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MAGFORUM 2023

Magnesium Minerals & Markets Conference

30 May-1 June 2023, Grand Hotel Dino, Baveno, Lake Maggiore (Milan)

Magnesium Hydroxide and Sulphate

Applications Review and Outlook



Samantha Wietlisbach

Head of Inorganics and Minerals
Research and Analysis

S&P Global Commodity Insights
Zurich, Switzerland

Thursday 1st June 2023

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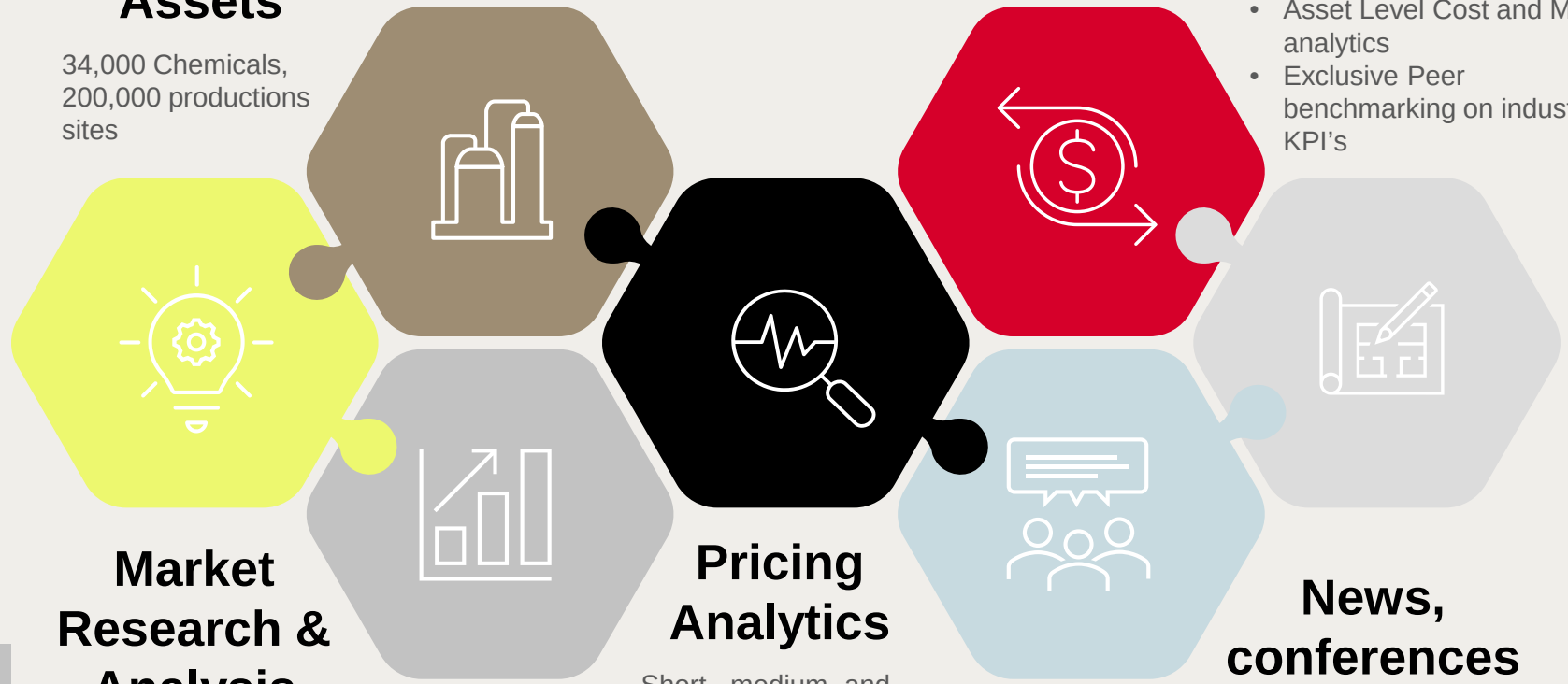
34,000 Chemicals, 200,000 productions sites

Company Analytics

- Asset Level Cost and Margin analytics
- Exclusive Peer benchmarking on industry KPI's

Technology Analytics

- 2000+ Process economics Decarbonization tools



Bespoke Research

.

Market Research & Analysis

Short- and medium-term market analysis on chemicals, derivatives and end markets

Pricing Analytics

Short-, medium- and Long-term Price Analysis

News, conferences and learning

- Chemical Week
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Chemical Economics Handbook

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Magnesium Hydroxide

- Flame retardants
- Imports and exports
- Environmental markets

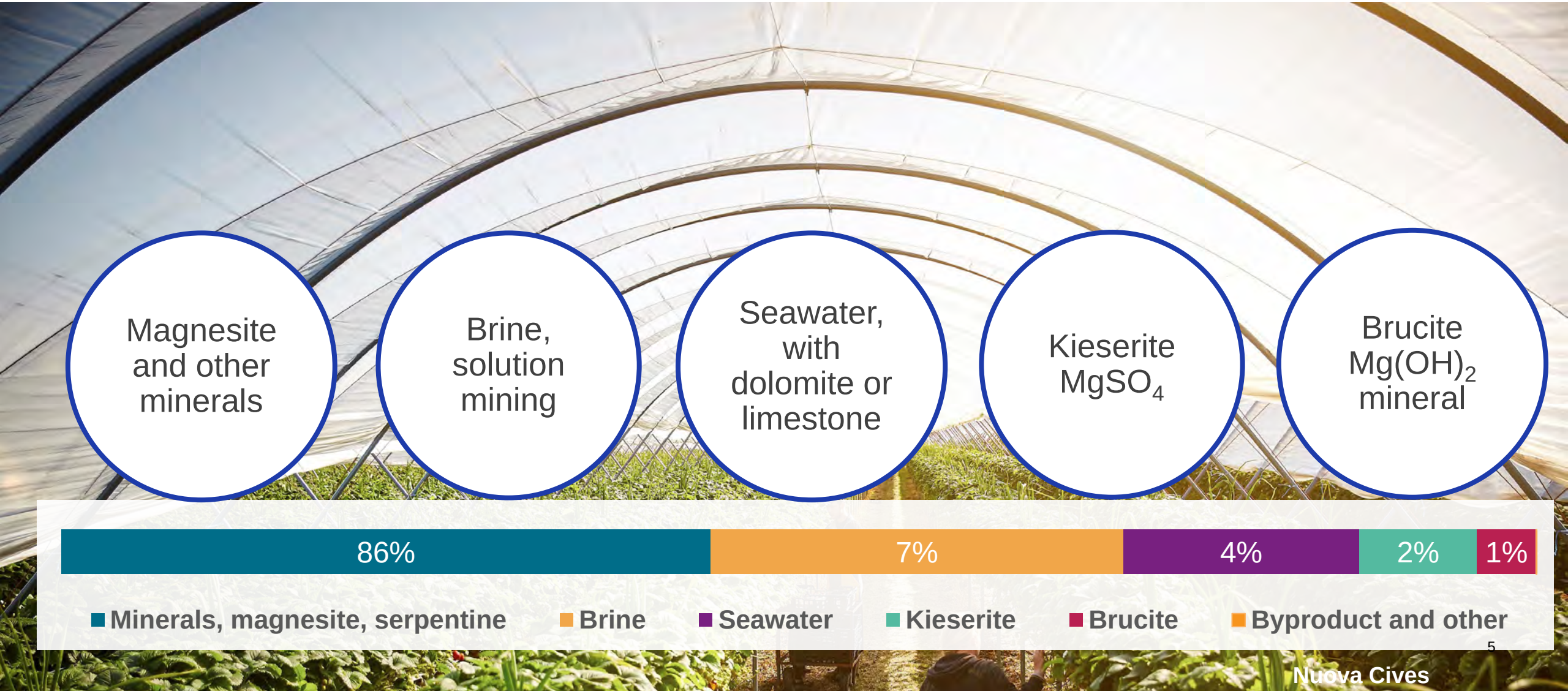




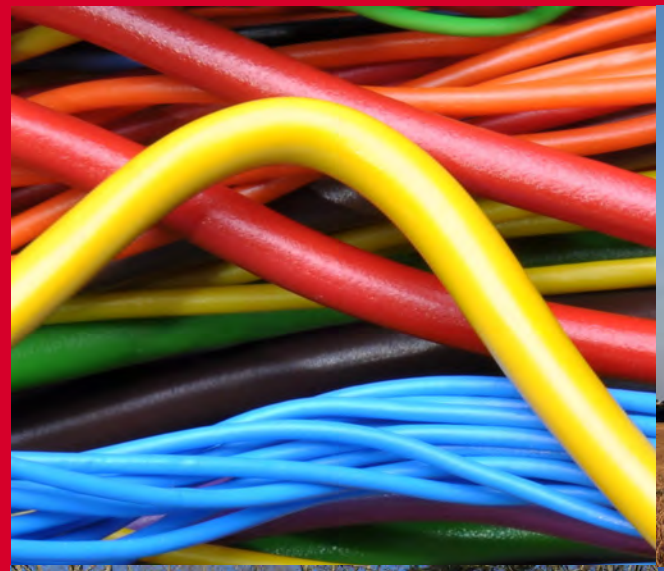
Magnesium Sulphate

- Sources of MgSO4
- Agricultural markets
- Plastic markets, ABS

86% of magnesium chemicals derived from magnesite and other minerals



Magnesium hydroxide



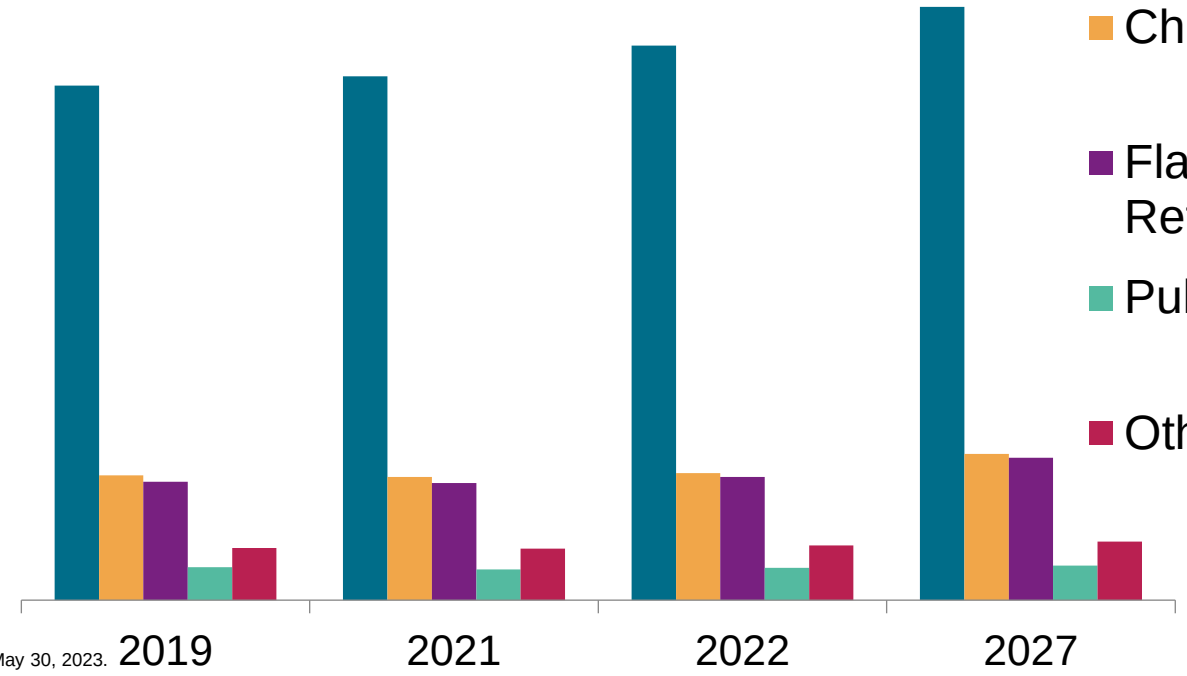






Magnesium Hydroxide Consumption

Total $Mg(OH)_2$ consumption forecast – world (kt)



