

MAGNIFICENT MAGNESIUM

Primary & secondary magnesium
material flows – challenges and
opportunities

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International Magnesium
Association

Salema Webinar
6.10.2023





- The **global voice of the magnesium industry**, IMA serves the industry and the membership through its Annual World Magnesium Conference, seminars, statistical programs, research and publications. Through IMA's efforts, manufacturers and consumers are increasingly aware of the numerous options and benefits the metal magnesium provides.
- Founded in 1943, the mission of the International Magnesium Association (IMA) is to promote the use of the metal magnesium in material selection and encourage innovative applications of the versatile metal. IMA's members consist of primary producers of the metal, recyclers, foundries, fabricators, end-users and suppliers.



Supporting the industry – The IMA Committees & Dialogues

IMA Regional Committees:



IMA Focus Committees:



IMA Exchange dialogues



Aluminium vs. Magnesium

Primary production (2022):

Global: 69 mio tonnes

China: 40,3 mio tonnes (59%)

Western & Central Europe: 4,2%

Average plant size:

Wide range [500.000 mt)

Largest 1,4 mio tonnes

Carbon Footprint:

Range: 4 – 20 CO₂kg/kg Al

Europe av. 6,8; global 16,1

Secondary production:

5% of primary production

Scrap:

Production/Post Industrial Scrap

Closed Loop

Post Consumer Scrap

Primary production (2022):

Global: 1,13 mio tonnes

China: 85%

Western & Central Europe: 0

Average plant size:

50 kto (China integrated pidgeon plant)

15 – 60 kto (Electrolytic range)

Carbon Footprint:

China average 21,8 CO₂ kg/kg Mg

Lowest in production: 7,78 (electrolytic)

Secondary production:

5% of primary production

Scrap:

