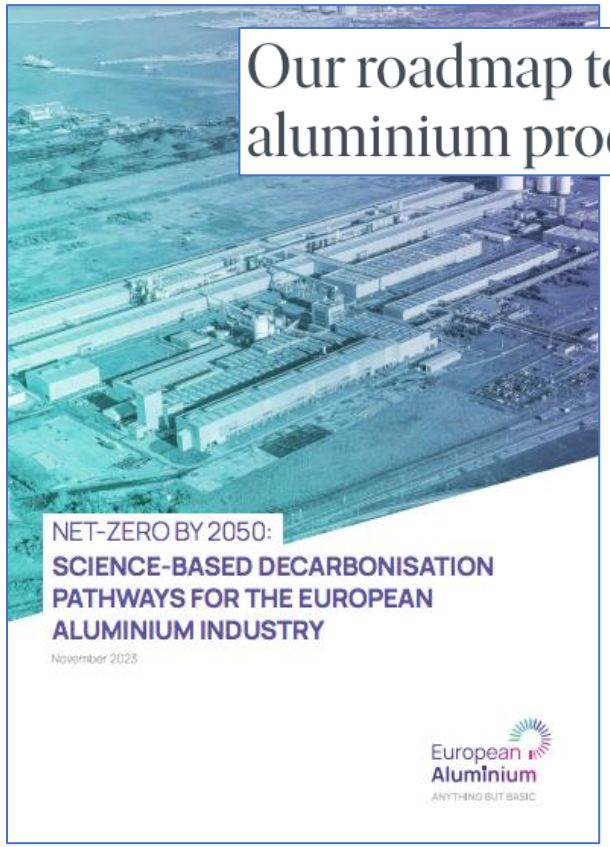
Progress Updates along the Strategic Roadmap for Decarbonization of the Global Magnesium Industry

Dr.-Ing. Martin Tauber, IMA European representative
Dr.-Ing. Elmar Beeh, IMA Sustainabilty Committee Chairman, German Aerospace Center
Mohamad Abdallah, German Aerospace Center

12.05.2025

82nd Annual IMA World Magnesium Conference 2025

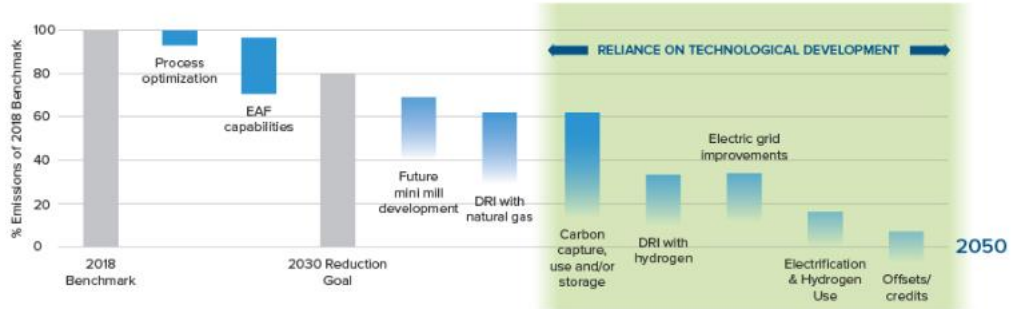
The global industrial way to Net-Zero



THE CORPORATE NET-ZERO STANDARD

Net-zero strategies for the automotive sector

Global steel decarbonisation roadmaps: Near-zero by 2050



SCIENCE BASED TARGETS

DRIVING AMBITIOUS CORPORATE CLIMATE ACTION

Open Fiber's Net Zero Plan: net zero emissions by 2040

International Magnesium Association

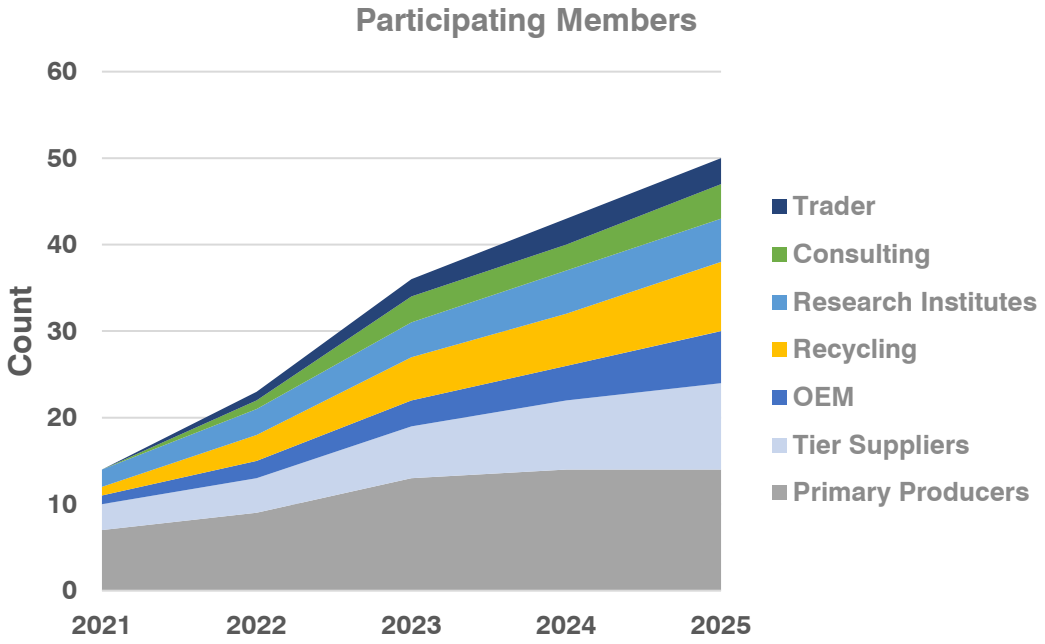
Sustainability Statement

"The members of the International Magnesium Association (IMA) are committed to make sustainability a guiding principle at all levels of operation, and to promote the same commitment to the whole Magnesium Industry. Our mission is:

- *To strive to reduce the impacts of greenhouse gases and natural resources by applying more sustainable technologies and using more renewable energy in our production processes;*
- *To continuously reduce the negative environmental and social impacts within the whole value chain;*
- *To strive to improve circular economy approaches for Magnesium to make end-of-life secondary Magnesium a useful source of greener material."*

