Heraeus

GROUP INTRODUCTION

Heraeus

THE HERAEUS GROUP – A FAMILY-OWNED TECHNOLOGY COMPANY

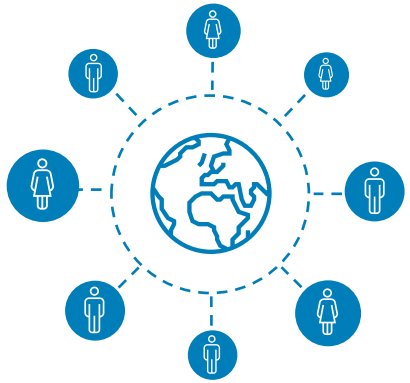
Total Revenue in 2023

25.6 bn. €

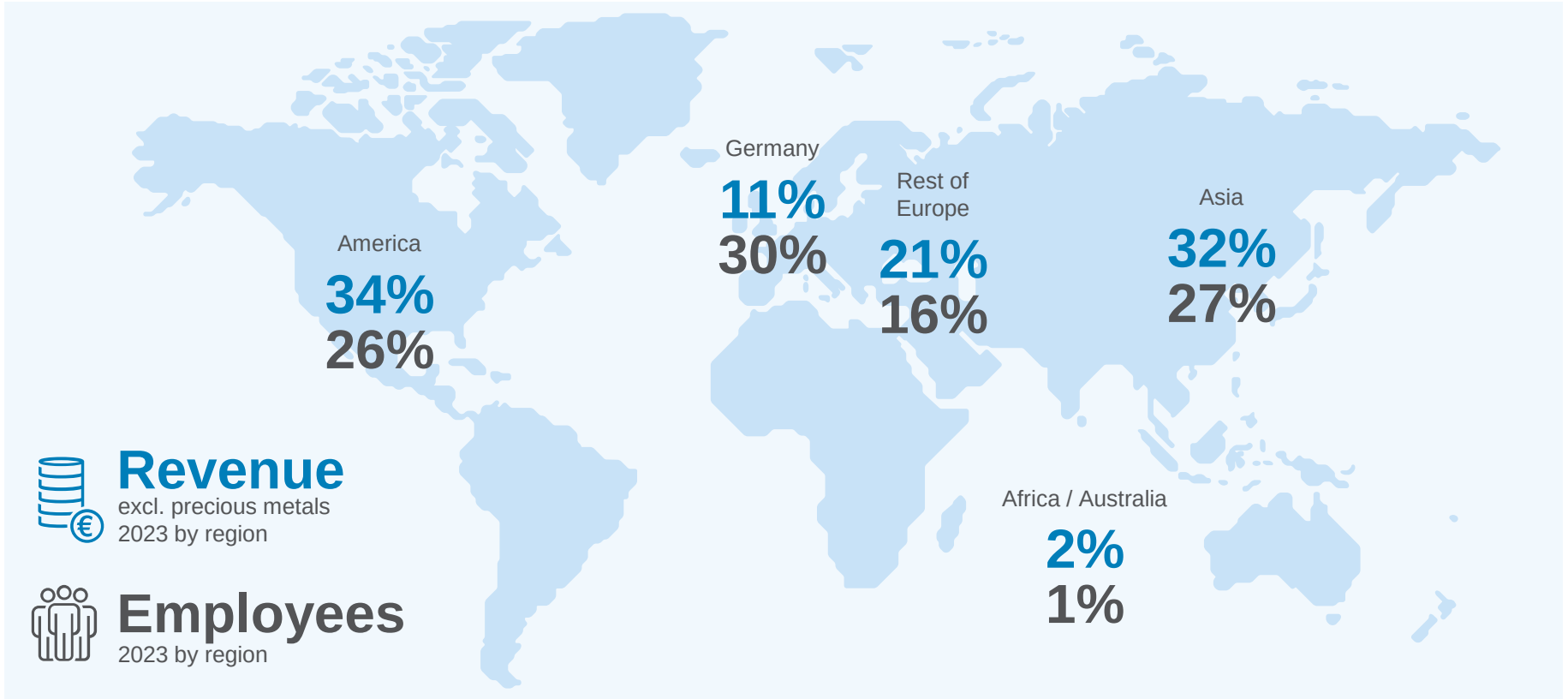
(27.7 bn. US$)

US$ calculated with 2023 average exchange rate (1€ = 1.0813 US$)

Approx. **100** sites in **40** countries



market-oriented distribution in **15 Operating Companies**



Revenue
excl. precious metals
2023 by region

Employees
2023 by region

6.0%
R & D Expenditures
based on revenues
excl. precious metals

APPROX. **16,400**
employees worldwide
incl. staff leasing

TOP 10
family-owned companies
in Germany

THE HERAEUS BUSINESSES – BROADLY DIVERSIFIED

Heraeus Holding

4 Business Platforms, 15 Operating Companies

Metals & Recycling

- Heraeus Precious Metals
- Heraeus Amloy
- **Heraeus Remloy**
- revalyu[1)]

Healthcare

- Heraeus Medical
- Heraeus Medevio
- Norwood Medical
- Mo-Sci
- ETS

Semiconductor & Electronics

- Heraeus Electronics
- Heraeus Epurio
- Heraeus Covantics
- Heraeus Printed Electronics

Industrials

- Heraeus Electro-Nite
- Smart Steel Technologies[2)]

