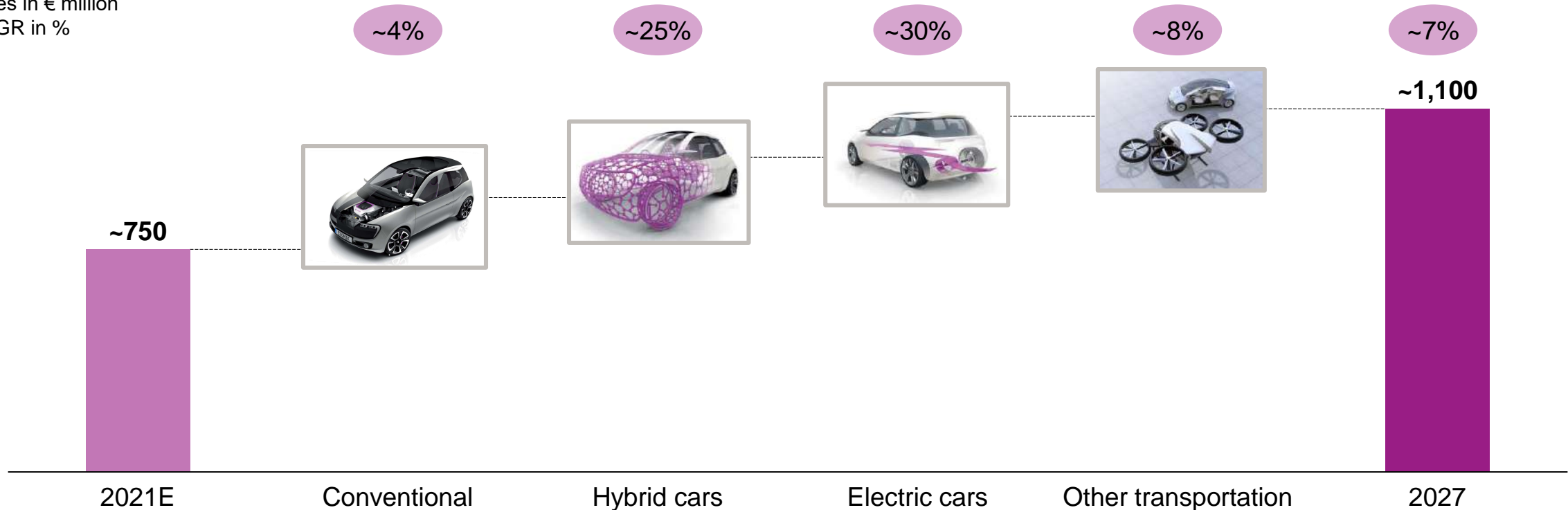


“Future Mobility” growth drivers

Growth to around €1.1 billion sales by 2027

Innovate mobility – we provide the chemistry

Sales in € million
CAGR in %



How Smart Materials is shaping the future car

Solutions in today's car

Conventional car today

High-performance fuel lines

Low rolling resistance tires

Battery additives

Polymer - Lightweight composites

Advanced adhesives & sealants solutions

Smart Materials' solutions
in a car today represent a value of

~€30



Note: Estimation based on BLs' survey.

How Smart Materials is shaping the future car

Solutions in hybrid and full battery car

Electric/Electronic Components

e.g. power busbar insulation

Tires
Reduced rolling resistance for extended range
Higher abrasion resistance for EV acceleration

Thermal Management

e.g. battery cooling lines

Battery
Electrode materials & additives for separators

Hybrid Car

In a hybrid car,
Smart Materials' existing solutions
with a value potential of

~€45



Full Battery Car

In a full battery car,
Smart Materials' existing solutions
with a value potential of

~€70

Enlarging the PA12 portfolio for hybrid & full battery cars

Increase of PA12 value from conventional to hybrid/e-cars by >50%

Cooling and A/C



Lightweight through metal / rubber replacement

- Weight reduction supports CO₂ and NO_x reduction
- Smart battery temperature management

Quick Connector



Fittings for fast connections between two lines, used to match fluid or air lines with equipment

- Lightweight through metal (brass) replacement supports CO₂ and NO_x reduction

Power Busbars



Insulation for flat copper bars for carrying current within sophisticated battery assemblies

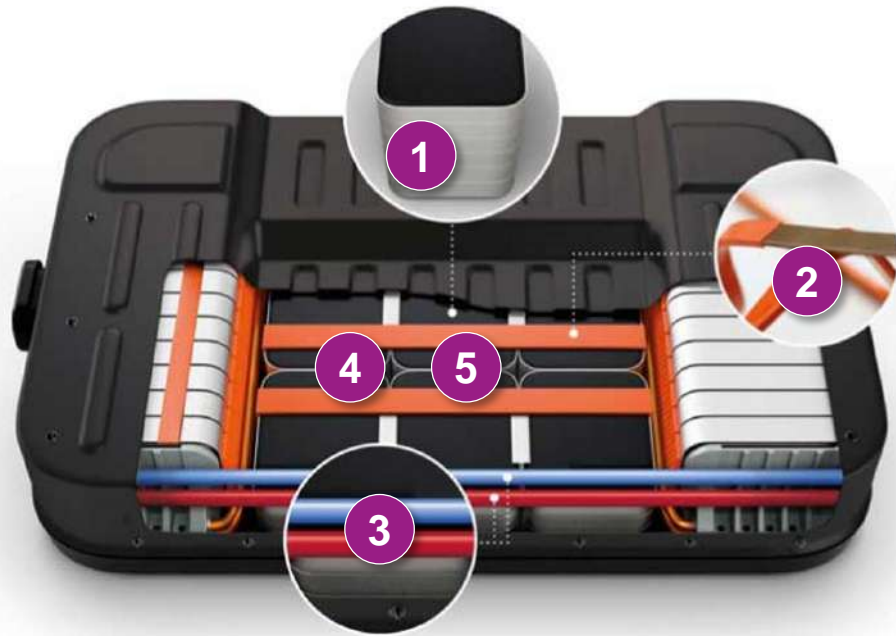
- Flame retardancy increases safety and security
- Smart processing

New production complex in Marl, Germany, with start-up in H2 2021, ready to serve high demand

Sources: AAFP, A2Mac1, ihs.markit, LMC, own estimates

How Evonik is shaping batteries

Evonik battery solutions today



- 1 AEROXIDE® fumed metal oxides improve performance, life-time and safety of Li-ion battery cells
- 2 VESTAMID® PA12 flame retardant power busbars provide excellent high-voltage insulation properties for safety requirements in EV
- 3 VESTAMID® PA12 tubing systems contribute to an ideal thermal management of HV battery, e-motor, inverter and a well-tempered overall ambience of the car
- 4 Polymer VS and TEGOSIL® additives for thermal management in EV battery¹
- 5 TEGOSTAB® and POLYCAT® silicone surfactants and amine catalysts to produce polyurethane froth foam for the protection of EV battery¹

How Evonik is shaping future batteries

Smart Materials battery solutions for tomorrow

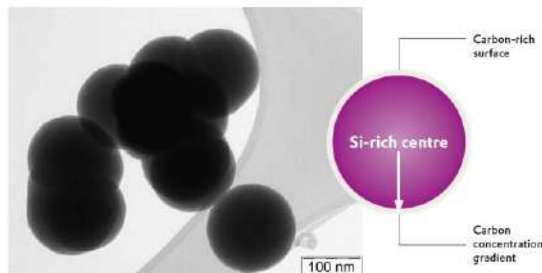
Improving the interfaces between main components (anode, cathode, electrolyte and separator)

Securing the integrity of the system over the lifetime of a battery cell and pack

