Green energy and innovation for sustainable mining

How digitalization, decarbonisation and strategic reorientation redifine mining in sensitive ecosystems

In this DTM you will learn:

- How modern technologies assist the industries transformation
- Which approaches are used to innovate mining
- Why mining is essential for green energy transistion
- How we can mine under nature parks and protect the environment

Discover the sustainable future of mining!

Institute of Mineral Resources Engineering
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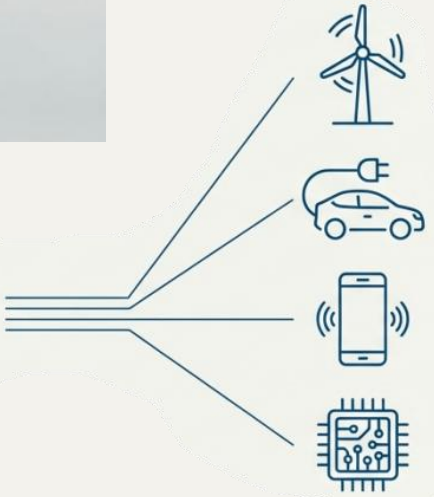
Future of Mining

The word 'mining' evokes images of hard work, dirt, and environmental destruction.

An image that has been shaped over centuries and is stuck in our minds – and is still present in some parts of the world

The future is built **on mineral resources**.

Energy transition and digitalization require huge quantities of **copper, nickel, lithium, and rare earths.**



The question is not **whether** we need mining, but **what** it must look like.

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The future of Mining – the sustainable Mine

To meet EU CRM Act Claims we need to extract more in Resources europe – rich deposits in most sensitve ecosystems like the arctic.

In arctic 31 of 34 CRM can be found. From now on sustainable & modern Mining Approaches can ensure secure, safe and eco-friendly supply.

This is how it can be done & and what challenges have to be tackled

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The Fundamental Tension of the 21st Century: Four Pillars of Modern Mining

Growing demand for raw materials conflicts with the requirement for minimal ecological and social impact.

Global Demand for Critical Raw Materials

Requirements for Ecological Footprint & Social Responsibility

The "Mine of the Future" is built on four interconnected pillars redefining productivity, sustainability, resilience, and social acceptance.

Click on the boxes and see how the mining industry responds with innovation and transformation.

Mining under a Nature Reserve: The Sakatti Project

New technologies in processing and konwledge in mining allow us to mine deeper and be more precise, leaving a smaller footprint.

So the envrionment can contiue looking nearly untouched:

See how this is realised

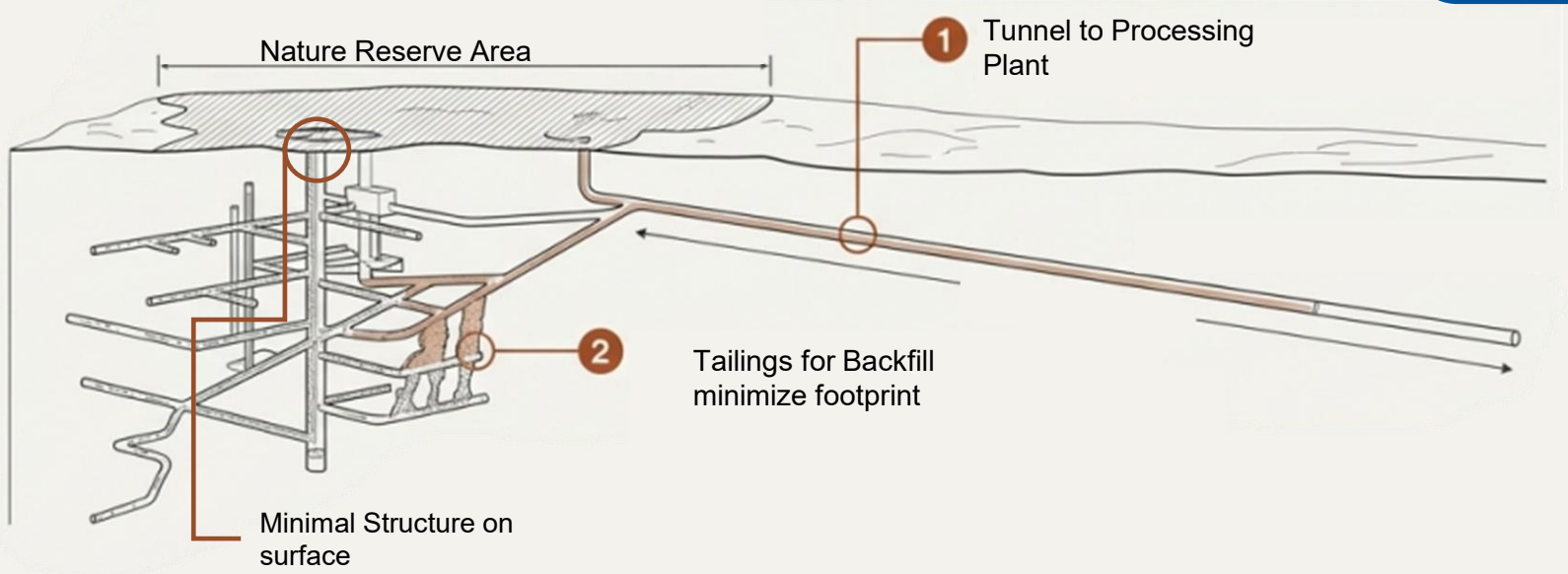
Mining under a Nature Reserve: Sakatti Nature Reserve

