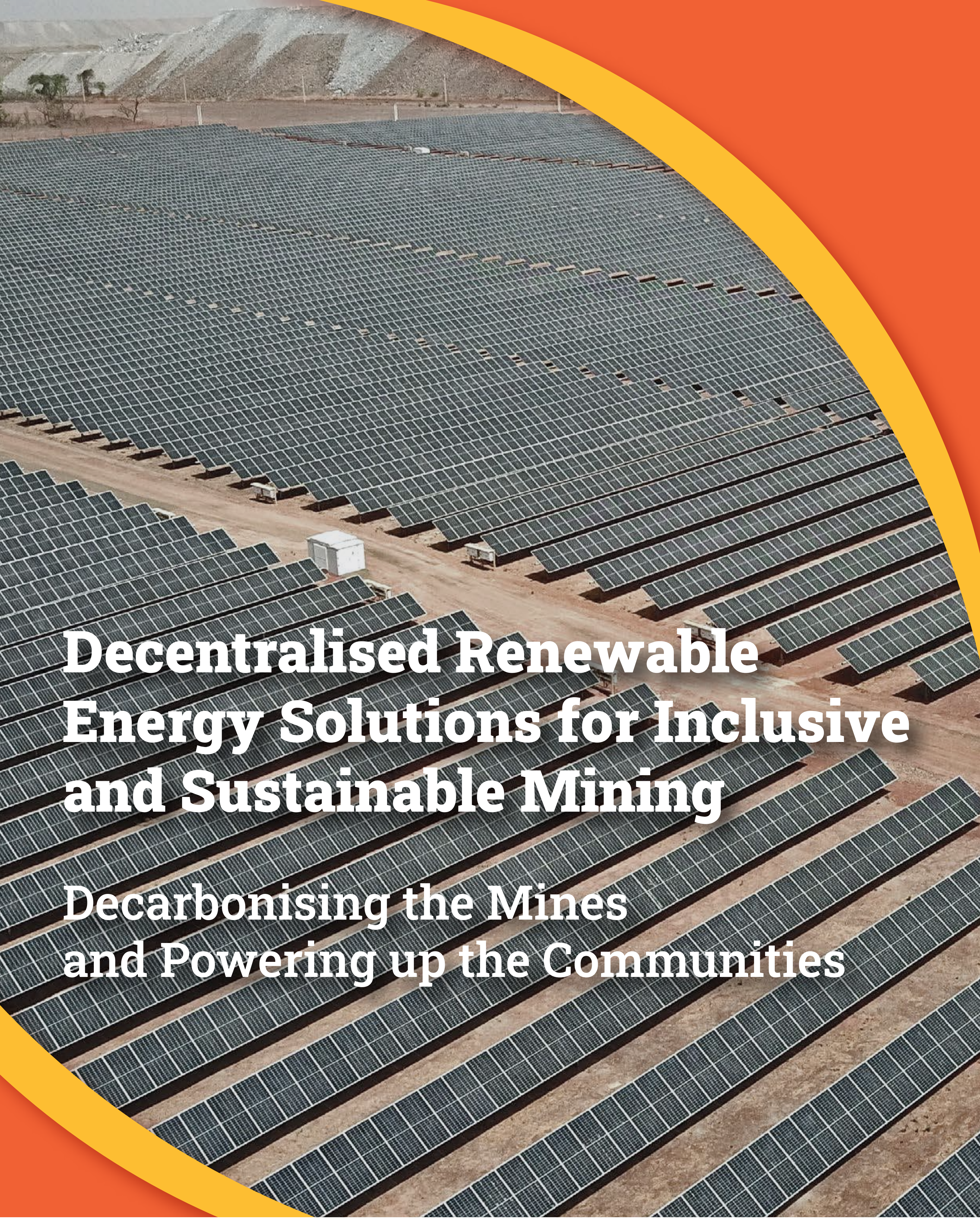

Decentralised Renewable Energy Solutions for Inclusive and Sustainable Mining

Decarbonising the Mines and Powering up the Communities

UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

ITPO
UNIDO NETWORK OF INVESTMENT AND TECHNOLOGY PROMOTION OFFICES
BONN, GERMANY

Alliance for Rural Electrification
Shining a Light for Progress

Sustainable infrastructure development can be achieved by introducing decentralised renewable energy systems in the mining sector and by powering surrounding communities. This will ensure a sustainable mineral supply for the energy transition while increasing electricity access to underserved regions

7 AFFORDABLE AND CLEAN ENERGY

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

Imprints

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Design & Layout: Alliance for Rural Electrification (ARE)

Cover Page Photo Credit: B2Gold

Date of Publication: December 2021

About ARE: Established in 2006, ARE is the only global business association that represents the whole decentralised renewable energy sector for integrating rural electrification in developing and emerging countries.

With more than 185 Members, ARE is the global association for the decentralised renewable energy (DRE) industry, catalysing private sector-driven markets for sustainable electricity services, creating jobs and powering equitable green economies.

About UNIDO ITPO Germany: The UNIDO Investment and Technology Promotion Office Germany (UNIDO ITPO Germany) opened in 2017 at the UN Campus in Bonn. It was founded based on an agreement between the United Nations Industrial Development Organization (UNIDO) and the German Federal Ministry for Economic Cooperation and Development (BMZ). ITPO Germany supports German and European technology providers and investors to find potential partners in developing countries. The office additionally advises companies and representatives from developing countries on sustainable and innovative technologies.