SIRIDION® BLACK

Silicon/Carbon composite, high-capacity additive for the anode

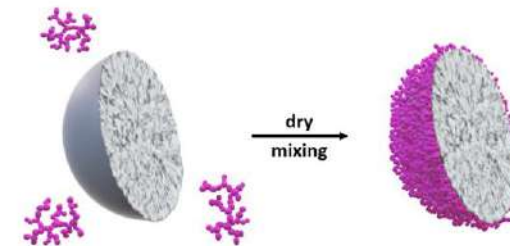
- Increased energy density and energy efficiency
- No compromises on service life
- Higher surface carbon content beneficial for oxidation protection, improved workability and compatibility



AEROXIDE®

Ion-conductive additives for cathode, anode, separator and electrolyte

- Surface protection of the cathode particles
- Less cathode material and electrolyte decomposition
- Significant increased capacity retention
- Longer battery life-time



New lithium-ion battery R&D center in China

Ensuring stronger foothold in China to accelerate focused R&D developments

A one-stop-shop technical center for customers and OEMs with testing facilities

Rationale

- **Regional focus:** over 90% of LIB producers are Asian, and most new and dominant players are from China
- **Local speed:** New facilities emerging around the world are based on designs and technology determined at Asian HQ
- **Global innovation:** Next generation battery development will be a global competition on eye level. Global scientific network is key for success

Benefits

Capability to develop in real life systems and generate relevant data for customers

- Build-up internal Evonik know-how, beyond chemistry
- Speed-up innovative technology development & introduction to market
- Close cooperation with key customers



Eco-Solutions

Division Spotlight Series 2021

24 June 2021

Gerd Löhden & Ralf Düssel

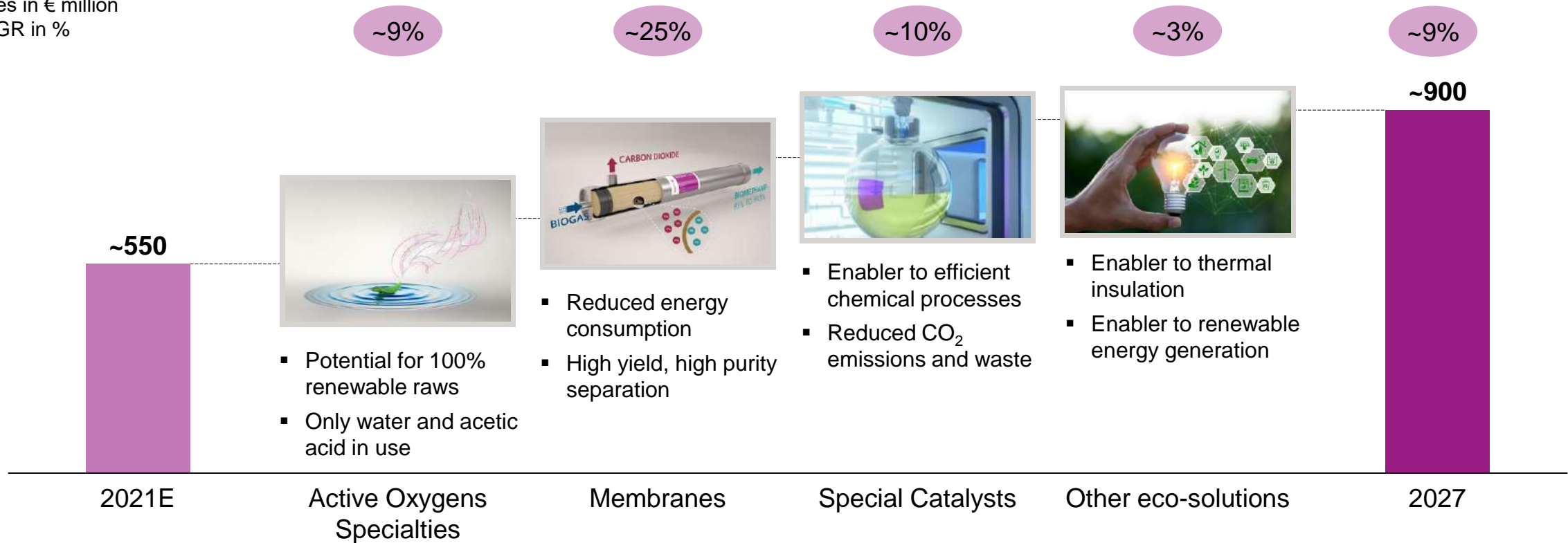


“Eco-Solutions” growth drivers

Growth to around €900 million sales by 2027

Focused on specialty end markets with strong secular growth trends

Sales in € million
CAGR in %



Active Oxygens Specialties

Hydrogen Peroxide and Peracetic Acid Specialties

Focus on environmentally friendly specialty applications

Basic raw materials (hydrogen, air, electricity and acetic acid): **100% renewable** source potential

Versatile chemicals, creating **no by-products** other than water and acetic acid when applied

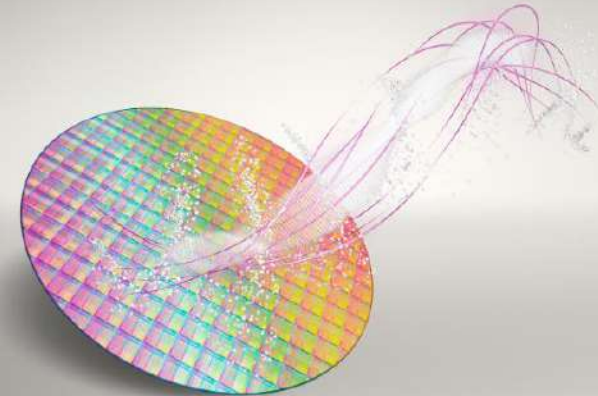
Stricter environmental regulations as overall demand driver for environmentally friendly peroxides

Diverse applications and high importance of application development to **expand high-growth & -margin specialties**

PAA for waste-water disinfection



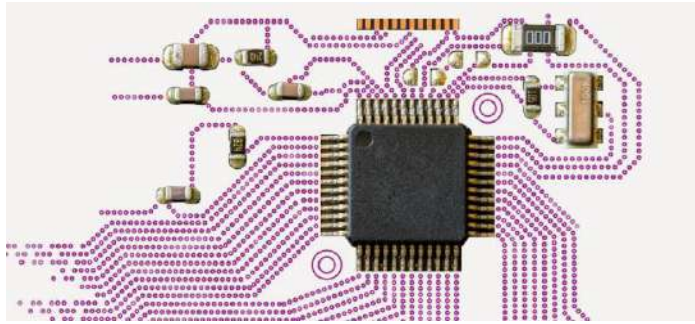
Ultra-high purity H₂O₂ for wafer-cleaning



Hydrogen Peroxide and Peracetic Acid Specialties

Diverse markets addressed with strong momentum

Ultra-high purity for wafer-cleaning



PAA for waste-water disinfection



PAA / H₂O₂ for food safety



Success factors

- Portfolio extension with PeroxyChem into dedicated ultra pure electronic-grade H₂O₂
- Forward integration moving closer to the end customers
- Global footprint ensuring reliable supply

- Leading PAA supplier in the municipal water treatment industry
- Improved market access as integrated solution provider for water treatment

- Solution provider for safe and effective food disinfectant processing & packaging
- Global capabilities to partner with the leading equipment providers of aseptic packaging solutions

Demand drivers

- Trend towards smaller electronic device geometries
- Increasing number of process steps require ultra-high purity agents

- Increasing demand for wastewater treatment solutions due to demographics and climate
- Tightening regulations require non-toxic, environmentally friendly solutions


- Growing population boosts demand for proteins & trend towards packaged food
- Increased focus on sustainable and effective solutions