Service Platforms

- Heraeus Business Solutions
- Heraeus Consulting & IT Solutions
- Heraeus Health & Education Services
- Heraeus Site Operations

1) Majority shareholding 2) Minority shareholding

RECYCLING NEODYMIUM MAGNETS

David Bender – Heraeus Remloy

RARE EARTH MAGNETS ARE CRITICAL FOR OUR PRODUCTS

Permanent **magnets** account for **>95% of the total value** of global **Rare Earth Elements** consumption

MINING OF RARE EARTHS HAS A SEVERE IMPACT ON THE ENVIRONMENT
DUE TO WASTE AND HIGH CO2 FOOTPRINT

RE's are accompanied by harmful elements

Uranium
&
Thorium

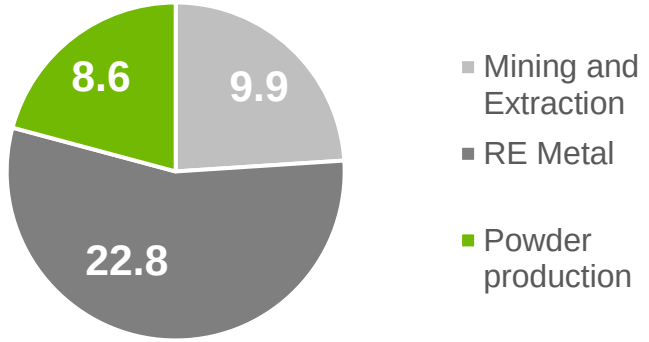
92	90
U	Th
238.03	232.04

1 to 1.4 tons

of radioactive waste is generated per ton of rare earth elements (2000 tons of tailings in total)

