



Enhancing low-carbon mobility

CEO Matti Hietanen, Finnish Minerals Group

World Materials Forum, Closing Session: Technologies for Sustainable Mining

6-7 July 2023 – Nancy, France

+ **Finnish Minerals Group is a State-owned holding and development company for the mining industry and battery value chain**



W O R L D
M A T E R I A L S
F O R U M

**FINNISH
MINERALS
GROUP**



MISSION

Responsibly maximising the value of Finnish minerals



VISION

We provide materials for climate neutrality



Our portfolio companies strengthen the sustainable European battery value chain



WORLD MATERIALS FORUM

FINNISH MINERALS GROUP

Raw materials

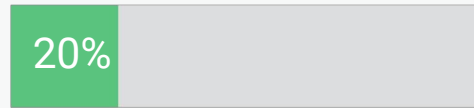
Terrafame

Large, vertically integrated nickel mine in a top tier European location



KELIBER

The most advanced integrated lithium project in Europe



SOKLI

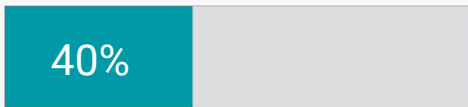
Large carbonatite complex with significant REE potential



Battery value chain

CNGR Finland

NMC pCAM production for the European market



Adven-FMG

Sodium sulphate management for the growing battery industry



Strategic development projects with partners



NMC CAM production for the European market



LFP CAM production for Freyr cell production in Vaasa



Anode material production for the European market

PARTNER to be announced Battery cell project in Kotka



+ Large, vertically integrated nickel mine in a top tier European location

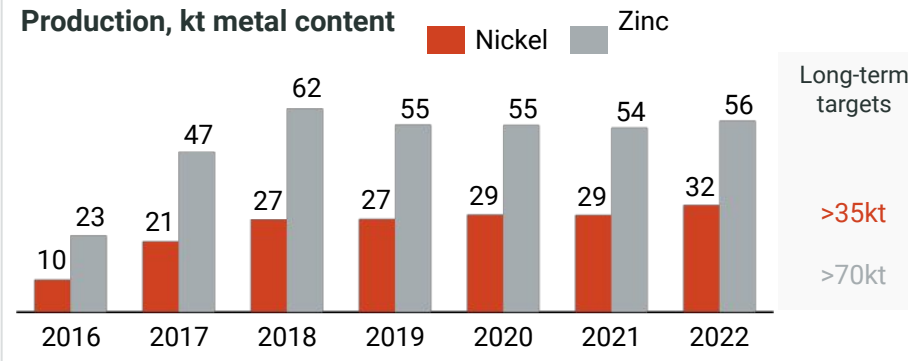
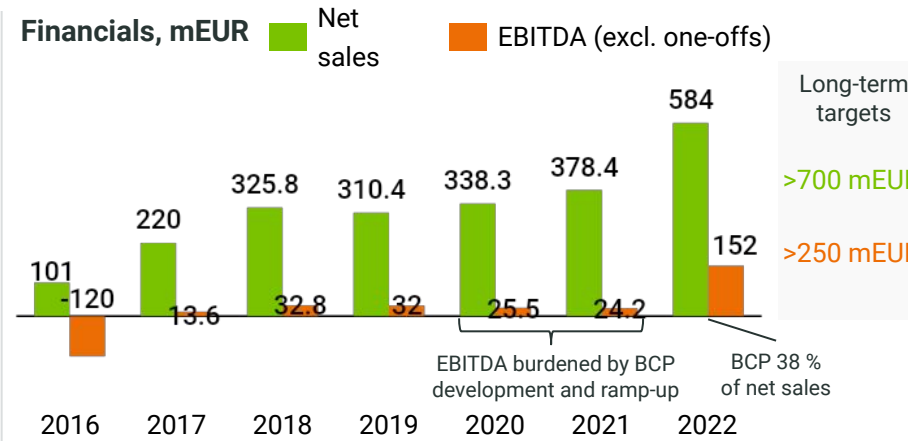


WORLD
MATERIALS
FORUM

FINNISH
MINERALS
GROUP

Terrafame

- Terrafame, operational since 2015, is an **integrated multi-metal company** producing nickel, zinc, cobalt and copper products
- The mineral resources at the mine in Sotkamo, Finland amount to almost 4 million t-Ni, indicating a **LOM of over 50 years**
- In 2021, the company completed the construction of an **on-site battery chemicals plant (BCP) in Sotkamo, Finland**
- The company is currently in the process of **transitioning from nickel intermediate (MSP) production to nickel sulphate production** via the BCP ramp-up
- Independent life cycle analysis indicates that Terrafame's nickel sulphate production offers the **lowest carbon footprint in the industry**
- Finnish Minerals Group is the majority shareholder with a 67% share, the rest being held by Trafigura and Sampo