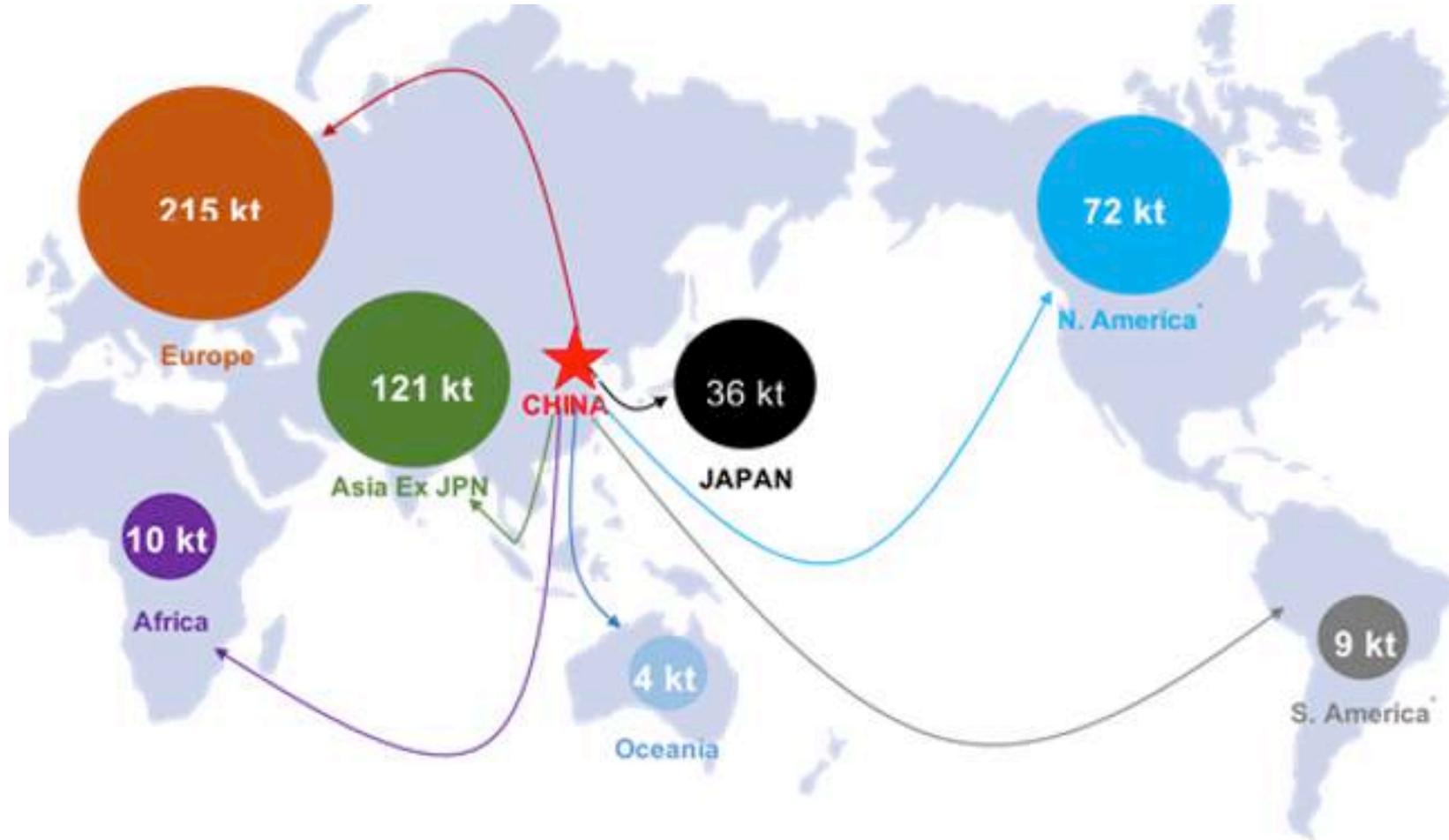
Production/Post Industrial Scrap

Post Consumer Scrap (limited)

* about similar electricity consumption



Mg China export streams



Source: CM Group/average values



Global Magnesium supply patterns

- Virtually all metal used in China and Russia is sourced from China and Russia respectively
- All metal produced in the USA is consumed in North America
- The majority of imports into North America come from China (via Canada) and Israel; Russia lost it's favourable import status
- Almost all magnesium produced in Brazil is used in Brazil
- The European market is dominated by metal of Chinese origin
- Almost all magnesium imported into Japan is of Chinese origin
- Almost all metal imported into ROW countries is of Chinese origin



The European Magnesium Import Flows – Trade values

Reporter		Partner			2018	2019	2020	2021	2022	1H 2023
					[USD]	[USD]	[USD]	[USD]	[USD]	[USD]
"8104"	EU	World	Trade Value	Imports	\$482.233.085	\$490.377.060	\$366.976.647	\$570.136.508	\$1.203.561.926	\$295.108.865
"8104"	EU	World	Trade Value	Exports	\$110.934.273	\$88.332.416	\$73.654.655	\$105.898.677	\$270.555.512	\$79.991.528
"8104"	EU	World	Trade Value	Net imports	\$371.298.812	\$402.044.644	\$293.321.992	\$464.237.831	\$933.006.414	\$215.117.337
"8104"	Switzerland	World	Trade Value	Imports	\$21.142.990	\$19.902.529	\$14.871.393	\$19.687.326	\$48.964.196	\$37.272.958
"8104"	Switzerland	World	Trade Value	Exports	\$7.909.667	\$7.458.741	\$5.951.321	\$9.149.199	\$13.459.182	\$5.292.524
"8104"	Switzerland	World	Trade Value	Net imports	\$13.233.323	\$12.443.788	\$8.920.072	\$10.538.127	\$35.505.014	\$31.980.434
"8104"	Norway	World	Trade Value	Imports	\$41.477.574	\$42.614.199	\$31.088.694	\$57.984.317	\$116.222.130	\$30.130.263
"8104"	Norway	World	Trade Value	Exports	\$5.226	\$25.488	\$123.957	\$21.400	\$303.782	\$82.311
"8104"	Norway	World	Trade Value	Net imports	\$41.472.348	\$42.588.711	\$30.964.737	\$57.962.917	\$115.918.348	\$30.047.952
"8104"	UK	World	Trade Value	Imports	\$45.894.694	\$35.297.126	\$25.190.448	\$36.163.149	\$60.555.720	\$16.430.374
"8104"	UK	World	Trade Value	Exports	\$64.947.115	\$39.829.491	\$29.307.669	\$40.344.218	\$51.624.316	\$13.684.674
"8104"	UK	World	Trade Value	Net imports	-\$19.052.421	-\$4.532.365	-\$4.117.221	-\$4.181.069	\$8.931.404	\$2.745.700
"8104"	EU+CHE+NOR+UK	World	Trade Value	Imports	\$590.748.343	\$588.190.914	\$438.127.182	\$683.971.300	\$1.429.303.972	\$378.942.460
"8104"	EU+CHE+NOR+UK	World	Trade Value	Exports	\$183.796.281	\$135.646.136	\$109.037.602	\$155.413.494	\$335.942.792	\$99.051.037
"8104"	EU+CHE+NOR+UK	World	Trade Value	Net imports	\$406.952.062	\$452.544.778	\$329.089.580	\$528.557.806	\$1.093.361.180	\$279.891.423