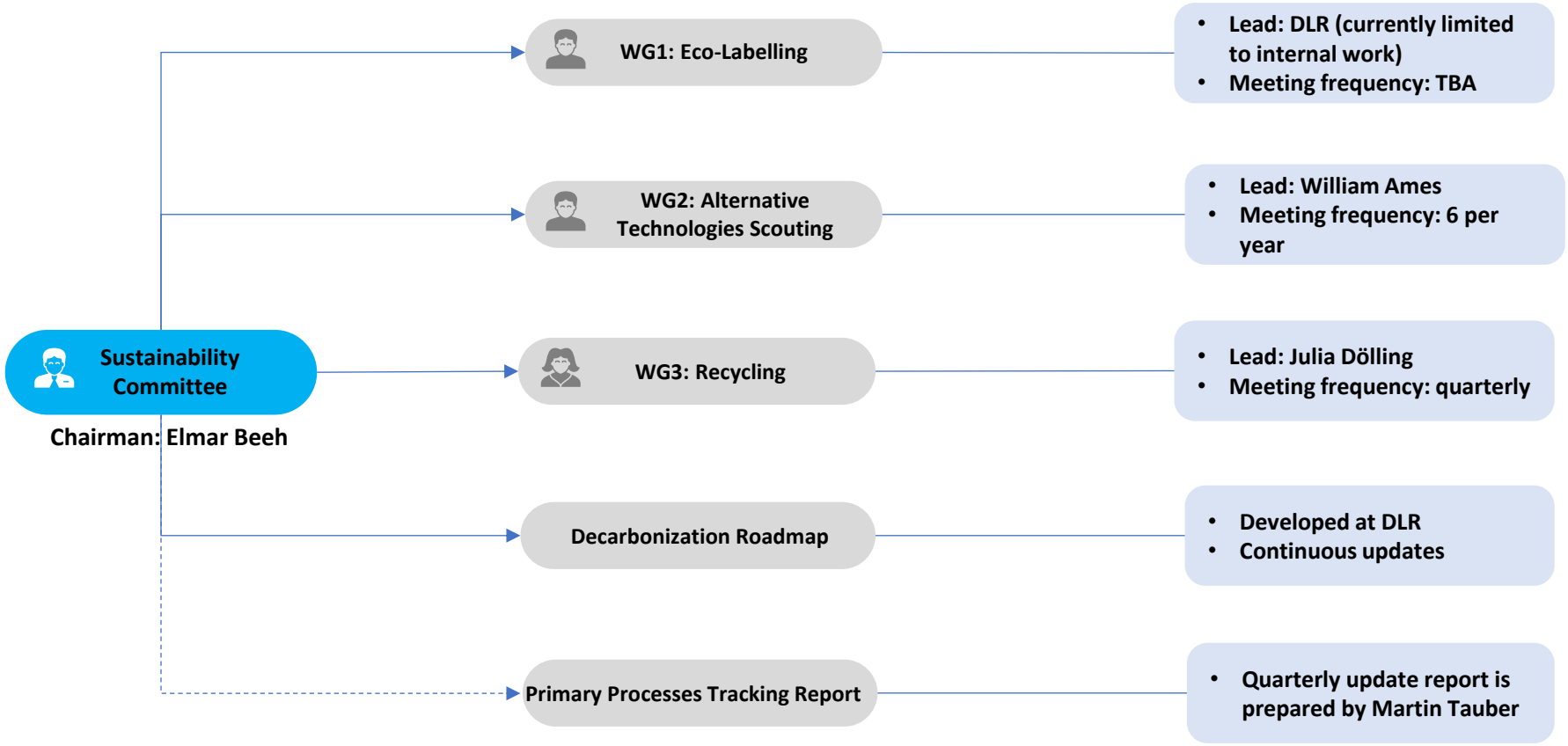
International Magnesium Association

IMA strategic priority



Strategic Priority	#4 SUSTAINABILITY		
Goals	Achieving defined roadmap items	Ensure dedicated resources are in place (committee)	Establish market transparency & Mg Scrap overview
Tactics	• Deliver on roadmap items	• Review needs and define required resources (funds, member support...) • Increase volunteer support	• Hand over to committee and support them working out a strategy & plan

Organization structure & working mode



Roadmap introduction

International Magnesium Association

GREAT DIE CASTING TECHNOLOGY FORUM

CONFERENCE ON MAGNESIUM CASTING MANUFACTURING TECHNOLOGY - CHALLENGES AND OPPORTUNITIES

13. RANSHOFENER LEICHTMETALLTAGE 2024

Hochschule Aalen

CRITICAL MINERALS INITIATIVE TURKIYE

SAE INTERNATIONAL

KIMS Korea Institute of Materials Science

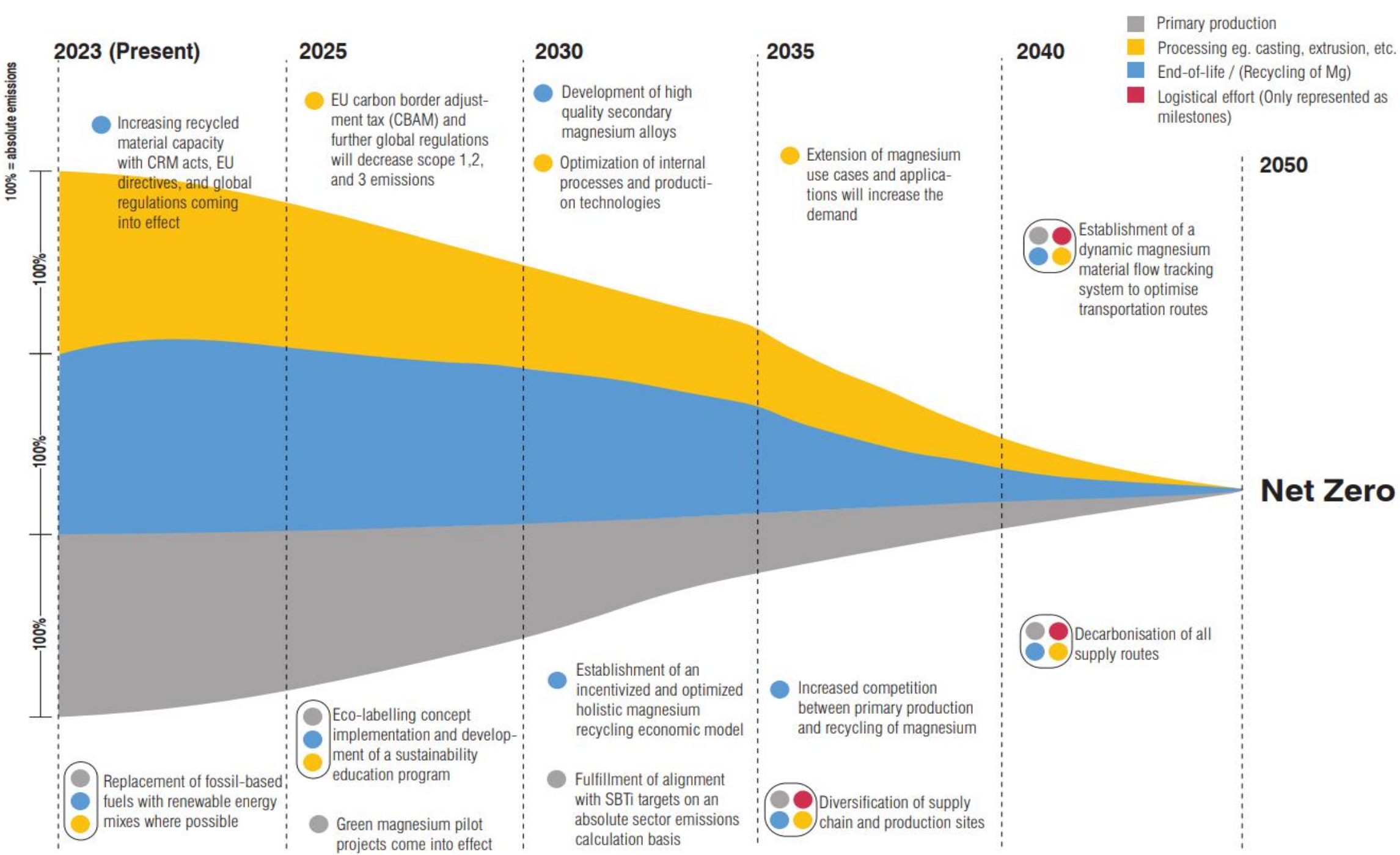
werkstoffplus auto
TAGUNG FÜR NEUE FAHRZEUG- UND WERKSTOFFKONZEPTE