Project Timeline

Challenge:
- The valuable Sakatti deposit is located beneath the Viiankiaapa-Reserve, protected by EU 2000-natura network

Process & Studies:
- Detailled groundwater & deposit research allows further permitting
- Precise geological models for accurate mining approach are adapted

Result:
- An environmental-consious mining Project is planned at Sakatti
- Processing units are planned outside the nature reserve, material transported via tunnels



Back to Four Pillars of Modern Mining

Responisble Mining:

Partnerships with locals and shareholder communities can guarantee responsible operations, following esg and Sustainable Development Goals (SDGs)

Strategic Alliance:

- Operates through an agreement between Teck Resources and NANA (an Indigenous Regional Corporation).

Ownership Structure:

- The mine is 100% owned by NANA, ensuring local sovereignty over resources.

Financial Flow:

- Significant revenue generated through royalties, which are reinvested into the community.

Employment Priority:

- Implementation of a "Shareholder Preference" policy for hiring and training.

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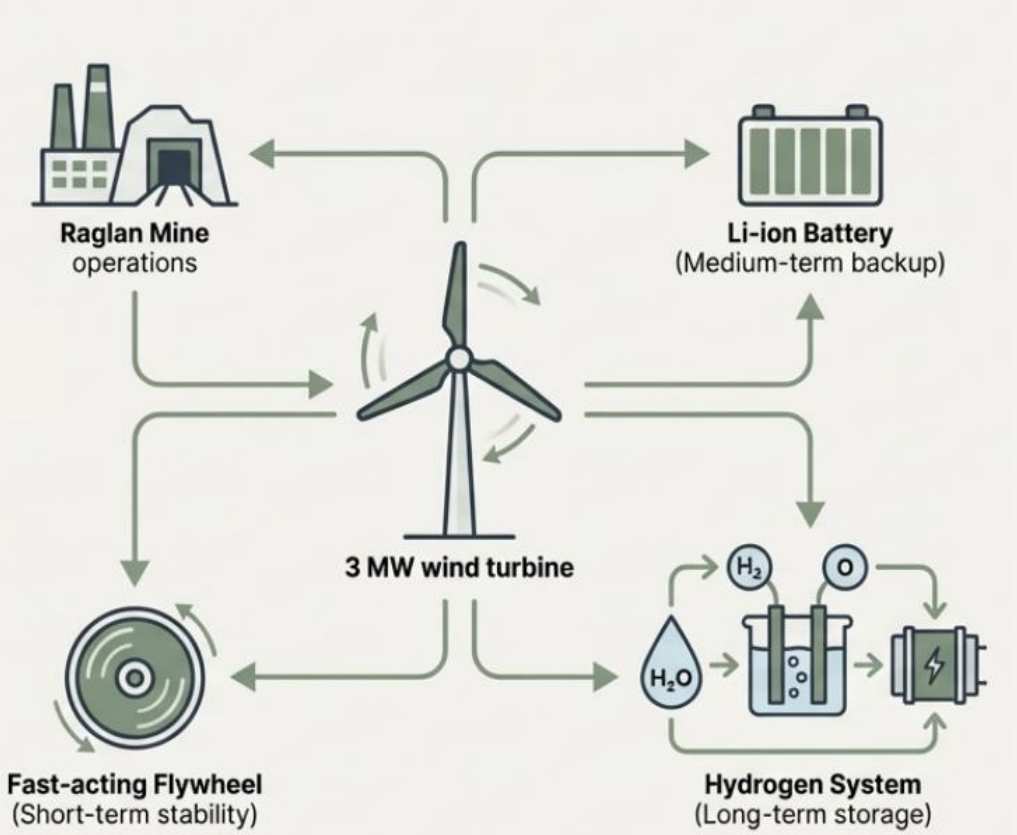
Energy Systems and Energy Management