"810411"	EU	World	Trade Value	Imports	39,6%	41,7%	42,5%	49,3%	46,5%	35,8%
"810419"	EU	World	Trade Value	Imports	33,7%	31,3%	36,7%	30,8%	36,8%	41,7%
"810420"	EU	World	Trade Value	Imports	1,0%	0,8%	1,1%	1,4%	1,2%	1,4%
"810430"	EU	World	Trade Value	Imports	14,8%	16,6%	13,7%	14,1%	12,9%	15,5%
"810490"	EU	World	Trade Value	Imports	10,9%	9,7%	5,9%	4,5%	2,6%	5,6%

Source: COMTRADE

The European Magnesium Flows – Pure Magnesium “810411”

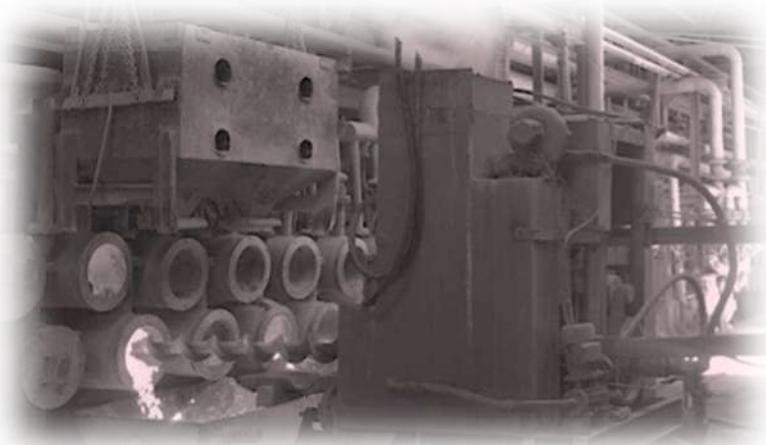
Reporter		Partner				2018	2019	2020	2021	2022	1H 2023
"810411"	EU	World	Trade Value	Imports	[tons]	80.202	80.800	70.351	79.871	131.756	29.134
"810411"	EU	World	Trade Value	Imports	[USD]	\$191.074.359	\$204.659.353	\$156.129.469	\$280.839.939	\$559.688.561	105.645.515
"810411"	EU	World	Trade Value	Imports	[USD/ton]	\$2.382	\$2.533	\$2.219	\$3.516	\$4.248	\$3.626
"810411"	EU	World	Trade Value	Exports	[tons]		2.209	2.948	3.367	5.637	1.253
"810411"	EU	World	Trade Value	Exports	[USD]	\$6.218.463	\$6.267.007	\$7.226.285	\$14.013.597	\$37.308.840	5.826.607
"810411"	EU	World	Trade Value	Exports	[USD/ton]		\$2.837	\$2.451	\$4.162	\$6.619	\$4.652
"810411"	EU	World	Trade Value	Net imports	[tons]	80.202	78.590	67.403	76.504	126.119	27.881
"810411"	EU	World	Trade Value	Net imports	[USD]	\$184.855.896	\$198.392.346	\$148.903.184	\$266.826.342	\$522.379.721	\$99.818.908
"810411"	EU	World	Trade Value	Net imports	[USD/ton]	\$2.305	\$2.524	\$2.209	\$3.488	\$4.142	\$3.580