ICM8 2024 Chongqing • China

2024 Mg Chongqing, China

ROADMAP UPDATES

Bildquelle: goodyear.eu, 2024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100%
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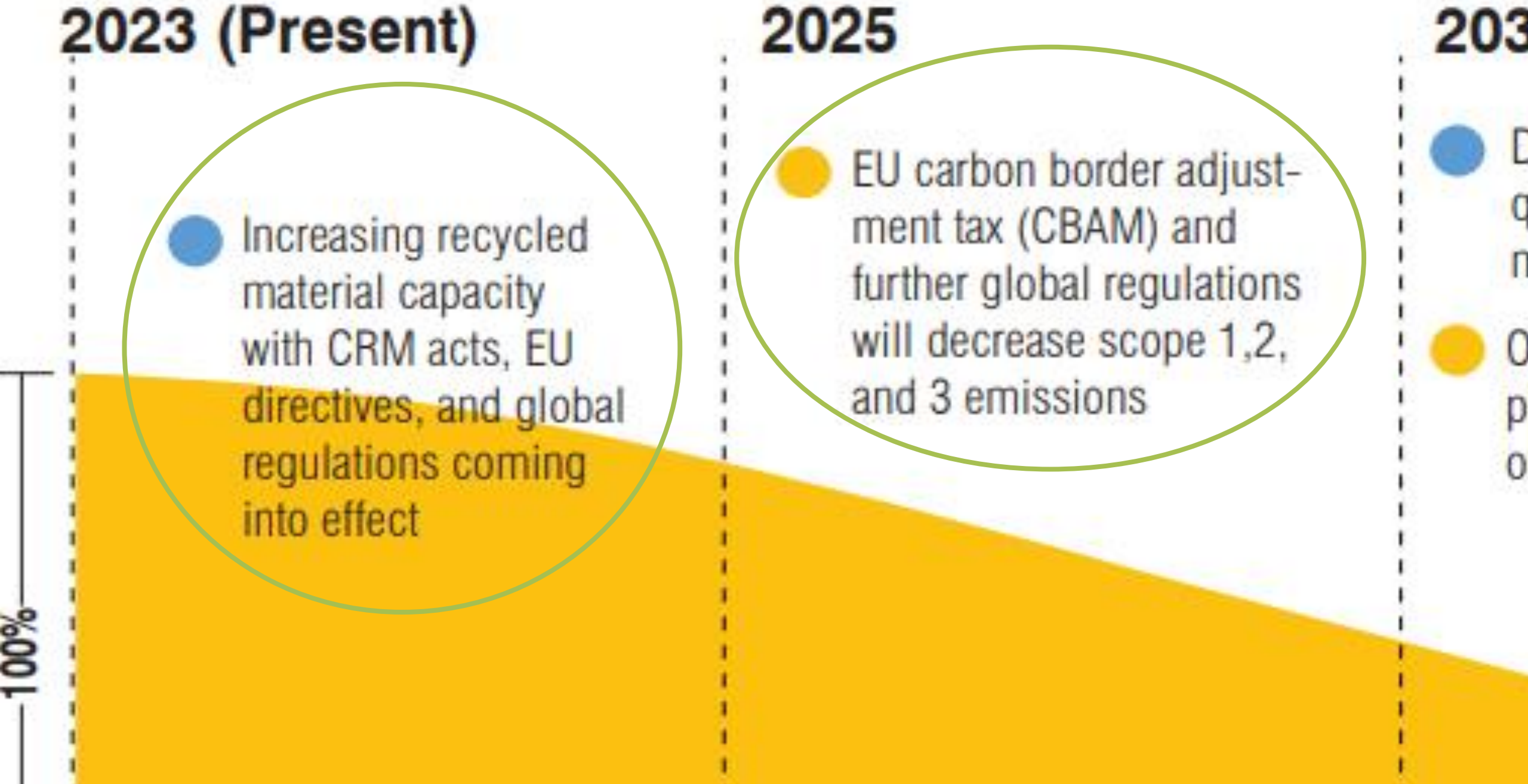
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Global Regulations Updates

EU

1. CBAM simplification package[1]

- ❑ New CBAM minimum threshold exemption of 50 tonnes mass. 99% of emissions still in the CBAM scope, while exempting around 90% of the importers.
- ❑ Delaying the requirement to purchase CBAM certificates for 2026 imports until February 2027.

2. CRM Act

- ❑ Extract 10%, process 40%, and recycle 25% of EU annual consumption of CRMs until 2030.[2]
- ❑ 47 strategic projects to bolster the production of 14 critical materials. e.g. Verde Magnesium[3] from EU. There might be more to follow from non-EU (Bosnia and Herzegovina, Iceland, etc.)

CHINA

1. Export controls[4]

- ❑ China has imposed export controls on certain magnesium materials, including magnesium-based composite materials and magnesium metal powder for solid propellant, effective December 1, 2024

2. Magnesium industry standards[5]

- ❑ Many national and local government policies issued to support the green transformation and high-quality development of magnesium.
- ❑ Magnesium smelting enterprises should have a recovery rate of not less than 80 percent, with the silicon utilization rate of more than 75 percent, according to the industry standards.

U.S.

1. Tarifs[6]

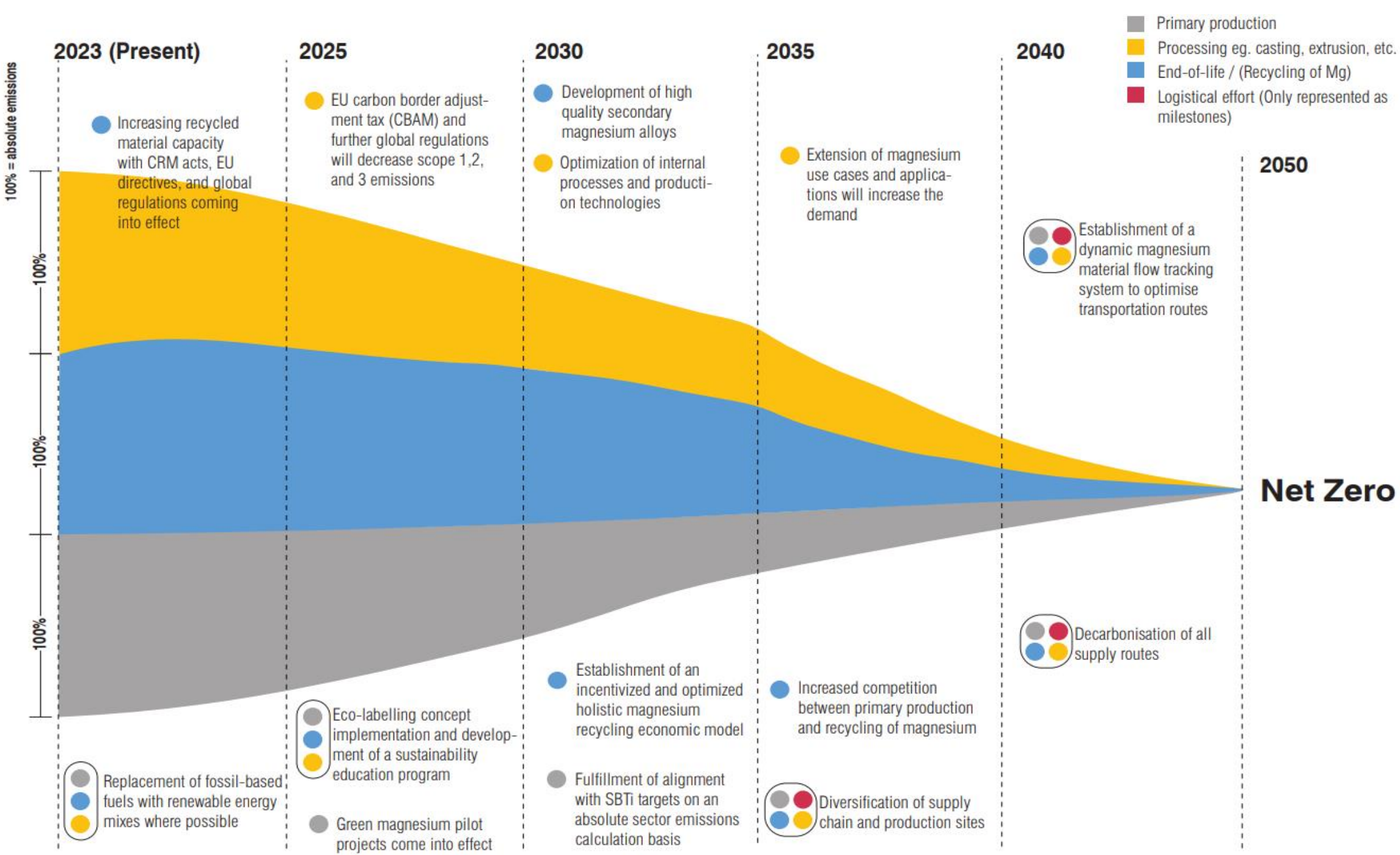
- ❑ Exemptions for all US listed critical minerals
- ❑ Covers magnesium, unwrought, containing at least 99.8 percent by weight, unwrought, waste and scrap, raspings, turnings and granules graded according to size; powders, articles

2. NATO list[7]

- ❑ Magnesium is not listed as the 12 targeted materials
- ❑ Magnesium is not on the list of considered materials

❑ Global regulations are aiming to diversify the supply chain, enable the circular economy, and retain material sovereignty.

