PROMETIA Scientific Seminar
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Responsible Mining

Boliden Strategy and Actions

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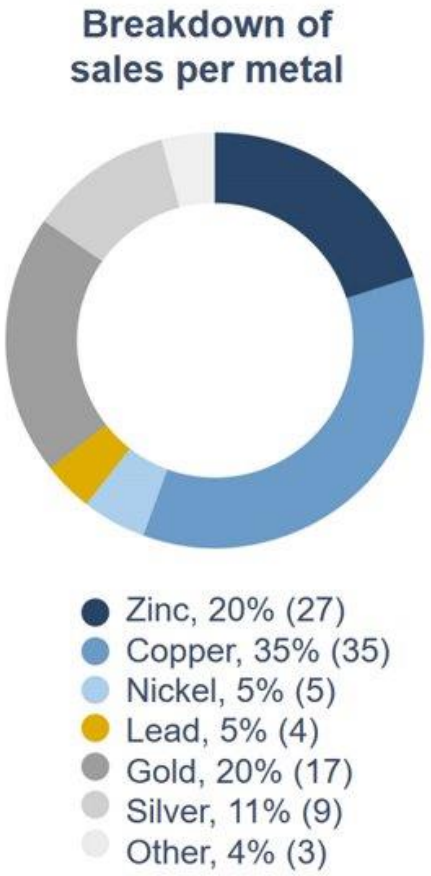
Boliden

The company

- Founded 1924 based on the discovery of an extremely rich gold deposit (100+ g/t Au) in northern Sweden
- Currently an integrated mining, smelting and recycling company. Divided into Business areas Mines and Smelters
- Key numbers:
  - 6000+ employees
  - Turnover of 8.6 billion € (2022)
  - Operating profit 1.6 billion € (2022)
  - 7 Mines, 5 Concentrators
  - 5 Smelters
- Main commodities Cu, Zn, Ag, Au, Pb, Ni, Te, PGE,…
- Significant actor in recycling of WEEE and batteries



What is responsible mining?

A mine that you cannot see?

…produces zero (or minimal) waste?

…is carbon neutral?

…has no H&S incidents?

…has full social acceptance?

…uses environmental friendly processes, no emissions?

…has no negative impacts on biodiversity?

…acts as a good member of society in addition to providing RMs?

A mine that complies with all of the above – or a mine that doesn't exist?

Or…

A mine that strives towards all of these, within certain environmental, social and economic boundaries…

Understands that there are trade-offs and trying to find the best overall solution…

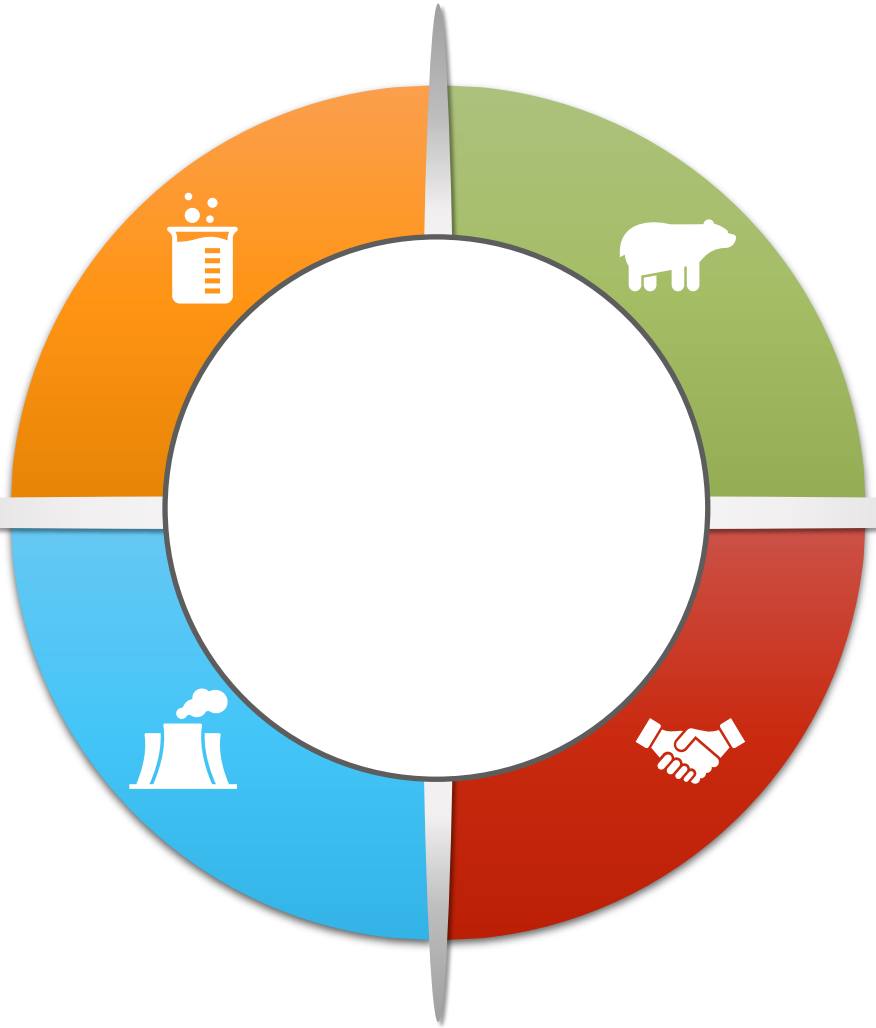
Boliden's sustainability work "in a nutshell"