Challenge & Location:
- Powering the Raglan Mine in Northern Quebec (Canada)

Solution:
- Deployment of an Arctic-ready wind turbine to reduce diesel dependency

Technology:
- An intelligent storage system ensures stable power supply, even when the wind is not blowing

Results since installation:
- Saved over 3 million liters of diesel.
- Reduced CO2 emissions by 9000 tons



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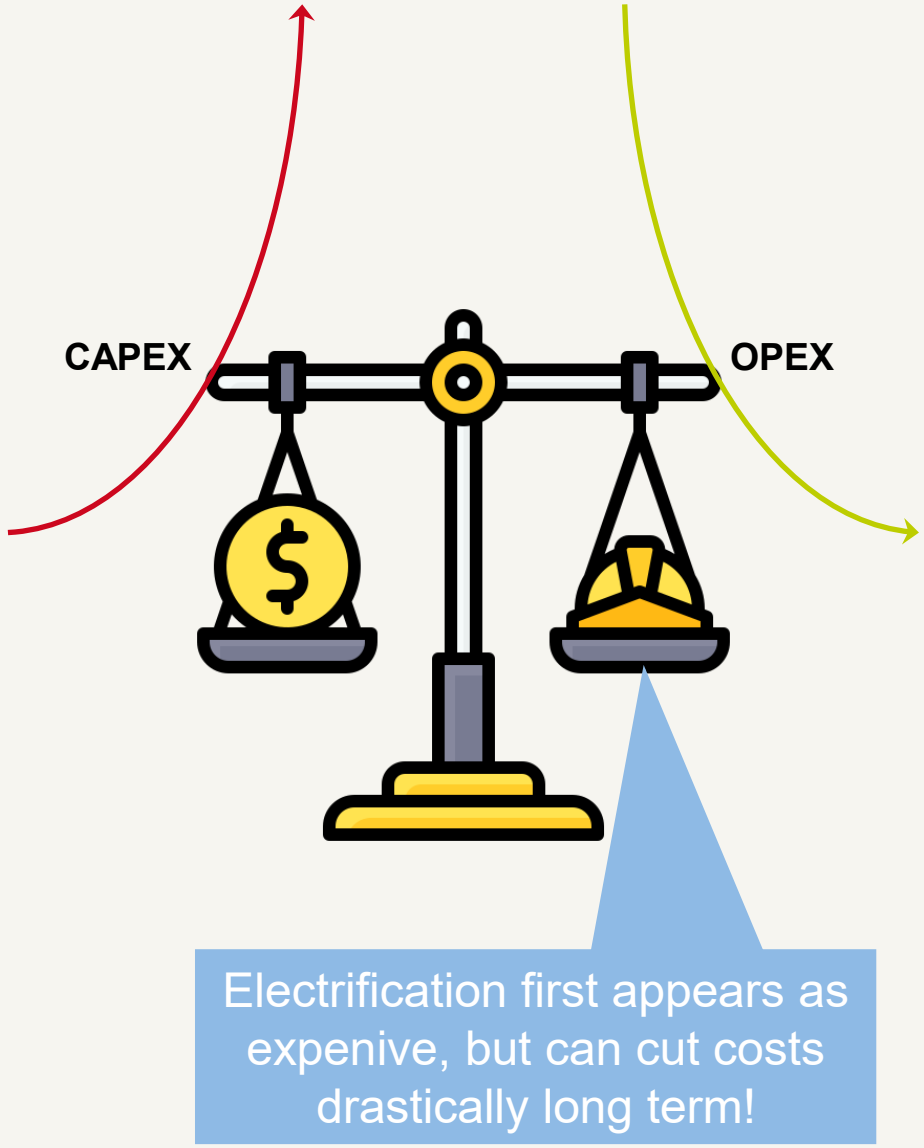
Electrification in Mining Operations: Financial Perspective

Minimising operating maintenance costs: Compared to diesel vehicles, BEVs have substantially fewer moving parts.