Traditional mining operations

CO2 footprint

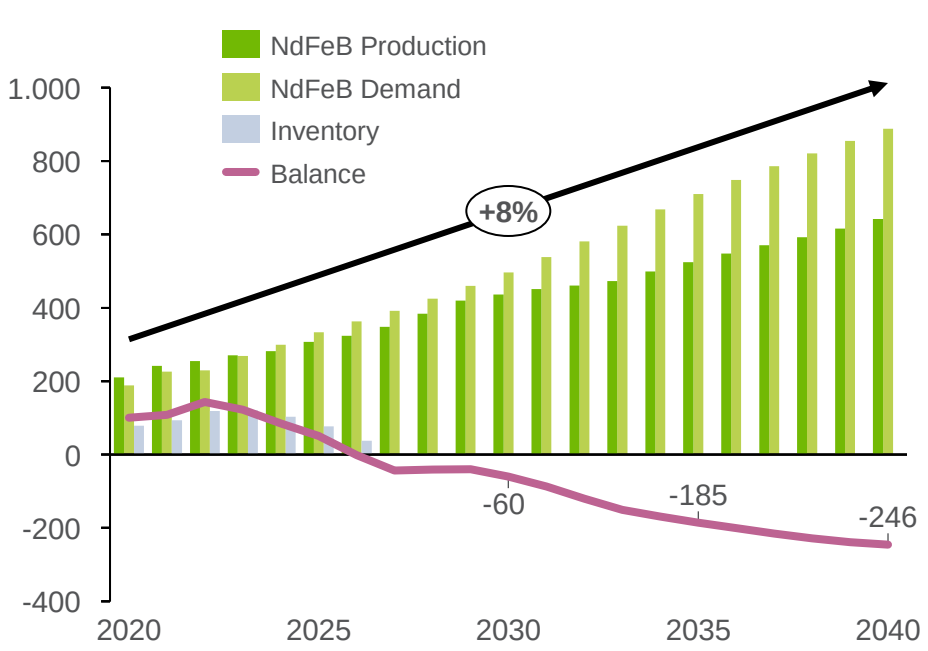


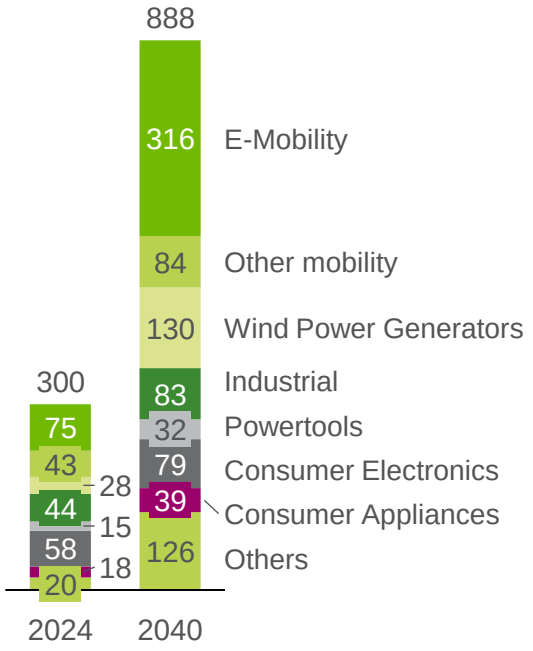
41 kg CO2 equivalent

is released by producing 1kg of NdFeB magnet material

GREEN TECHNOLOGIES DRIVE DEMAND FOR NDFEB AND SUPPLY WILL NOT BE ABLE TO KEEP UP OVER TIME

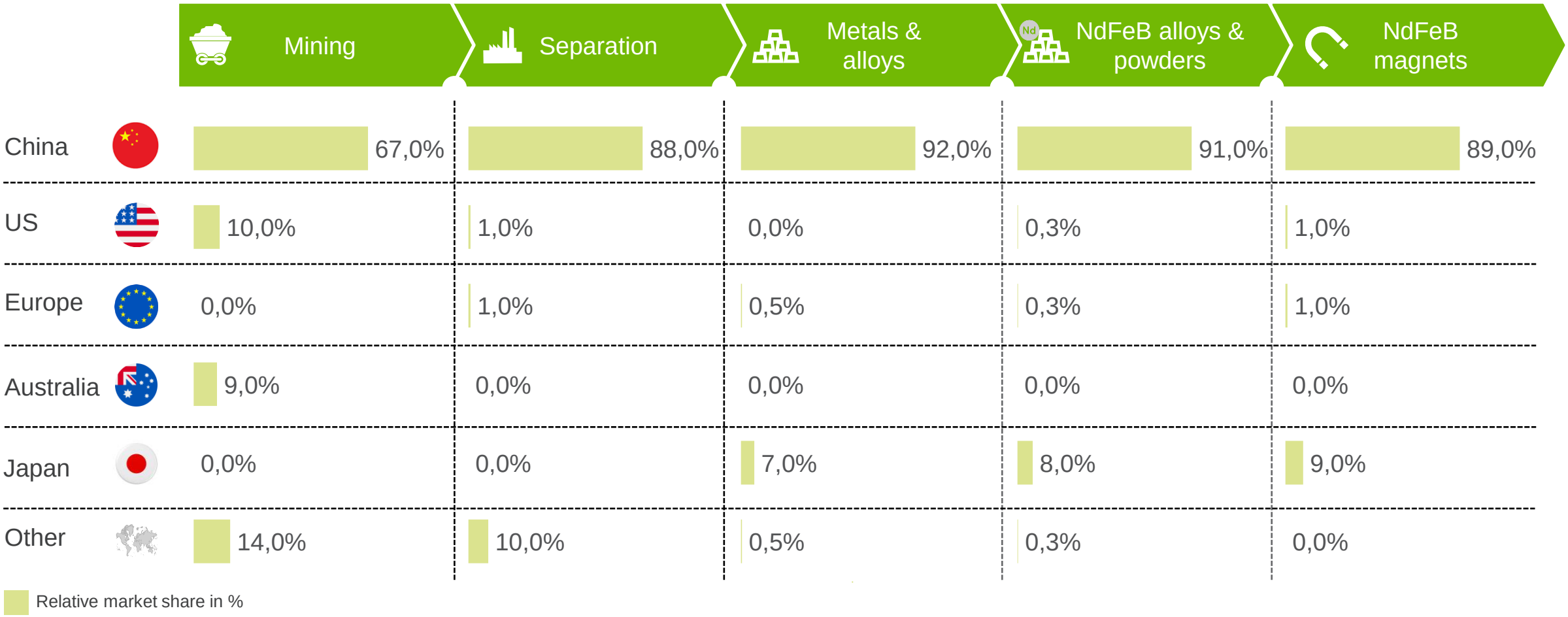
Global NdFeB demand and supply, in k tons





! **Forecasts predict a global supply gap on short term**

EUROPE IS HIGHLY DEPENDENT ON IMPORTS FOR MAGNET MATERIAL



THE CHANCE OF A PERMANENT EXPORT STOP FOR RARE EARTH MAGNETS SEEMS LIKELY

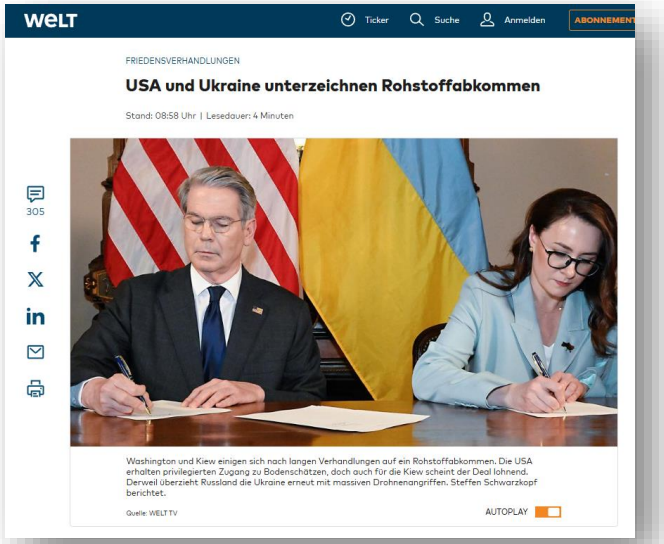
Geopolitical Conflicts:
In the event of trade or political tensions with the West (e.g., over Taiwan), China could use export restrictions as leverage. National security is also cited as a justification

Rising Domestic Demand
China increasingly needs rare earths for its own high-tech industries (e.g., electric vehicles, military technology, renewable energy)

Strategic Control:
China aims to keep more value creation within the country and prefers exporting processed products over raw materials

Who Will Play a Key Role in the Lead Markets of the Future?