PROCESS RESIDUES

- Safer TSF constructions with smaller footprint, drystacking
- Cost-efficient remediation technologies
- Prevention of acid mine drainage
- Valorization of waste

BIODIVERSITY

- Ecological compensation
- Validated measurements for biodiversity
- Towards 2030 and net positive biodiversity at Boliden's sites.



CLIMATE

- Electrification
- Mine waste for carbon capture
- Low footprint process reagents and explosives

SOCIETY

- Social and economical sustainability for local stakeholders
- The sami people and reindeer hearding
- Social acceptance and license to operate
- Health & safety

Valorisation of waste

First experience of large scale reprocessing…

- 3-3.5Mtons of tailings/residues identified for reprocessing in Boliden Area
  - Preceded by studies 1980-2011
  - Up to 9%Zn, 2g/t Au, 60g/ton Ag
  - 2011: Positive project NPV. Approx 10M€ estimated net income
- First phase: the “Korea Dam project”
  - Successful reprocessing, based on combination of gravimetry, flotation and leaching (in existing concentrator)
  - 60%Zn, 73%Au, 72%Ag recoveries
- Sustainability aspects
  - Environmental and safety liability removed
  - Land reclamation started
  - Goodwill and social acceptance - no noticeable benefits

Before and after: Reprocessing “Korea” tailings 2018-2020

Sampling for one of pilot trials

Valorisation of waste

Co and Ni potentials in Boliden high-sulphur tailings

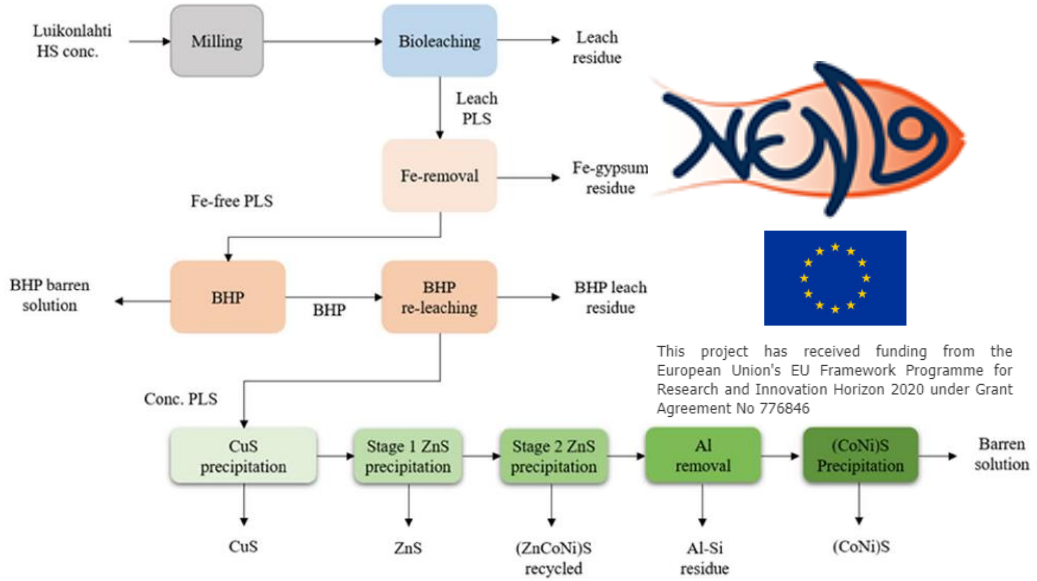
[1] Based on 10-year reprocessing plan
[2] Contribution to EU economy, based on 2019 demand statistics