About the ITPO & ARE cooperation:

The UNIDO ITPO Germany - ARE cooperation was established in the wake of the MoU signed between UNIDO and ARE in January 2019. Autumn 2020 marked the commencement of this cooperation with the common objective to foster cross-sectoral coordination, technology exchange and business matchmaking. The ITPO-ARE cooperation aims to showcase technologies, expertise and experience of German/European companies from the DRE sector in emerging markets. Along with that, the cooperation is also striving to facilitate interaction between key DRE stakeholders by providing a strong platform enabling further investments to be mobilised towards global energy access efforts and the achievement of SDG-7 and other SDGs by 2030.

List of Abbreviations

ARE: Alliance for Rural Electrification

ARENA: Australian Renewable Energy Network Association

BESS: Battery Energy Storage Systems

CBE: CrossBoundary Energy

CCSI: Columbia Center on Sustainable Investment

CO_2: Carbon dioxide

CSP: Concentrated solar power

CSR: Corporate Social Responsibility

C&I: Commercial and Industrial

DRE: Decentralised renewable energy

EPC: Engineering Procurement and Contracting

ESG: Environmental Social Governance

ESIA: Environmental and Social Impact Assessment

EUR: Euro

EV: Electric Vehicle

GHG: Greenhouse Gas

GW: Gigawatt

HFO: Heavy Fuel Oil

ICMM: International Council on Mining and Metals

IFC: International Finance Corporation

IPP: Independent Power Producer

IRR: Internal Rate of Return

ITPO: Investment Technology Promotion Office

J/V: Joint Venture

KEGS: Kinetic Energy Generator System

KV: Kilovolt

MW: Megawatt

MWh: Megawatt hours

NPV: Net Present Value

O&M: Operation and Maintenance

PPA: Power Purchase Agreement

PV: Photovoltaic

QMM: QIT Minerals Madagascar

RE: Renewable Energy

SDG: Sustainable Development Goal

UNIDO: United Nations Industrial Development Organisation

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Foreword

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Foreword

The global mining sector is currently facing a conundrum. As a growing energy and emission-intensive industry, the mining sector continues to be exposed to policy and regulatory risks arising from concerns of climate change and impacts on the environment. The remoteness of mine sites and difficulty in accessing reliable electricity grids, has compelled the industry to heavily depend on fossil fuels as an energy source, especially for extractive and transportation equipment, as well as for mineral processing. This has positioned the mining sector to be among the highest greenhouse gas (GHG) emitters. With the Paris Agreement aiming to combat climate change[1] and the 2030 Agenda for Sustainable Development indicating the urgency to shift to a low-emission global economy, there is a strong need for mining companies to rapidly transition to cleaner energy sources.

Meanwhile, the transition to cleaner energy systems is also bound to increase global demand for key minerals. For example, electric vehicles and battery storage are estimated to account for about half of the mineral demand growth by 2040. This additional demand is estimated to be dominated by lithium, cobalt, nickel, copper and rare earth metals, with lithium seeing a particularly fast growth (almost 90% of total demand for lithium is estimated to come from clean energy technologies by 2040, relative to 30% in 2020).[2] Consequently, as the demand for minerals increase and productivity of mines is further enhanced, energy consumption of the sector is projected to increase by 36% by 2035.[3] This is a particular challenge in emerging economies, where most of the global mining production is sourced from, and where access to modern and reliable energy remains a major challenge.[4]

With power generation playing a crucial role for the mining industry, decentralised renewable energy (DRE) offers a variety of benefits, such as a reliable and modern electricity supply, cost reduction, reduced environmental impacts, as well as the potential to mitigate climate change at scale. The challenge of sustainable power supply for mines also presents an opportunity for renewable energy and mining companies to collaborate with local communities to develop mutually beneficial solutions that meet the demands of both mining operations and surrounding communities. By doing so, local socio-economic development can be catalysed, relationships with communities strengthened and more investments mobilised.

In this context, UNIDO ITPO Germany and the Alliance for Rural Electrification (ARE) are highlighting the opportunity for mining companies and renewable energy providers to enter into partnerships to move towards a responsible and inclusive mining sector. The publication highlights four case studies and two experts' interviews of DRE in mining operations and community electrification and draws the lessons learned for future projects.

1 UN, Paris Agreement, 2015 (online)
2 IEA, The Role of Critical World Energy Outlook Special Report Minerals in Clean Energy Transitions, 2021 (online)
3 CCSI, The Renewable Power of the Mine, 2018 (online)
4 UNIDO, World Statistics on Mining and Utilities, 2016 (online)

In this publication, “responsible and inclusive mining” refers to the shared use of DRE infrastructure to power both the mines and nearby local communities. This provides an effective approach to address multiple challenges at once, especially SDG-7: addressing access to affordable, reliable, sustainable and modern energy for all and SDG-9: aiming to build resilient infrastructure, promote sustainable industrialisation and foster innovation.

Michael Schmidt
Deputy Head
UNIDO ITPO Germany

David Lecoque
CEO
Alliance for Rural Electrification

1. Introduction

Introduction

> If it wasn't grown, **it was mined or drilled**
>
> Daniel, M. Franks, 2015

ca. 1,600 tonnes

of minerals are consumed by one human during their lifetime*

*The World Counts, Mining, 2021

Modern economies are largely dependent on extraction of minerals. This includes a wide range of industries, such as manufacturing and construction, utilities, high-tech businesses, as well as clean energy technologies, which for example rely on lithium, cobalt, nickel, copper and rare earth metals.

Some emerging economies rely on mining activities for their well-being. Figure 1 illustrates the degree of dependency of a given country's economy on mining activities. If managed well, inclusive and sustainable mining can provide great opportunities for rural socio-economic development, climate change mitigation and renewable electrification especially in countries with the highest MCI score.

