IMOA 2024 LCI & Carbon Footprint Update Study

Mo Symposium

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Publicly available: IMOA 2024 LCI Update Study publications

Scope 3 Emissions

data for the

Steel industry

about Molybdenum

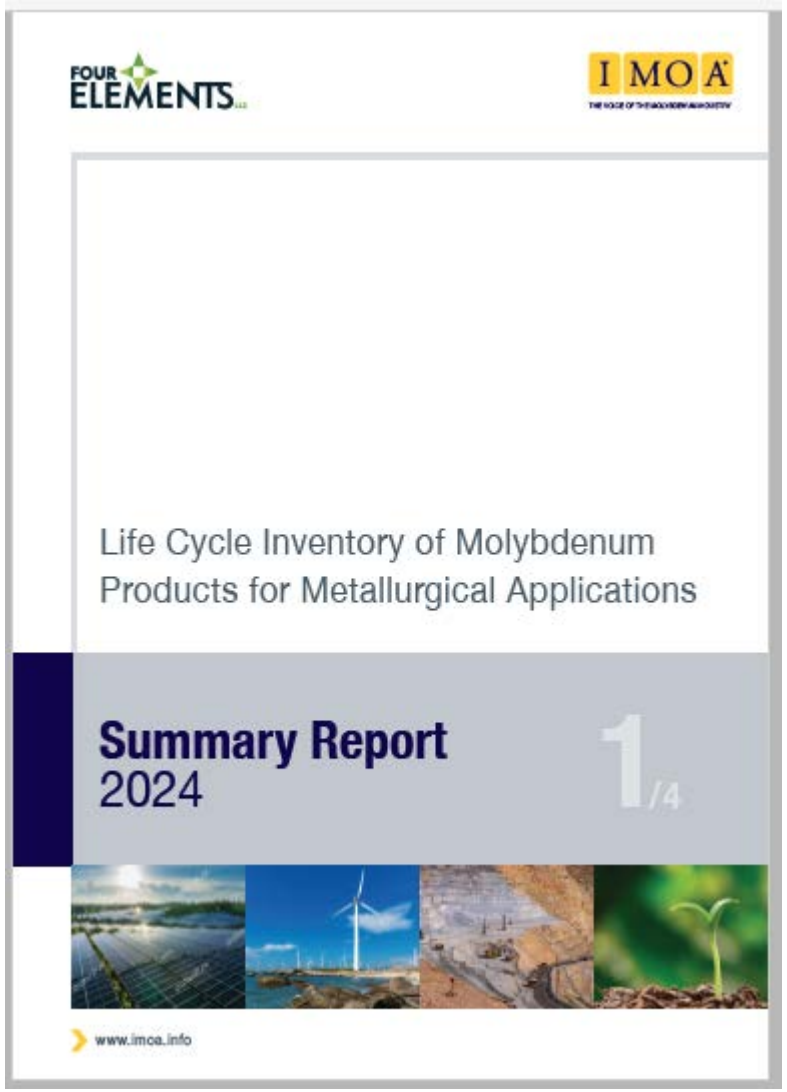
Alloying Input

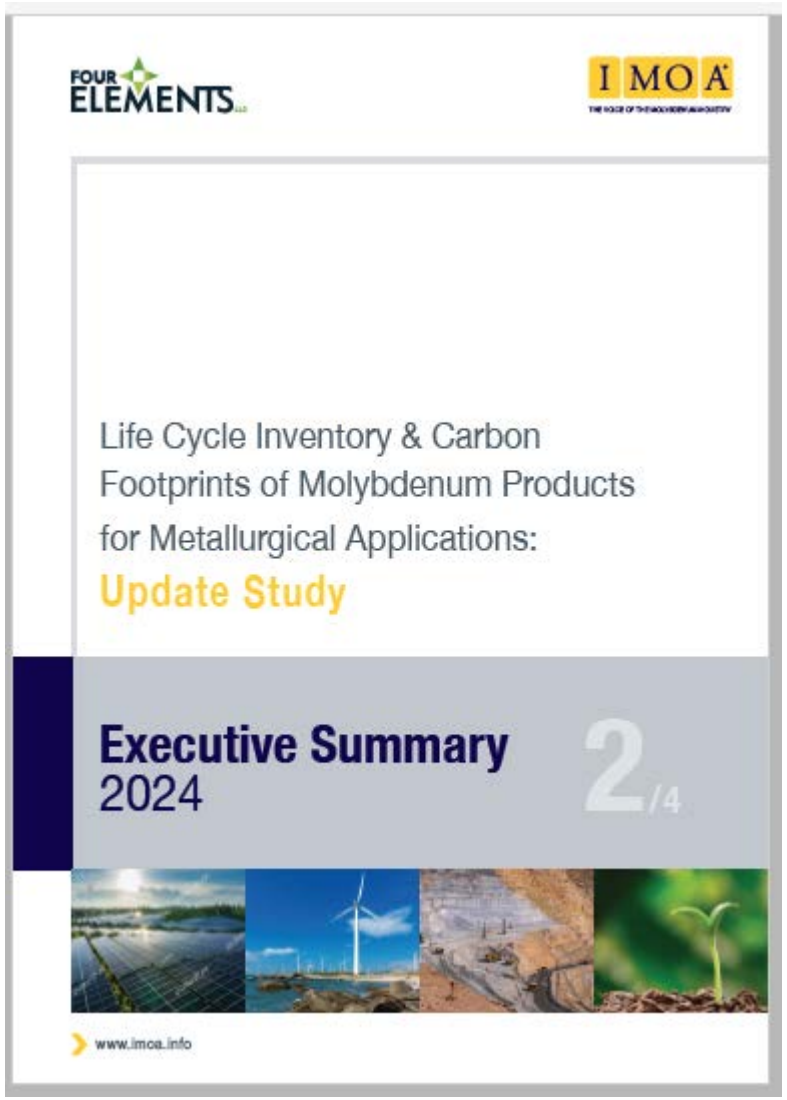
Materials

i.e. RMC (technical

grade moly oxide)