Descriptor	Luikonlahti site (closed)	Aitik site	Kevitsa site
Tailings type	HS-tailings	HS-tailings	HS-tailings
Tailings amount	**1.6 Mt**	1 Mt/y	**100 kt/y**
Nickel potential	**0.4%, 7000 tons**	0.02%, 200 tpa	**1.05%, 1000 tpa**
Share of EU demand	3% for 10 years[1,2]	<1%[2]	4%[2]
Cobalt potential	**0.7%, 10000 tons**	**0.06% 600 tpa**	0.05%, 50 tpa
Share of EU demand	10% for 10 years[1,2]	6%[2]	0.5%[2]
Other elements	Cu, Zn	Cu, Au	Cu, PGM

Valorisation of waste

Co/Ni recovery concept from HS-tailings

- NEMO H2020 project: production of battery grade metals from HS-tailings
- Process based on stirred-tank bioleaching, BHP production/re-leaching, sulphide precipitation
- Technical feasibility demonstrated
  - Co recovery 95% at 51% grade
  - Ni recovery 91% at 15-19% grade
  - Zn recovery 90% at 55-60% grade
- But…
  - Turns out not to be economically feasible at the end of the project (decline in metal prices, inflationary pressures on CAPEX/OPEX)
  - High CO2 footprint of lime neutralization – not in line with Boliden reduction targets