Reporter		Partner			2018	2019	2020	2021	2022	1H 2023
					[tons]	[tons]	[tons]	[tons]	[tons]	[tons]
"810411"	Germany	China	78,1%	Imports	21.874	21.279	17.192	17.250	17.925	4.688
"810411"	Germany	Netherland	11,7%	Imports	2.639	2.012	1.952	3.854	2.691	782
"810411"	Germany	Austria	3,0%	Imports	1.424	1.877	1.208	1.029	693	286

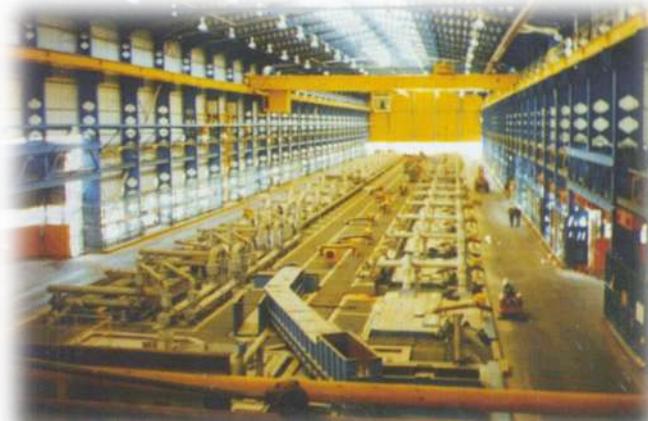
Reporter		Partner			2018	2019	2020	2021	2022	1H 2023
					[tons]	[tons]	[tons]	[tons]	[tons]	[tons]
"810411"	Norway	China	90,4%	Imports	14.388	13.777	12.177	16.210	14.933	7.305
"810411"	Norway	Turkiye	5,3%	Imports		25		780	875	0
"810411"	Norway	SAR	1,5%	Imports	229	848	762	176	253	0

Source: COMTRADE

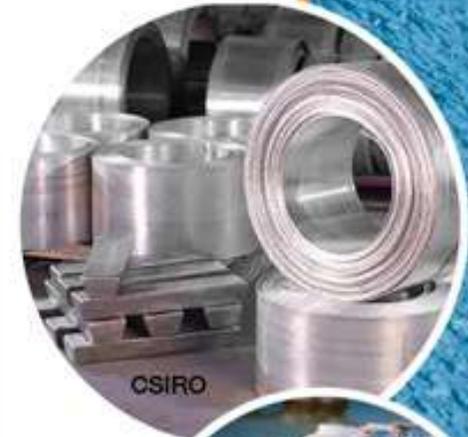
Primary Production Magnesium



Pidgeon Technology



Electrolytical Technology



>> Optimisation and Development of existing processes and in particular to use green energy and avoidance of waste

Primary process overview

	Unit	Horizontal P.	Vertical P.	Al Thermic	Electrolysis
Process		Pyrometallurgy	Pyrometallurgy	Pyrometallurgy	Electrolytic
Raw material		Dolomite	Dolomite	Dolomite	Sea Water, Brine
Raw material consumption	t/ t Mg	11,5	11	12,6	13,08
Reducing agent					
FeSi	t/t Mg	1,08	1,05	-	
CaF ₂	t/t Mg	0,19	0,17	-	N/A
Al Scrap	t/t Mg	-	-	0,8	
Consumables					
Energy source					
N. Gas	m ³ /t Mg	2.200	1.700	1.500	1.830
Electricity	Kwh /t Mg	2.200	2.200	9.500	10.500 - 13.200
Water consumption	m ³ /t Mg	15	10	16	13
Working temperature	°C	1250	1250	1150	550 - 800
Vacuum	Pa	<15	<15	<15	Atmosphere
Workforce	Person/10 ktpa Mg	235	225	200	N/A
CO ₂ footprint	t CO ₂ /t Mg	15 - 28	15 - 25	<5	5 - 10
Slag		yes	yes	no	yes
By-product		no	no	CaCO ₃ , Mg Al Spinel	HCl
Mechanization		no	semi	yes	yes
Cycle	h	10h	8h	5h	Continuous