THE GEOPOLITICAL SITUATION SHOWS THAT WE MUST TAKE RESPONSIBILITY FOR OURSELVES



THE GEOPOLITICAL SITUATION SHOWS THAT WE MUST TAKE RESPONSIBILITY FOR OURSELVES


The New York Times

Tariffs | What to Know | Fact Check | Timeline | Inside Trump's Reversal | Costs of Chinese Goods

China Halts Critical Exports as Trade War Intensifies

Beijing has suspended exports of certain rare earth minerals and magnets that are crucial for the world's car, semiconductor and aerospace industries.

Listen to this article · 8:57 min Learn more | Share full article | 2.9K

Export Controls since 4. April 2025:

- China restricted exports of key rare earth elements (e.g., dysprosium, terbium) as reaction to US tariffs
- Export licenses now required: Approvals limited
- Reason allegedly is the usage of HREE in defense

Jul / Aug:

- China resumed some magnet exports - license approvals improved but remain selective
- Various companies are close to running out of stock
- The world is looking for alternatives to Chinese HRE magnets but none is available

USA Response:

- Boosting domestic production, recycling, and refining.
- Implementing floor prices for oxides
- Offtake agreements by government and large enterprises

EU:

- Discussions and projects…

WHY DO WE NEED HEAVY RARE EARTHS?

REE overview

Note: Distinction between LREEs and HREEs based on atomic numbers

Light Rare Earth Elements (LREE)

21 Sc Scandium	57 La Lanthanum	58 Ce Cerium	**59 Pr Praseodymium**	
60 Nd Neodymium	61 Pm Promethium	62 Sm Samarium	63 Eu Europium	64 Gd Gadolinium

Heavy Rare Earth Elements (HREE)

65 Tb Terbium	**66 Dy Dysprosium**	67 Ho Holmium	68 Er Erbium	69 Tm Thulium
70 Yb Ytterbium	71 Lu Lutetium	39 Y Yttrium		

Focus REEs | Magnetic properties | No magnetic properties

HREE

Function:
- **Dy & Tb** improve heat resistance in magnets
- Without HREE the maximum operating temperature of magnets is at ~120°C

Applications:
- Military applications: Guidance systems, precision weapons, sonar, aircraft systems, …
- Industry: EV motors, wind turbines, robotics, …

Source:
- No relevant source available outside China

Alternatives:
- Reengineering of applications for more cooling
- Recycling of End-Of-Life applications
- Use other magnet types that do not need HRE (hot-deformed magnets)

→ **All alternatives have limitations**

WHAT OPTIONS DO WE HAVE TO MAKE EUROPE INDEPENDENT FROM MAGNET IMPORTS?

Remloy

Find additional countries for import

Establish mining operations in Europe

Recycling of magnets in Europe

Substitution with other magnet types

Reengineering for better cooling

Use alternative sources for LRE

Reduce dependency on HRE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Recycling and production of magnet material at Heraeus Remloy in Bitterfeld

REMLOY RECYCLING PROCESS

Melting

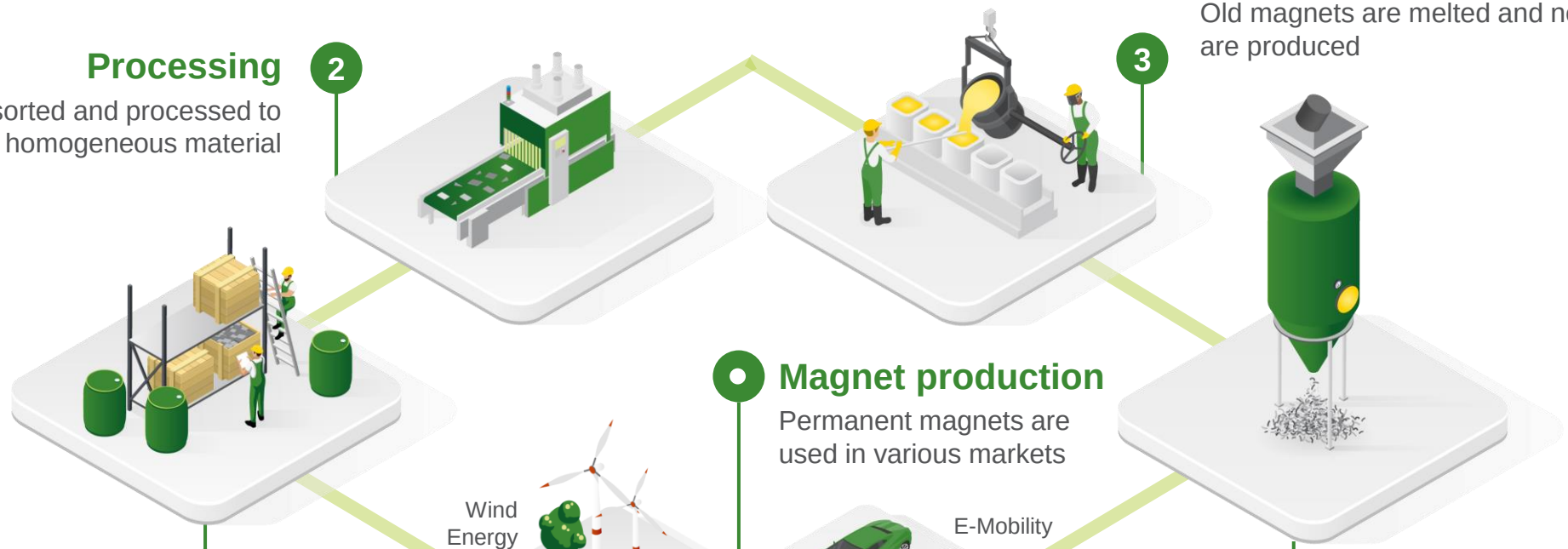
Old magnets are melted and new alloys are produced