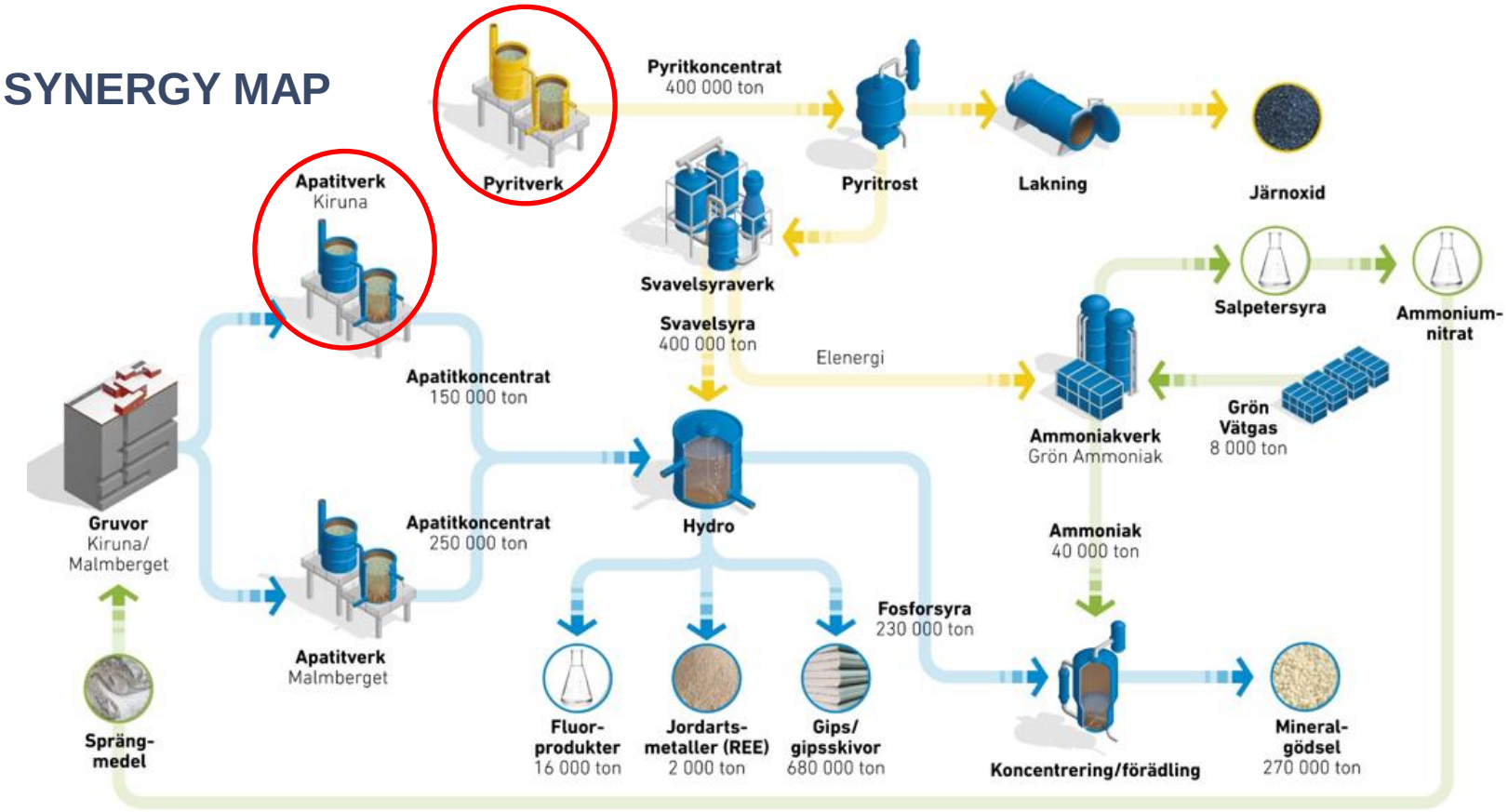
This project has received funding from the European Union's EU Framework Programme for Research and Innovation Horizon 2020 under Grant Agreement No 776846

Piloted concept for producing Co/Ni sulphide from Luikonlahti tailings

Valorisation of waste

The REEMAP Ecosystem

SYNERGY MAP



The REEMAP Project

- Production of fertilizer and REE (30%+ of EU demand) from LKAB and Boliden mine tailings
- Pyrite from Boliden Aitik approx 250 kt/year used in process
- …other possible byproducts
  - Iron oxide
  - Fluorine products
  - Ammonium nitrate
  - Gypsum

Using one residue to treat another residue, producing fertilizer and REE (to cover ~30% of EU demand)…

Valorisation of waste

Tailings as construction material

Bus stop/waiting area being constructed in Belgium from Tara mine tailings

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Transformation of mine tailings into cement-bound aggregates for use in concrete by granulation in a high intensity mixer

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ARTICLE INFO

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ABSTRACT

Mine tailings pose one of the world's largest volumes of challenging residues. To overcome the environmental liability and reduce monitoring and reclamation costs associated with the long-term storage of tailings – and to add

