Renewable Energy in the Resources Sector
Western Australia has recently seen declining demand for electricity on the primary electricity grid, the South West Interconnected System. However, demand is forecast to grow in off-grid areas, where abundant high quality renewable energy resources are available, driven primarily by resources sector projects.

The state has almost 3,200 megawatts (MW) of installed generation capacity in off-grid areas. Over 700 MW of this capacity is powered by liquid fuels, primarily diesel, and around 89 per cent is to service industrial applications, predominantly resources sector operations.

While the business case for augmenting existing generation with renewable energy in the state’s resources sector has been strengthened by access to high quality renewable energy resources, the decreasing price for several renewable energy technologies, and cost pressures on fuels for traditional generation, renewable energy uptake in Australia’s resources sector has been limited due to several barriers.
Integrating Renewable Energy

The Business Case

The increase in energy demand and generation cost, together with the state’s abundance of high quality renewable energy resources, make the integration of renewable energy generation into resources sector operations more attractive.

Longer mine life, higher fuel price, or the continued decline in the cost of renewable energy technologies, further strengthen the business case for integration.

Modelling indicates a solar photovoltaic (PV) system integrated into existing diesel fired generation, assuming a capital cost of $2.2 million per MW and diesel delivered at 100 cents per litre, would breakeven for a mine with a life of as few as seven years.

Internationally, several resources sector projects have successfully integrated renewable energy generation. These case studies demonstrate, under the right economic drivers and with qualified power system engineers and integrators, renewable energy can play an important role in providing reliable, sustainable and lower cost energy.

ARENA has committed funding to renewable energy projects and studies in Australia’s resources sector and will be sharing the findings to assist in overcoming the barriers to uptake and increasing the sector’s confidence in renewable energy as a form of reliable and lower cost energy supply.

Opportunities

- Renewable energy can offset fuel expenditure and improve certainty and diversity of supply in remote locations, while also hedging against fuel price volatility and any mechanism to price carbon.
- Through arrangements such as a build-own-operate model, renewable energy can be delivered off-balance sheet with little to no upfront capital expenditure in return for electricity off-take agreements that immediately reduce operating costs.
- Renewable energy can lower operational risk by diversifying energy supply sources, reducing the running time of traditional generators, and allowing for improved scheduled downtime servicing.
- Technology advancements mean renewable energy integration and control challenges, such as intermittency, balancing and forecasting, can be overcome and managed.
- Solar PV systems can be retrofitted in a short period of time into existing diesel powered systems with few or no power interruptions.
- Further development of scalable and transportable renewable technologies can reduce the importance of longer mine lives for project viability.

Barriers

- Opportunity costs of foregone mining production are substantial, favouring tried and tested generation over renewable energy, which may have reliability and intermittency concerns.
- Achieving higher renewable energy penetration levels can be challenging because renewable energy supply profiles may not match load profiles for mine sites, which typically maintain 24 hour operations.
- Renewable energy requires a long payback period and investment in renewable technology or power purchase agreements can have substantial balance sheet impacts that are unlikely to be viable for projects with a relatively short or uncertain mine life.
- Where mining projects have access to natural gas for electricity generation, the business case for renewable energy is made more challenging. Liquefied natural gas, compressed natural gas and electricity network extensions can also be cost competitive alternatives to renewable energy.
- Renewable energy power purchase agreements can create long term liabilities and conflict with existing arrangements with power station operators or fuel suppliers, which may act as a disincentive to fuel saving.
- Seasonal adverse weather events, which are prevalent in the state’s north west, can pose a greater risk to generation outages for renewable energy than for traditional generation.
- Availability of suitable land can prove more challenging for renewable energy as some technologies require a substantially larger footprint than traditional generation.

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Integrate solar photovoltaics or continue using diesel?

Integrate solar photovoltaics (renewable energy LCoE < diesel SRMC)

Continue using diesel (diesel SRMC < renewable energy LCoE)

Source: AECOM

4 Levelised cost of energy (LCoE) and short run marginal cost (SRMC)
5 AECOM modelling
Diavik Diamond Mine is located in the remote tundra of Canada’s Northwest Territories, 220 km south of the Arctic Circle on an island in a lake, Lac de Gras. Diavik Diamond Mine is an unincorporated joint venture between subsidiaries of Rio Tinto and Dominion Diamond Corporation. It is projected to produce more than 130 million carats of diamonds over its 16 to 22 year mine life. Extreme isolation and logistical challenges in securing reliable power to the off-grid mine site created a need to develop a cost effective energy solution. Wind power was an attractive and economical option to offset diesel requirements.

THE RENEWABLE PROJECT
The CA$31 million project consists of four 2.3 MW Enercon wind turbines, designed with a gearless direct drive generator. The project aimed to generate 10 per cent of the mine’s 22 to 26 MW load from wind energy. In 2013, the wind farm supplied 8.5 per cent, on average, of the mine’s power needs, reducing CO2 emissions by 10,726 tonnes. Instantaneous wind energy penetration of 58 per cent has been achieved for short periods. Over the first six months of 2014, the wind farm provided 10.3 per cent of the mine’s power and reduced diesel fuel usage by 2.5 million litres, which is on track to meet feasibility study projections.

THE DRIVERS
Diesel supply costs are high due to the remote location. For most of the year the mine can only be accessed by air, with road deliveries possible during an eight week period across a 385 km seasonal ice road. Diesel for the remainder of the year has to be stored at the mine. Diavik Diamond Mine also had a strong corporate commitment to operating the mine sustainably and reducing carbon emissions.