Source: IMA, ICL



Magnesium Primary CO₂ Footprint

		IMA report 2020	Big Blue Technology (website)	Own DSM publication	Magnium; external validated report	Latrobe Annual Meeting 2022 (10.000 mt fly-ash)	Latrobe Annual Meeting 2022 100.000 mt Ferro Ni slag	Alliance Magnesium information 16.8.2022	MFE DLR report 3/2023
		inc. credits kg CO2eq/kg Mg	kg CO2eq/kg Mg	inc. credits kg CO2eq/kg Mg	kg CO2eq/kg Mg	kg CO2eq/kg Mg	kg CO2eq/kg Mg	25 000 t/y for 2025 kg CO2eq/kg Mg	15.000 t/y for 2026 kg CO2eq/kg Mg
External databases									
Ongoing Mg primary projects									
Canada	Tergeo Critical Minerals							1,35 (excl. credits)	
Australia	Latrobe Magnesium	7,35				10,2	1,5		
China	Qinghai Magnesium	5,20							
Bosnia	Magnesium For Europe								<2,0 Al scrap; <2,5 Al
Canada	Mag One Products								
US	Big Blue Technologies		>5						
Australia	Magnium				1,45 - 1,46				
Current Mg primary producers									
Brazil	Rima	10,10							
Israel	Dead Sea Magnesium			7,78					
US	US Magnesium								
Turkey	KAR Mineral Madencilik	20,00							
China Pidgeon	Producer Gas	28,38							
China Pidgeon	Coke Oven Gas	19,44							
China Pidgeon	Semi Coke Oven Gas	19,26							
China Pidgeon	Natural Gas	25,86							
China Pidgeon	weighted average	21,80							

Primary Magnesium Tracking Report



Disclaimer: Research by IMA... International Magnesium Association

Primary Magnesium Tracking Report



Disclaimer: Research by IMA... International Magnesium Association

Primary Magnesium Tracking Report



Disclaimer: Please note the IMA Primary Magnesium Tracking Report is developed from various sources by internal member use. IMA cannot guarantee the accuracy of the data. The report is not intended to inform business decisions and should not be considered an authoritative update or relied upon for investment decisions. Where possible, IMA has provided links to the relevant sources and recommends that interested parties review those sites for any updated information provided. This report should not be cited for academic, papers or news reporting. For additional information about this report, please contact Martin Tiedler, IMA European Representative (martintiedler@ima.eu.com | +32 471 136605).

Source: IMA

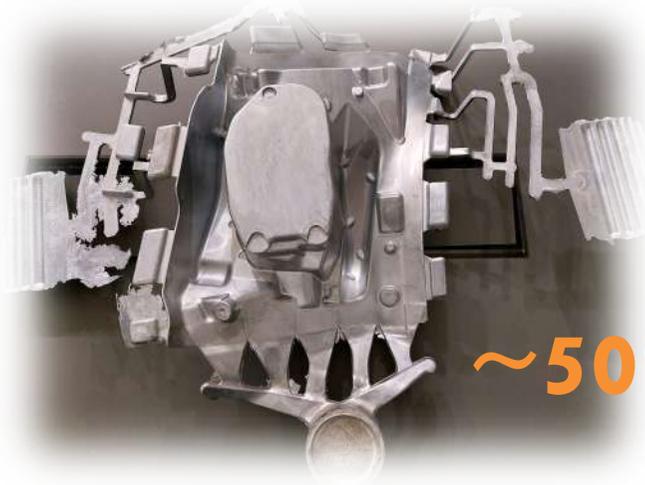
Whats happens in China in 2023 so far?

- Semi-coke furnace policy implemented in May 2023, unqualified semi-coke furnaces to be removed and rebuilt, **13 smelters in Shaanxi halt production**. As a result, China's primary Mg production in 2023 is estimated to drop 17% y-o-y to 840kt.
- YTD average **primary Mg prices US\$3,273/t** (FOB China), down 41% y-o-y with high inventories and weak demand. All primary Mg smelters in China profitable in August, average cost US\$2,131/t **average margin US\$585/t**.
- China primary Mg exported 142kt primary Mg from Jan-Aug 2023, down 25% y-o-y. Exports to Europe and Norther America down 30% and 26% to 49kt and 13kt respectively.
- Bouwu Mg Technology Corporation Ltd (formerly Yunhai Metals) is forecast to add 100ktpy capacity before end of 2023.
- Primary Mg inventories at 57kt down 37% from peak of 91kt in June, mainly attributable to cuts in Yulin.
- Market held moderate to bullish view with restrained production for October.