Processing

2

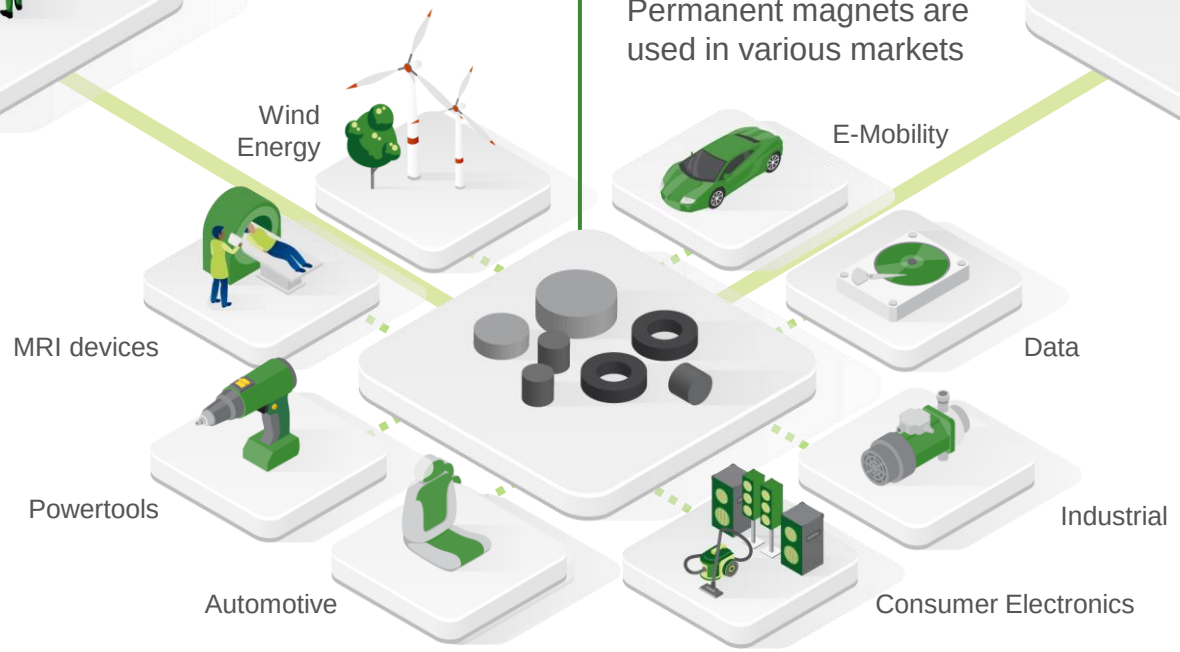
The magnets are sorted and processed to obtain a homogeneous material

3



Magnet production

Permanent magnets are used in various markets



Collection and Dismantling

1

Used magnets are collected, separated and demagnetized

Production of magnetic material

4

For plastic-bonded and hot-formed magnets

HERAEUS REMLOY RECYCLING PROCESS OF NDFEB MAGNETS WILL HAVE LARGE ADVANTAGES FOR THE INDUSTRY

High performance magnets as competitive alternative to primary material

Up to 80% CO2 savings

No radioactive mining tailings from REE extraction that contaminate environment

No extraction or usage of any Cobalt that is not already in alloy

Secure supply chain and European independency from imports

Fulfill requirements of 25% recycled REE content (European Commission)

CRITICAL RAW MATERIALS ACT: THE EUROPEAN COMMISSION WANTS TO COUNTERACT THE DEPENDENCY ON CRITICAL RAM MATERIAL IMPORTS

Goals of the European commission till 2030

At least **10%** of the EU's annual consumption from extraction

At least **25%** of the EU's annual consumption from recycling

At least **40%** of the EU's annual consumption for processing

Not more than **65%** of the Union's annual consumption of each strategic raw material at any relevant stage of processing from a single third country