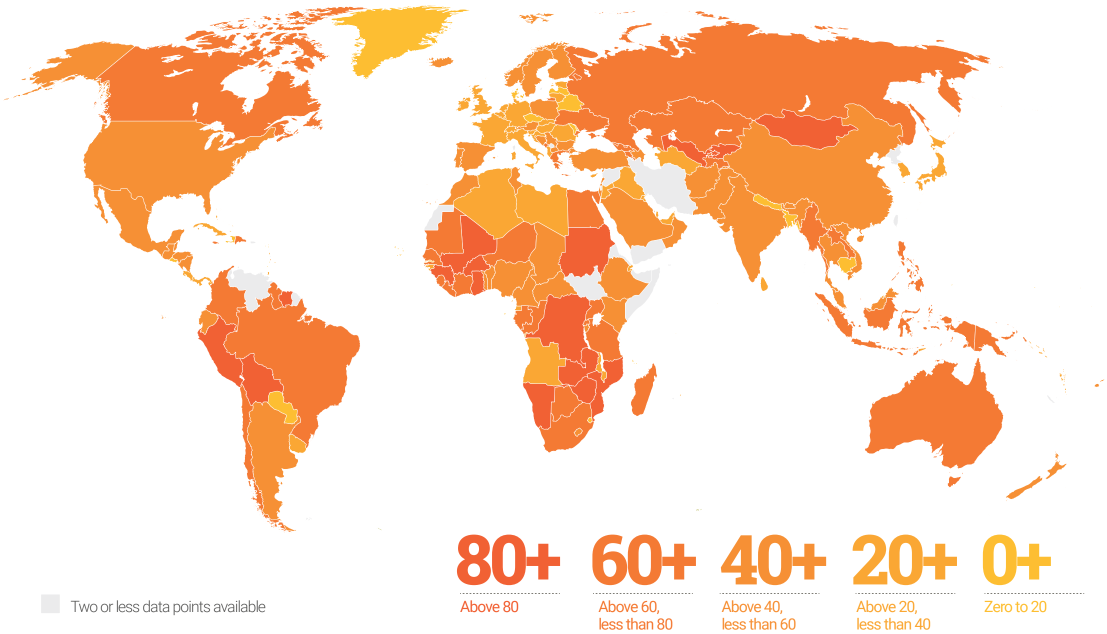

Figure 1: The Mining Contribution Index (MCI) illustrates the relative importance of the mining sector's contribution to the national economies, ICMM (2020)

1.25-11%

of global energy demand is derived from mining. That number is going to **increase by 36% by 2035** due to decreasing ore grades and growing mineral demand.*

*See footnote 3

Mining, a significant energy consumer, requires a constant and reliable source of power for its operations. The remoteness of mining sites, coupled with the need for a consistent baseload often implies limited access to the existing electricity infrastructure. This has compelled the industry to be heavily reliant on fossil fuel consumption to meet its energy requirements, making it one of the largest sources of CO_2 emissions.[5]

In recent years, there is an increase in the deployment of renewable energies in the mining sector. While there were 600 MW of installed power by renewable sources in mining in 2015, the number reached almost 5 GW in 2019 globally (incl. planned projects).[6] The benefits of deploying DRE solutions is clear: besides the obvious environmental and climate mitigation improvements, cost reduction is also a crucial factor, as the use of fossil fuels in off-grid scenarios is usually more expensive.

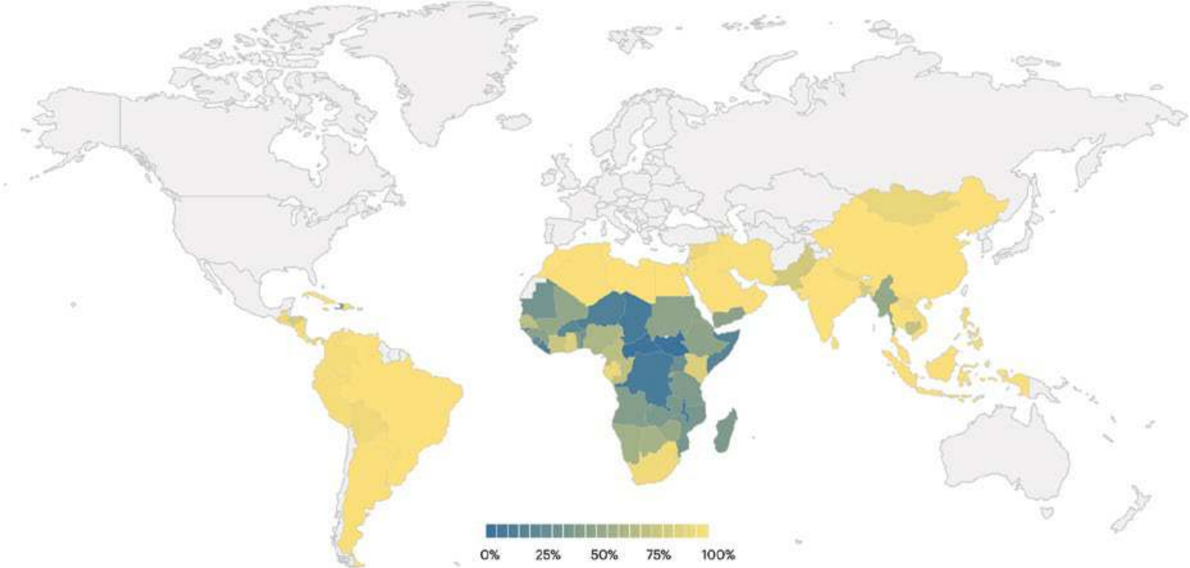

Figure 2: Proportion of population with access to electricity, IEA (2019)