Environmental	62%
Chemicals	14%
Flame Retardants	14%
Pulp & Paper	4%
Other	6%



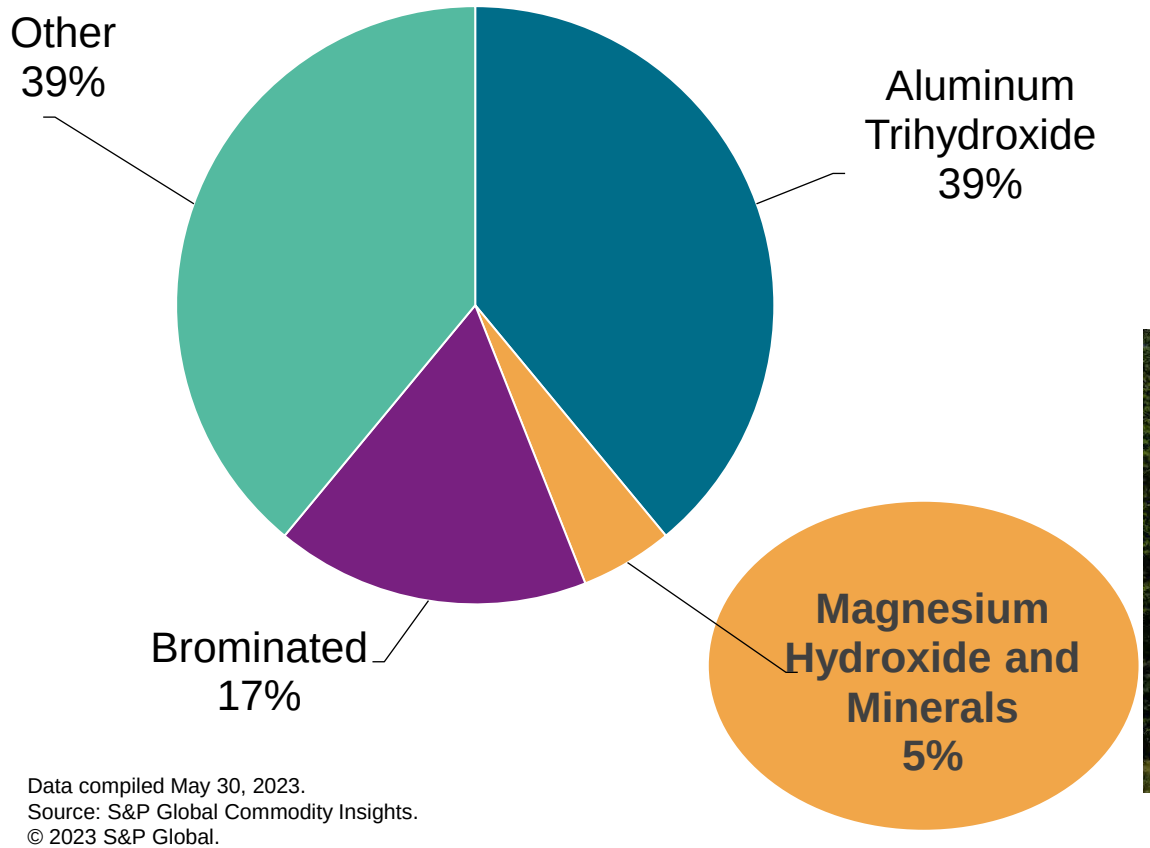




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ATH – aluminum trihydroxide is the most important flame retardant by volume

World consumption of flame retardants by type



Data compiled May 30, 2023.
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All flame retardants AAGR 2022-2027 ca 3%

Mineral flame retardants AAGR 2022-2027 ca 4%



Lösch- und Rettungszug SBB Switzerland

Cables are used in many mobile and permanent installations

Trains, planes and automobiles are major consumers of flame retardant materials



Communication

- Mobile and fixed network
- Equipment, buildings



Transportation

- Railways, automotive
- Ships, aircraft



Industrial

- Aerospace and defence
- Chemical, oil&gas, food processing



Health care / Appliances

. Hospital equipment

. Household appliances

- A growth market for flame retarded products is currently railway rolling stock
- Authorities are trying to make sure all aspects of rolling stock, seats, flooring, cladding as well as cables are flame retardant
- LSZH cable insulation and sheathing are preferred in areas wher many people could be effected by a fire



MDH mainly used when processing not possible with ATH

PVC or polyolefin compounding and cables

Aluminum Trihydroxide (ATH)

$2Al(OH)_3$ → $Al_2O_3 + 3H_2O$

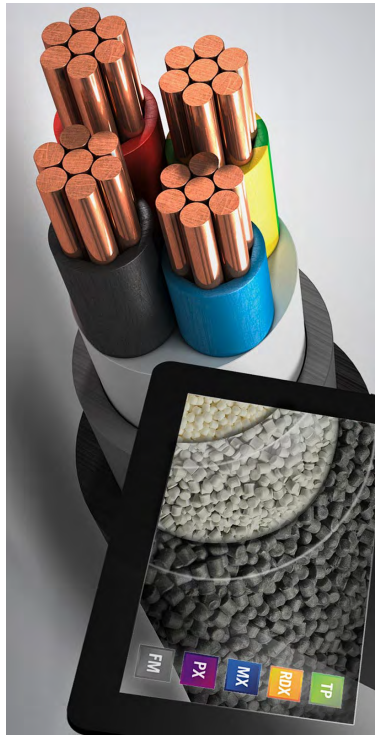
Processing up to 200 degrees

PVC or PO compounding and cables at temperatures not permissible for ATH

Magnesium Hydroxide (MDH)

$Mg(OH)_2$ → $MgO + H_2O$

Processing up to 300 degrees



85% of flame retardants are consumed in plastics and resins in Europe

Polyolefins (PE, PP, EVA)
- ATH or MDH
- Loadings up to 65% MDH

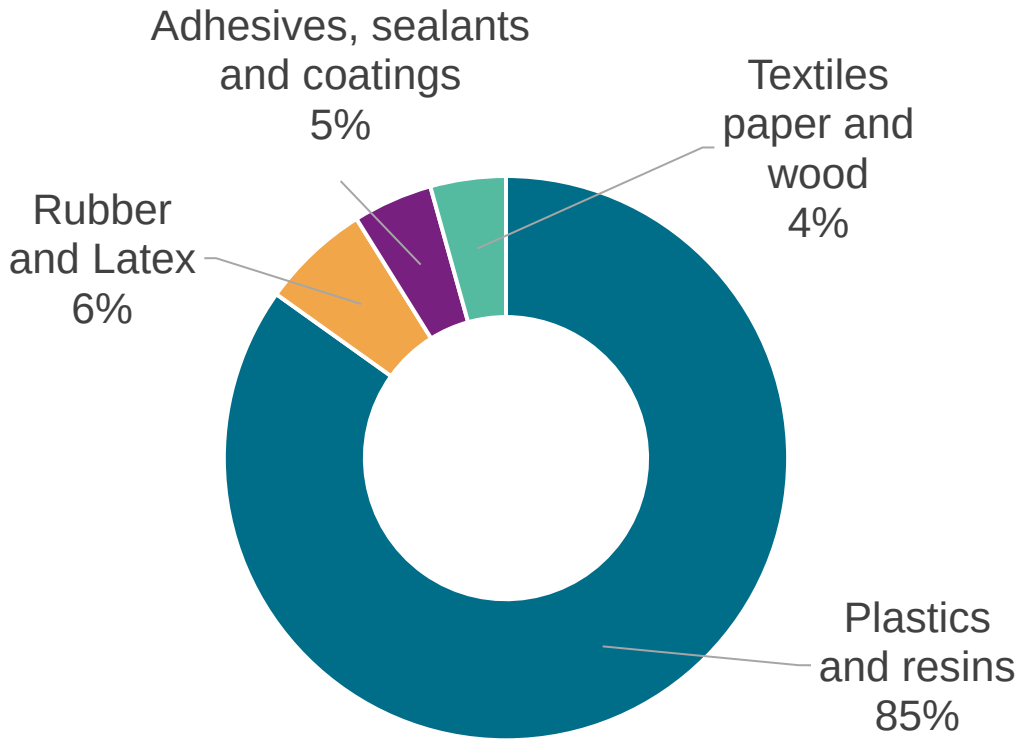
Polyurethane
- Only small amounts of mineral fillers
- Organophosphorus FR

PVC
- Wire and cable
- MDH rarely used, ATH more usual

Polyester - unsaturated
- Common in SMC and BMC
- Resins with ATH and glass fiber

TPO
- Thermoplastic polyolefin blend
- With EPDM as a filler

Polyolefins are the main plastic containing flame retardants in Europe



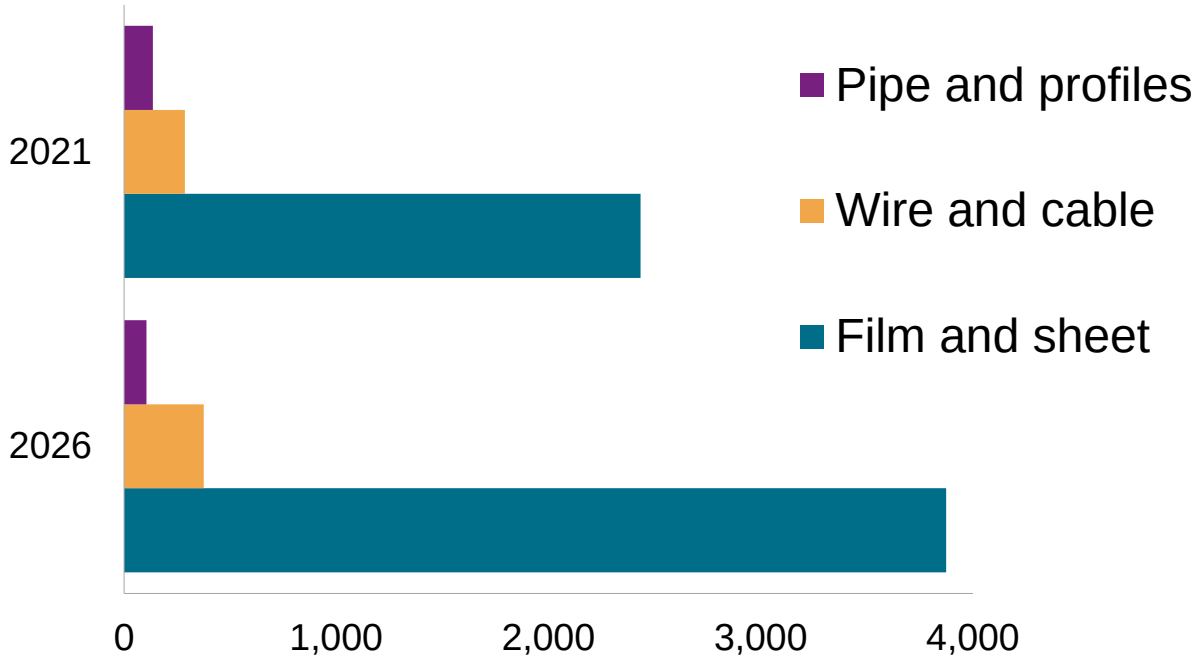
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Strong growth expected in the major EVA markets