Membranes

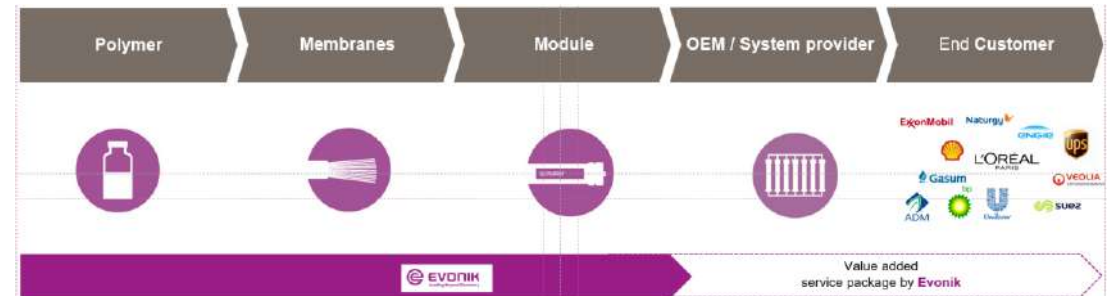
Membranes: Superior Evonik membrane technology

Best gas separation method enabled by tailored polymer properties

Benefits of Evonik membrane technology

- 
- ✓ Energy-consumption highly reduced
 - ✓ No waste and no emissions
 - ✓ Simple, modular setup
Flexible & easily expandable
 - ✓ High yield & high purity
Low maintenance

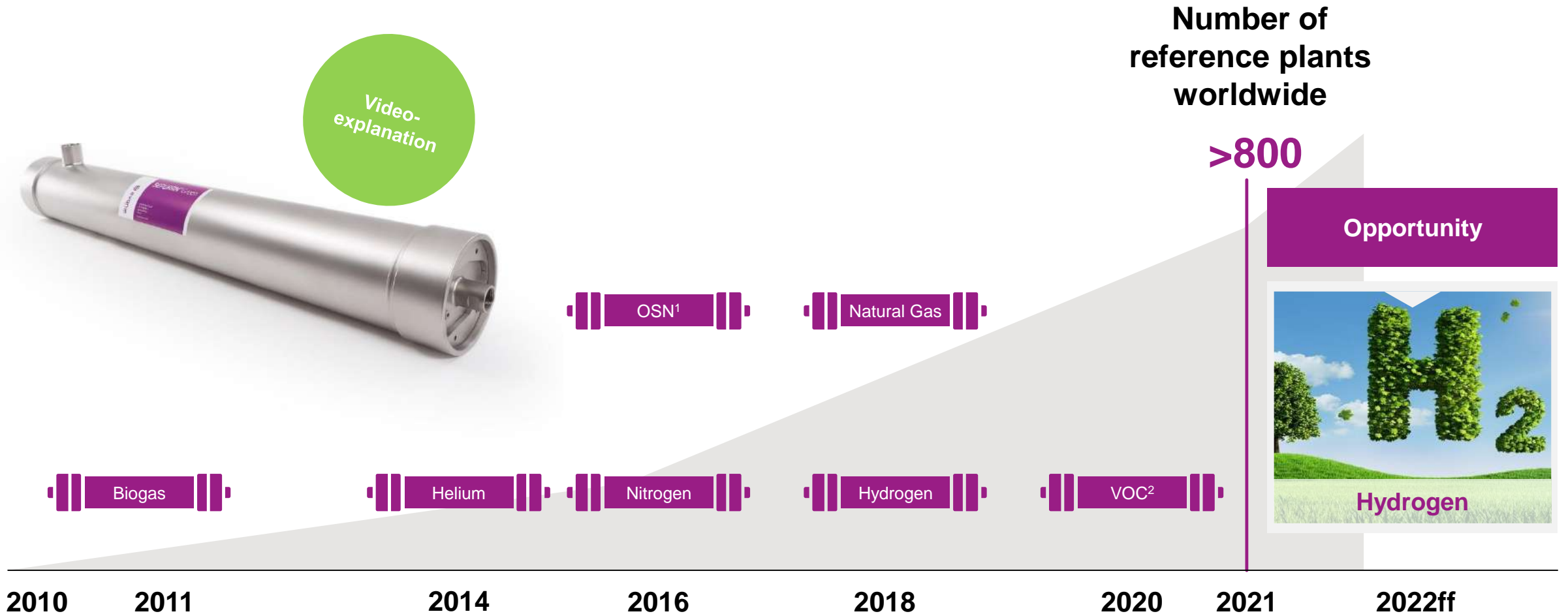
Leading Evonik market position



- Long-standing **chemical expertise** in polymer chemistry coupled with **full backward integration**
- **Innovation leader** by tailoring polymer properties at earliest development stage into superior membranes and separation solutions
- **Technology support** to adapt system for specific customer requirements

Membranes: From startup to global innovation leader within 10 years

Product diversification into multiple gas separation membrane markets



1. OSN – Organic Solvent Nanofiltration, 2. VOC – Volatile Organic Compounds

Our Membranes Vision: Smart enabler to the sustainable gas economy

Contributing to the transition with superior membrane technology



With our **membrane technology**, we significantly contribute to the transition to a sustainable gas economy:

1 SEPURAN® Green

- Raw biogas from organic waste is converted into **sustainable biomethane** and "green" CO₂

2 SEPURAN® Noble

- Our **hydrogen extraction membranes** enable to **use existing natural gas pipelines** to transport and extract green hydrogen
- In the **production of synthetic biomethane** from CO₂ and green hydrogen, we ensure efficient product separation

3 Anion Exchange Membrane

- With our ion-conducting AEM membranes, we contribute to the **breakthrough of electrolytic production of green hydrogen** in the future

Special Catalysts

Catalysts play a key role in global industries

No. 1 value generator in the chemical industry

Around 90% of all chemical products are manufactured by means of catalytic processes

Catalysts ensure resource efficiency of chemical processes leading to an improved CO₂ footprint



Evonik focus markets

Chemical catalysts



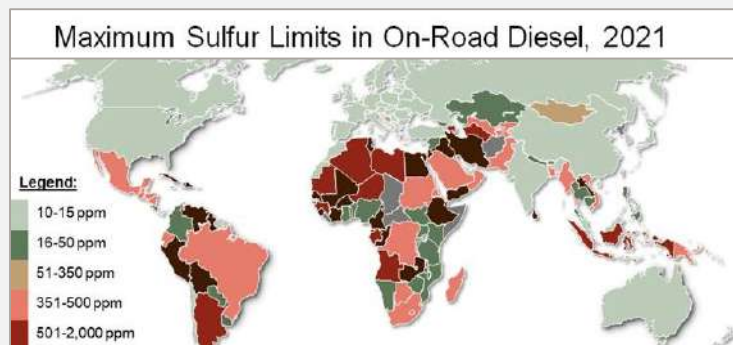
Refining catalysts



Source: European Cluster on Catalysis: Science and Technology Roadmap on Catalysis for Europe (2016). *World Bank

Sustainable solutions are at the core of catalysts' portfolio development

Adsorbents technologies

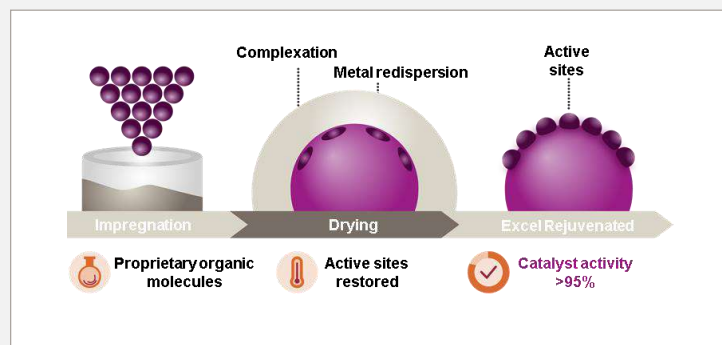


- Desulfurization of fuels is required to meet the stringent environmental regulations
- High quality catalysts, adsorbents and technical service ensure refinery operation at lowest cost and highest environmental standards

Acquisition

Source: information on sulfur limits by Stratias Advisors, April 2021

Rejuvenation technology



- Rejuvenation of catalysts avoids waste and reduces CO₂ footprint
- Excel® technology rejuvenated catalysts help to reduce the CO₂ emissions of hydro-processing in refineries by > 50% contributing actively to the circular economy

Carbon2Chem



- Synthesis gas is one of the key intermediates in the transformation of the chemical industry from linear to circular economy
- Development of catalysts and technologies for syngas processing to higher alcohols and olefins will be a cornerstone of the future clean and economic industry

R&D

Summary

24 June 2021

Claus Rettig



Summary: Unique positioning and strong growth potential

Clearly defined strategy to capture growth along attractive structural growth trends

Smarter...



