

THE IMPORTANCE OF CRITICAL RAW MATERIALS THROUGH THE EYES OF ORGANISED CIVIL SOCIETY:

THE CASE OF GRAPHITE

Dr. Corina Hebestreit EESC CCMI, 13 July 2021

CARBON AND GRAPHITE INDUSTRY - OPPORTUNITIES



- The **EU's Green Deal** and higher climate ambition will accelerate Europe's demand increase for carbon and graphite products in low-carbon technologies including
- steel recycling,
- clean steel technology with hydrogen,
- batteries and clean mobility, and
- renewable energy technologies.





ENABLING CIRCULAR ECONOMY



Synthetic graphite electrodes

- <u>Classical steel scrap</u> recycling (56% of EU steel comes from recycled scrap = 100 million t) – around 20 million t are currently exported and could be processed in Europe
- New <u>clean steel</u> technology with hydrogen requires electric arc furnaces and hence graphite electrodes are essential to the new technology!





CONTRIBUTION TO CIRCULAR ECONOMY AND CARBON NEUTRALITY

Graphite electrodes used in EAFs contribute to 84 million mt reduction in CO2 emissions per year in the EU, equivalent to emissions from 28 million passenger cars.



EU EAF steel production	67,500,000	MT
Quantity of EAF CO ₂ generated per year $*$	33,750,000	MT
. 2		
Quantity of CO_2 generated per year should the same		
steel amount be produced at BOF	118,125,000	MT
CO ₂ emissions savings by using EAF vs BOF	84,375,000	MT



TURNING SYNTHETIC GRAPHITE CRITICAL CARBON MATERIALS AND THE FUNDAMENTAL FLAW WITH THE EC ASSESSMENT: NACE CODES ONLY!



Compensation for increased energy costs under ETS (Decision 2020): — the EU's bias towards large sectors: NACE CODE ONLY!

the sector fulfils all criteria but is not eligible because there is <u>no Prodcom</u> <u>assessment!!!</u>

 Currently under discussion and timelines for Commission proposals all being published 14th June 2021 with the same <u>flaw:</u>

- ETS IV Amendment
- General environmental subsidies subsidies
- Revision of the Energy Efficiency Directive
- Revision of the Energy Taxation Directive
- Carbon Border Adjustment Mechanism
- Revision of the Renewable Energy Directive

Elimination of Carbon Leakage List Elimination of national structural New targets for efficiency

Increase/harmonisation of taxation Potential elimination/replacement of the Carbon Leakage List Increase of share of renewables in national grids NACE

NACE

NACE

EC REQUIREMENTS FOR COMPENSATION OF INDIRECT CO2-COSTS



Audited Report provided to the Commission and ignored !

NACE	PRODCOM	description	temperatures		
			direct	indirect	
23.99	23.99.11	articles of asbestos fibres, friction materials for brakes, etc.	app. 100 C	-	
other	23.99.12	articles of asphalt or similar	up to 150 C	-	
non-metallic	23.99.13	bituminos mixtures etc.	up to 150 C	-	
mineral	23.99.14	artificial graphite or carbon in form of semi-manufactures	up to 1.200 C	up to 3.000 C	
products	23.99.15	artificial corundum	-	up to 2.200 C	
	23.99.19	slag/rock wool, articles of peat, stone, carbon fibres, etc.	up to 1.200 C	-	

	NACE/ PRODCOM	Trade Intensity	Direct Emission Intensity	Indirect Emission Intensity	Emission Intensity	Carbon Leakage Indicator (CLI)	Indirect Carbon Leakage Indicator (ICLI)
		%	kg CO2/€	kg CO2/€	kg CO2/€		
23.99	manufacture of other non- metalic mineral products n.e.c.	19,40%	0,461	0,674	1,135	0,220	0,131
23.99.14	Artificial graphite; colloidal or semi-colloidal graphite; preparations based on graphite or other carbon in the form of semi-manufactures	63,30%	0,527	1,901	2,428	1,537	1,203

PRODCOM code	Sector name	ICLI	RAG rating	RAG rating under high carbon scenario	RAG rating before fuel and electricity substitutability
23.99.14	Artificial graphite; colloidal or semi-colloidal graphite; preparations based on graphite or other carbon in the form of semi-manufactures	1,19	Medium-high	High	Medium-high

Carbon & Graphite Industry differs from the other subsectors in NACE-Code 23.99

ICLI of PRODCOM 23.99.14 - **app. 1,2** far above 0,2 => **quantitative criteria** fulfilled

Carbon & Graphite Industry has the highest RAG-Rating together with aluminum industry

ENABLING E-MOBILITY AND DECARBONISATION OF TRANSPORT THE STRATEGIC VALUE CHAIN: LITHIUM-ION BATTERY MATERIALS





CRITICAL: DIVERSIFICATION OF NATURAL GRAPHITE SUPPLY





Canada
China
India
Korea, Dem. Rep.
Mexico
Norway
Russian Federation
Turkey
Ukraine

Zimbabwe

Brazil

Increase from 11 to 15 countries,

- Production dropped to 900.000 t in 2017 and is now rising again
- Reduction of Chinese % with more mines coming on stream



Global mine production of natural graphite, average 2010–2014 (Data from World Mining Data, 2016) and 2018 data.