Paver comparison – Tailings vs regular

Mini-concrete blocks for mechanical and durability testing

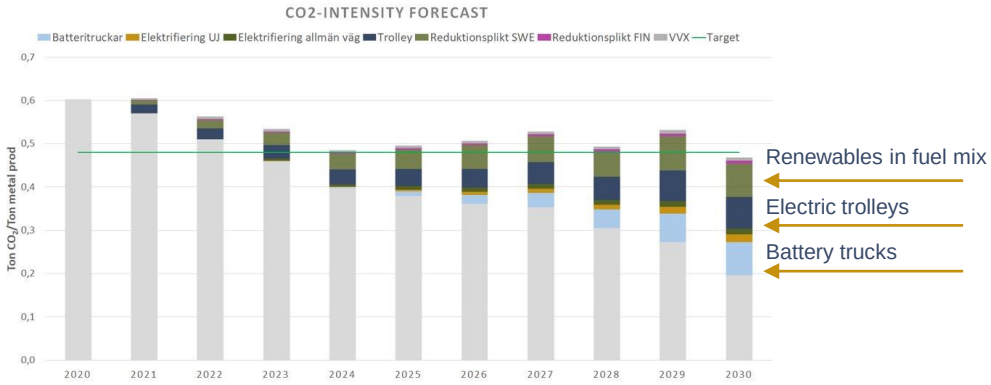
This project has received funding from the European Union's EU Framework Programme for Research and Innovation Horizon 2020 under Grant Agreement No 776846

Climate change and CO_2

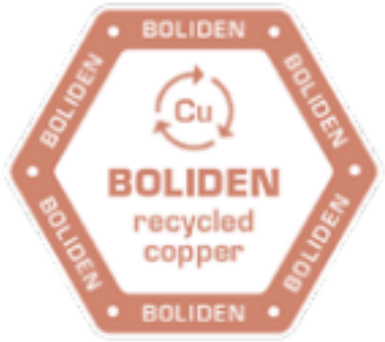
Cradle to gate, no credits, no offsets…

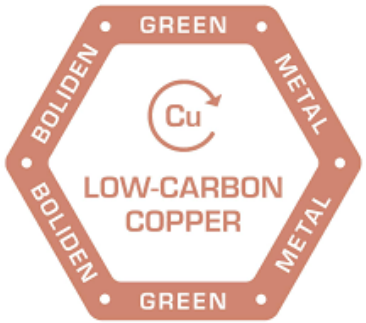
Boliden “Climate Leader in Europe” 2022 (by Financial Times), based on CO_2 reductions 2015-2020

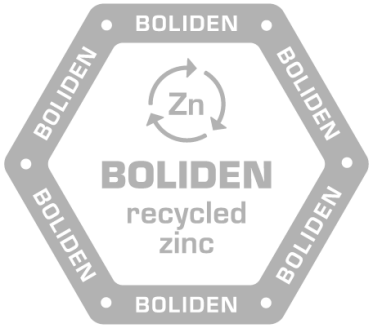
Worlds first fossil free mine? Construction ongoing at the Rävliden mine…



Boliden Mines 2030 goal to reach 40% reduction in CO_2 intensity to be reached ahead of time*







Product labelling launched by Boliden: 100% recycled copper and zinc, Low carbon copper and zinc. 1.5 $kgCO_2eq/kg$ Cu and <1 $kgCO_2eq/kg$ Zn (4.1 and 3.0 global average, respectively)

* Scope 1&2, GHG Protocol with base year 2021

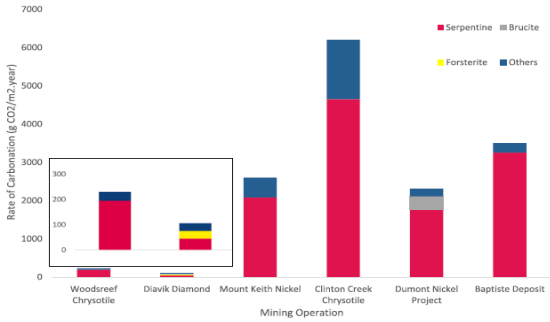
Climate change and CO_2

Beyond electrification

- Targets
  - 40% reduction by 2030 (Scope 1&2)
  - 30% reduction from supply chain by 2030 (Scope 3)
  - Net-zero by 2050