- We develop innovative solutions
- We tailor our solutions to the customer's needs
- We help our customers with individual know-how and services



- Our strategy based on innovation and sustainability, centered around our customers
- Strategic pillars Growth - Excellence - Leadership

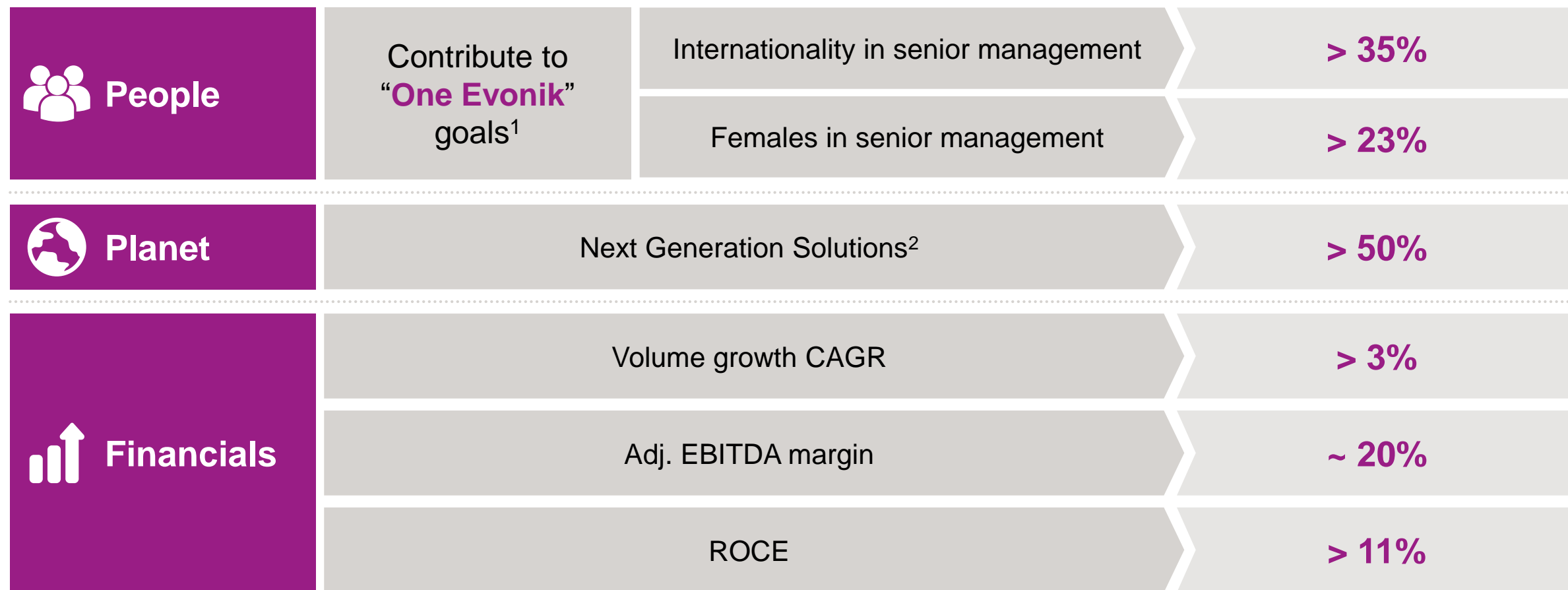


- Focus on our growth fields
"Future Mobility" and "Eco-Solutions"



... leading to our ambitious targets for Smart Materials

Committed to delivering enhanced value



1. Evonik Group targets on Management Circle 2 level, 2. Products and solutions with a clearly positive sustainability profile that is above or well above the market reference level