CHEAP MATERIAL SECURES THE CHINESE DOMINANT POSITION TODAY BY STRATEGIC GOVERNMENT INVOLVEMENT

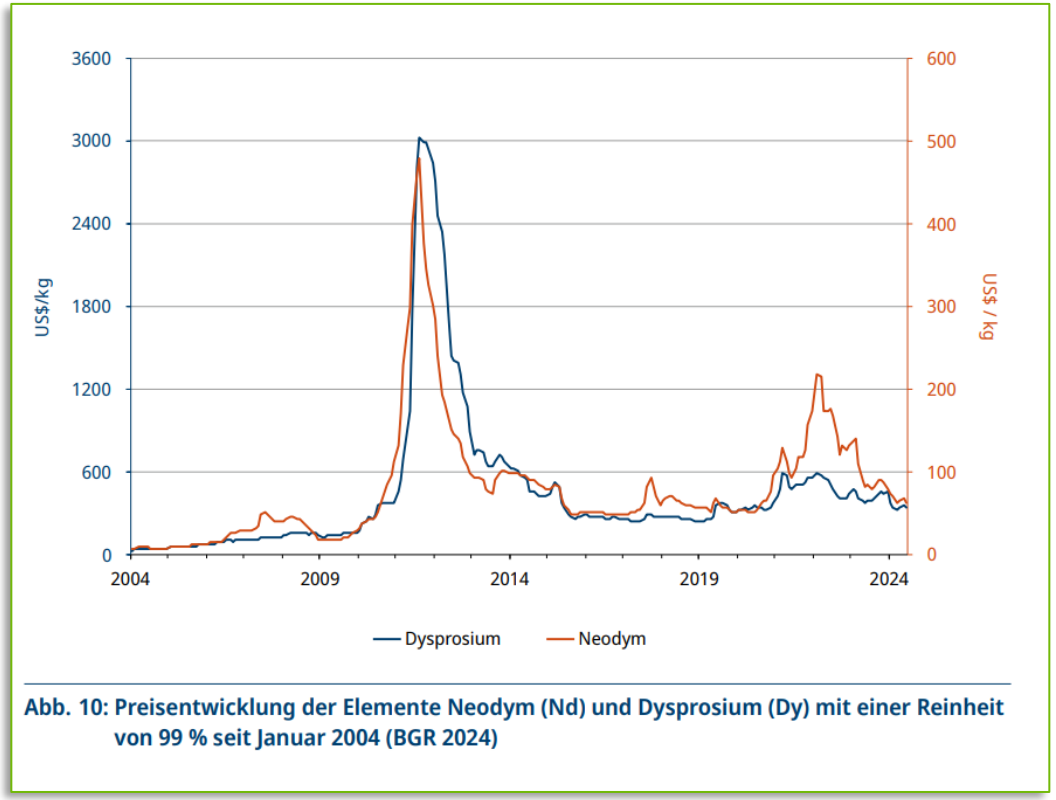


Abb. 10: Preisentwicklung der Elemente Neodym (Nd) und Dysprosium (Dy) mit einer Reinheit von 99 % seit Januar 2004 (BGR 2024)

+

10%
For finished magnet

PRODUCTION OF MAGNET MATERIAL WILL ALWAYS BE MORE EXPENSIVE OUTSIDE CHINA AND ADDITIONALLY GOVERNMENT SUPPORTS BUSINESSES

Lower wages
Generally lower costs for workforce

Electricity subsidies
Up to 50% below market price → Significant savings on energy costs (20–30% of production costs)

Interest-free or low-interest loans
State banks reduce capital costs to almost zero

Less stringent environmental regulations
Lower costs for requirements and controls (especially regarding radioactive waste)

VAT rebates and tax breaks
Refund on domestic products

Export promotion
13% tax refund on the export of magnetic material

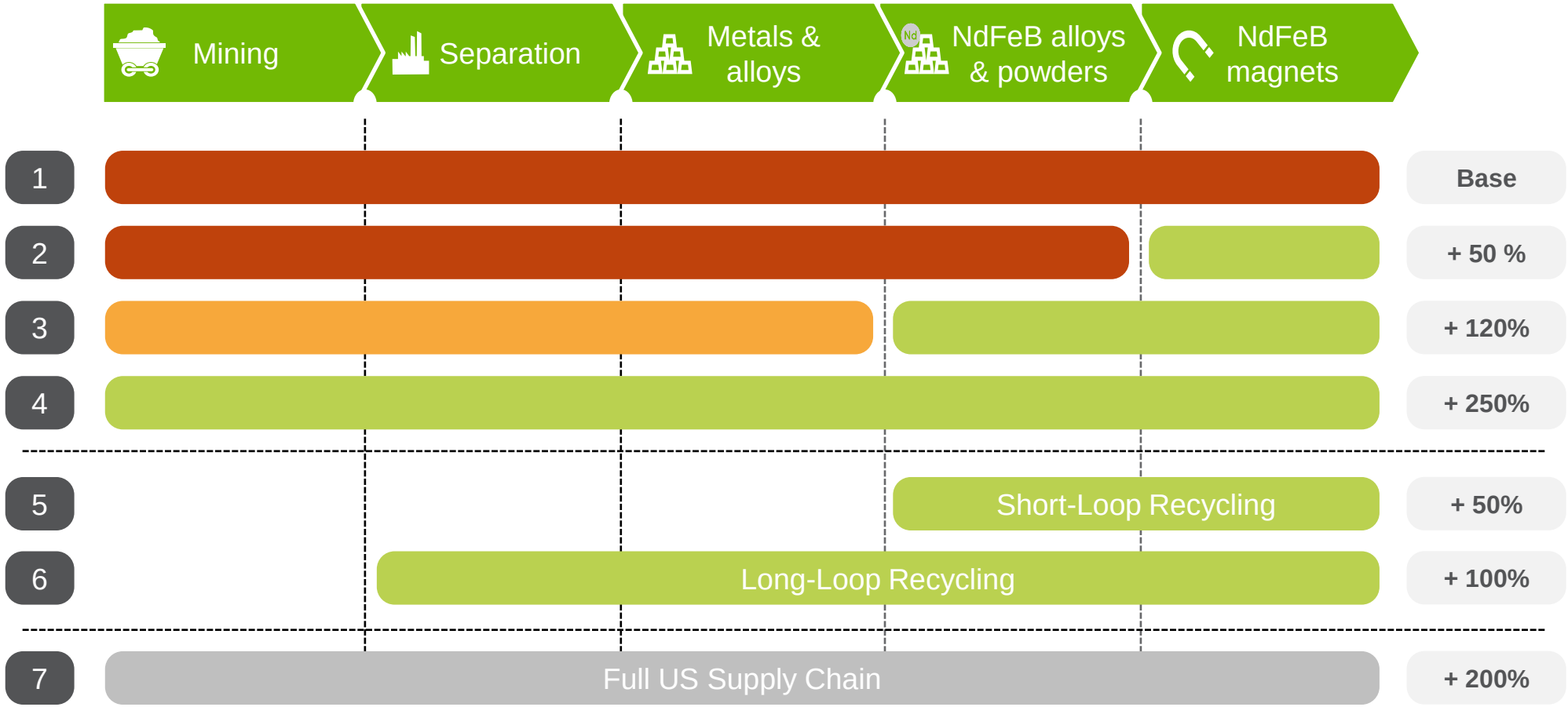
Long-term economies of scale and expertise
Decades of industry and expertise development