World consumption of EVA by selected application (kt)



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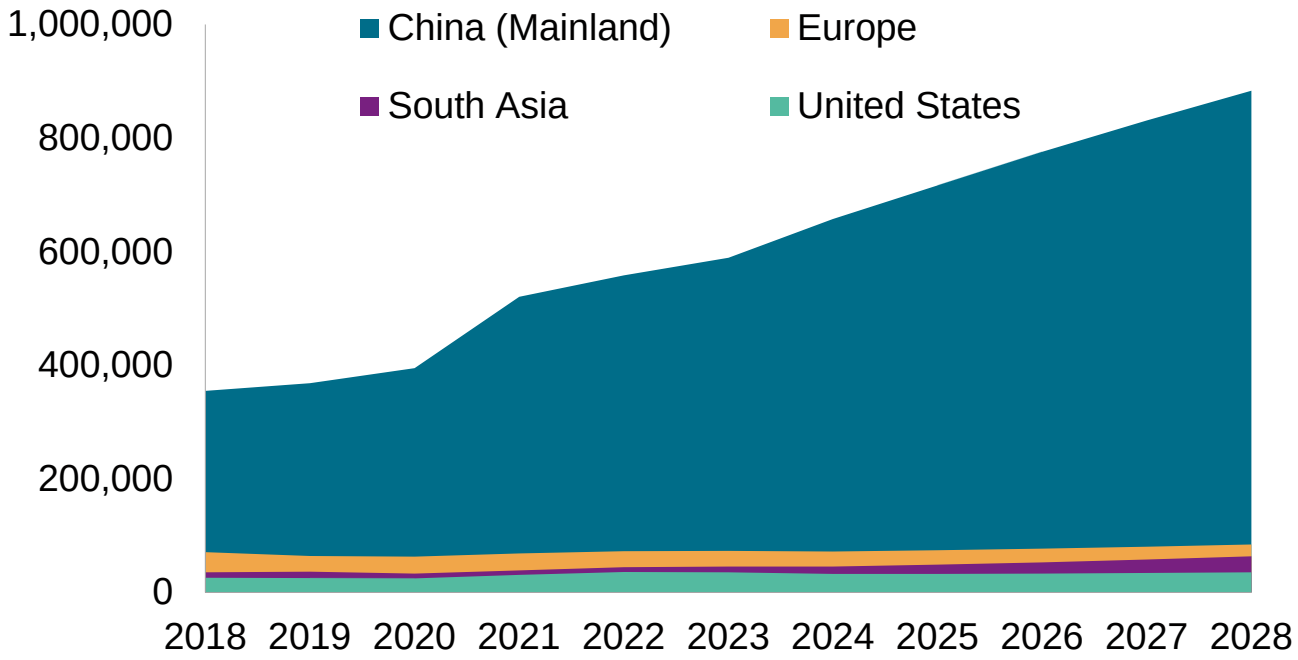
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- The main market for EVA is film and sheet, with 60% share
- Dominated by NE Asia, with 53% of total consumption
- Wire and cable has 6% share of EVA consumption globally
- Overall growth for EVA >8% over next 5 years
- Wire and cable to grow at >5%
- The top EVA producers are ExxonMobil, Formosa and China Petrochemical Corporation

Wiring, wired devices and cables will grow 7.3% globally by value 2023–28

Manufacture of Wiring and Devices (million US Dollar)





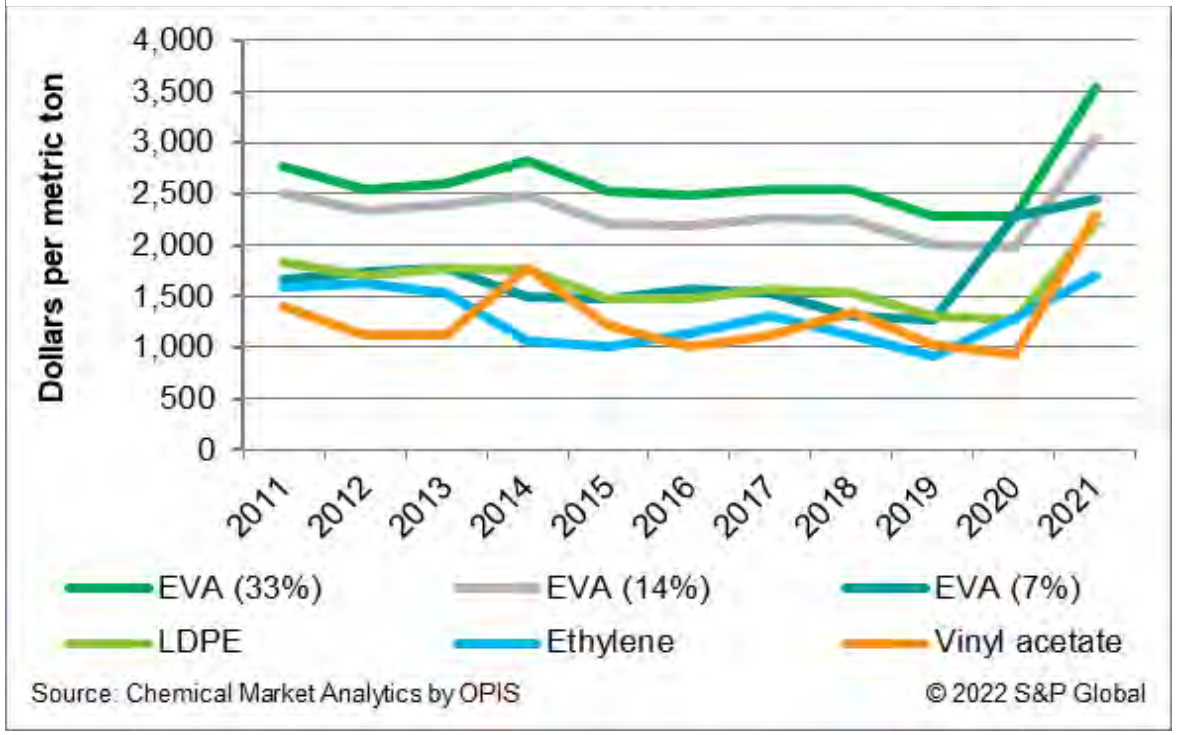
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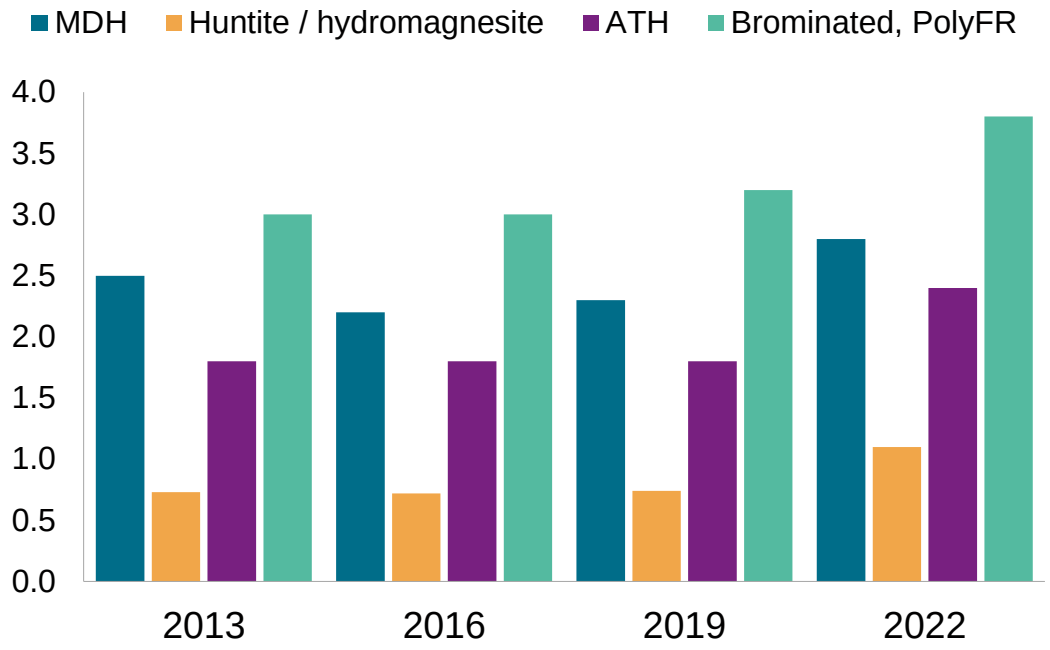
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Prices for all wire and cable components reached record highs in 2022

Western European prices for EVA and monomers



Average European prices for various flame retardants (USD/kg)



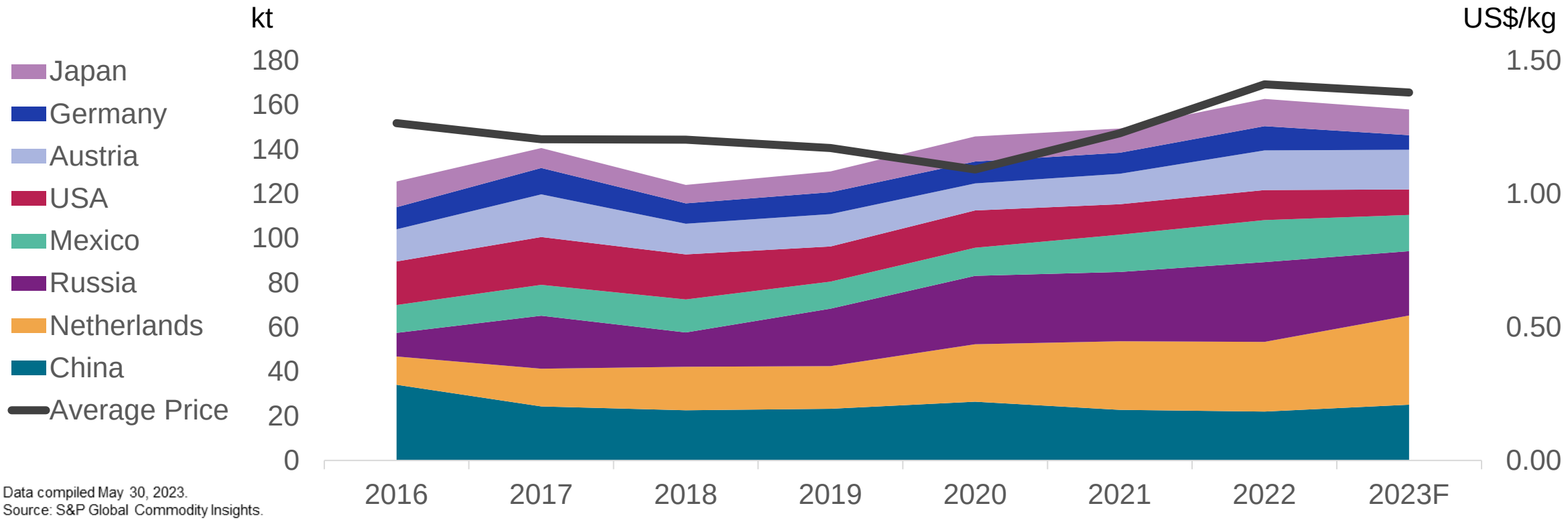
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Netherlands is emerging as the top global exporter of $Mg(OH)_2$ in early 2023