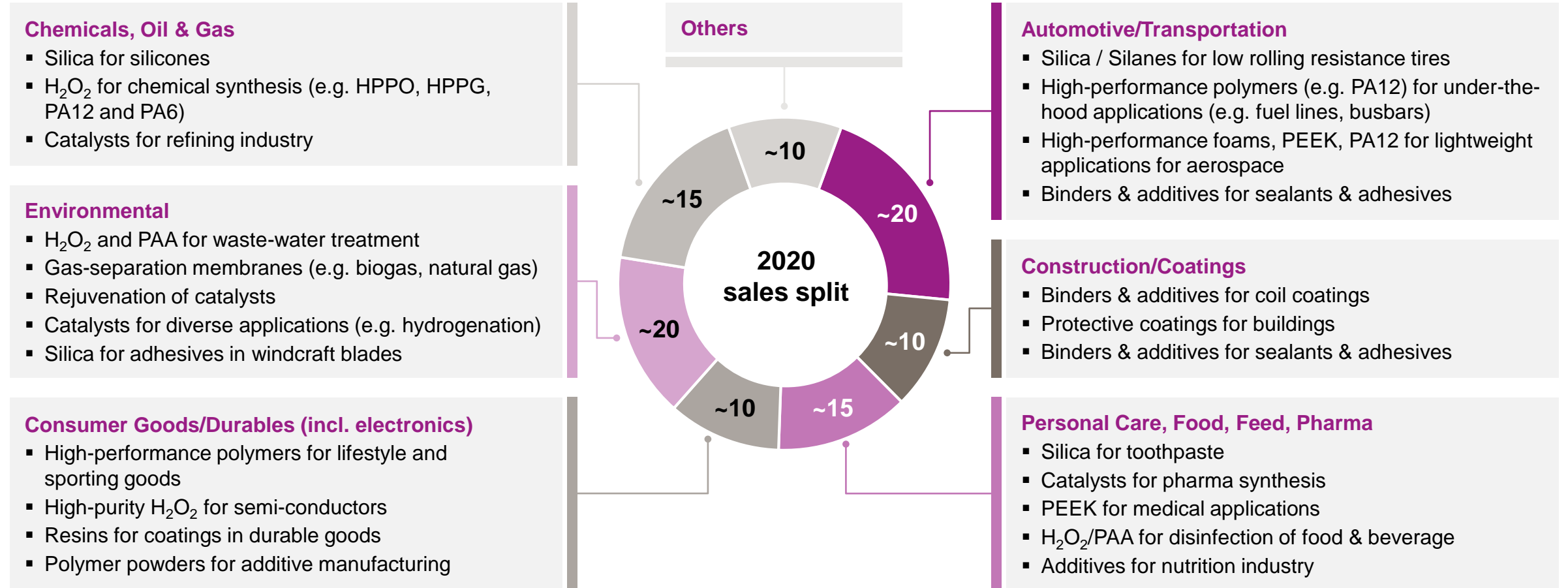


EVONIK

Leading Beyond Chemistry

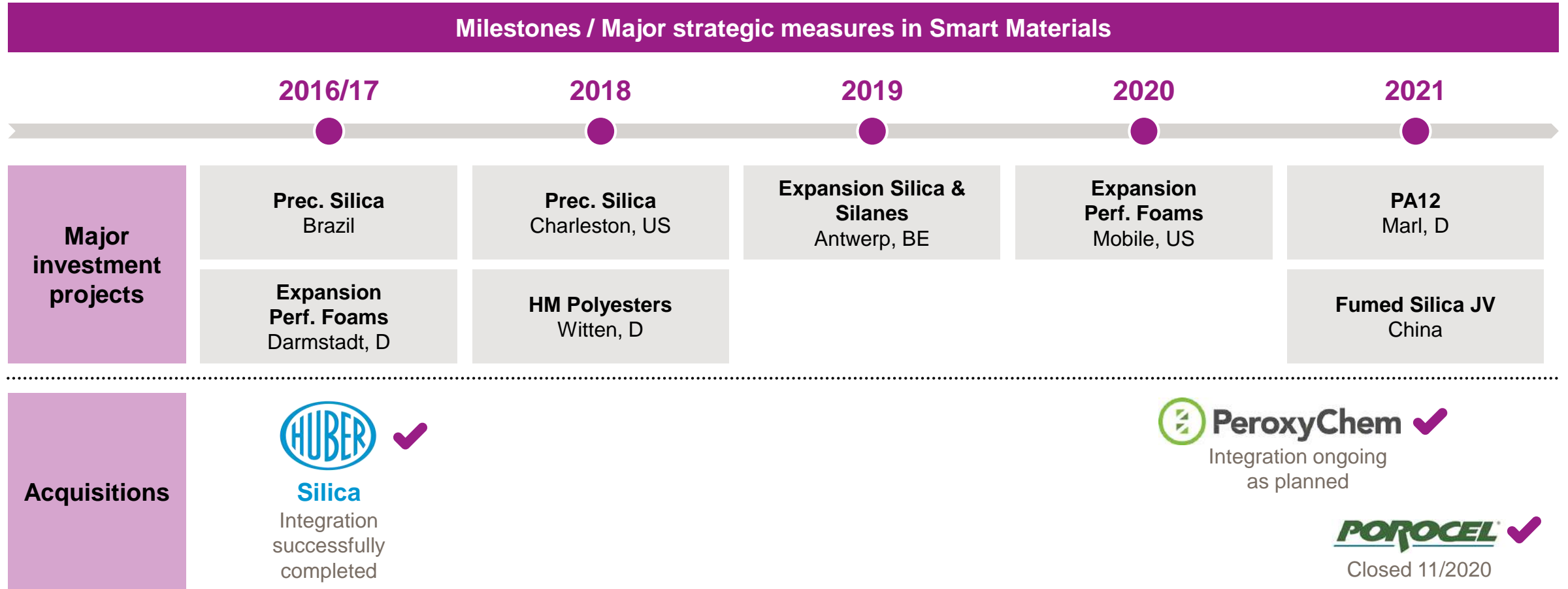
Appendix. Smart Materials

Smart Materials: Sales split & product examples



Progress in growth agenda

Major investment projects and bolt-on acquisitions



Silica Overview

A leading silica supplier with full coverage

Top #1

supplier for fumed and precipitated silica as well as metal oxides

32

industries served by industry experts

>100

products to solve customer challenges

~260

R&D and Applied Technology experts

26

production sites with global coverage

Featured markets (exemplary)



Tire and Mechanical Rubber Goods



Batteries



Silicones



Light & Electronics



Personal Care



Adhesives & Sealants



Toner



Food & Feed

Silica Innovation

Pipeline goes beyond the existing business

1 Re-innovate product solutions for existing markets

New ULTRASIL® grade for SUV tires

- Growing demand for larger SUVs tires
- Challenge for tire manufacturers: Sufficient stiffness in spite of their size
- **ULTRASIL® 7800 GR** offers the right mix to give SUV tires the needed stiffness, low rolling resistance and improved “grip”
- This reduces **CO₂-emissions** and **lowers fuel consumption** by up to **8%**



2 Tap into new markets via application development

AEROXIDE® as additive in Li-ion batteries

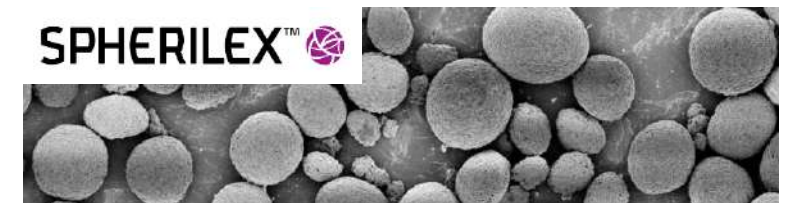
- Li-ion battery market shows a continued high growth rate, ultimately fueled by the **electric vehicle** market
- Key industry challenges are **performance**, **life-time**, and **safety** of the battery
- **AEROXIDE®** fumed metal oxides from Evonik help addressing these challenges as additives in Li-ion battery components



3 Create new technology options to enlarge the playing field






SPHERILEX® as new silica class

- New product class, unique, **patented manufacturing process** and materials
- Able to produce **novel, precipitated silica morphologies** with traditional raw materials
- Ability to control pore size, pore size distribution and surface area
- **Applications examples:** oral care, cosmetics and coatings



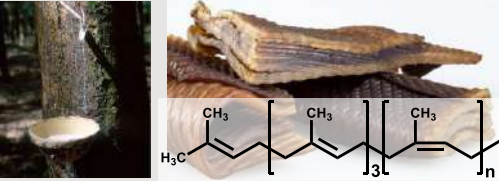
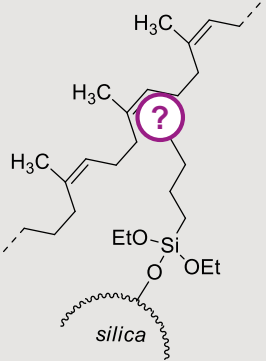
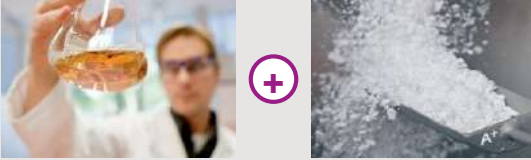

Silica Innovation

Contributing to sustainability and enabling further business growth

Industries		Contributions		
Green tire		CO ₂ e saving	✗	HD Silica in tires allows for reduced rolling resistance and thus for 8% reduced fuel consumption for combustion engine cars and increased range for battery electric vehicles
		Waste reduction		
		Better recyclability		
Adhesives in windmills		CO ₂ e saving	✗	Windmill bonding paste with Silica enables manufacturing of larger rotor blades allowing for 4-times higher generation of renewable energy
		Waste reduction		
		Better recyclability		
Food processing		CO ₂ e saving	✗	Better free flow capabilities allow for higher process efficiency and reduce food waste
		Waste reduction	✗	
		Better recyclability		
Li-Ion battery		CO ₂ e saving	✗	Aeroxide in Li-Ion batteries extends battery life by 50%, resulting in saving of 10 t CO ₂ e/kg Silica
		Waste reduction	✗	
		Better recyclability		
Automotive adhesives		CO ₂ e saving	✗	Silica-based adhesives reduce mechanical fastening and allow for revolutionary bonding concepts, thus enabling lightweight construction and easy-to-recycle glued components
		Waste reduction		
		Better recyclability	✗	

Silica Innovation

Inventor of first Silica/Silane system for natural-rubber-based truck tires

Unmet market need	Challenge	Approach	Next steps
<p>Reduced rolling resistance of natural-rubber based truck tires</p>	<p>Abrasion resistance of truck tires not met with Silica/Silane</p>	<p>New Rubber Silane combined with high surface area Silica</p>	<p>Road test with prototype truck tires in 2022</p>
<p>Today Carbon Black filled truck tires will not sufficiently fulfill new EU tire labeling for rolling resistance (RR) and wet grip</p>  <p>Hevea brasiliensis Cis-1,4-isoprene rubber</p> <p>- 10% RR → - 4% CO₂ emissions</p>	<p>Chemical structure of natural rubber requires new coupling mechanism</p> 	<p>New Rubber Silane with higher reactivity towards natural rubber</p>  <p>Highly dispersible (HD) Silica with high surface area (min. 200 m²/g CTAB)</p>	<ul style="list-style-type: none">▪ Pilot plant quantities of new silane available Q1/2022▪ New 200+ m²/g HD Silica available on pilot scale Q4/2021▪ Tire tread compound preparation and start of road trial with truck fleet in 2022 