Rare earth concentration
More REE material per kg ore

Project	Concentration
Greenland	0.5 - 1.5 %
Germany	0.5 %
Sweden	0.5 %
Norway	?
China	5-6 %
Mountain Pass	10 %

In Sweden, 12x more material have to be extracted to get the same amount of Rare Earth as in the Chinese Bayan Obo mine!

ALTERNATIVE SUPPLY CHAINS ALL COME WITH HIGHER COSTS COMPARED TO CHINESE MATERIAL - ALMOST IMPOSSIBLE TO QUANTIFY



Heraeus Remloy 1) Estimations based on expert survey – No actual numbers available

Legend: China | Ex-China | EU

SUMMARY: RARE EARTH MAGNETS ARE ESSENTIAL FOR EUROPEAN COMPETITIVENESS AND WE NEED TO BUILD A RESILIENT SUPPLY CHAIN

Availability of Rare Earth Material is **limited and China holds >90%** of worldwide capacity

Rare Earth Material is **already part of geopolitics** and used strategically

Even if access to material will become easier again, the next **export stop might be permanent**

Building a resilient supply is essential but will come at a significantly higher cost

BUT:

The additional cost of resilient material seems negligible to the total price of our products

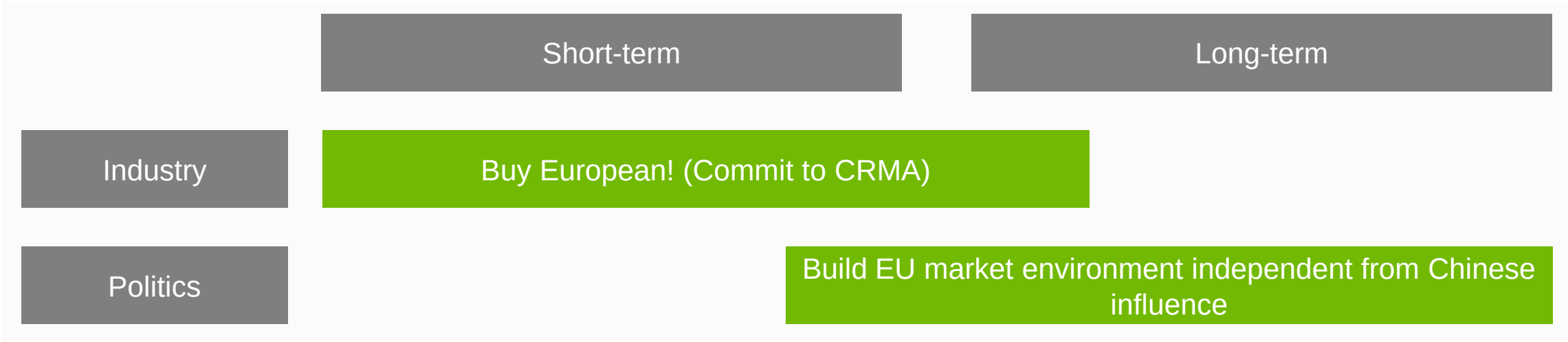
Example application: EV

- 3-4kg magnet material in total
- Price for Chinese material: 40 EUR / kg
- Price for EU material: 80 EUR / kg
- EU material amount: 25%

→ **40 EUR per car to build a resilient supply chain**

To become more resilient we need to make a minor invest in our products instead of starting new projects! Additionally we build higher Health & Safety standards and protect the environment with greener material.

HOW CAN WE BUILD A RESILIENT SUPPLY CHAIN?



- **The industry is in the driver seat!** - Politics will not save your company if your production stands still
- The only way to build resilient supply is by showing commitment for European demand
- Price needs to be secondary to resilience (risk needs to be a more important factor in purchasing)
- At the same time we need to build up pressure on politics to create appropriate market conditions

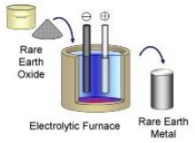
Heraeus

David Bender

david.bender@heraeus.com

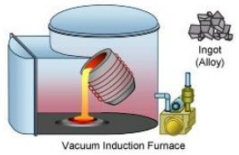
PRIMARY RARE EARTH MAGNET SUPPLY CHAIN: EUROPEAN PLAYERS ARE ALREADY ESTABLISHED AND NEW PLAYERS ARE COMING UP