Source: CM Group/September Report



Recycling – Process scrap



~50%

HPDC process
Thixo Moulding process
Extrusion
Sheet rolling



~80%

In-Cell Recycling
In-House Recycling
External Recycling

>> There is still room for design optimisation and closed-loop customer relations

Secondary/Recycling - Magnesium

Reporter		Partner				2018	2019	2020	2021	2022	1H 2023
"810420"	EU+CHE+NOR+UK	World	Trade Value	Imports	[ton]	1.061	988	1.143	1.312	2.334	2.350
"810420"	EU+CHE+NOR+UK	World	Trade Value	Imports	[USD]	\$10.361	\$9.607	\$5.601	\$8.925	\$12.555	4.173.937
"810420"	EU+CHE+NOR+UK	World	Trade Value	Exports	[tons]	4.867	4.111	3.018	3.410	5.823	3.951
"810420"	EU+CHE+NOR+UK	World	Trade Value	Exports	[USD]	\$3.089.295	\$2.248.046	\$1.632.308	\$1.660.740	\$1.401.894	

Recyclingraten

**ANTEIL RECYCLINGROHSTOFFE
IN DER PRODUKTION**



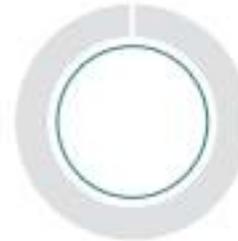
33 %
(Welt 2019)
(OECD 2019)

EOL-RECYCLINGRATE



39 %
(Welt 2019)
(OECD 2019)

**PRODUKTBEZOGENE
RECYCLINGRATE**



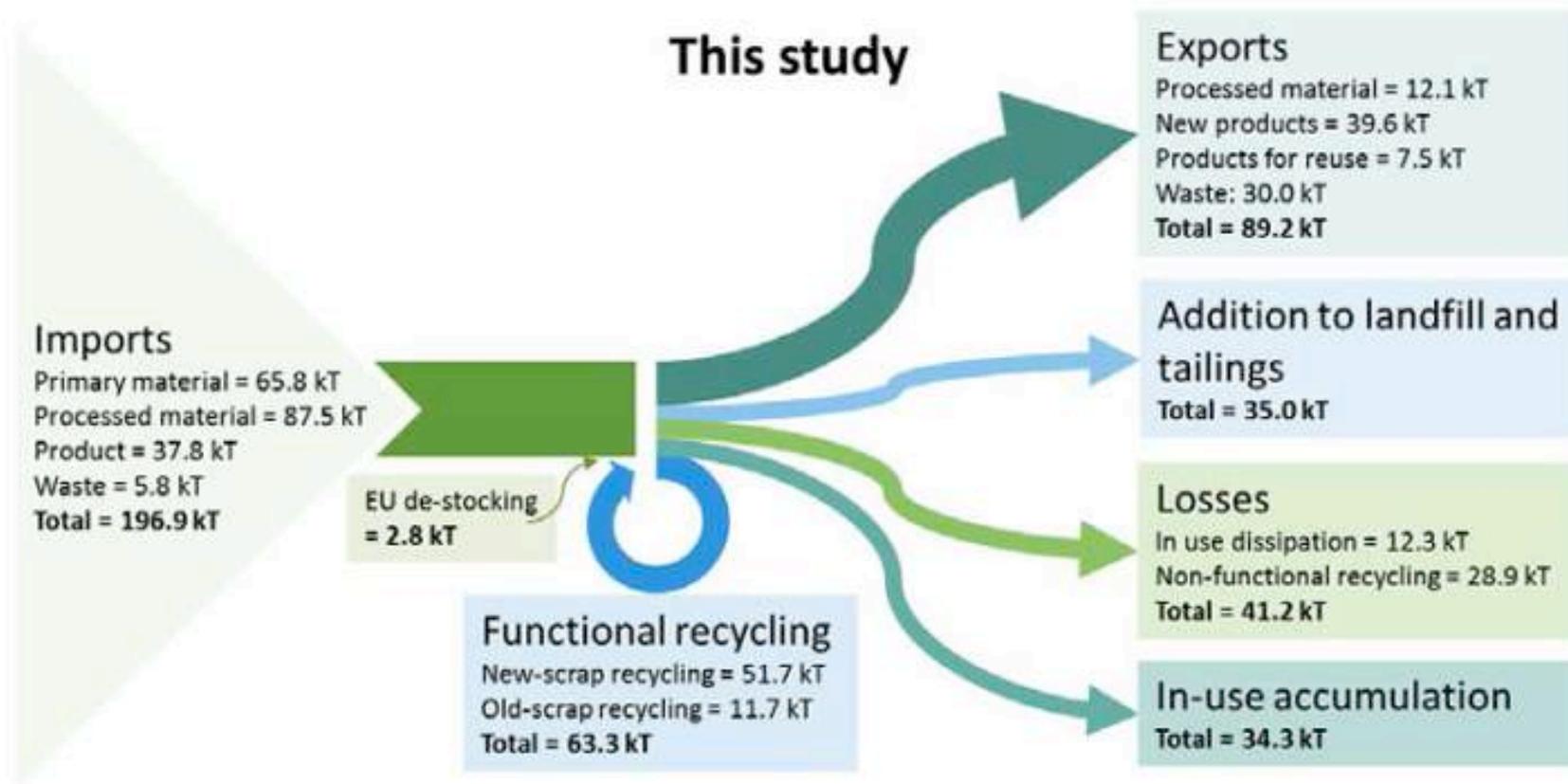
k. A.