5 See footnote 3
6 JISEA, Integrating Clean Energy in Mining Operations: Opportunities, Challenges, and Enabling Approaches, 2020 (online)

62%

of the energy used in mining
is fossil fuel based*

* See footnote 3

4-7%

of global GHG emissions*

* McKinsey & Company, Climate risk and decarbonization: What every mining CEO needs to know, 2020 (online)

80%

of the emissions arising from gold mining are directly related to power generation

'Inclusive Mining' refers to Electrifying mines and nearby local communities

Many resource-rich developing countries relying on mining activities for economic growth are now facing a major challenge to maintain their competitiveness in a low-carbon future. As renewables continue to become an increasingly cost-competitive source of power generation, mining companies are exploring the opportunities that renewable energy presents as one of the approaches to becoming a more sustainable, inclusive and responsible industry. The introduction of DRE can play a crucial role for the mining industry offering a variety of benefits such as a reliable electricity supply in often underserved areas, cost reduction, reduced environmental impact, as well as the potential to mitigate climate change at scale.

Access to modern and clean electricity remains a major issue in developing countries (Figure 2).[7] As it stands, 759 million are without access to electricity,[8] with another 2.8 billion[9] suffering from unreliable electricity services, particularly in remote areas of developing countries where many mining operations are located. Realising the concept of shared use of DRE infrastructure for mines and local communities could help facilitate dialogue and collaboration between mining companies, nearby communities and DRE project developers. Thereby, mutually beneficial solutions that meet the energy needs of both mining operations and surrounding communities can be developed.

However, as observed from the case studies and interviews highlighted in this publication, several key challenges must be addressed to enable a move towards a responsible and inclusive mining sector.

7 See footnote 4
8 ESMAP, The Energy Progress Report, 2021 (online)
9 The Rockefeller Foundation, Ikea Foundation and The Rockefeller Foundation Join Forces to Set up a Historic $1 Billion Initiative to Catalyze Investments in Distributed Renewable Energy, 2021 (online)

Key Challenges & Recommendations in Implementing Shared Use DRE Infrastructure in Mines

Challenges	Recommendations
1. GOVERNANCE STRUCTURES: Lack of clear policy guidelines for mining companies and complex energy regulations discouraging energy stakeholders and mining companies to initiate shared use DRE infrastructure at mine sites.	Continuously engage local constituencies in all stages of the project, through communications, consultations and develop an inclusive governance structure.
2.WORKFORCE AWARENESS & SKILLS: Many communities have limited awareness of opportunities and skills with regards to operating renewable energy systems. This is why training is often a necessity to develop local capacity and retain workers in remote areas.	Develop capacity building initiatives to help technical and managerial knowledge transfer and raise DRE awareness to local communities creating local skilled jobs, such as field technicians and operators, local project managers.
3. REMOTE & CHALLENGING CONDITIONS: Many mine sites and communities are located in harsh geographic regions with limited and or unreliable electricity supply.	Bring in innovative DRE technologies and reliable long-term partners that can provide capital as well and innovative business models that allow for demand variability.
4. LOW DEMAND FOR ELECTRICITY IN REMOTE COMMUNITIES: Limited economic activity and productive-use customers in remote and sparsely populated communities may limit demand for electricity and the long-term sustainability of business models.	Invest in local communities and productive uses of renewable energy prospects, as well as in entrepreneurial training, which can help catalyse demand and create local jobs in the long-term.
5. GENDER INEQUALITIES: Underrepresentation of women leading to missed socio-economic opportunities for communities and companies.	Embed a gender-lens in all projects to enhance local green job opportunities, education and training, and empower women to start small businesses, while improving education and health for themselves and their families.
6. COVID-19 RESTRICTIONS: Difficulties in delivering key components of a project and tasks in a timely manner, ultimately delaying the overall process.	Strong engagement between policymakers, DRE project developers, mining companies, local stakeholders and communities to help alleviate the impacts of the pandemic on a greater scale. At local level, for example, local stakeholders can be involved to help gather data needed and undertake some project tasks, e.g., contracting, site investigation and field operations.
7. MINING INDUSTRY & INVESTMENT STRUCTURE: The structure of the mining investment makes it difficult to integrate DREs before mine's end-of-life thus increasing financial risks of DRE projects at mine sites.	Mining companies in tandem with RE project developers could raise additional national/international funding to help reduce up-front capital costs. Developing aligned business models and incentives between mining companies and DRE developers to ensure assurance of return of investment. Pooling of power infrastructure with nearby communities without access to grid connections can help create economies of scale needed to support DRE projects.

2. Key Recommendations

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Key Recommendations

While there is undoubtedly high potential for a 'shared use' approach for DRE infrastructures to power mining operations and local communities, these projects also face numerous challenges. The following section provides key recommendations derived from the case studies and the expert interviews.

Challenges

- Governance structures
- Workforce awareness & skills
- Remote & challenging conditions
- Low demand for electricity in remote communities
- Gender inequalities
- COVID-19 restrictions
- Mining industry & investment structure

Recommendations

- Develop clearer and inclusive governance strutures
- Develop capacity building initiatives on ground
- Introduce innovative DRE technologies and business models
- Invest in local communities, productive uses and entrepreneurial training
- Embed gender equality and a gender-lens throughout projects
- Strong local stakeholder engagement and involvement in projects
- Build mining-energy partnerships and align mining and RE business models

Benefits

- Investor attraction
- Local socio-economic development
- Grid reliability & energy independency
- Women empowerment
- Decarbonisation of both electricity and mining sector value chains
- Cost savings
- Enhanced sustainability and efficiency of projects
- Achievement of SDG-7 and SDG-9

Different approaches of electrifying communities – What are the opportunities?