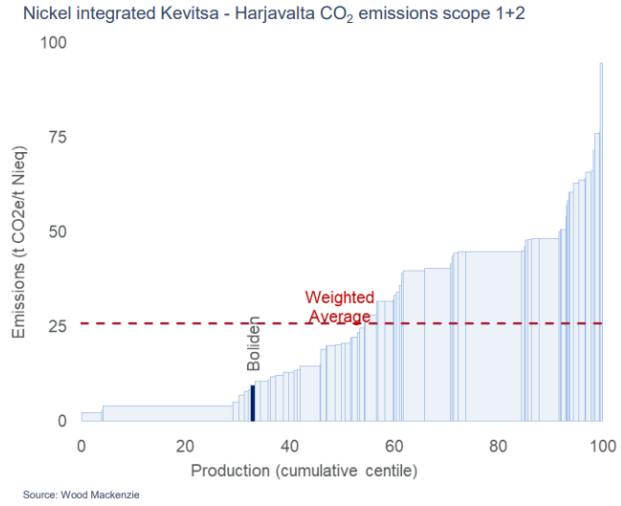
- Other sources of CO_2
  - Energy mix on grid (partly beyond our control)
  - Fossil-based explosives
  - Process reagents (flotation, etc)
  - Lime neutralization – BIG ONE!
  - Tailings can either emit or absorb CO_2 (depending on composition and conditions)

Development of biodegradable, non-toxic and fossil-free reagents for flotation



Mines as CO_2 system service? Studies show significant passive CO_2 uptake potential in tailings

Inspection of the first blast with nitrate free low CO_2 explosives at Boliden Kankberg mine



Societal service - Balancing the electric grid

Frequency regulation – FCR “demand response”

- Boliden Aitik mills have a combined power draw of 70 MW, corresponding to 10% of a nuclear reactor
- During the energy crisis, Boliden made agreement for short-term frequency balancing of the Swedish grid - “demand response”
- Fully automatic – Concentrator control system reacts to changes is grid frequency within seconds
- Experiences from 2.5-month trial period:
  - One incident where system was activated, 8 MW made available
  - Compensation from national energy company 4 MSEK (400 k€), lost production 170 tons

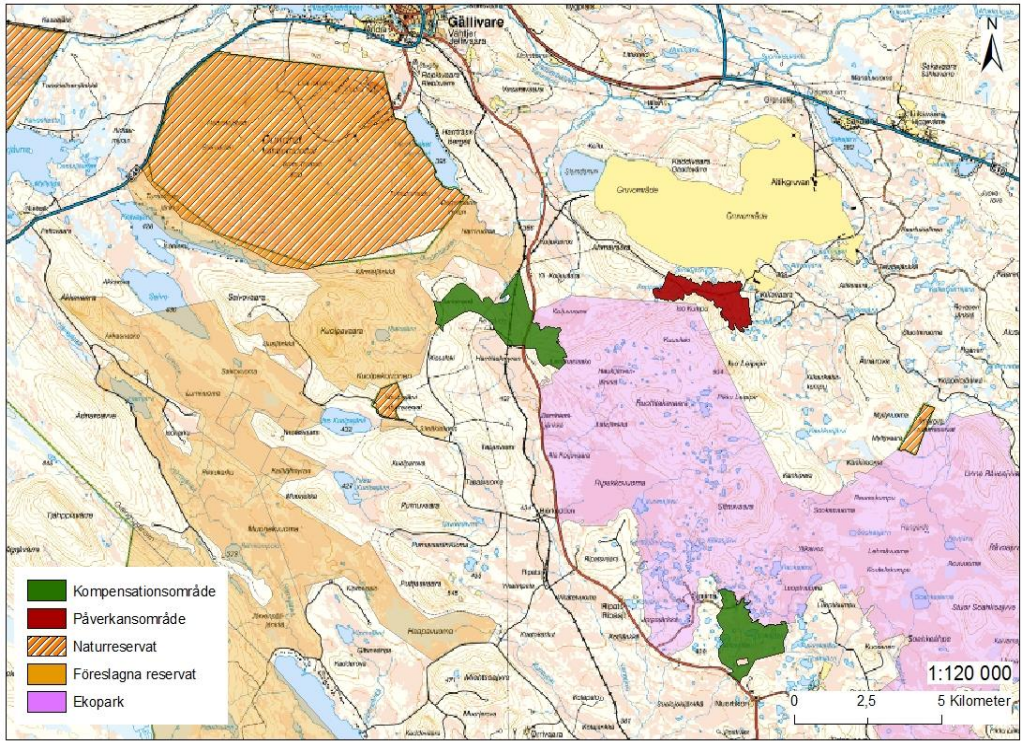
Boliden Aitik has two mill lines in the grinding circuit, with a combined power draw of 70 MW