Scrap Classes - Magnesium

CLASS	TYPE	SPECIAL	CONTAMINATION	CU + NI	MG CONTENT
1A	High grade clean scrap	biscuits, scrap castings, runners	Small amount of oxide, very low contamination	No Cu + Ni	>99%, AZ 91: ~90%
1B	Clean scrap with high surface area	possibly shredded	Small amount of oxide, very low contamination	No Cu + Ni	>99%, AZ 91: ~90%
2	Scrap castings, painted, organic adhesions and partial steel and aluminum inserts	no copper, brass or nickel inserts	Organic, lacquer steel, aluminium	No Cu + Ni	>95%
3	Dirty compact scrap, oily, wet, coated, containing sand, copper, nickel, ferro-silicon impurities, post consumer scrap	may contain silicon, aluminum alloys, copper contaminated alloys	Oil, water, sand, Cu, Ni, Fe, Mn, Si, plastic	Cu + Ni	>95%
4A	Chips, swarf, machining	clean, dry chips	Oil, water		>95%
4B	Chips, swarf, machining	dry and/or wet chips	Oxide		>95%
4C	Chips, swarf, machining	oily and/or wet scales, flashings and runners	Oxide, oil, water		>95%
4D	Chips, swarf, machining	sawings	Oxide, oil, water		>95%
4E	Chips, swarf, machining	Magnesium-containing sludge (from trimming or shot blasting)	Oxide, sand,...		>95%
5	Flux-free dross	Taken from the surface of melt at flux free furnace	Oxide, Intermetallic components		70-80%
6	Crucible sludge	Taken from the bottom of the crucible from flux free furnace	Intermetallic components, high rate of Al, Mn, Be, Fe, oxides, nitrides		70-80%
7	Flux containing residues, black dross		Flux, intermetallic components, high rate of Al, Mn, Be, Fe, oxides, nitrides		10-30%
8	Non-metallic residue				

Source: RAUCH/Calgary presentation 2023

Recycling - Magnesium



Source: IMA Study „Magnesium Recycling in EU“



Recycling – End-of-Life scrap



LIBS Technology

Line Sorting System

>> Joint projects to further optimize (1) aluminium alloy and mix scrap fractions and (2) make free magnesium available for the Mg industry



Source: Al Cycle/Steinert GmbH

Trend – Scrap related OEMs specifications



The X1 Carbon Gen 11 comes with 90% recycled magnesium in the palm rest and 55% recycled aluminum on the bottom cover. Meanwhile, the X1 Nano Gen 3 also comes with 90% recycled magnesium in both the palm rest and the bottom lid. In addition, these laptops come with more recyclable retail packaging, which Lenovo says is now made from 100% bamboo and sugarcane fiber. It's part of Lenovo's attempted initiative to be net zero by 2050, which is a long time from now.