Total $Mg(OH)_2$ exports– world

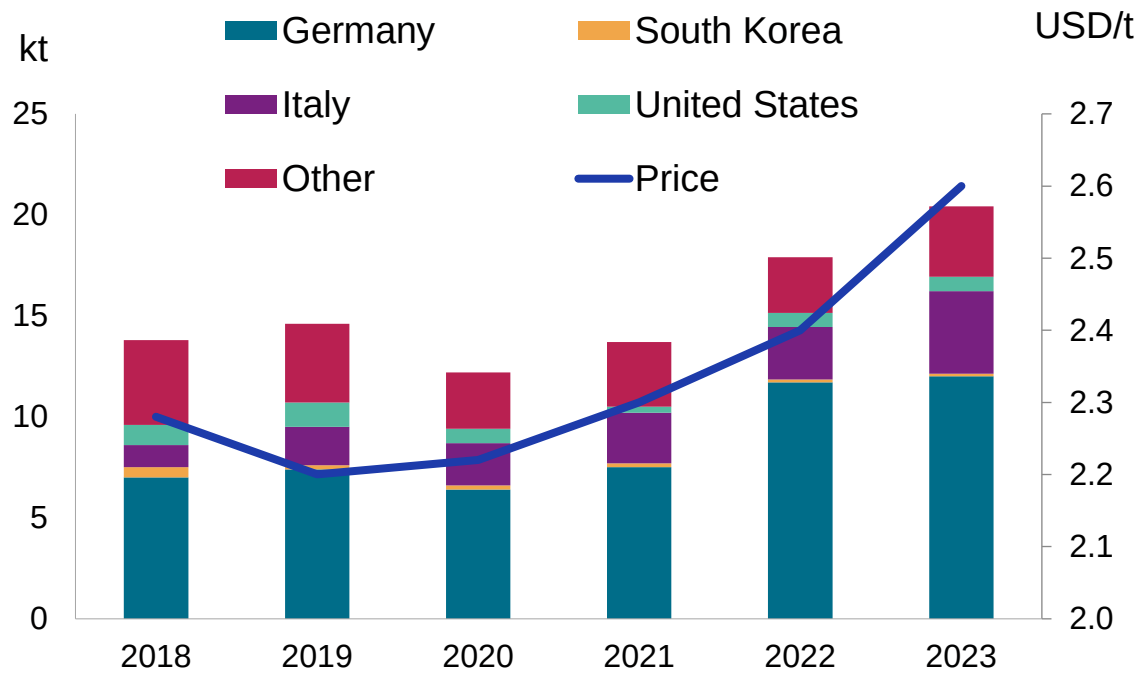


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Austrian exports of $Mg(OH)_2$ are mainly flame retardant grades

Austrian exports of Mg(OH)2



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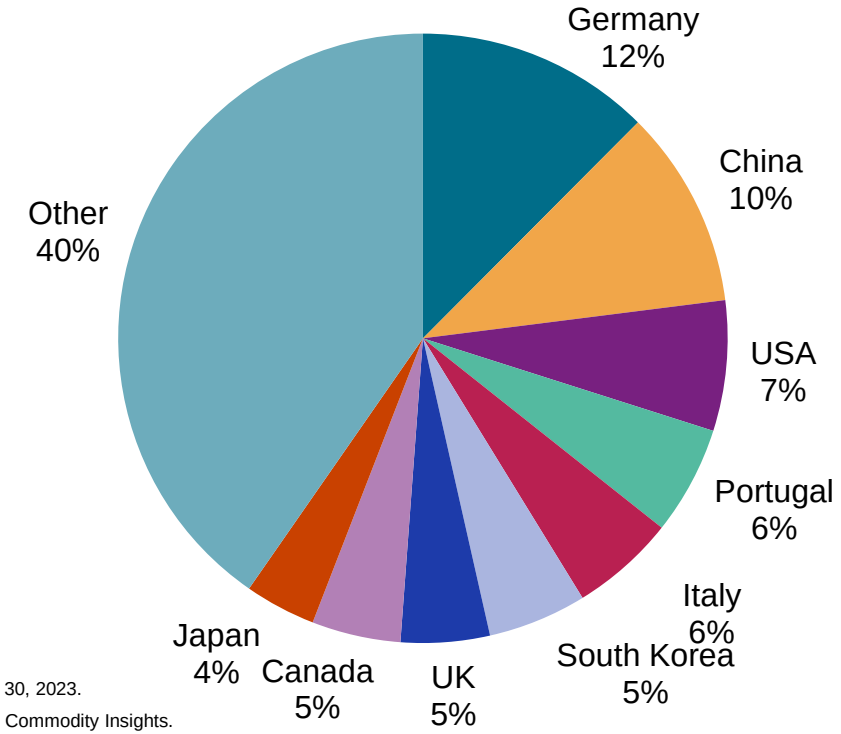
- Magnifin Magnesiaprodukte in Breitenau am Hochlantsch major FR producer in Austria
- Now fully owned by Huber Advanced Materials, acquisition completed January 2022
- Capacity increase for MDH announced in 2020, but location unclear, to double current capacity



Huber Advanced Materials

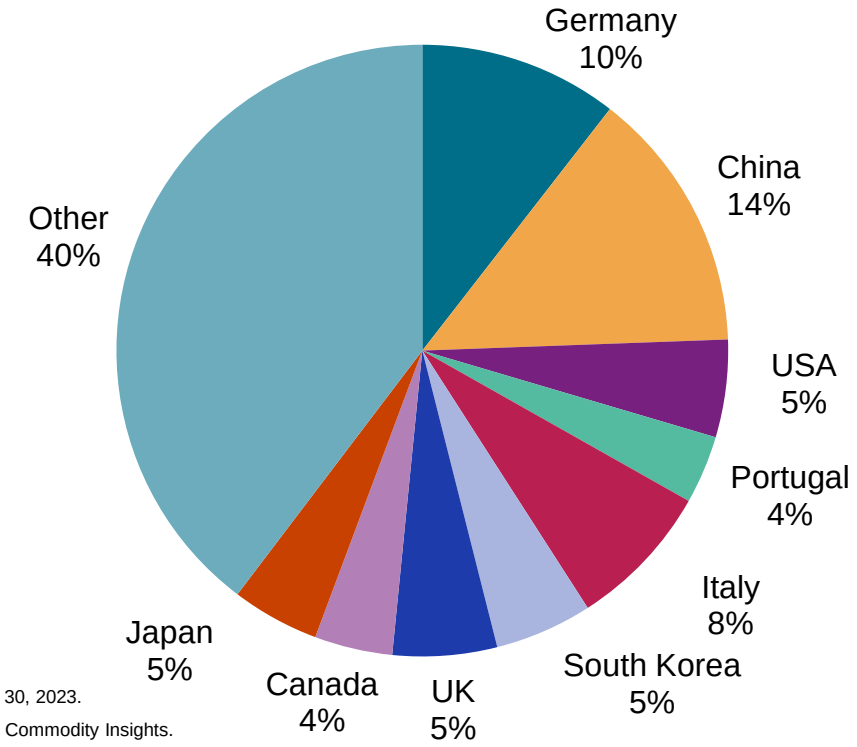
World importers of magnesium hydroxide

World imports of magnesium hydroxide in 2022



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World imports of magnesium hydroxide in 2023 forecast



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Magnesium hydroxide separator coatings Could provide safer and longer-life batteries

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Magnesium hydroxide in LIB separators and thermal management

Companies producing ceramic coated separators

LG Chem

璞泰来 PUTAILAI

Ube Maxell Kyoto Co., Ltd

UBE maxell

MITSUBISHI PAPER MILLS LIMITED

Companies producing LIB grade magnesium hydroxide

NikoMag®

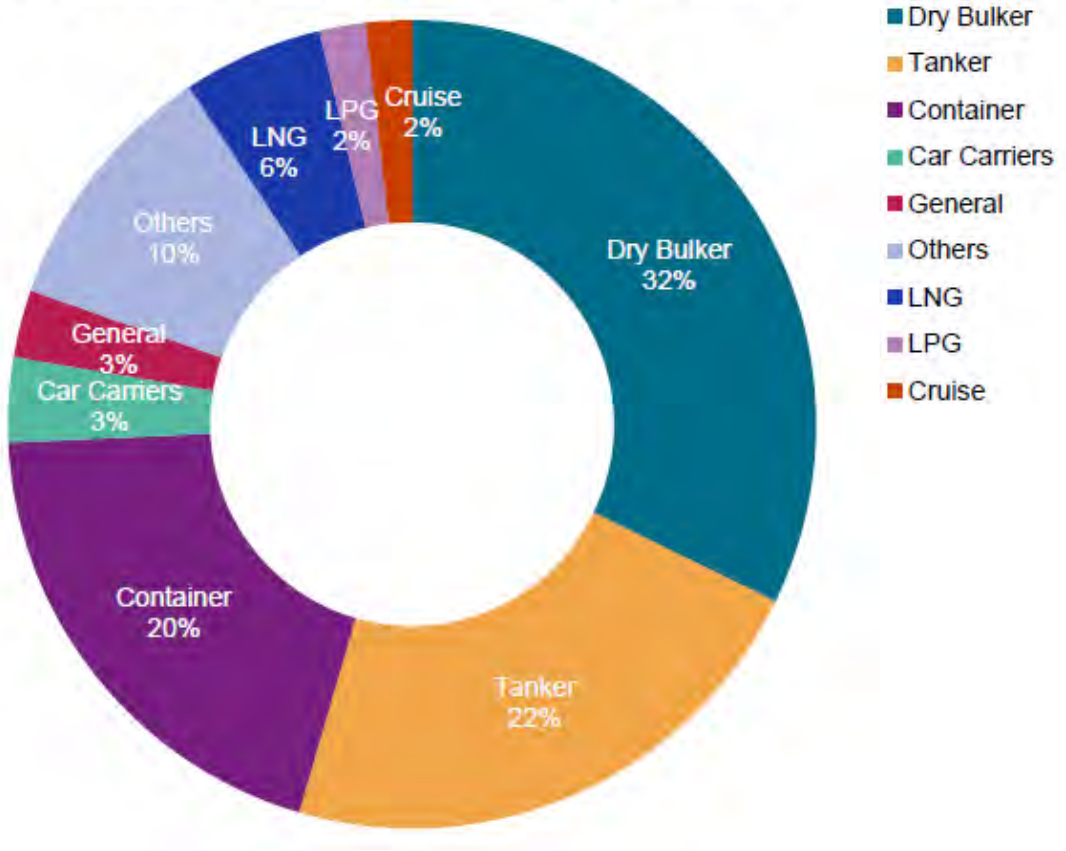
- Porous polymer, non-woven and inorganic composite membranes are the 3 most common on the market
- Magnesium hydroxide is being commercialized as a coating for LIB separators
- PGMP composite separators are made from PE/GF/MDH
- Improves safety performance in pouch cells
- When the battery reaches a high temperature, the pores of the separator close, preventing thermal runaway of the battery and safely stopping the function of the battery