High Performance Polymers

Highly demanding applications across various growth markets

Polyamide 12

- Temperature resistance
- High stability yet flexible
- Chemical resistance



Automotive / e-mobility



Appliance Industry



Gas Pipes / Offshore



Electronics & Medical



Additive Manufacturing



Sports & Lifestyle

VESTAMID®

VESTOSINT®

Additive Manufacturing (Powder suitable for 3D printing technologies)

- Highest mechanical properties
- Chemical resistance
- Easy to process



Powder Bed Fusion, Photopolymers, Industrial Scale AM

INFINAM® PA

Polyimide (Fibers & Membranes for gas separation)

- Highly sustainable solution
- Robust, withstands extreme pressure and temperatures



e.g. Biogases, Helium, Hydrogen

SEPURAN®

Polymethacrylimide (Performance Foam)

- Lightweight
- Resists highest temperature and pressure



Aircraft, Automotive, Electronics

ROHACELL®

PEEK

- Ultralight
- Inherent flame-retardant
- Energy efficient



Automotive, Aircraft, Medical (implant material), Construction

VESTAKEEP®

VESTAMID® PA12: Resilient, vigorous and persistent

Superior material to manage harsh conditions and environments

Resilient in cold and hot condition



- Long-term temperature application range of -40 up to 130 °C
- Superior thermal stability: No change of mechanical properties at -40 to 80° C
- Ductile break and flexible even at -40 °C

Vigorous material



- High flexibility without plasticizers
- High impact resistance under changing environmental conditions (e.g., low temperature, varying humidity)
- Low coefficient of friction without lubricants

Persistent powerful performance



- Excellent stress cracking resistance (e.g., for chlorides from sea areas, road salts)
- High resistance against all relevant fluids (fuels, oil, hydraulic liquids, cooling agents)
- Lowest water absorption of all commercially available polyamides

PA12: Selected growth market examples

Several growth markets profiting from unique PA 12 properties

Medical

Mid-term CAGR



VESTAMID® Care

>15% p.a.

- Heart catheters and tubes
- Durable medical equipment in imaging devices

Unique PA 12 benefit:
biocompatibility

Hi-tech sport equipment



VESTAMID® CW

>5% p.a.

- Impact-modified PA 12 for professional sports
- e.g. ski & snowboard boots

Unique PA 12 benefit:
low-temperature impact strength

Electronics & Telecommunication



VESTAMID®

>20% p.a.

- Sheathing for fiber optic cables for data transfer
- Protection of polymer optical fibers

Unique PA 12 benefit:
high flexibility (bending radius)

Lightweight design



VESTAMID®

>30% p.a.

- PA 12 matrix for carbon fiber tapes
- Used in composite structures for e.g. lightweight design in cars

Unique PA 12 benefit:
outstanding mechanical properties

PA12 Powder: Additive Manufacturing

Fueling the transition from low-volume prototyping to industry-scale production

Strong base established

- Evonik as **market leader** in PA12 powder-based 3D printing materials
- **Several platforms** available to serve all major powder-based printing technologies
- **Close partnerships** with major printing players and innovators:



Expand strong position

1st company which launched on Hewlett Packard material platform



Powder Bed Fusion
Expand polymers beyond PA12



Unique technology position with focus on Asia



Photopolymers
New Reactive Monomer Solutions



Developing with OEMs to enable transition to series production



Industrial scale AM
Substituting plastic machining and injection molding



Strengthened by targeted external technology investments



Polymethacrylimide: Performance Foam solutions for aerospace

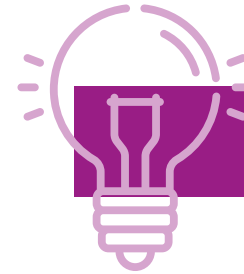


Engines in the air face high technical requirements on:

safety

acceptable speeds
and distance

energy-
efficiency



“We offer the smart solution.”






ROHACELL® HERO

As robust as any of
the ROHACELL®
foam products

Special quality making
it easy to visually
detect impact damage

Membranes: Overview of different gas separation markets

Portfolio built on strong technology platforms, innovation, global partner network

Membranes					
	Biogas	Process Gases	OBIGGS	Natural Gas	OSN/VOC
Market segment					
	Heat & Power – Transportation	Oil & Gas – Petrochemicals – Food & Beverage	Aircraft	Oil & Gas	Oil & Gas – Natural oils – Petrochemicals – Bio-Diesel
Evonik brands	SEPURAN® Green	SEPURAN® Noble	SEPURAN® N ₂	SEPURAN® NG	PuraMem® PuraMem® VOC

- **Attractive markets with global access:** Growth driven by increasing needs for sustainable energy supply
- **Strong technology platforms:** Backward integration, high-performance polymer expertise
- **Partnerships:** Global partner network to jointly shape further market needs with highly innovative separation technologies

Membranes: Extracting hydrogen from natural gas networks

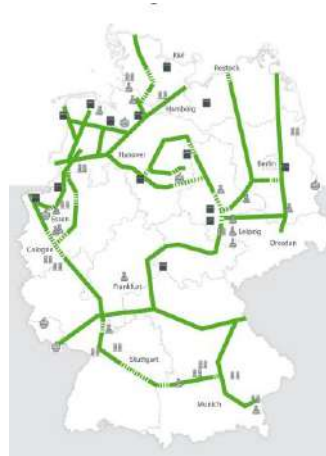
Evonik and Linde offer joint technology solution already today

Enabling the Hydrogen Infrastructure

Hydrogen accessible to industry & population

The German transmission system operators have developed a draft¹ for a visionary nationwide H₂ infrastructure using existing gas infrastructures. This way key locations of refineries, iron and steel works and the chemical industry - major consumers of H₂ - can be reached.

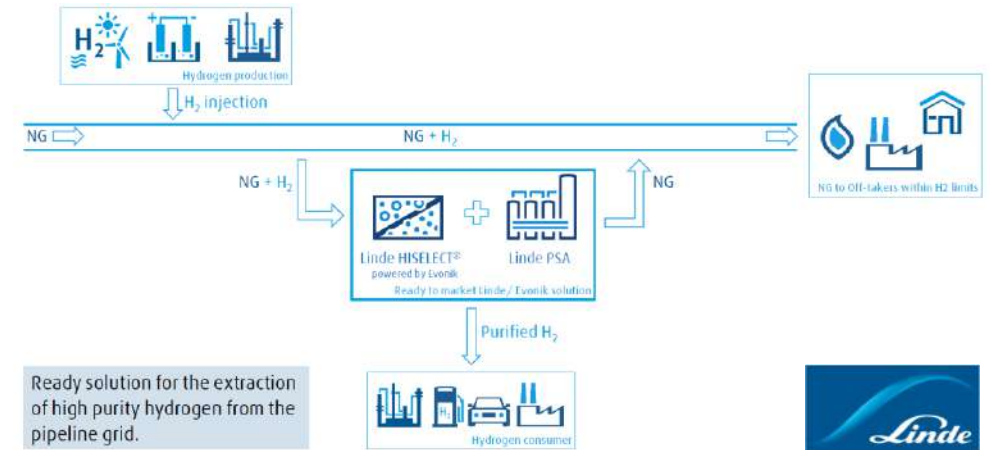
The H₂ network is also the basis for an extensive supply of hydrogen to filling stations.