1 Wet chemical separation

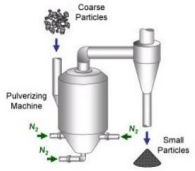


2 Electrolysis

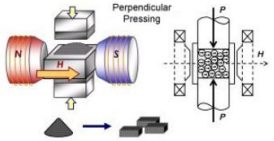
3 Alloying



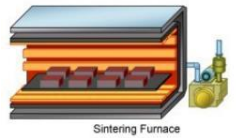
4 Vacuum melting



5 Pulverization (Hydrogen)



6 Compacting



7 Magnet Manufacturing

ionic TECHNOLOGIES

CARESTER Your partner for Rare Earths

SOLVAY

MKANGO

NPM SILMET OÜ

LCM less common metals

VAC VACUUMSCHMELZE

neo Performance Materials

MAX BAERMANN GMBH

wilo

SCHRAMBERG

GKN

mimplus

KOLEKTOR

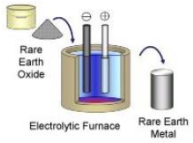
Startups (exept Silmet)

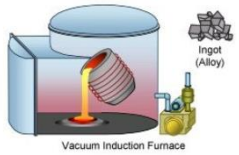
Established but low capacity

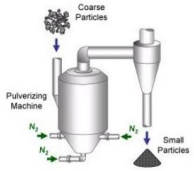
Established players (partly new business)

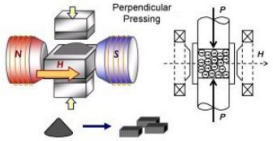
Heraeus Remloy 1) For simplification only sinter magnet manufacturing route is shown (no bonded or hot-deformed)

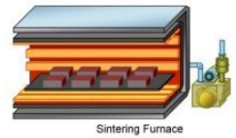
RECYCLING CONCEPTS ARE VARIANTS OF THE REGULAR PROCESS TO PRODUCE MAGNETS











1 Wet chemical separation

2 Electrolysis

3 Alloying

4 Vacuum melting

5 Pulverization (Hydrogen)

6 Compacting

7 Magnet Manufacturing

Short-loop

MagREEsource

HYPROMAG Magnet Recycling

Remloy

Simplified

Long-loop

MKANGO

ionic TECHNOLOGIES

SOLVAY

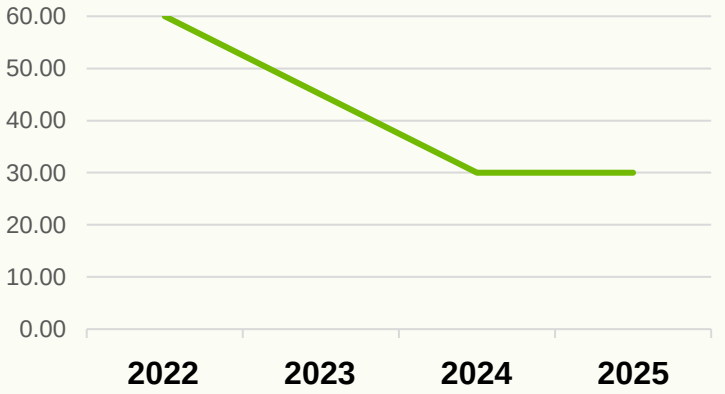
CARESTER Your partner for Rare Earths

Heraeus Remloy 1) For simplification only sinter magnet manufacturing route is shown (no bonded or hot-deformed)

COMMERCIAL CHALLENGE: EXAMPLE FOR BONDED POWDER

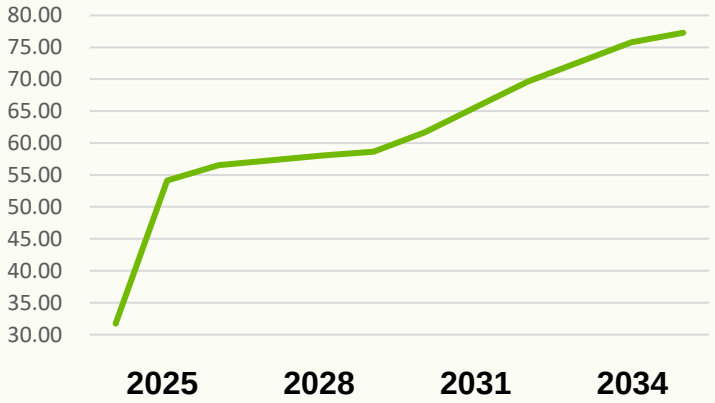
Situation:

- Technology is ready and companies are willing to use recycled material
- In the last few years the price for high-performance magnetic powder declined by ~50% from 60 EUR to 30-35 EUR per kg
- European material cannot compete at the declined price level



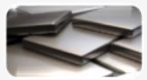
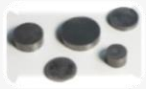
Outlook

- Market experts see a long-term price increase driven by limited supply and political influence[1]
- Geopolitical effects will further influence price development



REMLOY PRODUCES POWDER FOR BONDED MAGNETS AND HOT DEFORMED MAGNETS

NdFeB magnets

	Global share of NdFeB magnets	Crystal structure
Sintered magnets 	 90%	 Microcrystalline
Hot deformed magnets 	2%	 Nanocrystalline
Polymer bonded magnets 	8% 	 Nanocrystalline

Remloy

NdFeB magnet applications

Applications: drive train, e-motors, wind turbines, air conditioning, consumer electronics

Applications: selected drive train, e-motors, consumer electronics and industrial applications

High potential to substitute sintered magnets for selected applications

Applications: small e-motors, loudspeakers, industrial pumps, applications with complex geometry or high rpm