De-Risking Mining Operations with Renewable Hydrogen Energy Systems

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Moving from fossil fuels and creating bio-economies is now a policy imperative.

The technology is available to make the shift and there are successful precedents.

An economic shift in mining can be achieved through integrated systems design.
Transition from fossil fuel reliant economies to bio-economies based on Industrial Ecology (IE) principles has become a policy imperative for major industrial economies...
Industry Context

Support grows for renewables transition
The recent report on the National Electricity Market (NEM) by Australia’s Chief Scientist has identified the benefits of transitioning to a renewables based system including hydrogen.

Plans to turn renewable energy into export hydrogen
The importance of hydrogen to the growth of Australia’s export revenues has been highlighted by the launch of CSIRO’s Hydrogen Future Science Platform for technologies that enable the conversion of renewable energy into hydrogen for export.

Plans to transfer fleet vehicles to hydrogen
Formation of Hydrogen Mobility Australia has profiled the importance of hydrogen to the transition of Australia’s transport fleet from imported fossil fuels to locally produced renewable hydrogen.
ARENA and the CEFEC are offering grants and low interest loans to assist the increased deployment of renewable energy systems in the mining industry hence the scene is set for potential hydrogen application in this sector.

Renewable Systems Grants and Loans

Mining applications highlighted by industry bodies

The most recent report from the International Council on Mining and Metals (ICMM) highlighted numerous applications of renewables and hydrogen in the mining sector.
Available Technology Precedents

The value of renewable hydrogen for long term energy storage and clean transport fuel has already been proven in other industry sectors including gas network injection, de-carbonising oil refining and zero emission car, bus and materials handling fleets.
Mining Industry Potential

Mining applications include underground loaders, mining camps and rail prime movers all fueled by renewable hydrogen sourced from solar and/or wind power with rain and/or waste water as feedstock using electrolysis.

Immediate Issues and Opportunities

- **Green House Gases (GHG):** 1.0 MT/year of underground CO$_2$ eliminated from the 3.7 MT/year underground + open pit mining.
- **Health:** Fuel cells offer a total solution: no noise generation, vehicle heat load in deep mines, as well as eliminating all diesel emissions.
- **Operating Costs:**
  - Ventilation costs (savings of 10% in site electrical and energy bill, ~0.3-1.5 $M/year)
  - Diesel equipment, maintenance, downtime, automation vs fuel cell lower maintenance costs, higher reliability
  - Automation, tele-remote operation improved

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The Pathway to Hydrogen

In order to benefit from these potential savings via renewable hydrogen energy systems, existing mining operations should first undertake assessment of available land for solar PV and/or wind farms together with rainfall and wastewater resources as feedstock.

Subject to the results of this assessment, a renewable hydrogen energy system may be retrofit to provide a % of base load power as well as clean fuel for materials handling, personnel transport and ultimately rail prime movers with fuel cell power plants.
An Economic Spotlight on Hydrogen

Given the risk to mining sector profitability presented by rising energy and transport costs, it has been proposed to leverage the international lessons from the application of renewable hydrogen energy systems together with local funding options to help accelerate deployment.

Recent independent review of the LCOE demonstrated by the preceding international case studies on hydrogen systems by major project financiers has demonstrated savings of 30% to 50%+ when compared with conventional diesel and gas based power generation systems.
Geothermal Air Conditioning

Cooling and heating the mining camp whilst providing hot water for the bathrooms and kitchens to reduce overall electrical power demand by at least 50%.

Hydrogen Micro Turbines

Hydrogen micro turbines can be used for meeting peak electrical demand whilst providing high temperature water for absorption chiller refrigeration.

Hydrogen Gas for Kitchens

In the hydrogen gas fired kitchens electrical power demand is reduced and additional cooking options created.

Rooftop Solar

The roofing on the mining camp can be used to produce additional electrical energy via built-in solar PV cells together with a water cooling jacket to produce hot water for the bathrooms and kitchen areas.

Biogas Creation

The solid and liquid organic waste from the mining camp can be used to create biogas via anaerobic digesters to supplementing the hydrogen supply to the micro turbines.
The clean hydrogen fuel can be used to run a fleet of autonomous fuel cell electric buses available on demand to mine personnel thus reducing initial capital cost for civil and electrical works associated with traditional car parks for individual fleet vehicles

The hydrogen fuel can be used for other vehicles on site such as cars and forklifts
In the case of new mining operations under development, a re-think of the traditional linear, open-loop design process is needed so as to instead consider the mining camp as a biosphere or integrated, closed-loop system with drastic energy and transport use reduction.
Summary

Industry needs to drive the change that is being initiated by policy makers, hydrogen energy is a key part of this change.

Take technology precedents from other industries to enable a faster track to a lower fossil fuel future.

A change to a systems thinking approach is required to fully realise the economic and technical benefits of the change.