- Hydrogen can be transported using the **existing gas transmission network**
- Supply of H₂ to refineries and chemical parks, including initial applications for the transport sector

1. Source: FNB Gas e. V.

Evonik membranes for H₂ extraction from natural gas

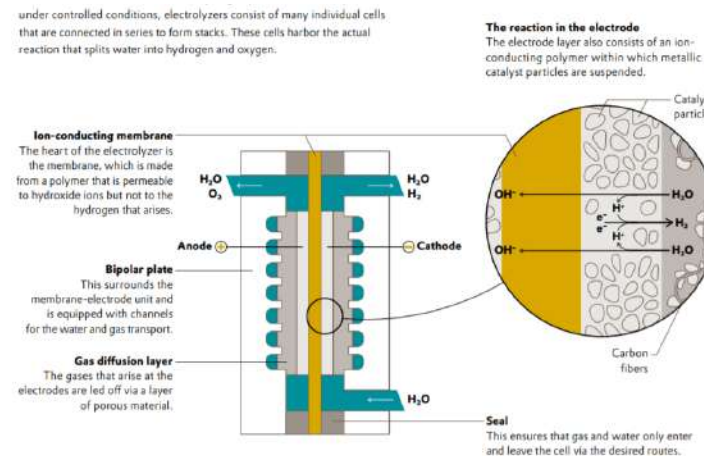


- Innovative combination of PSA1 unit by Linde plus **HISELECT® high-performance membranes** powered by Evonik
- Wide range of H₂ purities possible (H₂ as industrial feedstock, transportation fuel, heating, storage & buffering)
- Real-scale demo plant at Linde site in Dormagen (D) on stream soon

Membranes: AEM electrolysis making green hydrogen more efficient

Evonik membrane as key element for water electrolysis

- Evonik's **novel anion exchange membrane (AEM)** with durable, ion-conducting polymer at the core as the centerpiece for efficient water electrolysis
- More efficient green hydrogen production compared to other electrolytic processes such as conventional alkaline electrolysis using diaphragms (AEL²) or the more recent method of proton exchange membrane electrolysis (PEM³)
- **Key advantages** of the innovative AEM electrolysis platform:
 - Excellent conductivity, high current density, superior flexibility
 - Reduction of investment costs (no need for cells incl. precious metals): mid-term target to achieve costs of €500-600 per kW
 - Scalable technology: based on small modules as separate units



Process in alkaline environment

1. Water is split on the cathode side
2. Two H₂O molecules give rise to one hydrogen molecule and two hydroxide ions (OH⁻)
3. Hydroxide ions then move through the membrane to the anode, where they react to form oxygen and water

CONSORTIUM „CHANNEL“¹

- Consortium plans, constructs and tests an AEM electrolysis system based on the new Evonik membranes – demonstrator planned for 2022
- Project team covering the entire value chain for the production of green hydrogen
- 3 years duration, funding of ~€2 million by EU's Horizon 2020 research program

Team of highly qualified partners from industry and research organizations:



1. Cost-efficient Hydrogen production unit based on ANionN exchange membrane Electrolysis 2. AEL: robust technology, cell material inexpensive but diaphragm porous 3. PEM: high investment costs since precious metals needed for catalysts

Peracetic Acid as attractive wastewater disinfection technology

Evonik as leading PAA supplier in the municipal water treatment industry

Explanation of application & market & demand growth

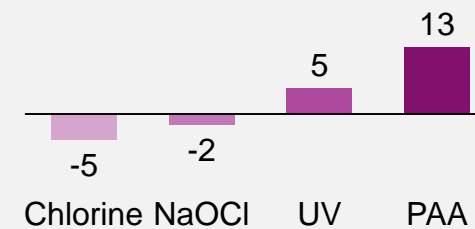
- Increasing demand for wastewater treatment solutions
- Driven by tightening regulatory requirements for non-toxic, environmentally-friendly solutions
- PAA as “green”, highly effective, safe alternative against bacteria gaining more and more relevance:
 - ✓ No harmful by-products or toxins
 - ✓ Low maintenance costs
 - ✓ Low capital investment to implement
 - ✓ Safety – no costly risk management plans are needed
- Improved market access as integrated solution provider for water treatment

1.Growth rates refer to North American Markets

2 incl. Hydrogen Peroxide

Available technologies (North American Market)

Water Treatment Technology Growth Rate (in %)¹



Chlorine, sodium hypochlorite (NaOCl) or UV as today's most commonly used technologies to disinfect wastewater

Increasingly replaced by PAA

Successful business set-up



- Long-term take-or-pay contract with City of Memphis in 2018
- As of today, already approved by 14 U.S. states

Ultra-high purity H₂O₂ is essential in manufacturing of electronic devices

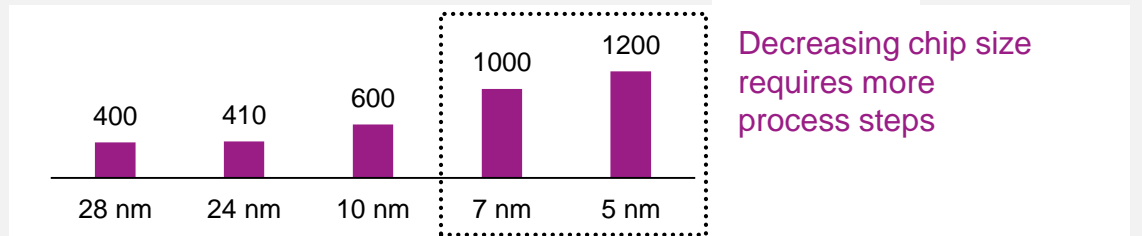
Strong demand due to changing process methods

- Increasing automatization, ongoing digitalization, IoT or e-mobility boosts demand for electronic devices and microchips
- Trend towards smaller electronic device geometries results in an increasing number of process steps, requiring ultra-high purity agents in semiconductor manufacturing
- At the same time, the process method is changing from batch to single wafer cleaning, driving the demand for ultra-high purity H₂O₂ significantly
- High-purity, electronics-grade H₂O₂ is preferred because of its low cost, effectiveness and reduced waste disposal

Increasing number of process steps

Value Chain

Standard Grade H₂O₂ > Pre-Electronic H₂O₂ > Ultra Pure H₂O₂ > Silicon Wafer Production > Application



Evonik winning potential

- Acquisition of PeroxyChem with dedicated ultra -pure electronic-grade H₂O₂ plant in Saratoga Springs (US) allows for a forward integration moving **closer to the end customers**
- Long-term contracts with renowned chip producers such as Intel, Samsung, Global Foundries
- Improved global footprint ensures reliable supply → geographic proximity is key to low cost and quality

H₂O₂ / Peracetic Acid in Food Safety Applications

Environmentally friendly microbial decontamination agent

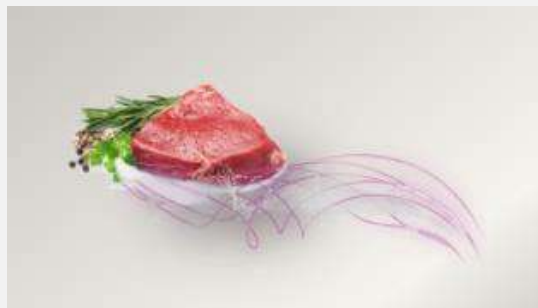
1 Aseptic packaging

- Growing consumer demand for preservative-free 'natural' beverages increases number of aseptically packaged products
- Evolving demands of low-acid, high-acid aseptic and extended shelf-life applications in the packaging market
- **Goal:** treat harmful microorganisms during the packaging process



2 Meat processing

- Growing consumer demand for proteins (e.g. poultry, red meat)
- High demand for environmentally friendly processing chemistries
- **Goal:** reducing contamination from pathogenic bacteria (e.g. salmonella) and limit product spoilage or decay in processing



Driver for success

- Through equipment and industry expertise, we provide a **safe and effective solution for food safety** as full solution provider
- Real-time intervention technology to capture and deliver detailed monitoring to help poultry processors **manage their dosing accuracy**
- Global Industry team working together to expand our market and provide safe solutions into all regions
- Based on poultry expertise, opportunity to **expand into beef** segment