[1] https://taxation-customs.ec.europa.eu/carbon-border-adjustment-mechanism_en
[2] https://ec.europa.eu/commission/presscorner/detail/en/ip_24_2748
[3] https://single-market-economy.ec.europa.eu/sectors/raw-materials/areas-specific-interest/critical-raw-materials/strategic-projects-under-crma/selected-projects_en
[4] https://wap.asianmetal.com/news/viewNews.am?nId=2130488
[5] https://en.imsilkroad.com/p/311705.html
[6] https://www.proactiveinvestors.com.au/companies/news/1069265/latrobe-magnesium-to-export-tariff-free-to-the-us-following-presidential-exemption-1069265.html
[7] https://www.nato.int/cps/en/natohq/news_231765.htm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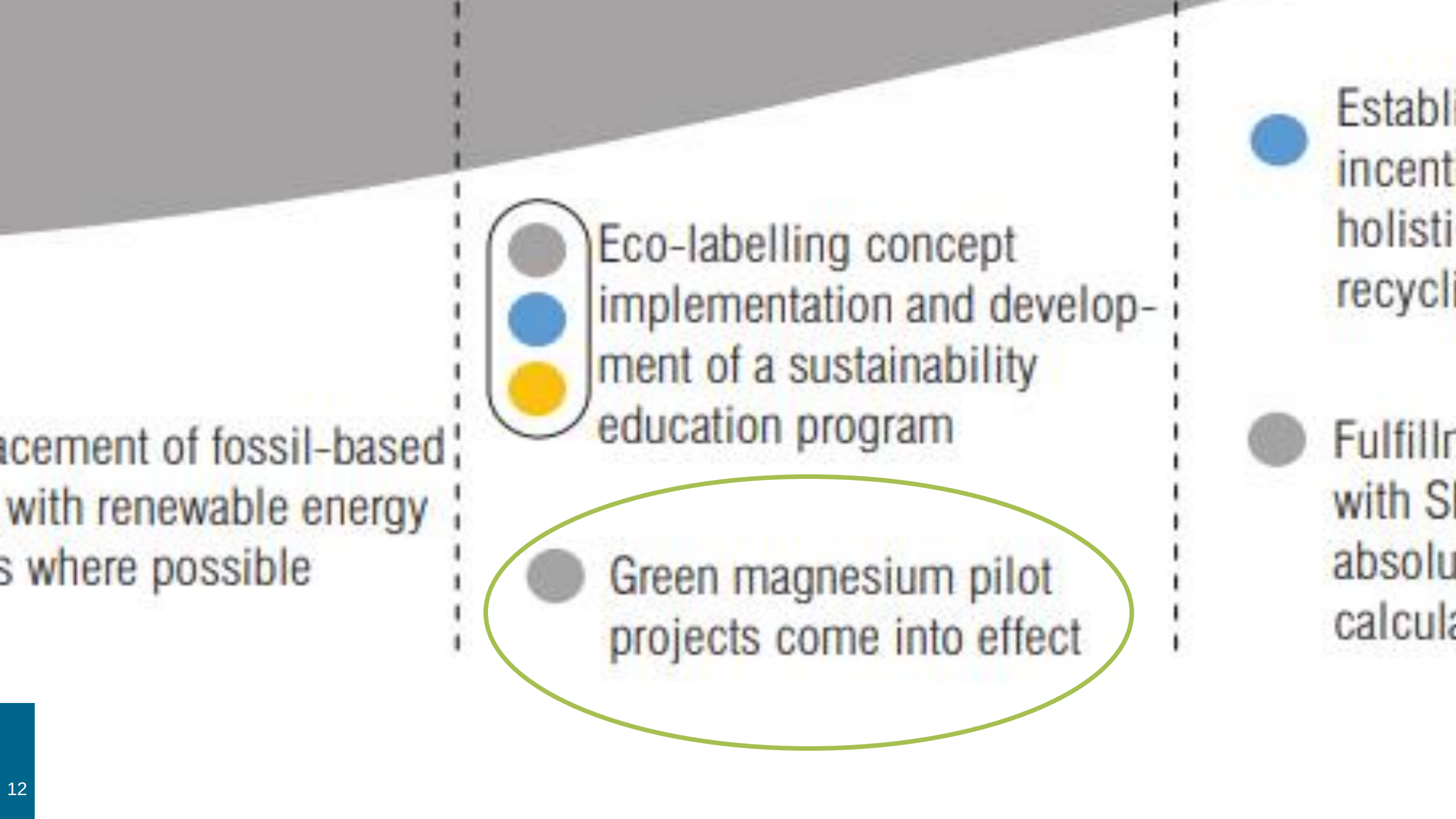
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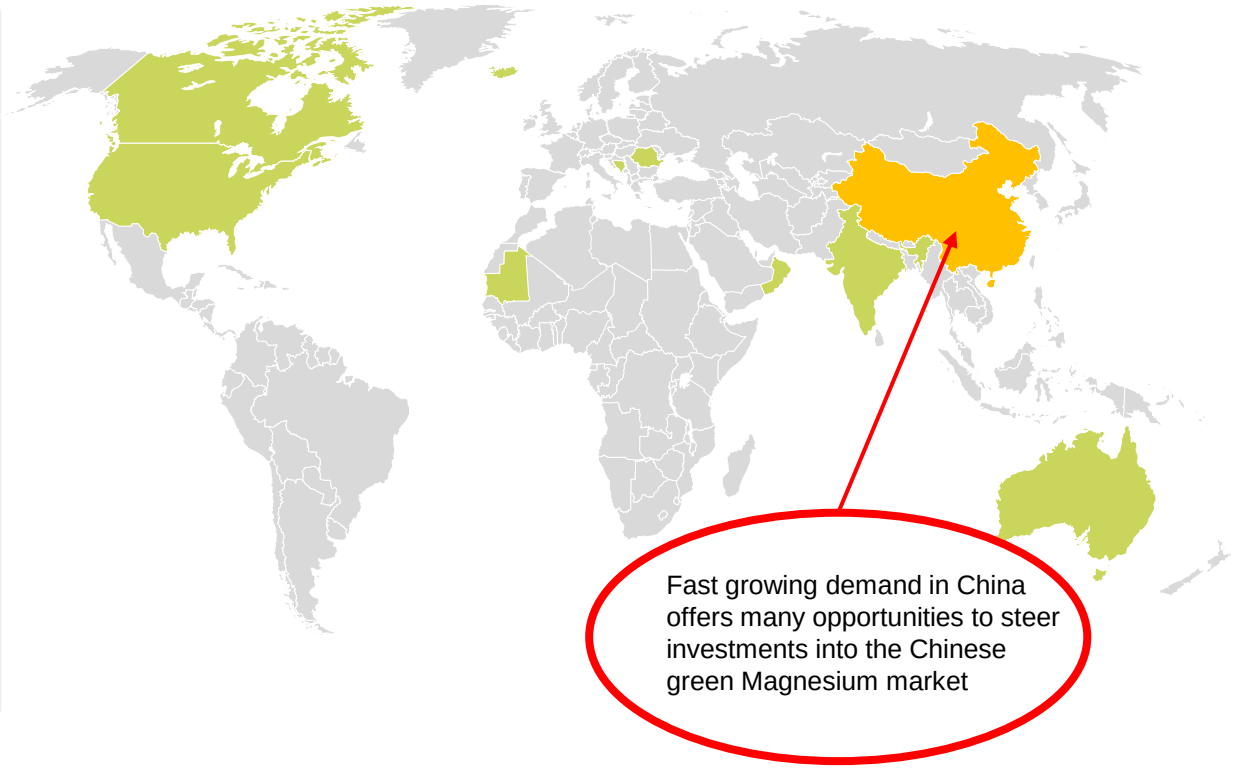
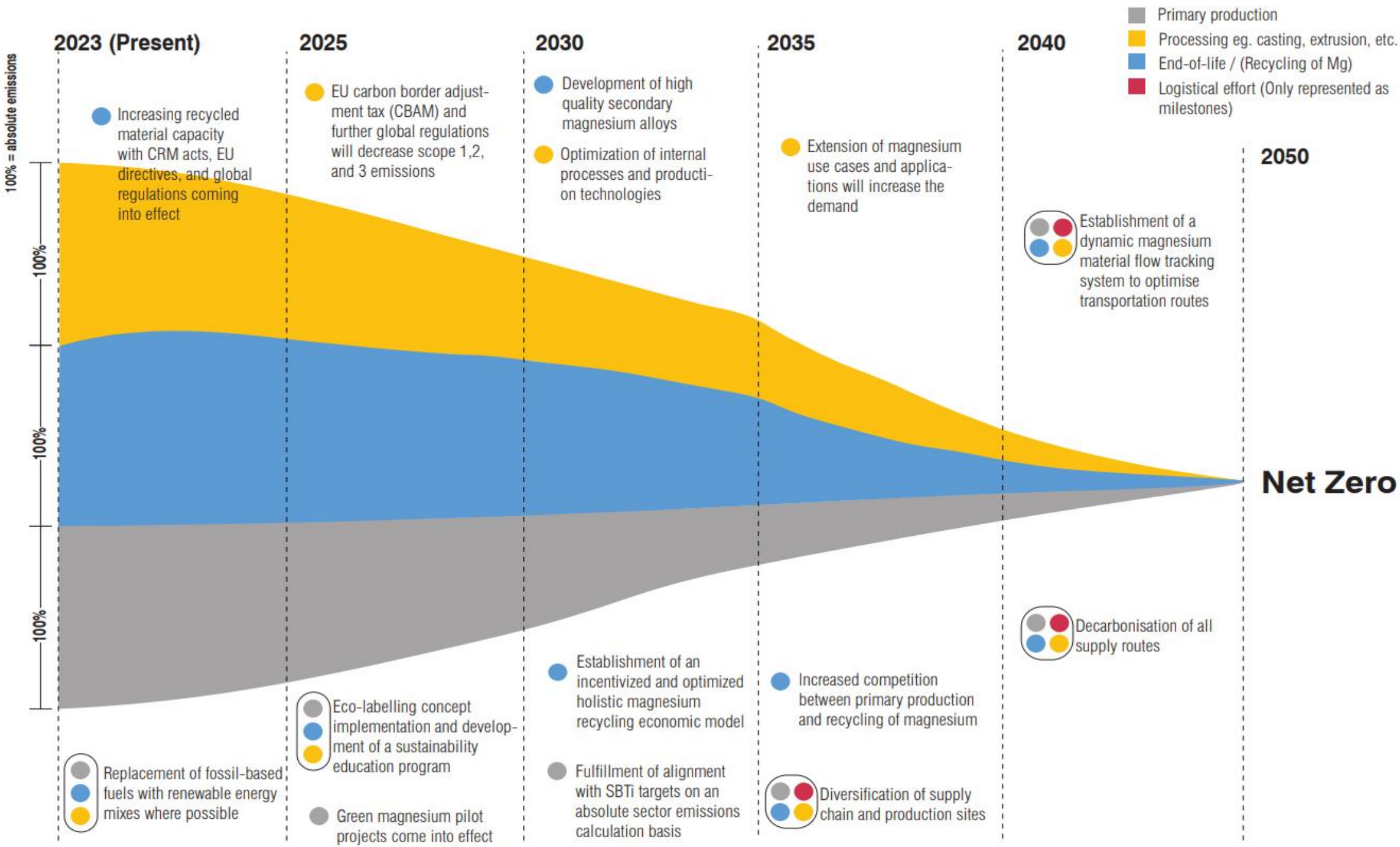
Green magnesium pilot projects