More EU mines need faster permits!

CRITICAL: ONGOING EXTENSION AND INVESTMENTS



• Plans to add 557 GWh/yr of battery manufacturing capacity in Europe by 2024 will require an additional 450,000 t/yr of anode material.

Europe

- Mineral Commodities <u>is building</u> an active anode material plant in Norway to supply European battery plants. The facility will initially produce 10,000 t/yr of coated spherical graphite and fines from flake supplied by its Skaland mine in Norway from 2023. It plans to add two 20,000 t/yr modules to process concentrate from its Munglinup mine in Australia when it begins output in 2024.
- Australia-based Talga Resources, which is focused on European graphite projects, is building a 19,000 t/yr coated anode plant in Sweden processing material from the Vittangi mine in Sweden.
- Norwegian silicon and carbon producer Elkem is building a pilot plant to produce anode materials that is scheduled for completion in early 2021.
- US based Superior Graphite is going to adapt its Swedish operation to produce additional battery grade material.
- SGL Carbon investing in synthetic graphite battery material.
- Leading Edge Materials investing in Sweden's Woxna mine and processing plant.

Other Parts of the World

- Syrah Resources is assessing the feasibility of producing 10,000 t/yr of anode material at its plant in the US and scaling up to 40,000 t/yr.
- Australia-based EcoGraf is planning to become fully integrated, with its Epanko graphite mine in Tanzania due to produce 60,000 t/yr of flake, and an anode plant in Australia planned to start production at 5,000 t/yr, scaling up to 20,000 t/yr by 2022.
- Other sources are being developed in Sri Lanka and Brazil, Madagascar.



today's recycling from a wide range of uses

- Batteries
- Brake pads
- Carbon brushes
- Etc.

Today recycling back into battery material is not possible!

Research into repairing crystallography will be needed. batteries

brake pads, brushes

electrodes and anodes



CRITICAL: SUSTAINABLE INVESTMENTS JRC STUDY ON GRAPHITE PRODUCTION IN BATTERIES

JRC Technical Report 2020 – Responsible and sustainable sourcing of battery raw materials

- The objective of the analysis was to determine potential criticalities in the materials value chain, thus using country-based data to identify which material supplier countries can be at risk in relation to selected aspects
- Several indicators were used to determin the level of risk (low-risk, medium-risk, high risk, very high-risk n/a) for each risk category

Conclusions:

- Natural graphite is also extracted in areas of high-risk regarding child labour issues: Mozambique and Tanzania among others
- Other countries where this material is produced present high risks in the governance and conflict category (Brazil, China)
- Compared with other battery materials, awareness of social and environmental issues seems lower

Sustainable Finance: EU Taxonomy

Both EU synthetic and natural graphite production should be assessed considering their performance on the basis of their contribution to decarbonisation, environmental protection and social contribution.

WAY FORWARD TO POLICIES TO ADDRESS CRITICALITY



• EC Criticality assessment:

- <u>Higher granularity of assessment</u> needed to cover and capture substitution situation in markets and applications.
- Relevance for future technologies under development should be covered in an anticipative way.

• Synthetic graphite: Existing and economic substitution of natural graphite through synthetic graphite under threat from EU policies

- Energy costs and decarbonisation increased renewables in grids is key to decarbonisation
- CSS recognition of "essential use" of some raw materials to achieve substitution
- Environmental Subsidies, CO2 cost compensation higher granularity in the assessment required to maintain viable substitution

Natural graphite:

- Diversification under way, but investments in natural graphite in the EU needed.
- Further exploration needed.
- Permitting needs to be improved.

Both:

- Trade Policy
 - Imports need to fulfil EU standards and need to prove this in a reliable way.
- Sustainable Finance Taxonomy needs to
 - take into consideration the supply chains in a more comprehensive form
 - needs to look at social criteria for raw materials and products along the value chain
 - needs to understand supply chains and substitution
- Horizon Europe needs to
 - Address chemical and energy related issues in case of substitution
 - Address current technological limitations for achieving higher performance and circularity.



THANK YOU!