Reducing operating energy costs: A fully electrified mine can decrease energy costs from anywhere between 30% and 50%

Electrifying mining operations removes diesel exhaust gases and the accompanying waste engine heat, leading to an estimated 40% **reduction in ventilation costs**.

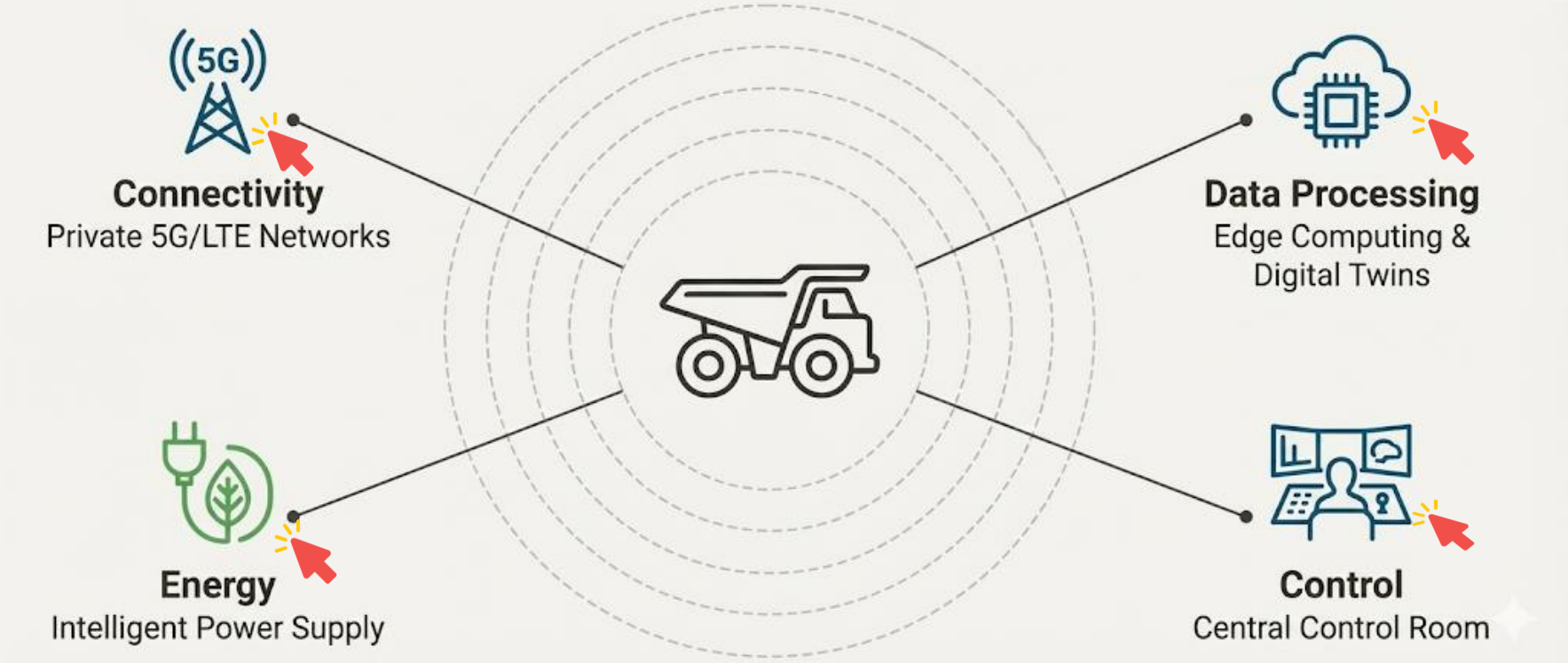


See How Trolley Systems Work

Smart, Safe & Sustainable Operations: The Connected Digital Mine

Buliding an autonomous & econonomic mine site is complex and capital expenditures (CAPEX) intensive, but rewarding in hindsigth.

Besides operational expenditure (OPEX) Digitalization will make mining safer, more intelligent, efficient, and greener.