Ongoing Mg primary projects	Hold/Unclear	Planning/Testing	Pilot/Building
Country	**Company name**	**Status 2024 Year End**	**Technology/Process**
Canada	Tergeo Critical Minerals	on hold/bankruptcy protection	Electrolytic
Australia	Latrobe Magnesium	MgO production/pilot plant commissioning	Hydromet-Pidgeon
US	Western Magnesium Corporation	pilot scale reactor	Pyro-met
Romania	Verde Magnesium	planning, sample ingot production, exploration licence	Alumino-Thermic
Romania	Mures Magnesium	planning, sample ingot production	Electrolytic
Bosnia	Magnesium For Europe (MFE)	planning, sample ingot production	Alumino-Thermic
Canada	Mag One Products	planning	Zuliani
Canada	General Magnesium Corporation	planning	unknown
US	Big Blue Technologies	pilot plant	Carbothermal reduction (CTR)/Alumino-Thermic
India	Tremag Alloys	on hold	
Australia	Pact Renewables	process development	
Australia	Magnium	planning/pilot plant building	Magsonic™ carbothermal technology
Canada	West High Yield Ressources	planning	Hydrometallurgical process
Australia	Korab Ressources (AusMag)	planning	
Saudi Arabia	ENOWA (NEOM)	planning	electrolytic/desalination
US	Magrathea Metals	planning/pilot tests	electrolytic/desalination
Iceland	Tjordur Holdings	planning	electrolytic/desalination
US	Tidal Metals	planning	electrolytic/desalination
Oman	MDO	planning	Horizontal pidgeon

Emerging pilot projects



- Pilot projects coming into effect should be ramped up to meet regional demand
- Diversification of the global supply chain on the primary side will further drive the reduction of emissions in the magnesium industry
- Investment in pilot projects with innovative production technologies and an improved environmental footprint should be supported (e.g. EU)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Examples of optimized and alternative magnesium part production processes

Vacural®[1]

- Improved and optimized quality at maximum shot speeds
- Minimal gas and oxide inclusions
- Superior surface finish: fewer defects

Thixotropic Piston Injection Technology (TPI)[2]

- No cover gas required
- Precise and consistent, lower thermal stresses
- Lower footprint than traditional casting

Gigacasting[3]

- faster, ideal for high volume production
- Improved structural integrity but limitation in mechanical consistency
- Less material waste and improved energy efficiency per part produced

- Promising and diverse cost-effective and greener process technologies emerging; the sustainability committee will continue to scout, monitor, and share information with the members where possible.

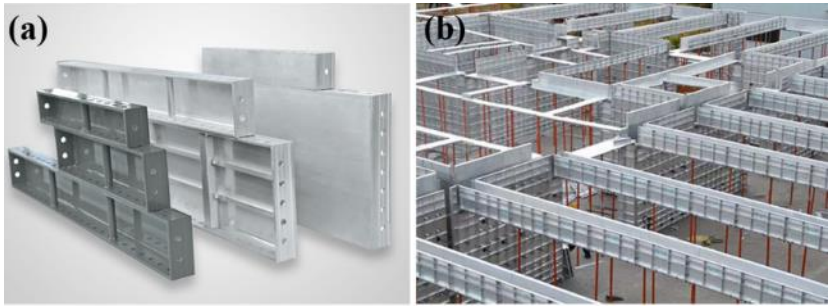
[1] https://www.frechusa.com/vacural-technology

[2] https://tpi-technology.com/products/superplast/

[3] https://insideevs.com/news/673158/tesla-giga-casting-manufacturing-becomes-mainstream/

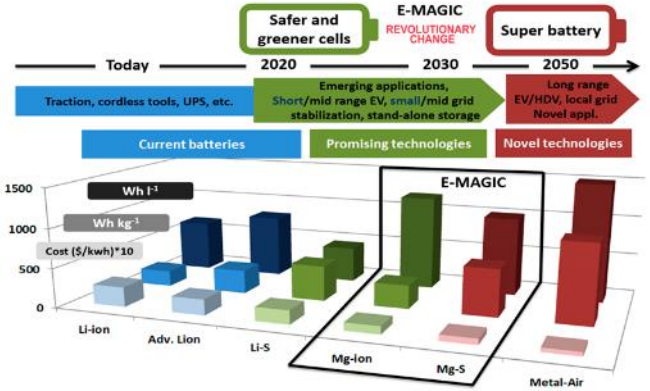
Examples of emerging magnesium use cases

Magnesium construction formwork[1,2]

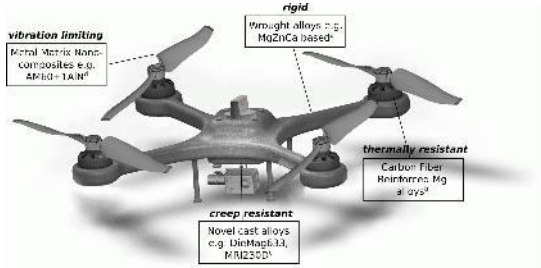


Humanoid robots[3,4]

Battery applications[5,6]