This publication provides four different approaches that can be adopted to build an inclusive mining industry with DRE solutions. The geographical conditions of the mine and the regulatory framework in the country of operation are crucial to decide which approach is most suitable. However, it is essential to involve the communities and local stakeholders as early as possible to ensure relevance to the local context and contribute to increased ownership and commitment from the communities.

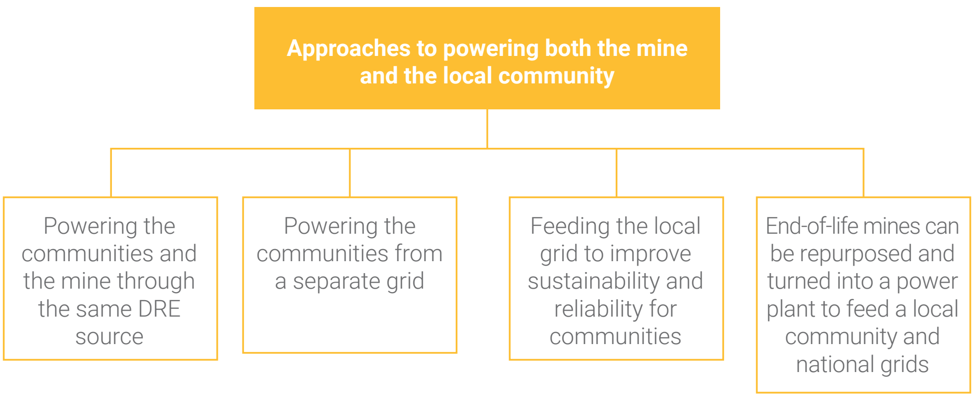

Figure 3: Different approaches of electrifying mining operations and local communities with DRE solutions, as highlighted by the case studies

Key recommendations for public sector stakeholders, mining companies, energy providers & communities

1. Develop clearer and inclusive governance structures: It is recommended to hardwire a solid governance structure when developing inclusive renewable electricity projects for mines. This requires regular engagement with key stakeholders (Figure 4), especially local communities and governments. Communication and engagement before and throughout the implementation process are important to achieve the best possible outcome.

Building on experience from the featured case studies, strong governance can have positive effects on the outcome of inclusive renewable energy mining projects. This is especially the case when communities have been proactively engaged via transparent and regular communications and consultations, ensuring that advice, valuable inputs and concerns of all stakeholders are addressed in the early stages of projects. On that note, it is recommended to initiate every inclusive mining project with a stakeholder mapping in order to ensure appropriate and effective engagement with local constituencies.

This is best illustrated in the 247Solar Inc. case study where the RE company is working alongside representatives from the local mining company, government and the community by holding regular meetings and consultations, resulting in robust DRE solutions that regard the interests of all stakeholders.

Figure 4: Stakeholder engagement

Also, for governments, it is recommended to further enhance enabling regulatory environments, which:

1. Enable and catalyse the deployment of DREs for energy-intensive industries such as mines
2. Enable and encourage sharing of DRE infrastructure with communities, local grids or businesses in the area.

Another best case example for good governance structure is seen in South Africa, which recently allowed the installation of 100 MW energy projects without the requirement of a license.[10]

2. Develop capacity building initiatives: In the context of skills development, there are two major issues with regards to renewable energy. One is that the majority of the population residing in remote areas have limited access to education. This may limit awareness of the opportunities renewable energy provides for the communities. Also, there may be critical views on renewable energies due to potential intermittency problems. It is recommended to integrate educational campaigns when implementing renewable energy projects to raise awareness within communities on the benefits and need for renewable energy solutions.

The second issue is limited technical skills in rural and remote communities to operate renewable energy projects and in some cases limited skills transfer to communities. Capacity building for local communities is particularly important to create economic development and unlock new job opportunities. This includes technical training for field operators and installers and in turn enabling locally trained technicians to be hired by mining or renewable energy companies to operate the renewable energy projects.

3. Introduce innovative DRE technologies and business models: Many mine sites and communities are located in isolated and harsh geographic regions where access to reliable electricity remains a major challenge. Due to their locations, dependency on fossil fuels (usually imported) is high, extension of existing electricity grids is not viable and power supply is limited and unreliable. The deployment of DRE solutions in such areas, combined with energy sharing, allows for a high penetration of renewables into either the existing local grid or new greenfield projects without compromising stability or reliability. Moreover, RE systems based on a mix of technologies (hybrid) are especially suited for off-grid mining sites, as they decrease dependency on a single power source and help improve grid resilience and reliability. Hybrid systems include a mix of renewable energy sources (e.g., solar and wind) in addition to energy storage. Energy storage can play a key role in that regard by providing backup power hereby ensuring a consistent power supply for mining operations even when the sun is not shining, or the wind is not blowing.