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BACKGROUND MATERIAL

KEY FIGURES AND REPRESENTATION









> 3,011 billion Euros Turnover in Europe

ECGA Members as of 1 January 2021

ASBURY CARBONS **ELKEM ASA CARBON** ELSID CARBON ENGINEERING S.A. GRAFTECH INTERNATIONAL Ltd. **GRAPHITE COVA GMBH GRAPHIT KROPFMUHL GMBH** IMERYS GRAPHITE & CARBON SWITZERLAND LTD. MERSEN CORPORATE SERVICES SAS MORGAN ADVANCED MATERIALS RHEINFELDEN CARBON GMBH&CO.KG SANGRAF ITALY SCHUNK KOHLENSTOFFTECHNIK GMBH SHOWA DENKO CARBON Holding GmbH SUPERIOR GRAPHITE EUROPE LTD SGL CARBON GMBH TOKAI COBEX GMBH TOKAI COBEX SAVOIE TOKAI COBEX POLSKA sp. z o. o. TOKAI ERFTCARBON GMBH VUM a.s.

Associate members:

BAWTRY CARBON LIMITED PHILLIPS 66

OUR PRODUCTS' APPLICATIONS





- Energy: carbon and graphite specialities
- Electronics: graphite specialities
- E-mobility, aerospace, defense: carbon and graphite specialities



Corrosive chemicals: graphite



Process industries (aluminium, steel, alloys, ceramics): carbon and Graphite electrodes, cathodes, refractory materials



World: Consumption of graphite by application, 2017 and forecast 2027

Source: Roskill, 2017 17

FINISHED PRODUCTS IN THE EU





62 kt of Natural Graphite

53 kt of Natural Graphite

Figure 13: Shares of finished products containing natural graphite manufactured in the EU (left) and shares of finished products containing cobalt used in the EU (right), by application.

Source: Material system analysis of five battery related raw materials: Cobalt, Lithium, Manganese, Natural Graphite, Nickel JRC 2020

ECOSYSTEM: RENEWABLE ENERGIES AND ENERGY STORAGE

- Manufacturing equipment for multi- and monocrystalline silicon
- Specialty products for rotor blades increasing efficiency, longevity and rotor dynamics
- Carbon fibres, semi-products and carbon brushes







ECOSYSTEM: ENERGY STORAGE AND E-MOBILITY



- Synthetic and natural graphite as anode material for lithium-lon batteries,
- Battery felt in stationary energy storage
- Gas diffusion layer in fuel cells improving efficiency
- Specialty graphites in lead-acid batteries
- Carbon ceramic brakes
- Steel (produced with graphite electrodes)
- Ferroalloys (procuced with carbon and graphite electrodes)
- Aluminium produced with carbon and graphitised anodes)
- Light weight structures on the basis of composite materials to save electricity in use phase
- Specialty graphites for cooling water pumps and vaccum pumps
- Speciality graphite for charging stations and moving parts









ECOSYSTEM: AEROSPACE

- Production of steel and aluminium
- Light-weighted construction parts to save fuels
- Carbonfibre reinforced composite materials for primary and secondary structures, sub-systems and interior outfitting



ECOSYSTEM: DIGITAL ECONOMY



- Speciality graphite for the manufacturing tools for semi-conductors
- Silicon carbide coated wafer carriers for computer chips
- LEDs create light for semiconductors
- Isostatic graphite is elemental for the production of semiconductor coatings For computers





USES AND END-USES OF NATURAL GRAPHITE IN THE EU



Examples

of

4-diait



Applications	2-digit NACE sector	sector (millions €)	NACE sector				
Refractories for steelmaking	C24 - Manufacture of basic metals	55,426	C2410 - Manufacture of basic iron and steel and of ferro-alloys				
Refractories for foundries	C23 - Manufacture of other non-metallic mineral products	57,255	C2311 - Manufacture of flat glass				
Batteries	C27 - Manufacture of electrical equipment	80,745	C2720 - Manufacture of batteries and accumulators				
Friction products	C23 - Manufacture of other non-metallic mineral products	57,255	C2399 - Manufacture of other non-metallic mineral products n.e.c.				
Lubricants	C20 - Manufacture of chemicals and chemical products	105,514	C2013 - Manufacture of other inorganic basic chemicals				
Recarburising	C24 - Manufacture of basic metals	55,426	C2410 - Manufacture of basic iron and steel and of ferro-alloys				
Pencils	C23 - Manufacture of other non-metallic mineral products	57,255	C23.9.9 - Manufacture of other non-metallic mineral products n.e.c.				
Graphite shapes	C28 - Manufacture of machinery and equipment n.e.c.	182,589	C2849 - Manufacture of other machine tools				

Value-added

of

EU end used of natural graphite in 2016. Background data from Draft MSA 2019.

