Integrating Clean Energy into Mining Operations

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JISEA Technical Report, 2020

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Applied Energy 2021

Series on Oil and Gas, see https://www.jisea.org/clean-energy-opportunities-in-the-oil-and-gas-sector.html
Clean Energy in the Mining Industry
Clean energy deployment addresses EY’s top three business risks to the mining industry

Source: Mitchell 2021
In 2015 there were about **600 MW** of renewable energy projects serving mine sites.

In 2020, over **5 GW** cumulative of renewable energy projects serving mining operations have either been installed or are planned.
21 of 30 largest mining and metals companies have set some kind of net-zero emissions target.
Clean Energy in Mining
### Mine Energy Loads and Sources

<table>
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<tr>
<th>Mining process</th>
<th>Activities and Equipment</th>
<th>Fuel Source</th>
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| **Exploration, Extraction and Auxiliary Operations** | Ventilation: HVAC                                                                        | • Electricity
|                                        | Drilling: Loader trucks, diamond drills, rotary drills, percussion drills, drill boom jumbos | • Natural Gas     |
|                                        | Dewatering: Pumps                                                                        | • Electricity
|                                        | Digging: Hydraulic shovels, cable shovels, continuous miners, longwall mining machines, drag lines, front-end loaders | • Diesel
|                                        | Power supply: Generators                                                                 | • Compressed Air  |
| **Material Handling**                 | Discrete transportation systems: Haul trucks, service trucks, bulldozers, pickup trucks, bulk trucks, load-haul dumps, shuttle cars, hoists | • Diesel
|                                        | Continuous transportation systems: Conveyor belts, pumps, pipelines                       | • Electricity    |
| **Beneficiation and Processing**      | Comminution                                                                              | • Electricity    |
|                                        | Crushing: Crushers                                                                       |                  |
|                                        | Grinding: Mills                                                                          |                  |
|                                        | Separations: Physical: Floating, centrifuge; and Chemical: Electrowinning                 | • Electricity
|                                        | Drying, Firing, Smelting: Oven/Furnace                                                   | • Fossil Fuels   |
|                                        | Refining e.g. Electrolytic refining, fire refining                                        | • Fossil Fuels   |

Every mine operation has different requirements, but in general and across sites, **electricity** comprises the largest energy demand.

Most of that electricity is derived from **fossil fuels**.
Clean Energy Applications in Mining

- Renewable onsite electric loads
- Zero-emissions mobility
- Green hydrogen applications
- Low emission process heat and feedstocks

Technology Readiness Level

High  Low
Supplying Onsite Electric Loads

- Wind, solar, and—in some cases—energy storage—are commercial technologies that can offset diesel-fired electric generation.
- Variability of generation is a challenge since mine sites often have consistent 24/7 loads.
- Long term energy storage or dispatchable modular power systems needed to enable higher levels of renewable energy.
- Breakthrough technologies include electrolytic hydrogen, flow batteries, and small modular nuclear reactors.
Zero Emissions Mobility

- Electrifying transport reduces both GHG and air emissions
- Can also facilitate deeper integration of variable renewable generation by having vehicle batteries act as storage devices, or having electrolyzers produce H₂ for use in haul trucks
- While trolley assist and other electric transport (e.g., conveyors) have a market track record, Li-ion and H₂ are still emerging technologies for heavy off-road vehicles

Hydrogen fuel cell excavator prototype  
*Source: JCB*
Green Hydrogen

- $H_2$ can be used as an energy carrier for electricity generation, storage, mobility, process heat, or as a feedstock
- $H_2$ prices, supply chain, and technology readiness are still major barriers
- While some mining companies are investing heavily in an $H_2$ future, most analysts believe that low-cost green hydrogen at least a decade out from this reality

Source: Engineering News 2020
Many low- and no-carbon thermal technologies, such as concentrating solar, have not been commercially demonstrated for mining applications, but R&D is accelerating.

Electrification of process heat can be a pathway to incorporating renewable generation, both on mine sites and on the grid generally.

Alternative fuels and feedstocks for mineral processing require additional R&D to ensure process efficiency and product quality.

- E.g., H₂ reduction of iron ore
Challenges and Opportunities for Integration
Conclusion

Renewable energy technologies need mined materials, and mining operations can benefit from using renewable energy

Barriers:
• Conflicting business models between mine operators and renewable energy developers
• Lack of renewable energy expertise and demonstrations in the mining industry
• Land constraints and suitability

Enablers:
• Aligning incentives and using innovating contract structures
• Designing mine site energy management and making loads more flexible
• Capacity building and training
• Technology development and R&D
• Supply chain certification
• Policy and regulatory measures
• Collaboration!
Thank you!

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NREL/PR-6A50-82537