Located in a Tier 1 jurisdiction close to the European EV market



Enhancing low-carbon mobility with responsible battery chemicals

Terrafame
BUSINESS MODEL



IMPACT

Committed personnel – Safe working environment – Economic value-added – Solid customer experience



TRACEABLE SUPPLY CHAIN, LOW CARBON FOOTPRINT

INTEGRATED AND ENERGY EFFICIENT PRODUCTION

Open-pit

Materials handling

Bioleaching

Metals extraction

Battery chemicals plant



RESOURCES

Largest nickel ore reserves in Europe – Skilled personnel – Wide partner company network

VALUES

Safety – Commitment – Efficiency

Kolmisoppi deposit

Numbers from 2023

1a

Kuusilampi open pit

Waste rock area

Ore mined 17,9 Mt
Waste rock mined 31,8 Mt

Total water consumption
3,9 Mm³ (raw water ~70 %)

Total chemical use 521 200 t
Ni production 31 550 t

Maximum capacity of nickel sulphate hexahydrate production
170 000 t (~1 million EV's)

Secondary heaps

2b

New waste rock area

2a

Primary heaps

1b

Ore handling

3a

Metals recovery

Uranium extraction (2024)

3b

4

Battery chemicals plant

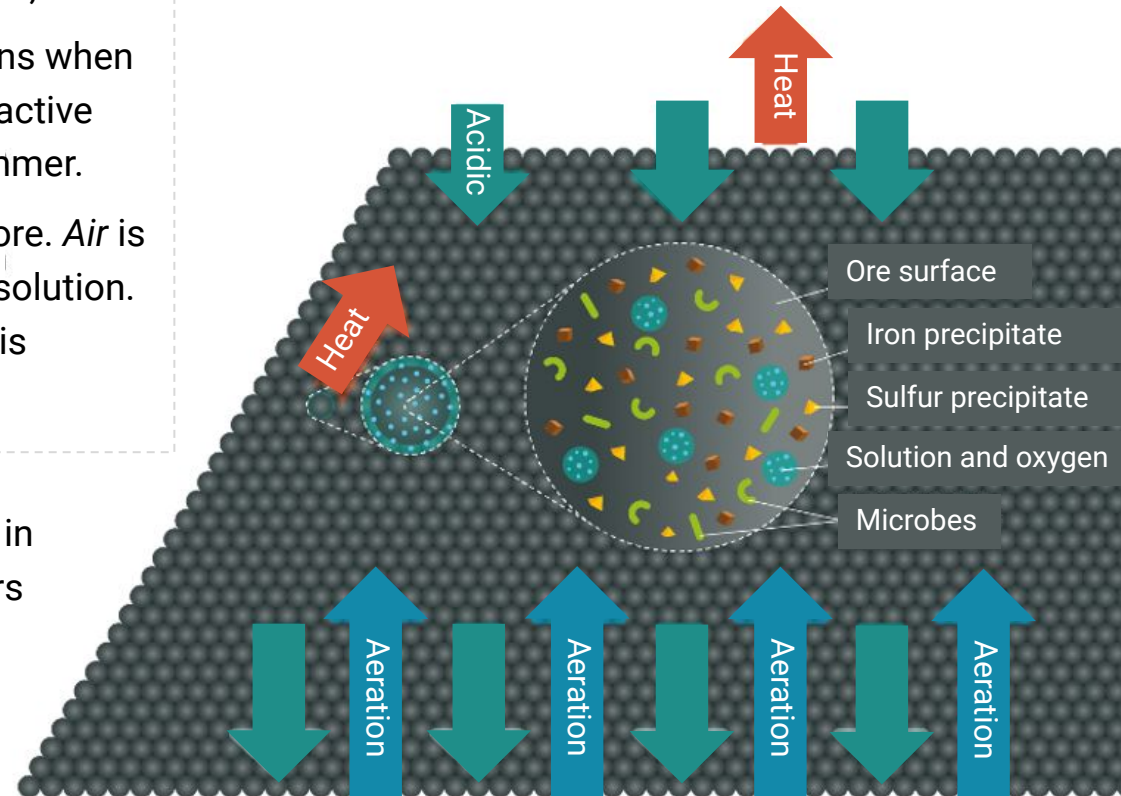


Terrafame bioleaching in-depth

Heap leaching is a staple technology for gold and copper production. *Typical* heap leaching operation is in dry areas, where it is a challenge to find fresh water, and operated outside the winter period. Also, these processes do not require forced aeration.