FCR = Frequency Control Reserve

Biodiversity

Creating a net-positive impact

- Commitment by Swedish mining industry: A net gain in biodiversity by 2030
- First large-scale demonstration by Boliden: Sarkanenä Sustainability Park
  - Compensate effect of tailing dam expansion
  - 1200 acres of wetland, forest, etc
  - Enhanced biodiversity by adding dead wood, creating habitats for insects, birdlife, …
  - Walking trails, …



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Society

Social acceptance, Indigenous people's rights, Workers H&S

- Strong commitment in local communities
  - Enjoy high degree of trust in mining communities
  - Dialogue and consultations with local stakeholders
- Boliden's indigenous people commitment – along with ICMM guidelines
  - Respectful and continuous dialogue
  - Finding compromises and offset impacts
- Worker health and safety
  - Culture where it is ok to report incidents and observed risks, etc. (BSafe)
  - Proactive rather than reactive risk mitigation
  - LTI frequency 3.5* per million worked hours (reduced by 50% in 10 years)
  - No employee fatality for 15 years

Automation and electrification, increasing productivity and safety

Building trust with Sami communities in Northern Sweden

* 2022, including subcontractors

A wish list for Santa…

What is needed? – Technical, economical and social challenges

- Low-cost hydrometallurgy (CAPEX, OPEX) for treatment of lower value residues?
- Valorisation methods for precipitated metals in WTP sludges?
- Reclamation using tailings? Low-cost dry deposition?
- What can replace lime/limestone in neutralisation, pH adjustment and gangue depression?
- New business models, better economic impact analyses and making industrial synergies work!
- How can we make the construction and industrial minerals sectors accept to use tailings?

Thank You!

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And you can never make everyone happy…

”It can be questioned how relevant copper will be in the future, as copper is not listed on the EU list of especially important raw materials.”

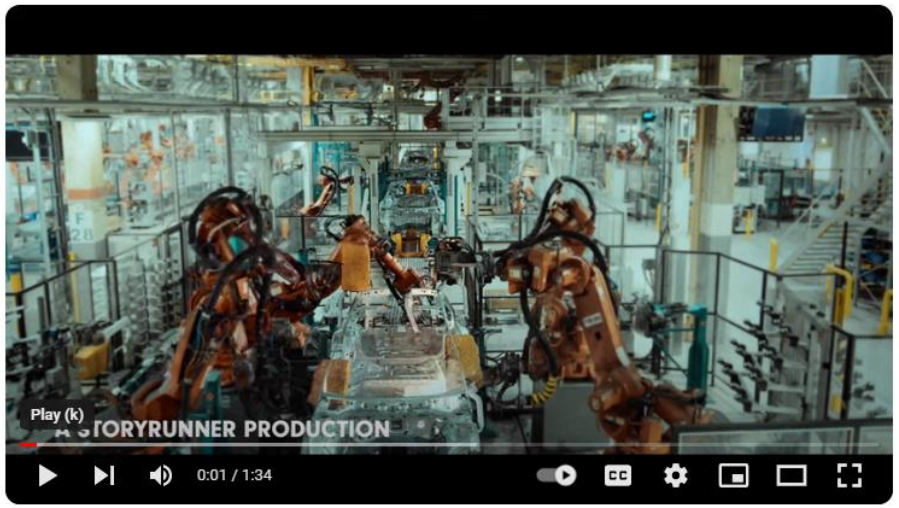
Swedish authority appealing court judgement on permit for Boliden mining project (2021)

”Mining is bad because of the high salaries. Our youth rather want to work in mining than with reindeer farming.”

Sami leader

If you want more, there is more!

Responsible Mining in Europe
Search "Responsible Mining" on Youtube
Account: SIM2 KU Leuven



Made in Europe – From Mine to EV
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