Flue Gas Desulfurization at Sea



Dry bulk vessels make up 32% of total fleet

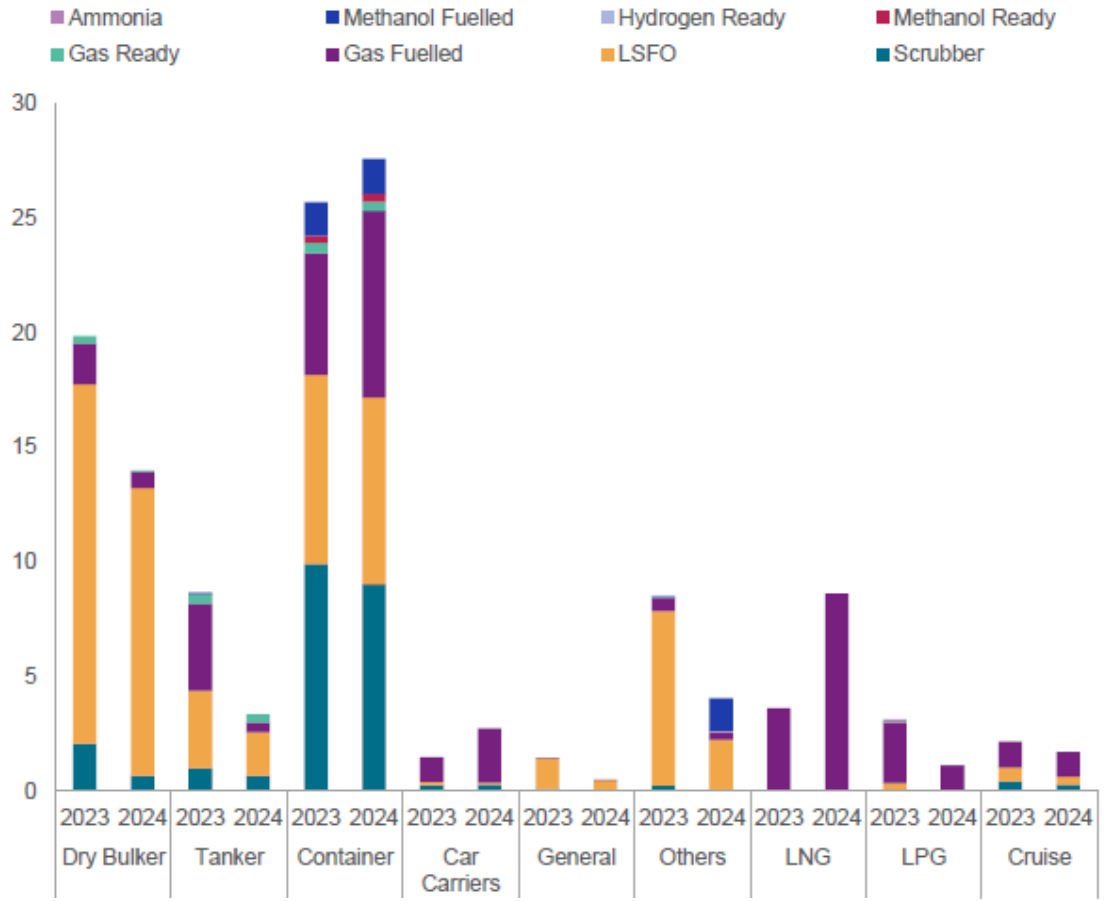
Global commercial ship type in service (GT basis)



As of Feb. 2023.
Sources: Ship data from S&P Global Market Intelligence; Analysis from S&P Global Commodity Insights FRF

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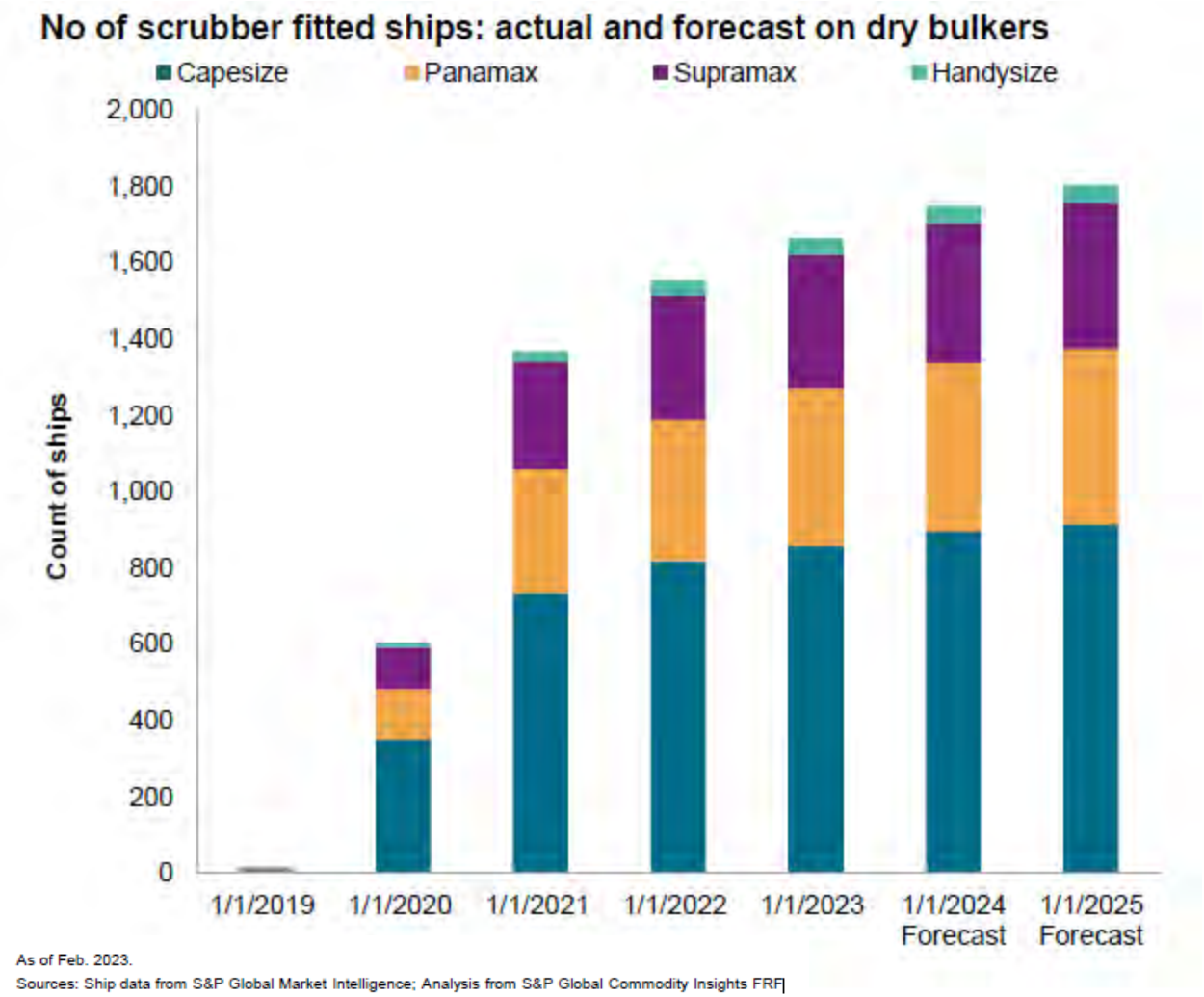
Fuel preference of vessels on order (million gross tonnage)



As of Feb. 2023.
Sources: Ship data from S&P Global Market Intelligence; Analysis from S&P Global Commodity Insights FRF

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In 2022 13% of the dry bulk fleet have scrubbers fitted, larger bulkers 44%





As of Feb. 2023.
Sources: Ship data from S&P Global Market Intelligence; Analysis from S&P Global Commodity Insights FRF