During extreme weather events, for example, DRE operators have the further advantage and ability of being able to quickly assess the extent and location of damage to power infrastructure that may result in outages. DRE thus has an advantage in emergency situations where power for infrastructure is crucial. To make best use of this advantage, it is recommended to leverage modern technologies to facilitate grid reliability, resilience and safety. These technologies include, but are not limited to, advanced sensors that allow operators to assess grid stability, digital and smart meters that report outages and electricity consumption, line sensors and smart relays that sense and recover from faults in the substation automatically, modern

10 CleanTechnica, South African Companies Now Allowed To Generate Up To 100 MW Without Applying For Generation License, 2021 (online)

control and management systems, and remote monitoring. Embedding these modern DRE technologies in addition to RE hybridisation will further greatly reduce the frequency and duration of power outages, reduce extreme weather impacts, and improve the reliability of electricity supply.

In addition to modern technologies, the choice of the renewable energy solution provider is also an important factor. From an early stage of project conceptualisation, project developers and mining companies need to ask themselves if the electricity service company can provide the necessary experience and know-how in community and renewable electrification to make the projects a success. ARE offers the opportunity to connect with experienced technology and service providers in this regard.

Lastly, it is recommended to account for demand fluctuation in all community electrification projects, including inclusive mining projects. The Suntrace case study provides an example of one potential solution for this issue by implementing a project that caters for both the community and mines energy demands.

4. Invest in local communities, productive uses and entrepreneurial training: Remote communities in emerging markets typically start out by having low electricity demand as they are often sparsely populated with limited economic activity and productive uses of energy. Strong community involvement greatly increases the likelihood of new local businesses emerging, leading to increased electricity demand while creating positive socio-economic multiplier effects.

Investing in local communities and productive uses of renewable energy (PURE) prospects can hereby help catalyse demand and subsequently create local green and skilled jobs. On that note, it is recommended that DRE and mining companies prioritise entrepreneurial training to make use of renewable electricity for income-generation purposes as part of inclusive DRE mining projects. Providing funding opportunities for local communities to purchase productive use equipment or appliances may constitute an additional way of catalysing demand.

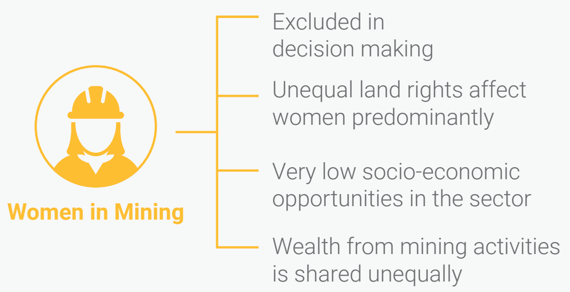

Figure 5: Challenges for women in mining regions

The case study of Suntrace provides an example, in which energy supply via solar panels directly powers social facilities such as schools, health centres and a local market, ensuring that energy is used for community development.

5. Embed gender equality and a gender-lens throughout projects: Gender inequalities with regards to payments, land rights and job opportunities put a heavy burden on women in mining communities, as they are underrepresented in mining activities and in decision making processes. This can lead to missed opportunities of economic welfare for communities and companies.[11,12,13]

Gender expert, Abimbola Olufore, observed that when women participate in negotiation processes, it is more likely, that benefits associated with energy access will be shared equally. The provision of sustainable power infrastructure, in particular, can contribute greatly to achieve gender equality if women´s voices are considered. To achieve an inclusive mining industry with DRE solutions, projects should embed gender equality to provide local green job opportunities, education and training, and empower women to start small businesses, while improving education and health of themselves and their children.

Women Empowerment

1 Include women in decision making processes and negotiations

2 Make sure that energy access is distributed equally among the community

3 Provide opportunities by offering training and jobs especially for women

Figure 6: Embedding women empowerment to help deliver an inclusive mining sector

Moreover, empowered women have positive socio-economic multiplier effects. This is because women are more likely than men to reinvest their earnings within their communities in micro, small and medium-sized enterprises (MSMEs) and vital services such health, education and nutrition.[14]

6. Strong local stakeholder engagement and involvement : COVID-19 restrictions continue to impede DRE implementation efforts globally. For projects under construction, delays in the delivery of key components - which are either halted in transit or under manufacturing – and services are delaying project delivery timelines. In addition, the ability of parties to participate in tender processes may be impaired, particularly if contractors cannot get to the site in order to assess risks to bid competitively. This challenge is, for example mentioned in the CrossBoundary Energy (CBE) case study where the company faced difficulties in contracting and conducting site surveys due to travel restrictions imposed during the pandemic. In this case, strong engagement with local communities from the start of the project and involvement of local contractors played a crucial role in reducing further delays in project activities.

However, there are several measures to be undertaken by different stakeholders to alleviate the barriers associated to COVID-19 restrictions. For example, ARE highlighted five key recommendations to governments, funders and philanthropies in its Call to Action:[15]

11 Oxfam, Gender and the Extractive Industries: Putting Gender on the Corporate Agenda, 2016 (online)
12 Progressio, How can the extractive industries provide 'shared value' for rural women in Africa?, 2015 (online)
13 UN Women, Promoting Women's Participation in the Extractive Industries Sector - Examples of Emerging Good Practices, 2016 (online)
14 ARE & GET.invest, Women Entrepreneurs as Key Drivers in the Decentralised Renewable Energy Sector: Best Practices and Innovative Business Models, 2020 (online)
15 ARE, Call to Action: Roadmap for the DRE sector to survive and flourish in the wake of the COVID-19 crisis, 2020 (online)

1. Creation of a ‘Global DRE Relief Fund’
2. Fast-tracking of existing procurement and funding procedures for DRE projects
3. Pooling of resources for a ‘Rural Electrification Stimulus Plan’ to achieve the SDGs
4. Recognition of DRE sector as an ‘essential service’
5. Step up technical assistance for DRE companies

7. Build mining-energy partnerships and align mining and renewable energy business models: The upfront capital cost of RE systems remains a challenge in comparison to conventional power plants and diesel generators. As highlighted in the CCSI report, “The Renewable Power of the Mine,” aversion to capital expenditure by the mining industry can be problematic when considering options of higher renewable penetration. While RE projects provide cost-effective solutions in the long-term, shareholders may want quick returns on investments. To address this, it is important to create the economies of scale needed to support RE for inclusive mining projects through pooling of power infrastructure with nearby communities. It is also recommended, as highlighted under the CBE case study, for mining companies to build strong partnerships with RE developers (independent power producers (IPPs)) to outsource and fund the renewable energy projects. This will enable mining companies to focus all or a larger share of their own capital investments on high-yielding mining activities.