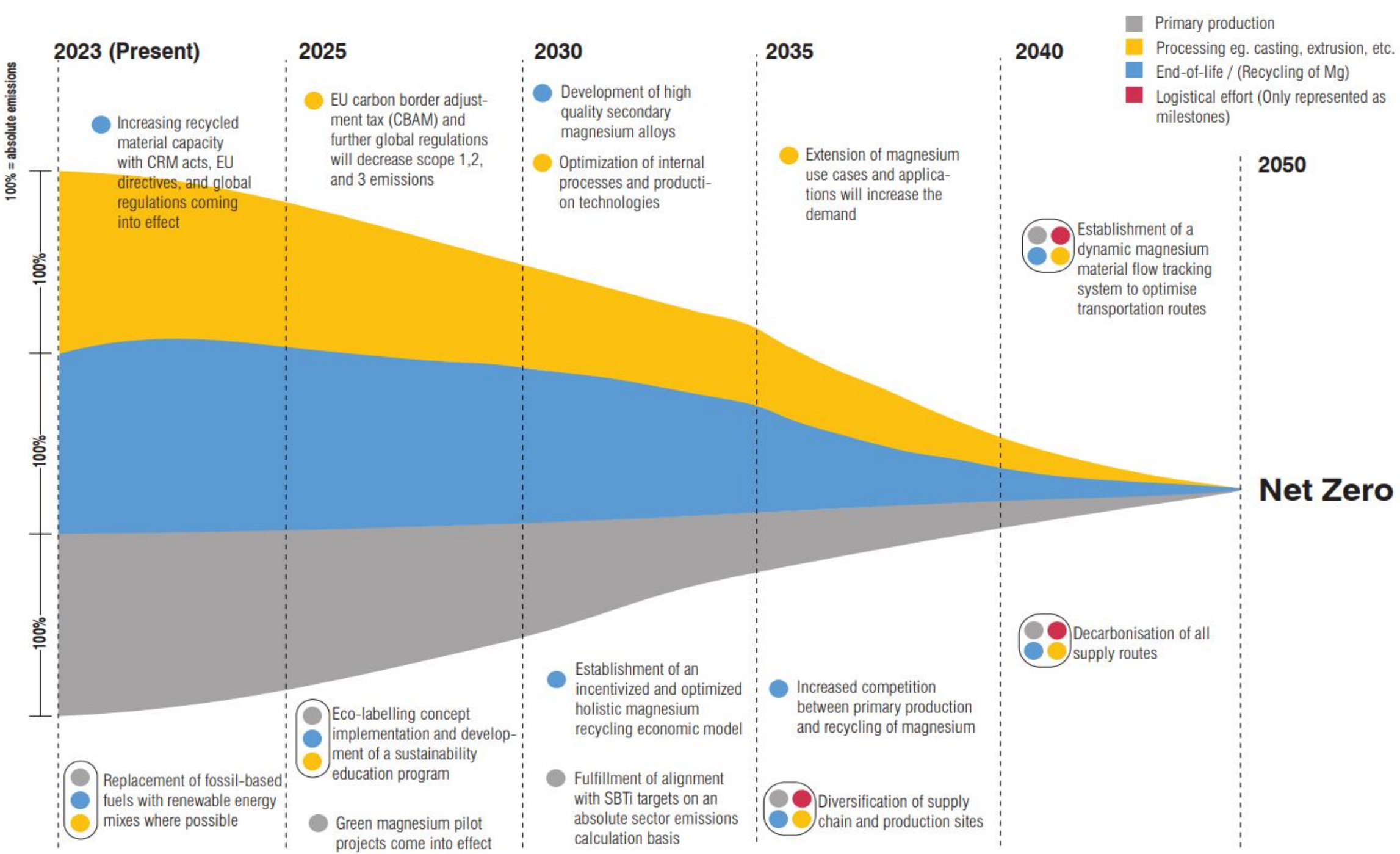


Drones and scramjets[7,8,9]



- Many further emerging use cases (e.g. biomedical), which will further increase the demand of magnesium and underly the importance of supply chain diversification

[1] https://www.cathodicprotection-anodes.com/news/magnesium-alloy-building-formwork-is-mainly-used-for-roof-and-wall-panels-119447.html
[2] https://www.researchgate.net/figure/A-magnesium-alloy-building-formwork-and-its-application-scene-214_fig14_378742770
[3] https://www.linkedin.com/posts/taubermartin_magnesium-thixomolding-activity-7301614378875822080-hwGb/
[4] https://robotsguide.com/robots/asimo
[5]https://www.kit.edu/kit/english/pi_2019_001_magnesium-batteries-dawn-of-the-post-lithium-era.php
[6] https://www.e-magic.eu
[7] https://www.frontiersin.org/journals/materials/articles/10.3389/fmats.2021.575530/full
[8] https://www.saesgetters.com/designhouse/emeth-p11-defining-safety-standards-for-the-drone-industry/
[9] https://www.sustainability-times.com/in-depth/twice-the-thrust-double-the-drama-chinas-giant-magnesium-afterburner-propels-scramjets-into-a-new-era-of-speed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A need for further development of magnesium recycling

Challenges

- ❑ Availability of high-quality scrap
- ❑ Lack of transparency on pricing and material flow data
- ❑ Lack of holistic assessments on environmental x economical feasibility
- ❑ No reutilization of EoL lower classes scrap recycling, loss of Mg as alloying element

Pathways

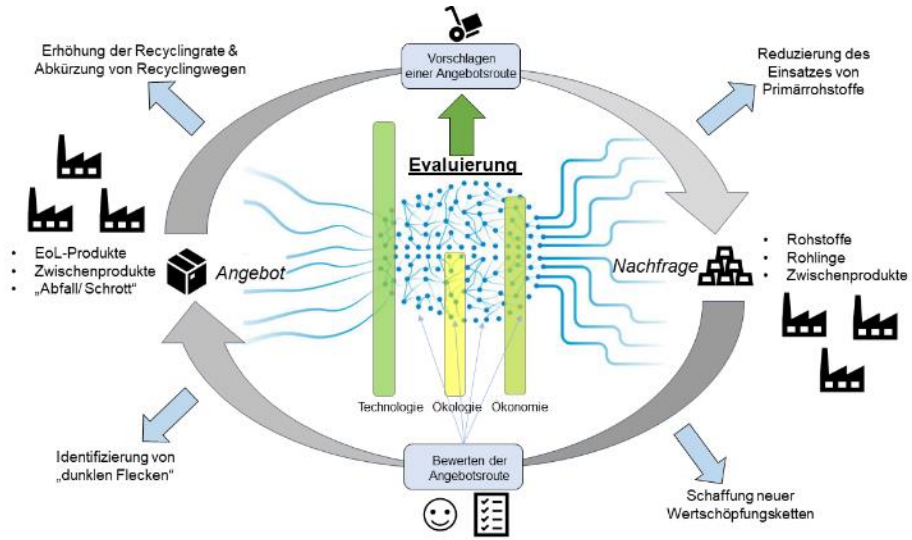
- ❑ IMA Sustainability Committee WG3 to discuss challenges and build up scenarios
- ❑ Regional, centralized, and shared sorting centers
- ❑ Cross-industrial utilization in magnesium recycling: using short-lifecycle EoL magnesium scrap as feedstock for other industries
- ❑ A comprehensive and holistic scrap trading platform