Chemicals for wet scrubbing

MgO powder

MDH 50% slurry

NaOH 50% solution



Soda Ash powder



MgO and MDH are easy to handle, safe for the environment

Chemicals for dry scrubbing

Soda Ash powder



$NaHCO_3$ Sodium bicarbonate



$Ca(OH)_2$ hydrated lime

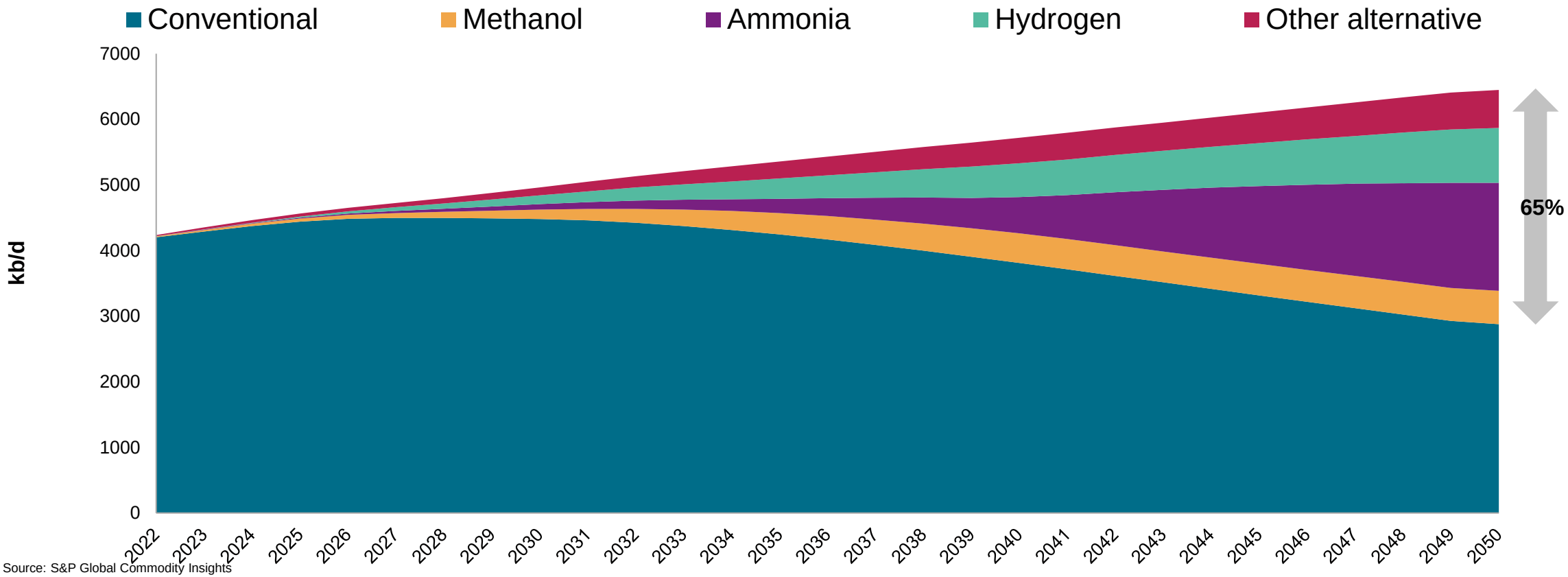






Alternatives will make up 65% of entire bunker consumption in 2050

Annual fleet consumption, 2022-2050



Source: S&P Global Commodity Insights

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Magnesium sulfate



Most $MgSO_4$ is derived from magnesite, other sources also important

$MgSO_4.7H_2O$ Epsom salt

Anhydrous $MgSO_4$

27% from magnesite

10% from CCM

Crystallization

Dehydration

Magnesite

CCM MgO

H_2SO_4

Magnesium sulfate

Boric acid and kieserite

H_2SO_4

Szaibelyite boron magnesium minerals



Seawater

Brine



Kieserite

Ground ore containing KCl, NaCl and $MgSO_4.H_2O$

Electrostatic Separation

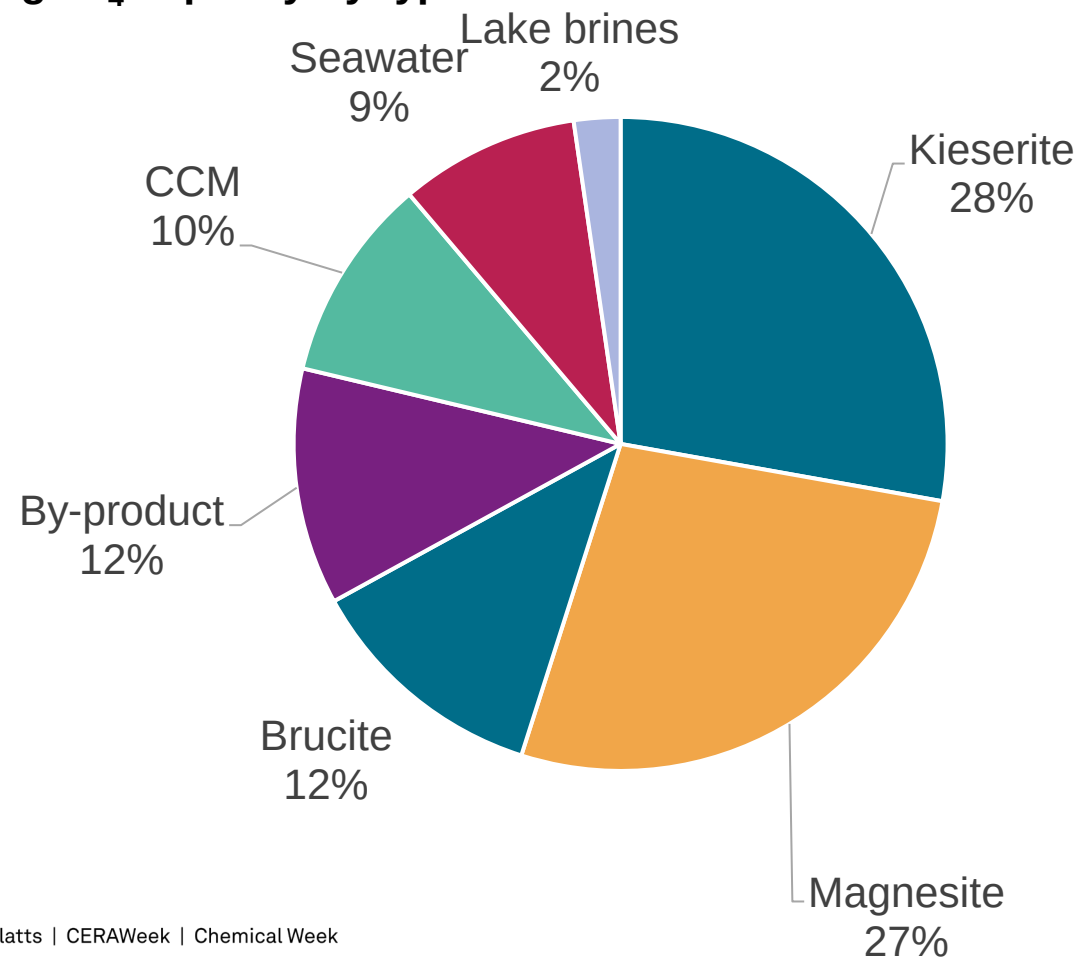
ESTA® Kieserite

Natural kieserite
High solubility
Less salt impurity



$MgSO_4$ World capacity by raw material source

$MgSO_4$ capacity by type



- Most producers in China are back integrated into magnesite production
- The only country producing such volumes as a by product, mainly from boric acid production
- Glass insulation fibre main market for boric acid

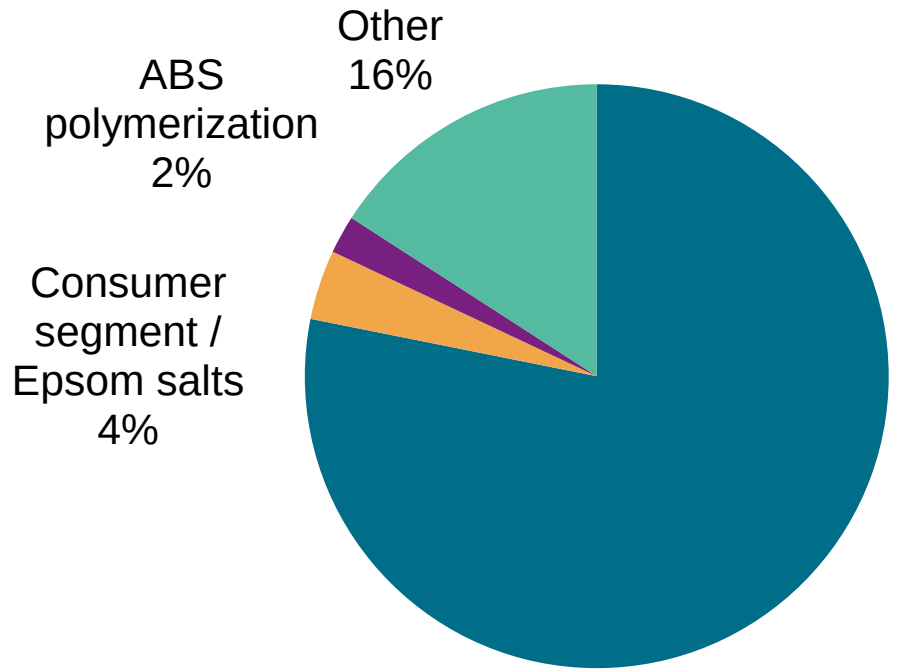
Magnesium sulfate is very important in agriculture in fertilizer and animal feed

- Magnesium sulfate is important for plants, they need magnesium for photosynthesis
- Improves plant health and crop yields
- Feed additive, which helps to prevent tetany or grass staggers in dairy cattle.





World consumption of magnesium sulfate



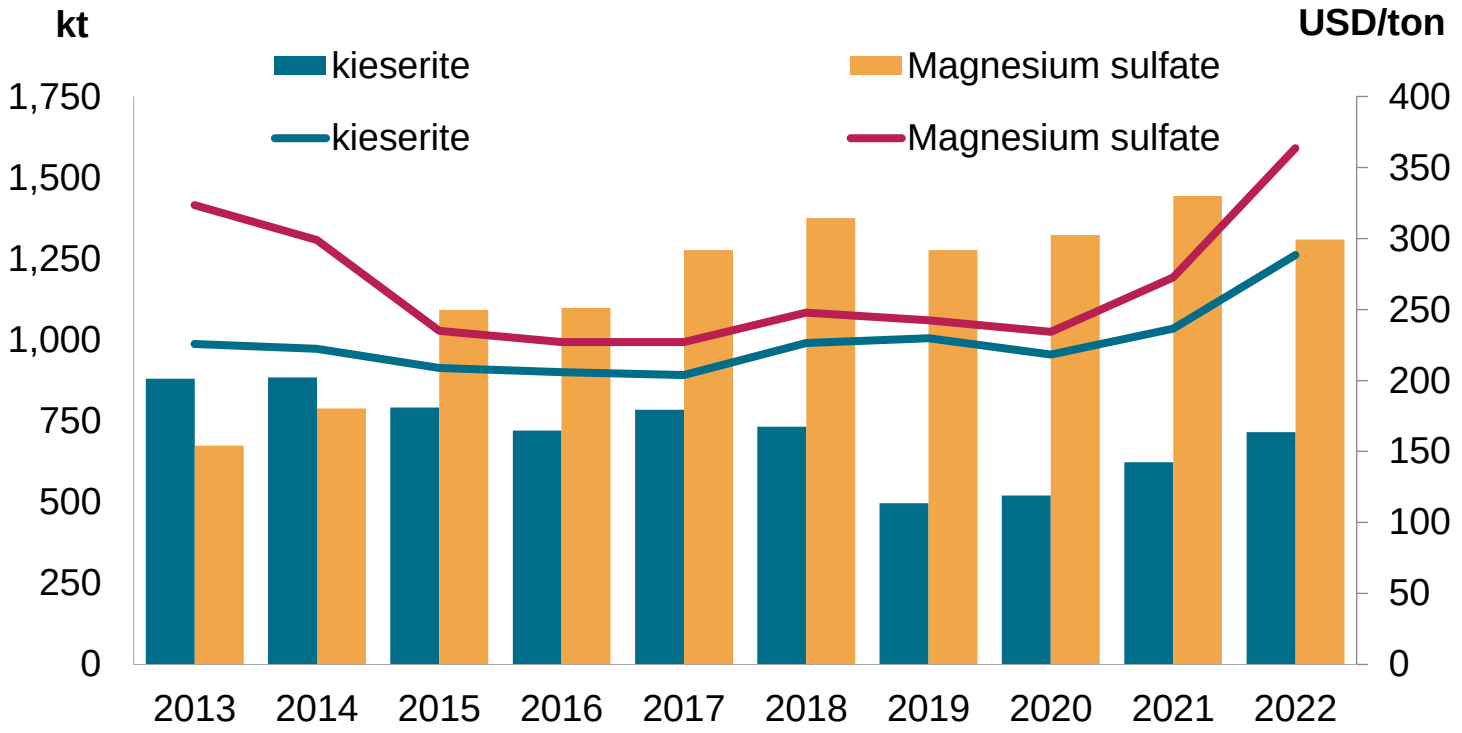
Data compiled May. 30, 2023.