Conflicting business models between the mining and energy industries provides a further challenge in developing cost-effective renewable contracts. For example, the 20-year PPAs that is predominantly used by utility scale renewable energy developers as a contracting mechanism is not well aligned with the annual energy demand for off-grid mine operations and in most cases, with the lifetime of the mine. It is therefore recommended to develop aligning business models and incentives that ensure mining flexibility and assurance of return on investment for the RE developers.

3. Case Studies


© CrossBoundary Energy

3.1 **247 Solar - Australia**

This case study is situated close to an aboriginal community in Queensland, Australia. The community is currently connected to the national grid. 247 Solar is going to install a hybrid-renewable energy grid for the project, owned by local mining company (80%) and the local community (20%). The renewable plant will feed 100% of the mine's electricity demand, its campsite, and an export jetty. Additionally, the grid will meet 50% of the community's electricity demand with renewable power, sourced from the microgrid. This is an example of satisfying the electricity needs of a mine and a community sourced from the same grid, thus significantly contributing to the achievement of SDG-7, decarbonisation, job creation, climate change mitigation and the expansion of social infrastructure, such as the health centre and school.

Company
247Solar, Inc.

Name of project
Local Community Township

Location of project
Queensland, Australia

Project period
Jan 2022 - Dec 2024

Total project budget
EUR 35,000,000

Total Project Budget

	Amount in EUR	Financing organisation
Grant	1,900,000	Queensland government
Debt	6,600,000	Federal government (ARENA)
Equity	26,500,000	TBC

Stakeholders

Organisation	Role in the project
Mining company	• Project development & implementation • Mine operator • Mine owner (80% shareholder)
Local Aboriginal Community	• Traditional landowner (Native title; Deed of Grant in Trust awarded in 1986 of total area of 110,000 hectares of land) • 20% shareholder in joint venture (J/V) with the mining company • DRE beneficiary
Engineering Procurement Construction (EPC)	• 247Solar's local partner in Australia: installation, commissioning and O&M

Financing Entities	**Queensland State Government:** • Grant of up to EUR 1,600,000 • Loan of up to EUR 1,600,000 • Other financial assistance: up to EUR 300,000 (local employment) **Australian Federal Government:** • Loan of up to EUR 5,000,000 (ARENA)

Context

Population of mining area & surrounding communities	• **Local community township:** 950 (2021) growing to 1,150 within 2 years of mine commencing operations • **Mine campsite & facility:** 75 • **Export jetty:** 20
Type of energy source before DRE system intervention	• **Mine:** Diesel • **Mine campsite:** Diesel • **Local community township:** On-grid but unreliable and expensive • **Export jetty:** No power
Energy requirements of mine and community	• Total of 4 sites on total land area of 2,100 km^2 • Total estimated demand of 8 MW across all 4 sites based on a preliminary feasibility study completed in Q4, 2020 (To be confirmed by separate independent consultant's Power Feasibility Study which will be completed by end Dec 2021)
Distance from the national grid	• **Mine:** 30 km • **Mine campsite:** 25 km • **Export jetty:** 40 km
Grid extension plans	• No plans for government grid expansion • Queensland State government encouraging private sector for all DRE

DRE Solution

Type of renewable energy solution	• **Hybrid microgrid (247Solar Project Lead) combining:**
	  • Concentrated solar power (CSP) (247Solar)
	  • Wind (STAG technologies)
	  • Solar photovoltaic (JinkoSolar)
	  • Storage (247Solar)
	  • Control System (Smarter Microgrids Ltd.)
	    • Phase 1: 3 MW & Phase 2: 5 MW
	    • **Duration of Project:** 3 years

Energy storage & backup power capacity	• Storage (247Solar HeatStorE long duration thermal storage: 1 MW / 9 MWh • Turbines integral to HeatStorE can burn diesel for backup • All 247Solar turbines will be green hydrogen enabled by end Q1, 2022
Negotiation with the local community	• Primary negotiation between the mining company and the local community representatives • Secondary negotiation between 247Solar and the mining company with access to local community representatives

Involvement of locals at different stages of the DRE project	• Major involvement of Local Community Congress:
	  • All local mining permits and approvals
	  • Selection of DRE partners and suppliers
	  • All environment impact studies
	  • Local employment and career path development working at mine site
	  • Upgrading of all Commercial & Industrial (C&I) businesses located in the community
	• Major on-going decision making regarding all environmental, social & governance (ESG) matters

Contractual regulation	• Contractual regulations of both local Shire councils and Queensland state government • Power Purchase Agreement (PPA) to be signed between 247Solar (or our introduced Independent Power Producer (IPP)) & local community