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Data driven optimization through Connectivity

Data collection from sensors & systems throughout mining operatrions

Real-Time Locations Systems

Predictive Maintanace

On-Demand Ventilation

On-Demand Energy provison

Decreased Risk of Downtime

Automatization

Process Optimization

Connected sensors help mining companies to identify the condition of every mine site asset in real time

This can help predict potential failure and extend the lifetime of the assets.

Back to Topic Overview

Data Processing, IoT (Internet of Things) and digital twins

The integration of **data processing,** serves as the "infrastructure spine" of modern mining, shifting the industry from purely moving rock to managing intelligence

Transformation of the workforce is the consequence:

- New jobs with higher qualifications & requirements
- Advancing training for personel
- Making operations safer with less human workforce exposed to dangerous locations on site

Predictive Asset Maintenance:
Collecting data from sensors helps to identify the condition of every mine site asset in real time which can help predict potential failures and use condition-based maintenance to reduce costs, increase utilization and extend the lifetime of the asset.

Advantages for Mining Applications

Data Processing, IoT (Internet of Things) and digital twins

Advantages of Data-usage for Mining Applications:

Significant Productivity Gains:

The use of analytics platforms to turn Data into real-time decisions typically results in **productivity increases of 10–30%**

Improved Safety:

By utilizing remote monitoring and autonomous systems, **fewer personnel are required in high-energy zones**, significantly reducing risk

Enhanced Operational Efficiency:

Data-driven systems allow for **smoother plant feed**, optimized vehicle dispatch, and increased operating hours

Optimized Maintenance and ESG Reporting:

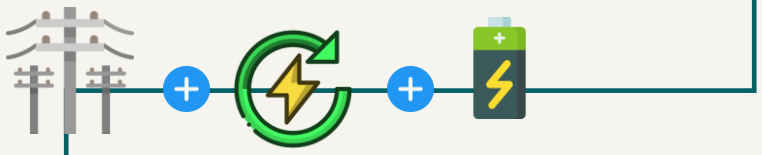
Telemetry data enables more precise **predictive maintenance plans** and provides accurate data for transparent **ESG reporting**

Transport: Trolley System

Boliden, Sweden:

What can it do?

- 100% Velocity gain (from 15 to 30 km/h)
- many more haulage cycles per day
- Less diesel consuption and less GHGs emitted



Dynamic charge:

Charge whilst on trolley system & recuperation when driving downhill; drive on battery in remote areas

On trolley System: Implementaion of autonomous Trucks self-steering & driving, dodging Rocks and uneven parts

Remote operations and automation, allow personnel to monitor automated processes and operate machinery long distance using virtual presence allowing for 24/7 operations

Back to Topic Overview

AutoMine Concept Drill

- Smart and electric Drilling: a way to maximize Safety for Workers and reduce Ventilation expenditures
- Less noise and no emitting of GHG
- Save capacity and energy through smart fleet management,

European Response for a new era of strategic autonomy

EU CRMA Key Points:

- **secure the EU's supply of critical minerals**
- **minimize reliance on single-country imports**
- **faster and more predictable permitting processes**

The EU designates the LKAB's project as **strategic**

The Project has potential to secure green transition and strengthen Europes industrial resillience, supporting EU Values and Economy

Strategic Positioning: Building a new value chain

The project aims to produce 6% of current agricultural used phosphorous in the EU

- Existing iron ore mine in Gällivare:
- New process for apatite extraction from side streams & mine wastes

Luleå Processing Unit

Phosphorus EU import dependency: 90%

Rare Earth Oxides EU import dependency on China: >95%

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Summary: Mine of the furure

The mine of the future will be smart, green, strategic, and socially responsible.

Mining IN THE PAST

- Diesel-powered & emission-intensive
- Manual & dangerous
- High land consumption
- Waste as an end product

Mining TODAY

- Electric & renewable
- Autonomous & connected
- Minimal footprint
- Waste as a resource (Circular)

Today leading companies treat autonomy, sustainability, geopolitics, and social responsibility as inseparable parts of their core strategy.

Get your key takeaways

Key takeaways

Mining remains **essential for the energy transition** and digitalization.

The question is not whether we mine, but how responsibly and sustainably we do it.

Modern **technologies help reduce environmental impact** while improving **safety and efficiency**.

Electrification can lower emissions, reduce diesel dependency, and cut long-term **operating costs.**

Responsible mining depends on **environmental protection**, local partnerships, and strategic **raw material security**.

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