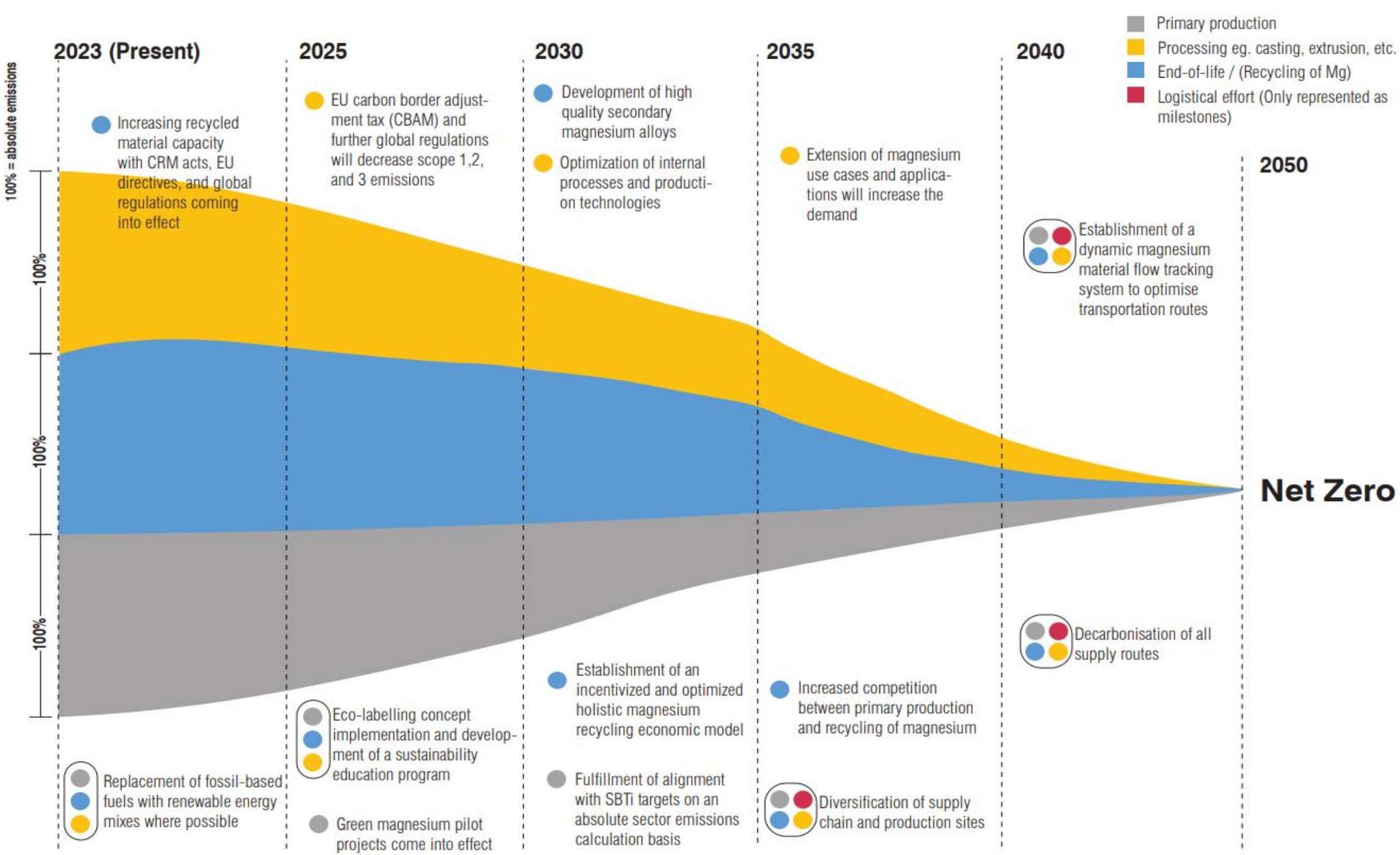
Relevant Funding Calls

- ❑ Horizon Europe 2025–2027: Digital transition and innovation for CRMs
- ❑ EIT RawMaterials ERMA Booster Call
- ❑ Other international calls?

Mg scrap classes	Characterization
Class 1A	High-grade clean scrap without impurities (e.g., scrap castings, biscuits, etc.)
Class 1B	Clean scrap with a high surface area in proportion to the weight
Class 2	Clean scrap with aluminum or steel inserts. No copper or brass impurities
Class 3	Clean, dry, and uncontaminated turnings and swarfs
Class 4	Flux-free residues (e.g., dross, sludge)
Class 5	Painted or coated scrap with/without Al or steel inlays. No Cu or brass
Class 6	Oily and/or wet turnings and swarfs
Class 7	Unclean and contaminated metal scrap (e.g., post consumer scrap) may contain: Si (Al alloys, shot blasting), Cu contaminated alloys, Ni coatings, Non-magnesium sweepings
Class 8	Flux-containing residues from magnesium recycling

[1] https://www.researchgate.net/figure/Magnesium-scrap-classification-system-7_tbl1_306294318

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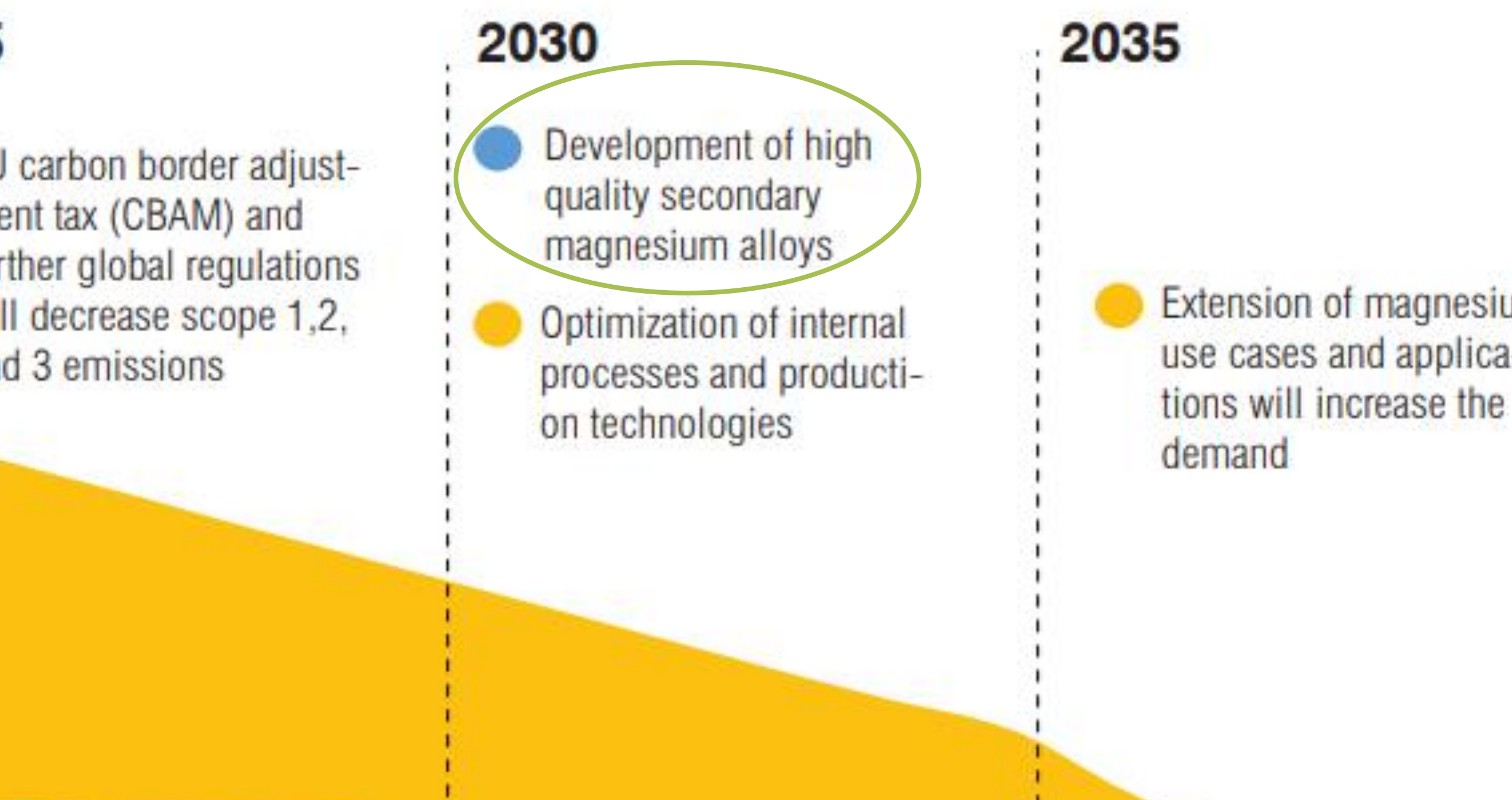
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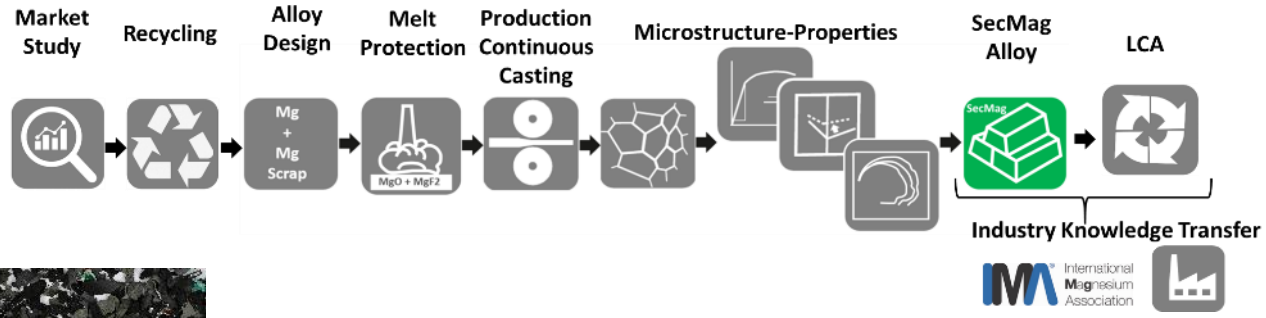
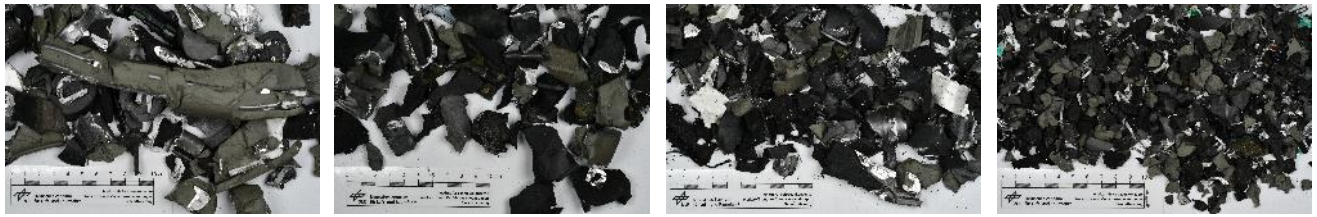
Development of secondary magnesium alloys