- Terrafame mine is the only mine utilizing heap leaching for the recovery of Ni and Zn. The black-schist ore contains in addition Cu, Co, Mn, U, graphite, ...
- *Net positive rainfall, all-year-round leaching* also during winter conditions when temperature can fall to -40°C This is enabled by the high amount of reactive sulfidic minerals in the ore. Temperature can rise to $+30^{\circ}\text{C}$ during summer.
- The bioleaching process utilizes *microbes* to extract metals from the ore. *Air* is blown into the heaps, and they are *irrigated* with an acidic production solution. The process relies on *high temperature* generation within the heap. This creates optimal conditions for the *microbial activity* within the heaps.

The climate conditions, water availability and Terrafame ore composition in combination with a high safety and sustainability mindset are key enablers of the unique bioleaching operation in Sotkamo.

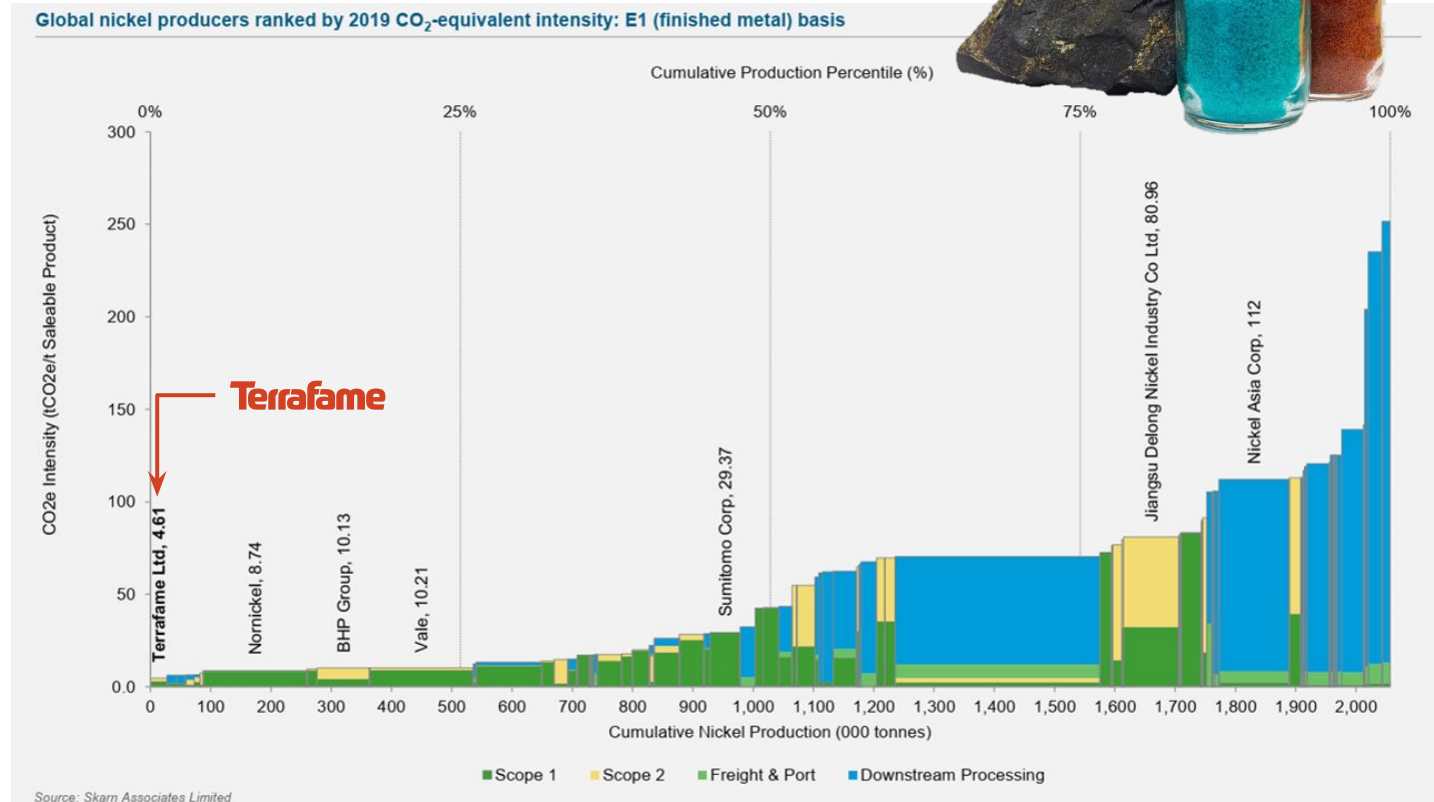




Terrafame Ni production has the lowest CO₂ footprint



- Analyses show that the nickel produced by Terrafame has the smallest carbon footprint among nickel producers globally
- The small footprint is mainly due to the use of bioleaching**
- Whether or not the same approach is applicable elsewhere for Ni mines, is highly dependent on the deposit type and the climate conditions
- Terrafame has joined the UN Global Compact in 2020 initiative and has been involved in the TSM (Towards Sustainable Mining) standard since 2017



The carbon footprint of the nickel sulphate produced by Terrafame is more than 60% smaller than average!



Cooperation enhances European low-carbon mobility



WORLD
MATERIALS
FORUM

FINNISH
MINERALS
GROUP



*"Terraframe Ltd and Stellantis N.V. announced today the signing of a **supply agreement for nickel sulphate** to be used in electric vehicle (EV) batteries. Beginning in 2025, Finland-based Terraframe will supply Stellantis with nickel sulphate over the **five-year term** of the agreement." (18.01.2023)*



*"Umicore has signed a long-term agreement with Terraframe Ltd. for the supply of low carbon, sustainable high-grade nickel sulphate. Following the successful completion of the qualification process, **commercial deliveries have already started** with further ramp-up of volumes to take place during 2023." (02.02.2023)*



*"Fortum and Terraframe have signed an agreement for an experimental project in which **metals recovered from the black mass** of EV batteries by Fortum **will be utilised in Terraframe's battery chemical production**. The collaboration between Fortum and Terraframe will enable an even more sustainable value chain to meet the needs of the European battery manufacturing industry." (14.06.2023)*