>> OEMs might request even more recycling content

Trend – Scrap related specifications



Product Carbon Footprint Certificate
No.: CTI-SZTZJ202301028
Awarded to
Tianjin Huanzhi New Energy Technology Co., Ltd

Product Name: Magnesium alloys made of 40% recycled magnesium material (AM50A, AM60B, AZ91D, AS31)
Standard: ISO 14067:2018 Greenhouse gases — Carbon footprint of products — Requirements and guidelines for quantification
Reporting period: From March 2022 to February 2023
Boundary: Cradle-to-gate
Functional unit: 1 t
GHG emissions: 10.96 tCO₂e/t
Commissioned by: Nanjing Weilow Metals Co., Ltd.
Manufacturer: Wutai Yunhai Magnesium Industry Co., LTD
Factory location: Wutai County Industrial Park
Issue date: May 5, 2023

Life cycle distribution:

Stage	Percentage
Raw material acquisition stage	78.10%
Production stage	40.90%

CTI Certification Co., LTD.
Zone A 8F CTI Building, No.4 Liao Xian San Road, Xian'an Street, Bao'an District, Shenzhen, China.

General manager:



Certificate

Carbon Footprint Calculation

Crown Metals CZ, s.r.o.
Nádražní 214, 435 33 Louka u Litvínova
Company ID: 26449218

1 ton of magnesium
produced by
Crown Metals CZ, s.r.o.
causes a carbon footprint of
2.42 tCO₂e/tonne.

The calculation of the carbon footprint includes direct emissions (scope 1), indirect emissions from purchased electricity (scope 2) and other indirect emissions (scope 3) and was performed in accordance with the GHG Protocol.

18.09.2022 Prague
Date and place


Jan Zvěřina, Jedhatel
Green0meter

Source: WIMEX, CROWN METAL

Challenges & Opportunities – Impact on Materials Flows

- China energy/CO2 policy
- Technology adaptations & innovation (primary & secondary)
- Access to green & renewable energy sources
- CO2 dominated purchasing as a “must” criteria
- Geopolitical trade mechanism (quota, CBAM, alliances,...)
- Circular & Secondary/Scrap focus
- Industry/Supply Chain Alliances
- Green labelling acceptance
- Scrap definitions & flows



Next IMA events (external)

IMA SUSTAINABILITY WEBINAR

SAVE THE DATE

The Challenge of Global Magnesium
Primary Production, and How The Industry
Eyes to Net Zero

25 OCTOBER 2023 | 09:00 CEST & 20:00 CEST

IMA Sustainability Webinar “Recycling”
6.12.2023

https://www.intlimg.org/events/event_list.asp?show=&group=&start=1%2F8%2F2022&end=&view=&cid=17043



"IMA - The challenge of global Magnesium primary production, and how the industry eyes to net zero"

25.10.2023



- **Status up-date of IMA Sustainability & Labelling** by Dr.-Ing Elmar Beeh of DLR
- **Comparison and development of processes for primary Magnesium production** by Ilhan Goknel
- **New development of primary magnesium industry in China and prospect of future supply** by Mr. Dong Chunming ,GM of Sunlight Metal Consulting (Beijing) Co.,Ltd.
- **Environmental Insights from DSM: Assessing Carbon Footprint of Electrolytic Production and Future Reduction Strategies** by Vladimir Kotlovsky / Chief Technologist, DSM.
- **NEOM's New Development of Primary Green Magnesium Metal Production: Addressing Sustainability** by Mohamed Abdelaziz, MBA, PMP / Project Manager, Magnesium Development

IMA Global Magnesium conference - Annual flagship event

Technical & Applications presentations



Networking



Committee meetings



Exhibition

81st edition in Japan

Award of Excellence



IMA 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 missions are:

- 1) 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.
- 2) To continuously reduce the negative environmental and social impacts within the whole value chain.
- 3) To strive to improve circular economy approaches for Magnesium to make end-of-life secondary Magnesium a useful source of greener material.





Contact Us

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