& FeMo





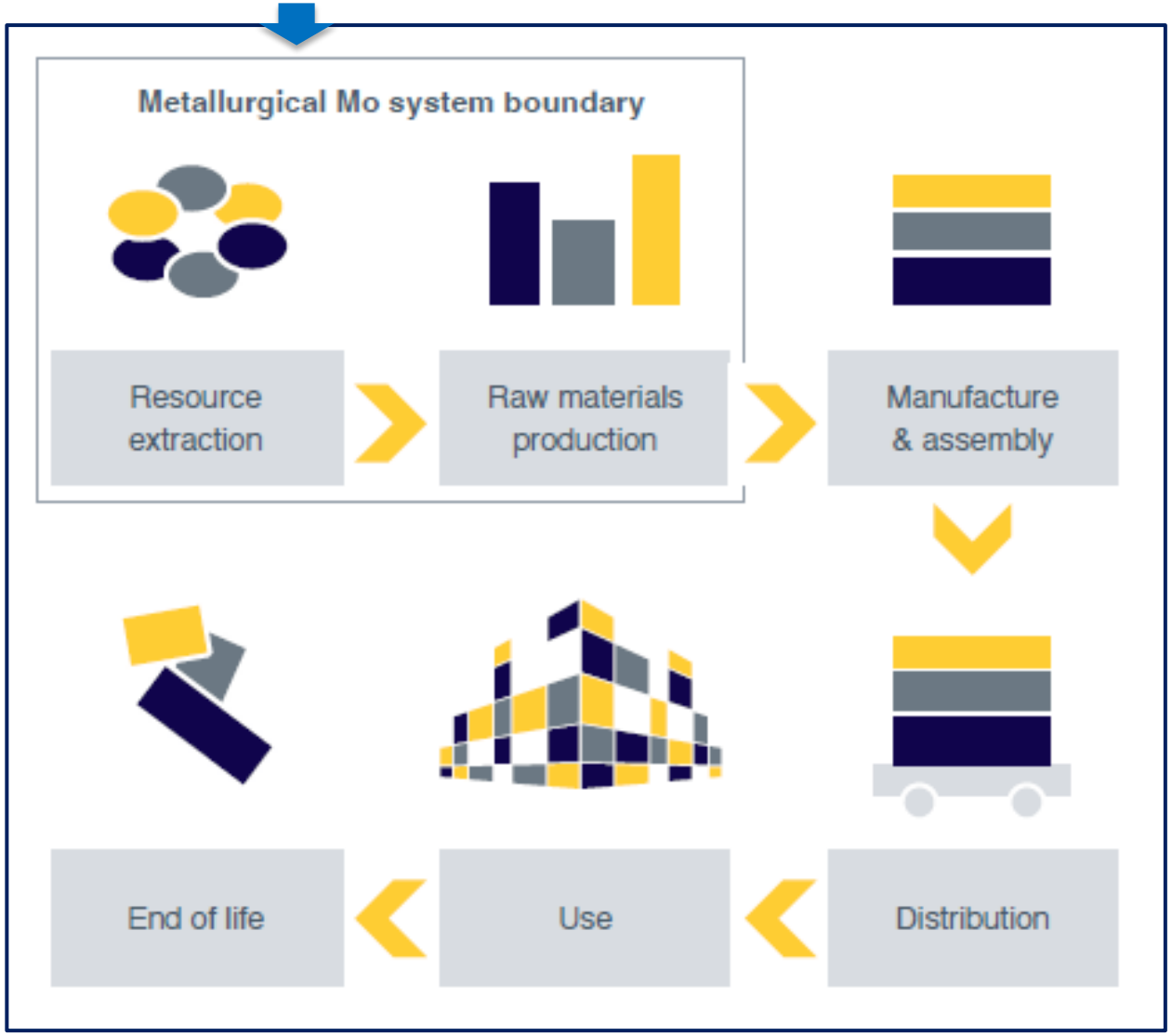
Life Cycle Inventory System Boundaries

Mo Results: Cradle-to-Gate

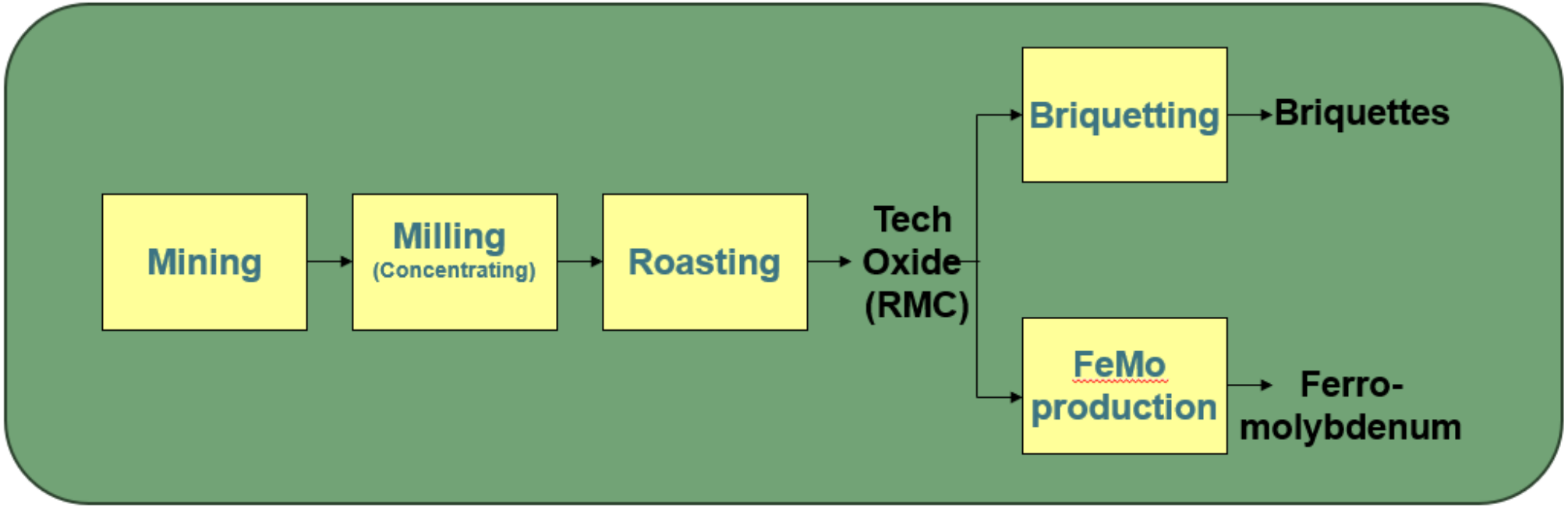
These upstream environmental footprint data will be linked to downstream product manufacturing (e.g. stainless steel) datasets for Life Cycle Assessments purposes.

LCA informs stakeholders about the environmental strengths & challenges of a product over its lifetime.

IMOA LCI boundaries within an LCA:



System boundaries of IMOA Life Cycle Inventory (and carbon footprint scope)



Each process stage e.g. Mining has its own LCI questionnaire

FOUR ELEMENTS LLC

Data sources and representativeness:

- 24 facilities across 11 IMOA member companies
  – *Up from 8 companies in 2018!*

- 24% of total global molybdenum mined, which is 50% of global mined production outside of China, Mongolia and CIS.