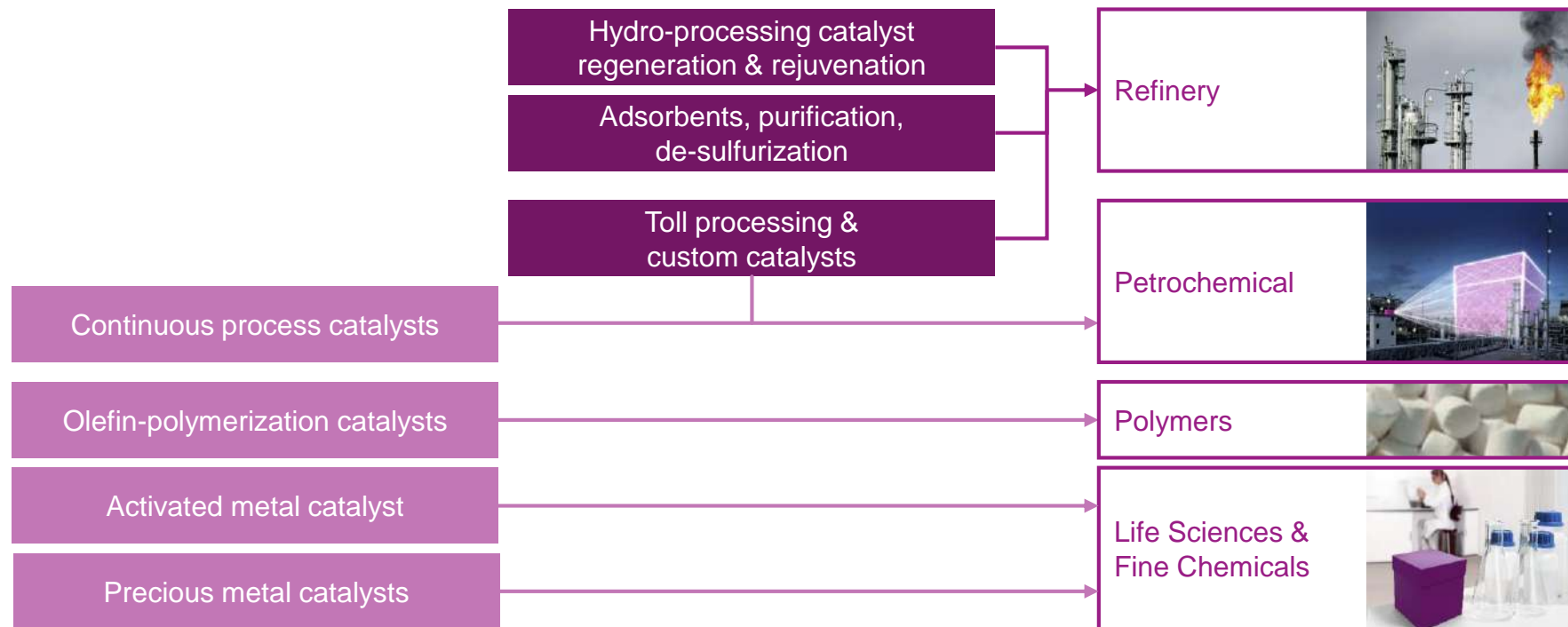
Evonik winning potential

- Acquisition of PeroxyChem with the expertise and business model experience **facilitates global growth**
- Footprint in North America for synergies to improve strong margin position
- Opportunities to leverage Evonik existing contacts (Animal Nutrition segment) to support the development of innovation pipeline

Evonik Catalysts Portfolio

Serving selected attractive end markets

- Accelerate chemical processes while not being consumed during the reaction
- Steer chemical reactions towards the desired products and avoid by-products / waste
- Enable efficient chemical processes by using less feedstock while reducing energy consumption



- Low-sulphur / non-sulphur fuels

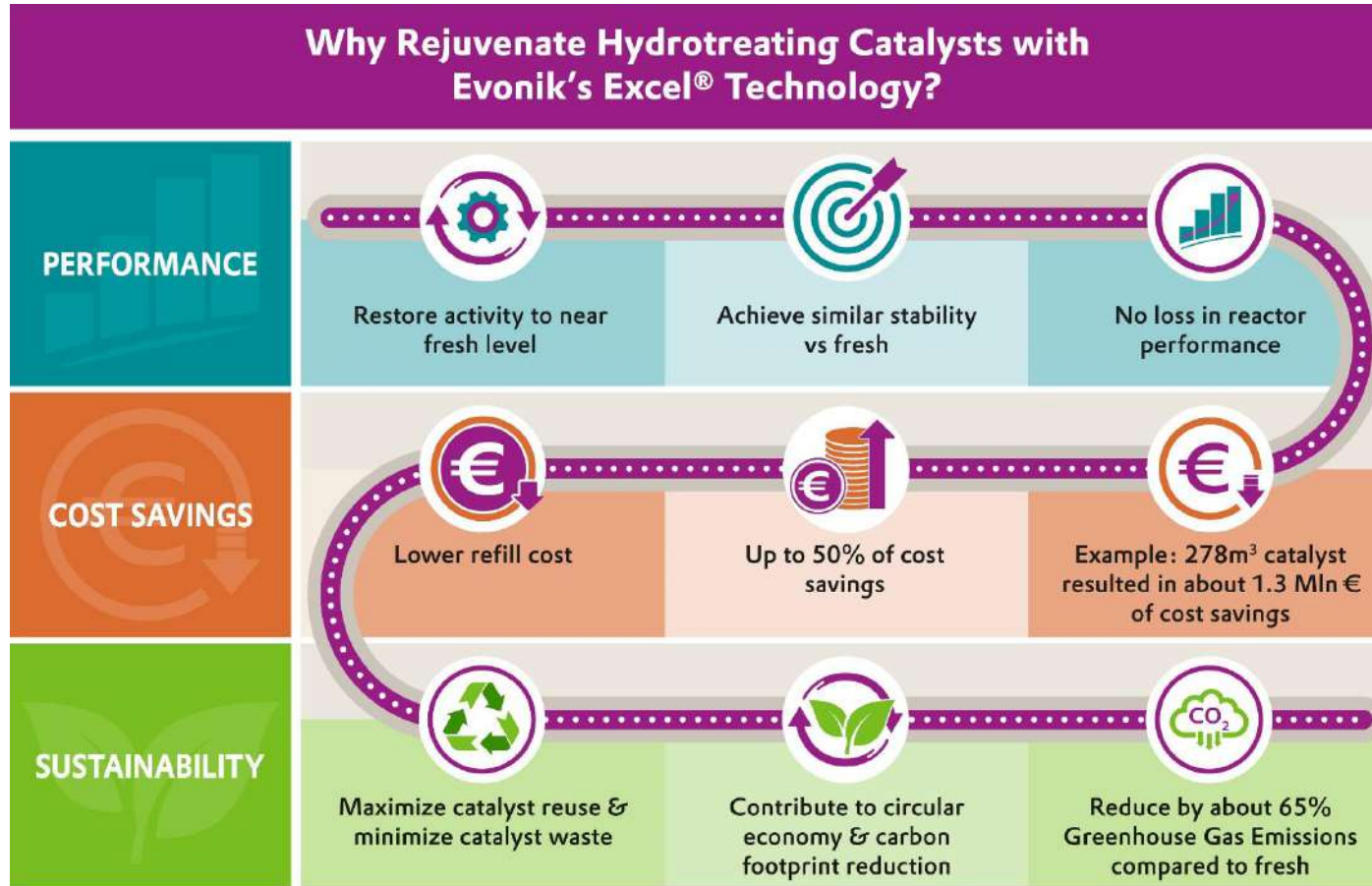
- Intermediates
- Solvents
- Monomers

- Polyethylene
- Polypropylene

- Agriculture
- Feed & Food
- Pharmaceuticals

Spotlight on Excel® Rejuvenation technology

Rejuvenation catalysts contribute to considerable CO₂ savings



Video links

- **Tradition meets the future: Polyamide 12 high-performance plastics**

https://www.youtube.com/watch?v=_oQ2YMzsjJU

- **Membranes for efficient biogas upgrading - SEPURAN® Green**

<https://youtu.be/C2jW0NkCKmw>

- **Hydrogen Peroxyde: One of the most versatile chemicals in the world**

<https://www.youtube.com/watch?v=2agHAITypCI&list=PLEgRVFIttdRZlrEtaGFQcRW01Q8ODe7yiq&index=6>