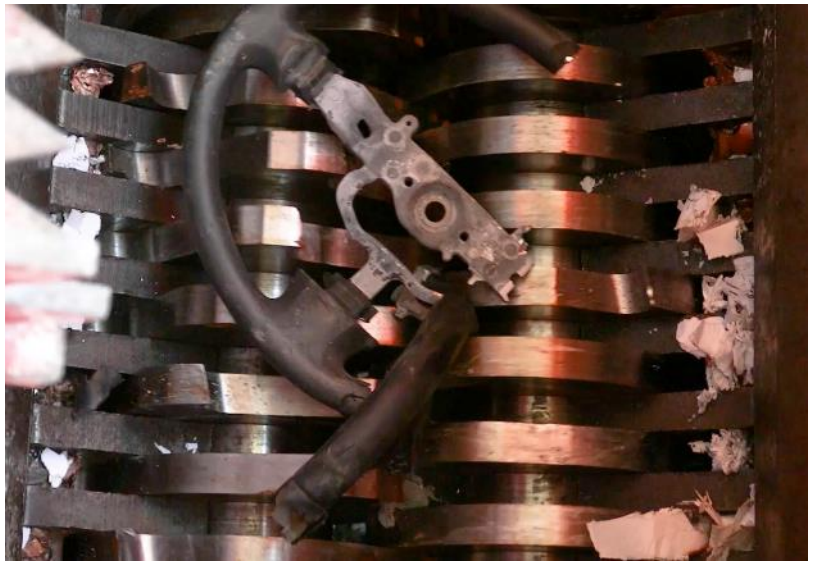
SecMag Research Project by DLR and Helmholtz Center Hereon in Germany

Objectives:

- ❑ Strategic scrap sorting and recycling of lower-quality scraP
- ❑ More targeted processes for secondary alloy production
- ❑ Optimized inert gas application





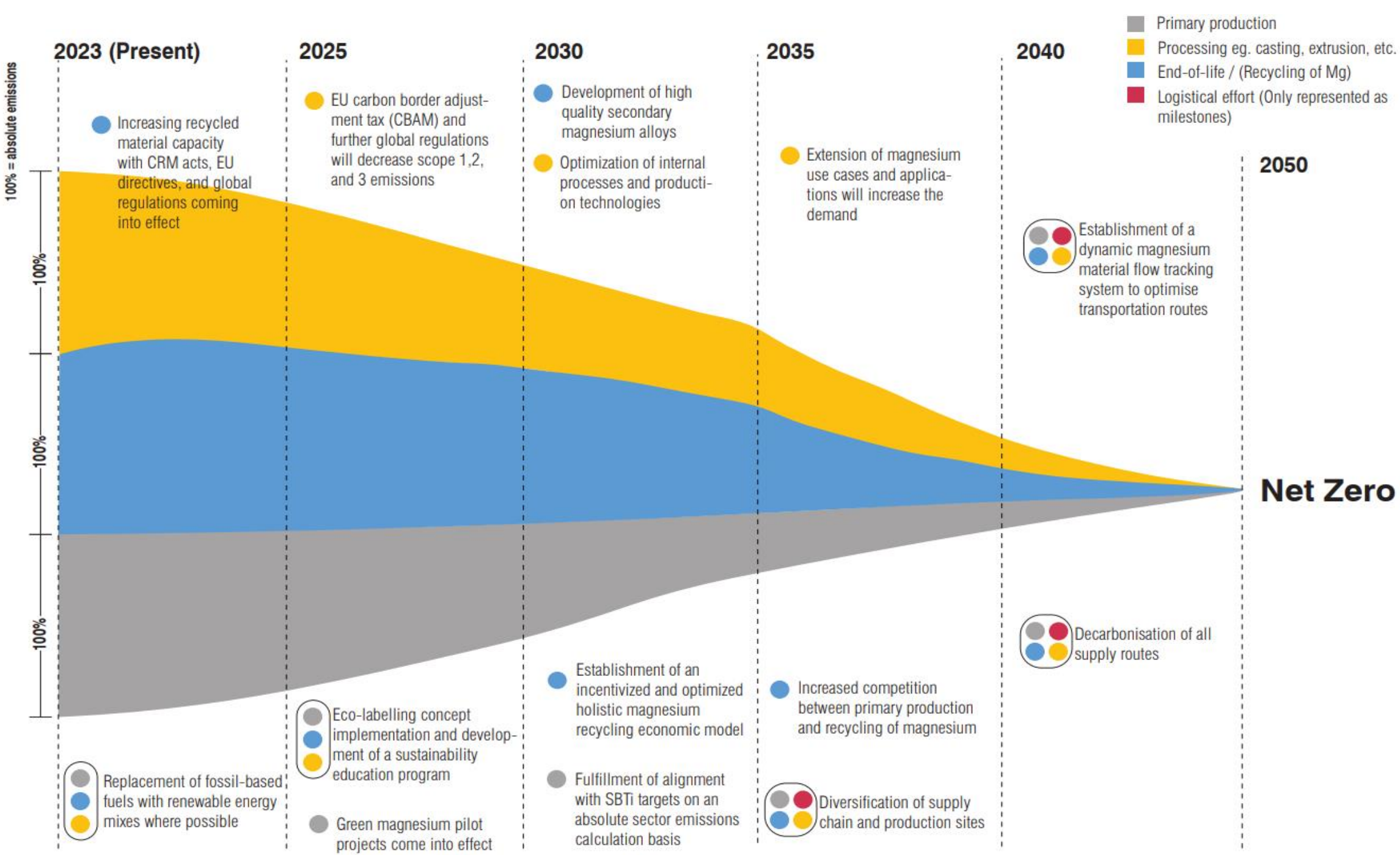


Industry progress:

- ❑ Increased % in production processes
- ❑ R & D to address lower-class scrap categories

Production process \ Recycling intensity	10%	20%	30%	40%	50%	60%	70%	80%	90%
Pidgeon Process (CN, w/o credits)	25.3	22.5	19.8	17	14.3	11.5	8.8	6	3.3
Pidgeon Process (CN, avg. 2020)	19	16.9	14.9	12.8	10.8	8.7	6.7	4.6	2.6
Electrolysis (ISR)	13.6	12.1	10.7	9.2	7.8	6.3	4.9	3.4	2
Silicon-thermic process (BRA)	9.1	8.1	7.2	6.2	5.3	4.3	3.4	2.4	1.5
Electrolysis (CN)	4.6	4.1	3.7	3.2	2.8	2.3	1.9	1.4	1

Carbon footprint [kg.CO2/kg.Mg] for various recycling percentages in the global Mg primary production (values are taken from IMA DLR LCA 2020 study)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Optimization of internal processes and production technologies
Extension of magnesium use cases and applications will increase the demand
Establishment of a dynamic magnesium material flow tracking system to optimise transportation routes
Decarbonisation of all supply routes
Replacement of fossil-based fuels with renewable energy mixes where possible
Eco-labelling concept implementation and development of a sustainability education program
Green magnesium pilot projects come into effect
Establishment of an incentivized and optimized holistic magnesium recycling economic model
Fulfillment of alignment with SBTi targets on an absolute sector emissions calculation basis
Increased competition between primary production and recycling of magnesium
Diversification of supply chain and production sites

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Establishment of an incentivized and optimized holistic magnesium recycling economic model

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Increased competit
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Diversification
chain and produ

Meeting the industry's absolute emissions targets

The Sustainability Committee Ecolabelling working group:

- ❑ Developing an ecolabelling concept
- ❑ Conducted a survey to assess industry acceptance and feedback on the approach
- ❑ Decoupling the decisive factor of selecting magnesium metal purely on the basis of outdated LCA databases – but also updating them.

*it remains a challenge to get an accurate measure of global magnesium emissions. Therefore, estimates and assumptions are made to track the progress along the decarbonization roadmap.

Summary and Outlook