Graphite applications, 2-digit NACE sectors and associated 4-digit NACE sector, and value-added per sector (Eurostat 2019).

Source: Material system analysis of five battery related raw materials: Cobalt, Lithium, Manganese, Natural Graphite, Nickel JRC 2020

2-digit NACE sector

Applications

EU TRADE OF NATURAL GRAPHITE

100,000

90,000

80,000

Trade flows (t)

countries 10% Russia Canada 2% 2% Madagascar. 2% Belarus 4% Ukraine China 4% 49% Zimbabwe 7% Norway 8% Brazil 12%

Other non EU

EU imports : 89 kt

EU imports of natural graphite, average 2012-2016 (ESTAT Comext 2019)

0 2012 2013 2014 2015 2016 EU imports (t) EU exports (t) Net imports (t)

EU trade flows for natural graphite (ESTAT Comext 2019)

Source: EC CRM_2020_Factsheet on Natural Graphite

70,000 60,000 50,000 40,000 30,000 20,000 10,000



WORLDWIDE EXPORTS AND IMPORTS OF NATURAL GRAPHITE





Total Exports: USD 452 million

Top-10 natural graphite exporting and importing countries in 2017 by value, based on trade date for trade code HS 250410 "Natural graphite in powder or flakes" and HS 250490 "Natural graphite (excl. in powder or in flakes)". Background data from UN Comtrade 2019

Source: EC CRM 2020 Factsheet on Natural Graphite





EC/JRC STUDY ON GRAPHITE PRODUCTION IN BATTERIES

Table 10 Hotspots analysis results for battery materials

		Material	s supply stage)	(mining	Gover	nance	Conflicts		Human and social rights			Environment		
Material	Country	% reserves and resources	% global mining production	% EU sourcing	Resource Governance Index	Worldwide Governance Indicators	INFORM - HH	Fragile State Index	Global Peace Index	Child labour*	Fair salary*	Global Slavery Index	Environmental Performance Index	Water Risk Index
	Australia	10	4	1	1	1	1	1	1	1	1	1	2	3
COBALT	Congo DR	46	57	69	3	4	4	4	4	4	2	4	3	1
	Finland	1	1	14	n.a.	1	1	1	1	1	1	1	1	1
	Argentina	20	12	5	n.a.	2.5	1	2	1	2	1	1	2	2
	Australia	8	36	65	1	1	1	1	1	1	1	1	2	3
	Bolivia	21	0	0	n.a.	3	3	3	2	4	3	2	2	1
	Chile	12	38	0	1	2	2	2	1	2	1	1	2	3
	Portugal	0	0	10	n.a.	2	1	1	1	2	2	2	2	3
	USA	13	3	0	1	1.3	3	2	3	1	1	1	2	2
	Australia	14	17	1	1	1	1	1	1	1	1	1	2	3
	Brazil	1	7	17	n.a.	3	3	3	2	2	1	1	2	1
	China	2	17	0	n.a.	3	3	3	2	3	2	2.5	2	3
MANGANESE	Gabon	10	10	20	n.a.	3	3	3	2	4	1	3.5	3	1
	South Africa	41	28	25	2	2.5	3	3	3	n.a.	1	2	3	3
	1154	10	0	0	1	13	2	2	2	1	1	1	2	2
	Brazil	1	7	12	n.a.	3	3	3	2	2	1	1	2	1
ΝΑΤΙΙΡΑΙ	China	0	64	47	n.a.	3	3	3	2	3	2	2.5	2	3
	India	0	11	0	n.a.	2.5	3	3	3	1	2	2.5	3	3
GRAPHITE	Mozambique	68	0	0	n.a.	3	2	3	2	4	1	3	3	2
	Tanzania	13	0	0	2	3	2	3	1	4	1	3	3	3
	Australia	13	11	U			1		1	1	1	1	2	3
	Canada	7	10	7	n.a.	1	1	1	1	1	1	1	2	1
	China	3	4	47	n.a.	3	3	3	2	3	2	2.5	2	3
	Greece	1	1	10	n.a.	2.5	2	2	1	1	1	3	2	3
NICKEL	Indonesia	17	18	0	1	3	3	3	1	2	1	2.5	3	3
	Philippines	10	17	0	2	3	4	3	3	2	3	3	2	3
	Russian Federation	11	11	0	n.a.	3	3	3	4	2	1	3.5	2	1
F	South Africa	4	2	14	2	2.5	3	3	3	n.a.	1	2	3	3

1, low risk; 2, medium risk; 3, high risk; 4, very high risk. n.a. not available