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Kieserite and refined magnesium sulfate exports and export price development

World exports of kieserite mineral vs magnesium sulfate



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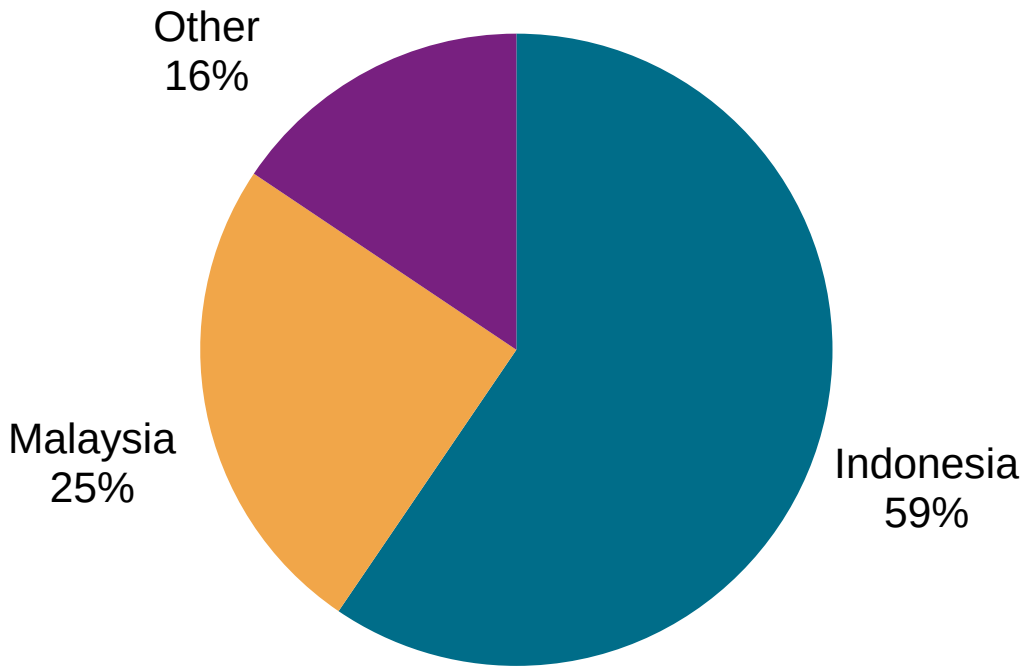
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Palm oil production is concentrated in Indonesia and Malaysia

World Palm Oil Production by Major Country 2022 (millions of metric tons)

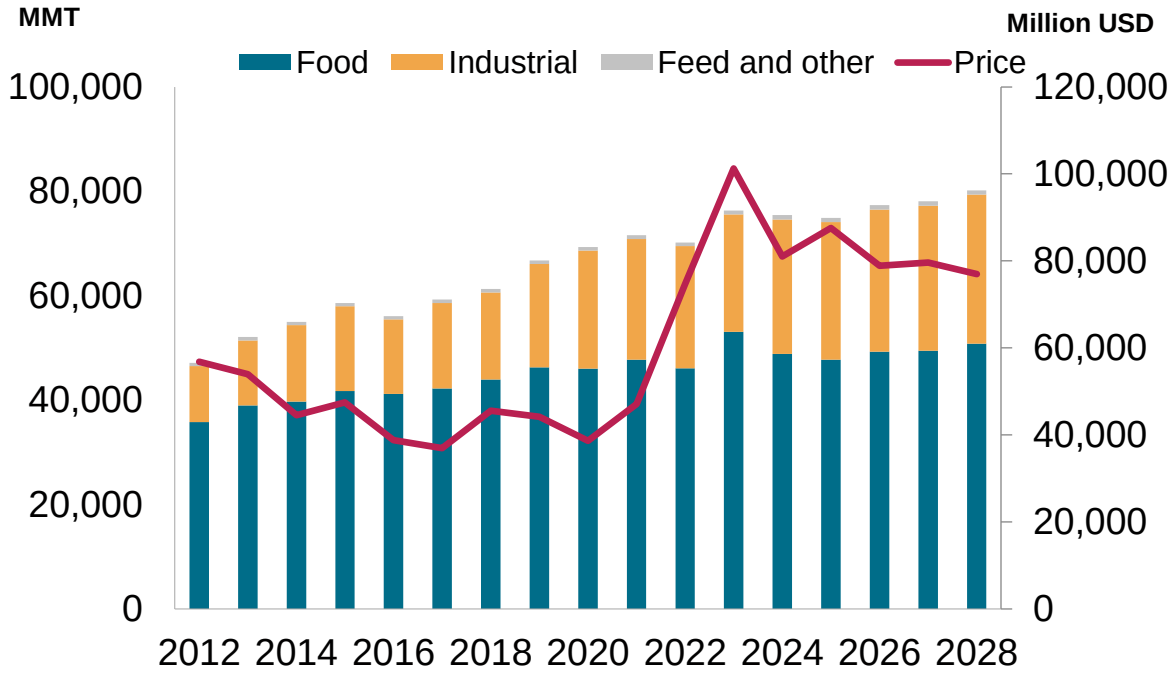


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World palm oil consumption by type and price



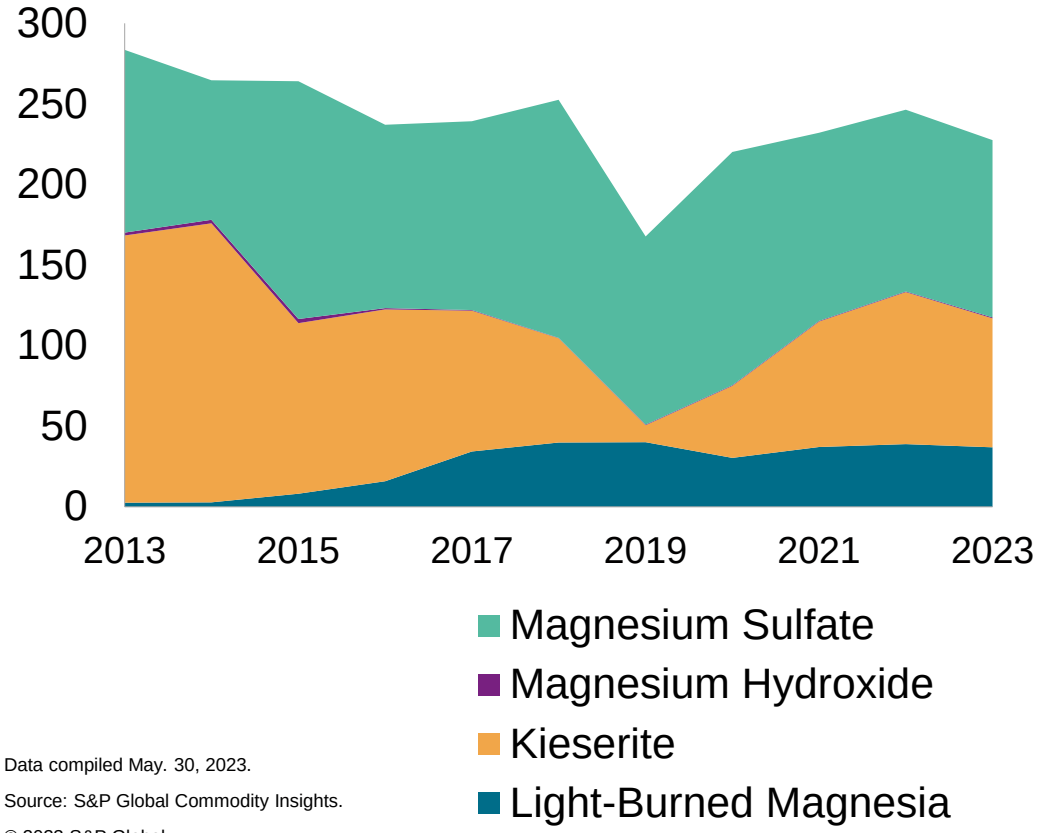
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Malaysian and Indonesian imports of magnesium sulfate

Malaysian imports of magnesium compounds (kt)

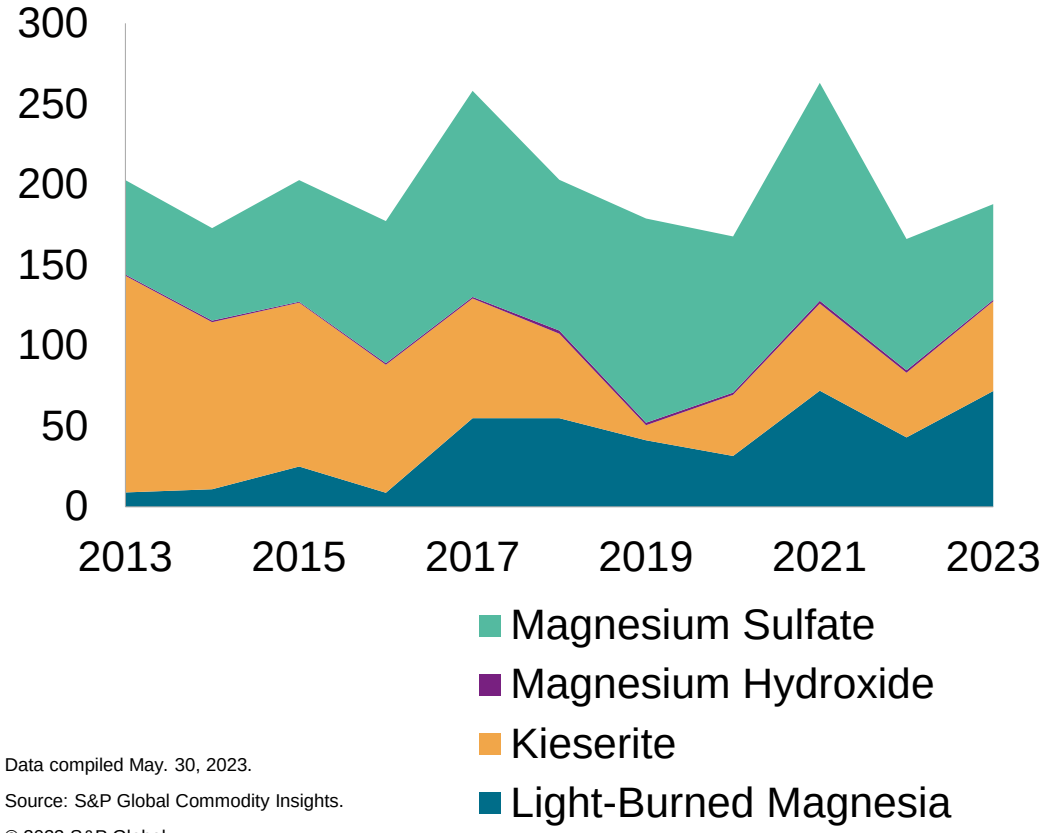


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Indonesia imports of magnesium compounds (kt)