*"Terraframe and Renault Group have signed a multi-year agreement for the supply of low-carbon and **fully traceable nickel sulphate** for electric vehicle (EV) batteries. With the agreement, Renault Group will secure a significant supply of sustainably produced nickel sulphate from Terraframe, **sufficient for more than 200,000 EV's annually**" (02.12.2022)*

FINNISH MINERALS GROUP

SUOMEN MALMIJALOSTUS





Traceable production with low carbon footprint

1 Open pit mining

- Terrafame is the largest Ni mine in Europe.
- Mining of low-grade ore containing Ni, Zn, Co, Cu, and other metals in Kuusilampi (669 Mt) open pit.
- Ore concentration Ni 0,26%, Zn 0,54%, Co 0,02%, Cu 0,15%
- Crushing and agglomeration of ore.
- Stacking of ore to primary and secondary heap leaching areas.
- Mining in the Kolmisoppi deposit (831 Mt) is to be started around 2030.

Ore mined 17,9 Mt
Waste rock mined 31,8 Mt

2 Bioleaching

- The bioleaching process utilizes microbes to extract metals from the ore. Air is blown into the heaps, and they are irrigated with an acidic production solution.
- The stacked ore is first leached in the primary heap for about 15 months.
- The ore is then reclaimed and conveyed onto a secondary heap for final leaching.
- Bioleaching is an energy efficient production method.

Total water consumption*
3,9 Mm3 (raw water ~70 %)

3 Metals recovery

- Metals are extracted from the recyclable production solution, which is precipitated in stages into nickel-cobalt, zinc and copper sulphides in a metals recovery plant.
- Zinc and copper sulfides are filtered and sold for refining.
- A ready-built uranium recovery plant is located on Terrafame's industrial site. After the ramp-up phase starting 2024, the recovery plant is expected to operate at full capacity by 2026.

Total chemical use* 521 200 t
Ni production 31 550 t

4 Battery chemicals

- The nickel-cobalt sulphide is fed into the battery chemicals plant (BCP). The investment was around 250 M€.
- The nickel-cobalt sulphide is further processed into nickel and cobalt sulphates i.e. battery chemicals.
- The ramp-up of the BCP started in 2021. The hydrometallurgical process stages include pressure oxidation, solvent extraction and crystallization.
- The facility is one of the biggest in the world of its kind.

Maximum capacity of nickel sulphate hexahydrate production
170 000 t (1 million ~EV's)