THE CHALLENGES
Finding technology suitable for the harsh conditions was a challenge. Regional temperatures vary from -40°C to 20°C and lightning strikes are common on the island. Logistics posed a significant challenge – the turbine blades were the longest loads ever taken on the ice road. Turbine reliability was also crucial as any service equipment and spare parts also need to be transported on the ice road or stored at the mine site.

KEY LESSONS
Understanding the renewable energy resource was important. Diavik Diamond Mine conducted a three year wind data study before committing to the project. The meteorological tower was then donated to Det’on Cho Earth Energy, a local Aboriginal joint venture company.

Building a supportive internal team enabled working through early challenges, such as solving frost build-up on the blades and lubrication and electronics problems, which arose during the first winter of operations. Ensuring the initial installation was conservatively designed also allowed knowledge to be more easily transferred throughout the organisation.

Communities were informed early and updated throughout the project.

Higher penetration rates can be accommodated without the need for grid management technology such as batteries.

“The Diavik Wind Farm is the first major intermittent renewable project for Rio Tinto and has been very successful. Where applicable, the key lessons learned will be transferred to potential wind and solar PV projects across our operations internationally. Rio Tinto is continually evaluating new opportunities for renewable energy and is currently considering several projects in Australia.”

Ian Palmer, Senior Analyst — Integrated Planning & Performance, Rio Tinto

Diavik Diamond Mine: www.diaavik.ca
CRONIMET Mining Group’s chrome mine, CRONIMET Chrome Mining South Africa Pty Ltd (CCMSA), is located in Limpopo province, around 250 km north west of Johannesburg. CCMSA holds 30 year mining rights for the site, which is currently open cast.

The mine produces 35,000 tonnes per month of chromium ore and plans to expand up to 90,000 tonnes per month.

Due to its remote off-grid location, CCMSA employed its group power unit, CRONIMET Mining Power Solutions, to plan, finance, build and operate a turnkey hybrid renewable energy system, retrofitting the captive diesel mini-grid with a 1 MW solar PV plant to power the mine.

"With virtually no variable operating expenses, the PV plant’s running costs are extremely low. As it is a hybrid solution, the diesel generators are always able to ramp up to 100 per cent of power in a matter of seconds if a large weather front were to create cloud coverage that dropped the PV plant output by 80 per cent in a short period."

Rollie Armstrong, Managing Director, CRONIMET Mining Power Solutions

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THE RENEWABLE PROJECT

CRONIMET Mining Power Solutions engineered, arranged financing, constructed and now operates the US$2.66 million PV system, which comprises 4,158 solar panels and 63 decentralised inverters installed on a hectare of unused land at the mine.

Prior to retrofitting with the PV system, the mine relied on two 800 kilovolt ampere diesel generators to supply the mini-grid. A fuel saving computer controller now enables the power systems to communicate immediately, regulating PV output and guaranteeing system stability and reliability. This allowed CRONIMET Mining Power Solutions to safely penetrate the existing diesel mini-grid with a ratio of 60 per cent PV power with no storage required.

The PV system is regulated to produce no more than the maximum available spinning reserve of the diesel generators and no more than 70 per cent of the maximum load, so the generators never operate below 30 per cent output. If the PV system drops out, the generators ramp up immediately to prevent system collapse and guarantee system stability.

CRONIMET Mining Group owns and operates the PV system through an affiliated holding company that entered into a power purchase agreement with CCMSA.

The PV system was planned and constructed in less than six months and commissioned in November 2012. CRONIMET Mining Power Solutions was able to integrate the PV system to the mini-grid without plant disruptions.

THE DRIVERS

1.9 million litres of diesel was previously used to power the mine each year. The PV system has reduced this to 1.45 million litres – an annual diesel saving of 20 to 30 per cent.

Depending on the cost of diesel and solar irradiation on site, the PV system will breakeven in three to five years, providing a 20 year hedge against rising diesel costs, as all PV power is effectively purchased upfront.

THE CHALLENGES

There were few challenges integrating the PV system. The technology was proven, CRONIMET Mining Group had the expertise, and the PV system was planned for the climatic conditions and reliability requirements of the mine.

The interfacing and control challenges were overcome and the concept is now proven and can be implemented to off-grid diesel generator systems without technical issues.

KEY LESSONS

The system integration must be optimised to the different requirements of the diesel generator, considering transient response time, sequencing strategy, and controller technologies.

Diesel generators are proven and are able to handle large inductive load changes. They can easily react to power output deviations from a PV system caused by cloud movements.
ABOUT CME
The Chamber of Minerals and Energy of Western Australia (CME) is the peak resources sector representative body in Western Australia. Having been in operation since 1901, the role of CME is to champion the Western Australian resources sector and assist it in achieving its vision to lead the world in sustainable practice through innovation and to underpin Australia’s position in the global economy.

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ABOUT ARENA
The Australian Renewable Energy Agency (ARENA) was established by the Australian Government as an independent agency on 1 July 2012 to make renewable energy technologies more affordable and increase the amount of renewable energy used in Australia. ARENA invests in renewable energy projects, supports research and development activities, boosts job creation and industry development, and increases knowledge about renewable energy.

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ABOUT AUSTRADE
The Australian Trade Commission – Austrade contributes to Australia’s economic prosperity by helping Australian businesses, education institutions, tourism operators, governments and citizens as they:
- develop international markets;
- win productive foreign direct investment;
- promote international education;
- strengthen Australia’s tourism industry; and
- seek consular and passport services.

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