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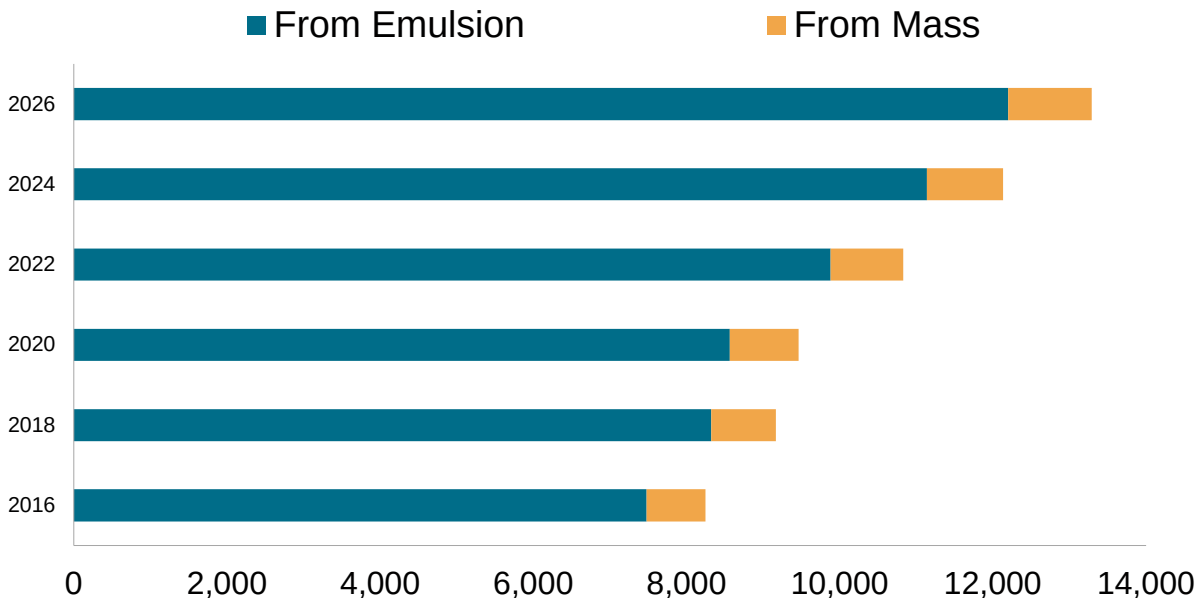
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Magnesium sulphate – coagulating agent in ABS emulsion polymerization

Over 90% of ABS production capacity utilizes the emulsion polymerization method

World production of ABS Resins (1000’s metric tons)

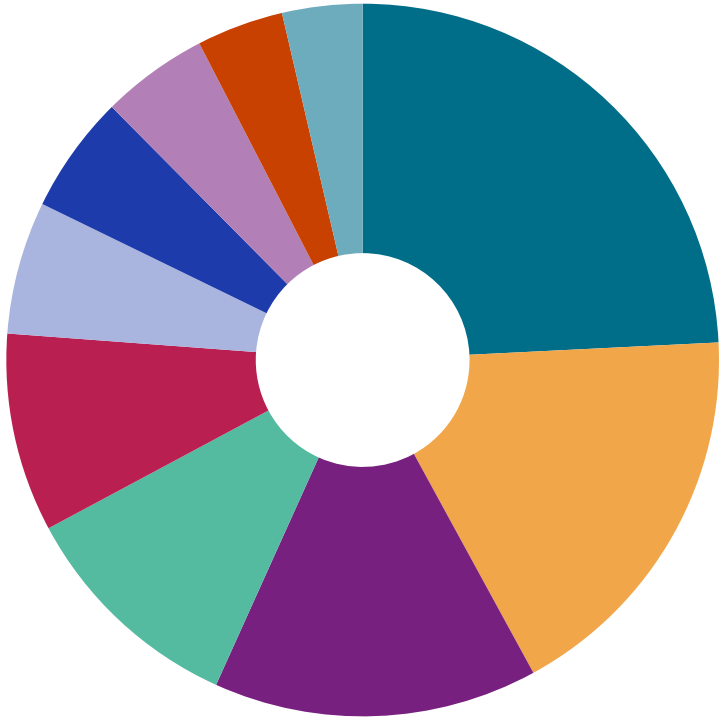


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Three companies have more than half the world ABS capacity

World top producers of ABS resins



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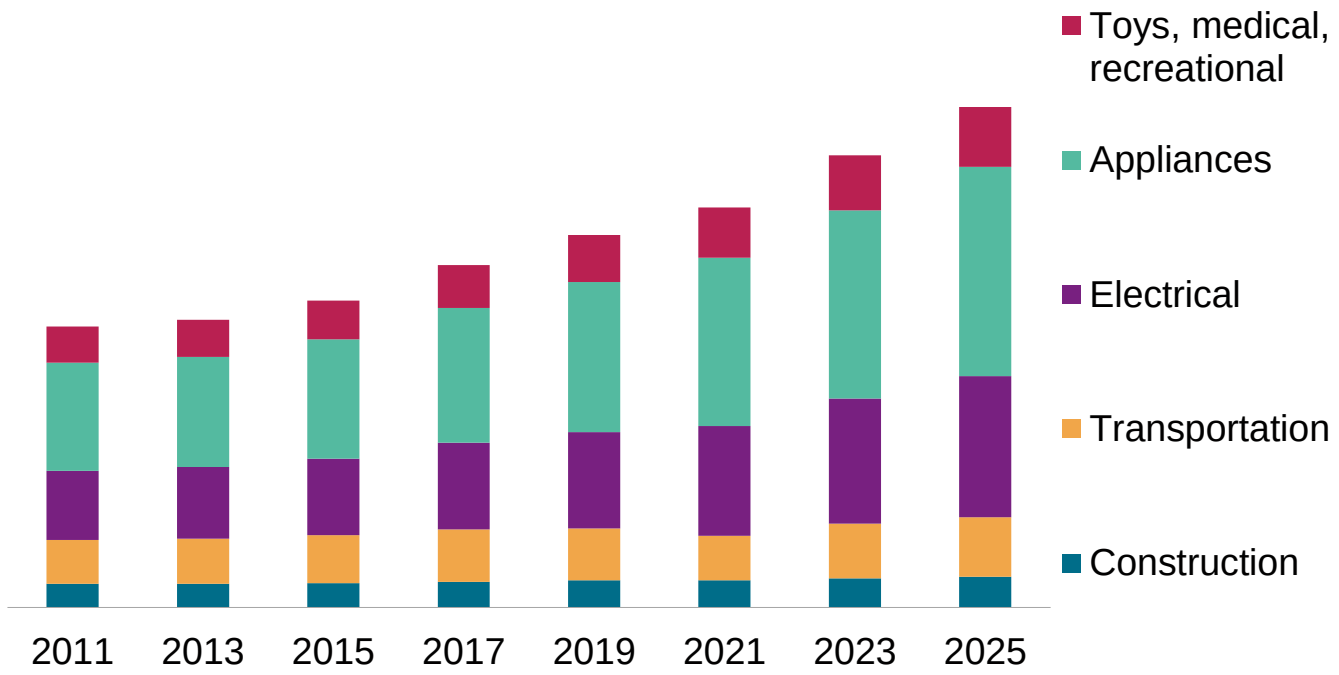
- 75% of world capacity in NE Asia
- The Taiwanese Chimei group the largest world producer, 24%
- LG Mainly S Korea 18%
- Ineos - the only major player outside NE Asis. Mexico, US and WE.
- Capacity expansions taking place in most regions except Japan and India

Electrical applications and appliances are the major growth drivers of ABS

- Appliances 42% share, forecast to grow at 5.5% per year through 2026
- Transportation has 11% share o ABS market, forecast to grow at 6.4% annually on average



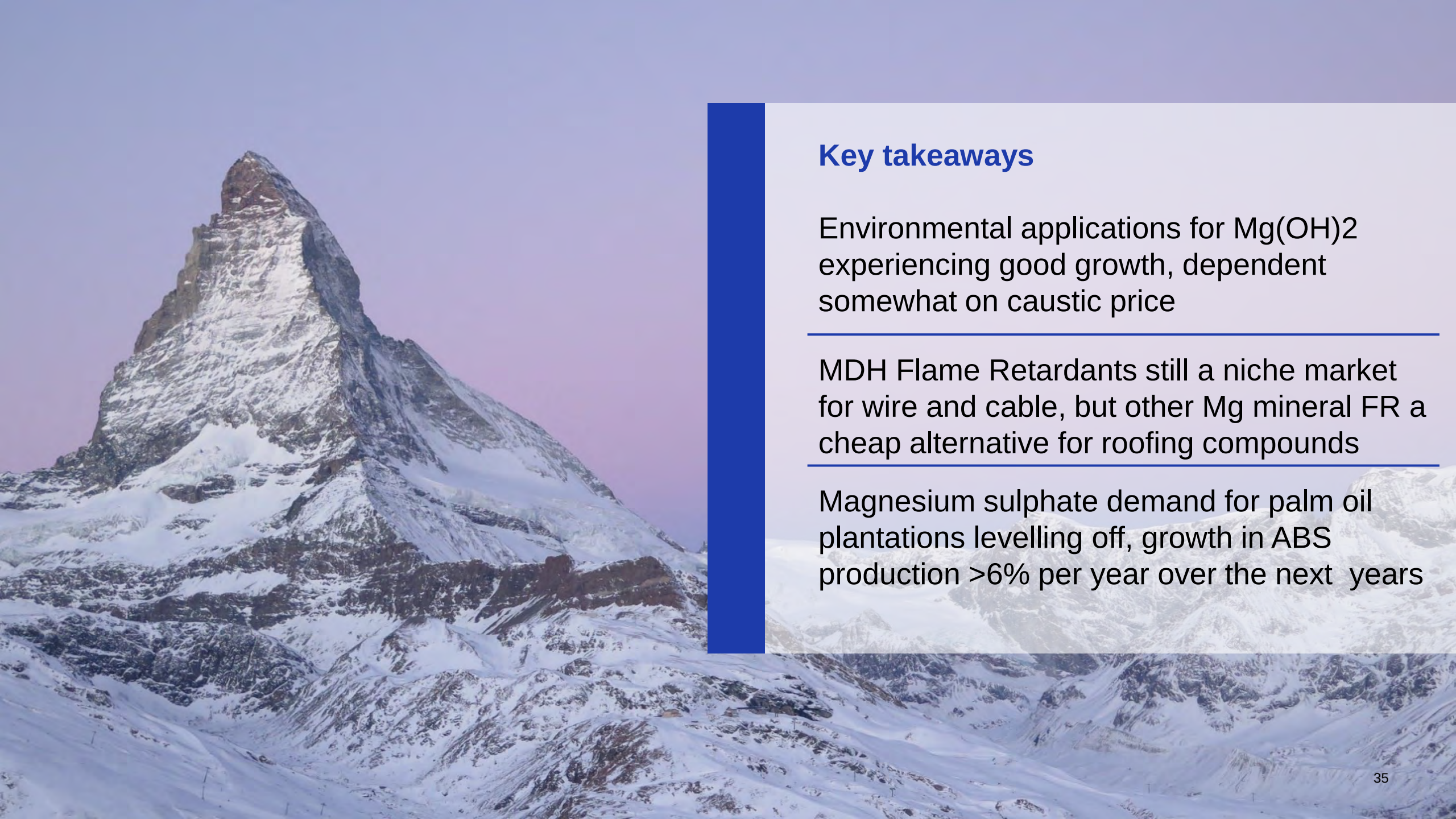
World consumption of ABS Resins (thousands of metric tons)



Data compiled May. 30, 2023.

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Key takeaways

Environmental applications for Mg(OH)2 experiencing good growth, dependent somewhat on caustic price

MDH Flame Retardants still a niche market for wire and cable, but other Mg mineral FR a cheap alternative for roofing compounds

Magnesium sulphate demand for palm oil plantations levelling off, growth in ABS production >6% per year over the next years

Chemical Economics Handbook



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- Includes Petrochemicals, Organics, Inorganics, Industrial Gases, Fibers, Resins and Elastomers

80-90 reports issued annually include:

- Executive summary with key commercial conclusions for the product group
- Global summary; regional coverage
- Producers with annual capacities and plant sites
- Production figures and trends
- Consumption and forecasts by end use application
- Historical annual prices and price trends
- Trade imports and exports

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