- Data from Asia, Europe, North & South & Central America

Four Life Cycle Inventory datasets:

1) **(Unroasted) Molybdenite Concentrates (MoS_2)**

2) **Roasted Molybdenite Concentrates (technical grade moly oxide)** in **powder** form (MoO_3)

3) **Roasted Molybdenite Concentrates (technical grade moly oxide)** in **briquette** form (MoO_3)

4) **Ferromolybdenum**

LCI Datasets will be included in commercial databases

Cradle-to-Gate Inventory of FeMo (per 1 kg FeMo)

	Flow	Unit	FeMo Total (67% Mo)
Raw Materials	Crude oil (resource)	kg	4.40 E-01
	Hard coal (resource)	kg	5.70 E-01
	Lignite (resource)	kg	1.51 E-01
	Natural gas (resource)	kg	6.31 E-01
	Uranium (resource)	kg	8.38 E-06
	Molybdenum	kg	1.23 E+00
	Iron	kg	1.19 E-01
	Limestone (calcium carbonate)	kg	6.31 E-01
	Total freshwater consumed (I)	L	1.53 E+02
Air Emissions	Carbon dioxide	kg	6.66 E+00
	Carbon monoxide	kg	1.36 E-02
	Hydrogen chloride	kg	3.28 E-04
	Hydrogen cyanide (prussic acid)	kg	9.26 E-09
	Hydrogen fluoride	kg	2.72 E-05
	Hydrogen sulphide	kg	2.15 E-04
	Nitrogen oxides	kg	3.28 E-02

Partial screenshot of Ferromolybdenum LCI dataset

Carbon Footprint Size Reductions between 2018 to 2024

Updated Carbon Footprints:

New Carbon Footprint

IMOA LCI Global Average Carbon Footprint per Kg product

Year	Unit	1 kg Molybdenite Concentrate (~50% Mo)	1 kg RMC (~60% Mo)	1 kg RMC briquette (~59% Mo)	1 kg FeMo (~67% Mo)
2024	kg CO_2-eq	2.84	3.79	4.03	7.41
2018	kg CO_2-eq	Not calculated	4.96	5.04	8.04
% reduction between 2018 & 2024 values		n/a	↓24%	↓20%	↓8%

Key reason for 2024 lower carbon footprint of molybdenum products for metallurgical applications:

Some flow comparisons – energy results

		Tech Oxide		FeMo	
		2024	2018	2024	2018
Crude oil (resource)	kg	0.49	0.37	0.66	0.58
Hard coal (resource)	kg	0.56	1.43	0.85	3.35
Lignite (resource)	kg	0.04	0.14	0.23	0.29
Natural gas (resource)	kg	0.75	0.69	0.94	1.02
Molybdenum (in ore)	kg	1.80	1.50	1.84	1.55
Total freshwater consumed (l)	L	197	849	283	1033
Carbon dioxide to air	kg	5.94	8.71	9.95	16.29
Sulphur oxides to air	kg	0.02	0.03	0.02	0.06
Particles to air	kg	0.05	3.21	0.18	3.32
Molybdenum to air	kg	2.53 E-10	5.03 E-07	7.10 E-06	4.62 E-05
Overburden (deposited)	kg	602	374	620	393
Tailings (deposited)	kg	291	249	298	256
Total Primary Energy	MJ	121	118	169	222
Primary energy (non renewable, NC	MJ	71	100	101	186
Primary energy (renewable, NCV)	MJ	51	18	67	37

The switch from non-renewable to renewable energy sources

IMOA Life Cycle Information Updating Project 2024

Why did IMOA do this project?

- Significant increase in market pressures for this type of information in the sustainable mining & products context. IMOA member companies receiving increasing numbers of enquiries from their supply & value chains.
- Similar situation for carbon footprint values for molybdenum products
- More LCI/LCA practitioners than ever before looking for data because of sustainability/green energy/carbon neutrality initiatives.
- Need to avoid the use of disadvantageous proxy data that can give LCA outcomes prejudicial to the moly industry.

- Key moly product consumption sector, i.e. steel industry, under significant pressure to reduce its carbon footprint and demonstrate improvements, so are looking to alloying material inputs to achieve some improvements that can benefit their steel LCI/LCAs.

- Our updating frequency guideline is 5-yearly, and our last update was 2018.
- (There is increased interest in having more frequent updates than 5 yearly, so working on this with other metals).

Sources of Toxicology Data for Molybdenum

From a sustainability standpoint: Carbon Footprint and Toxicology data are both important green credentials

EU Commission ambition is a toxic-free environment