Outcomes

<table>
<tr><td rowspan="1">Mining operations powered by DRE solution</td><td colspan="2">Mine site: 100% (diesel back-up)
Mine campsite: 100% (diesel back-up)
Export jetty: 100% (No diesel back-up since jetty only in operations 1-2 times per week)
Local community: 50% renewables & 50% Queensland state grid</td></tr>
<tr><td>Expected benefits after project implementation</td><td colspan="2">Reduced carbon footprint of 90%
Reduced cost of energy (power & heat) of 25%
Local employment creation for an estimated 350 persons across all 3 mining related sites and the community township
Enhanced relationship and partnership with local community
Leading showcase example in Australia for how local communities consisting of diverse populations (13 different aboriginal clans and other Australians) can live, work and prosper together.</td></tr>
<tr><td rowspan="3">Advancement in local community electrification status</td><td>Private households</td><td>250</td></tr>
<tr><td>Public institutions</td><td>5</td></tr>
<tr><td>Small businesses and anchor loads</td><td>15</td></tr>
<tr><td>Positive impact on the beneficiaries at both community and mine level</td><td colspan="2">Jobs creation: 350 (mining operations: 150 and local community: 200)
Community infrastructure:
Expansion of healthcare centre/hospital (additional 5 staff)
Expansion of aged care hostel (additional 3 staff)
Expansion of primary school (additional 5 teaching staff)
Expansion of mobile playgroup: kindergarten (additional 2 teaching staff
New clean water solution: artesian bore
Transportation: 3 new electric vehicle (EV) buses
Greater mine workforce and local community pride in implementing a recognised successful DRE project to the benefit of mining operations, local community educational, healthcare and living standards</td></tr>
<tr><td>GHG emissions savings</td><td colspan="2">Mine site: 50,000 tonnes of CO_2 /year
Mine campsite & facilities: 7,500 tonnes/year
Export jetty: 2,000 tonnes/year
Local community township: 35,000 tonnes/year</td></tr>
</table>

Anticipated Lessons

<table>
<tr><td rowspan="3">Expected major challenges & solutions</td><td colspan="2">Time and patience to engage fully with local aboriginal community and win trust and respect</td></tr>
<tr><td>Training and upgrading skills of local aboriginal community</td><td>Solution: investing and developing a local school.</td></tr>
<tr><td>Workforce retention.</td><td>Solution: improving local community pride and sense of ownership in a better integrated mix population community</td></tr>
<tr><td>Key recommendations</td><td colspan="2">• Focus on regular and committed communication: regular ‘town hall’ meetings involving entire community (indigenous and other)
• Genuine commitment
• Appropriate investment in local businesses and corporate and social responsibility (CSR) projects</td></tr>
</table>

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3.2 CrossBoundary Energy – Madagascar

CrossBoundary Energy is installing a hybrid-renewable energy grid for the QIT Minerals Madagascar (QMM) mine by Rio Tinto near the Madagascan town of Fort Dauphin, which is home to about 67,000 people. The current (local) grid is unreliable and is powered by heavy fuel oil (HFO). CrossBoundary Energy's plant will power the mine only, however, QMM exports up to 30% of its generation into the local grid, administered by the state-owned utility, JIRAMA. Thus, accessibility, reliability and sustainability will be increased for the whole town of Fort Dauphin. This case study provides an example of indirect electrification of communities, which could be effective in highly populated areas, as feeding into the local grid can considerably improve electrification status and sustainability.

Company
CrossBoundary Energy (CBE)

Name of project
Rio Tinto: QIT Minerals Madagascar (QMM)

Location of project
Fort Dauphin, Madagascar

Project period
Jun 2021 – Present

Total project budget
EUR 24,152,505

Total Project Budget

Total project budget	Amount in EUR	Financing organisation
Equity	EUR 24,152,505	CrossBoundary Energy

Stakeholders

Organisation	Role in the project
CBE	Project development & implementation
CBE	Project financing
Rio Tinto, QMM Mine, and region of Fort Dauphin	Beneficiaries
Juwi	Engineering Procurement Construction (EPC)
GLW International	International (local environmental consultant)
WSP International	International environmental consultant
Zutari	Technical advisor

Context

Population of mining area & surrounding communities	67,000
Type of energy source before DRE system intervention	HFO medium speed thermal generators
Energy requirements of mine and community	24 MW HFO generating sets
Distance from the national grid	680 km to the nearest alternative source of power
Grid extension plans	The Malagasy government's Stratégie Nationale d'Electrification sets an objective of achieving 70% national energy access by 2030 through both grid expansion and off-grid solutions

DRE Solution

Type of renewable energy solution	• **Solar PV:** 8 MWp • **Wind turbines:** 12 MW • **Battery storage system (BESS):** 8 MW / 8 MWh
Energy storage and backup power	8 MW BESS and 21 MW HFO medium speed generators
Negotiation with the local community	Through an International Finance Corporation (IFC) compliant ESIA stakeholder engagement process executed by local and international environmental consultants
Involvement of locals at different stages of the DRE project	During construction and implementation, local labour will be employed. Local environmental specialists conducted ESIAs for both wind and solar components

Outcomes

<table>
<tr><td>Mining operations powered by DRE solution</td><td colspan="2">Rio Tinto's QIT Minerals Madagascar (QMM)</td></tr>
<tr><td>Expected benefits after project implementation</td><td colspan="2">• Environmental emission reduction
• Operating cost reduction
• Reliability and sustainability
• Recourse and defer risk
• Focus on core mining activities</td></tr>
<tr><td rowspan="3">Advancement in local community electrification status</td><td>Private households: estimated 50% of population currently connected to local grid</td><td>Overall carbon intensity of the regional grid is reduced by 60% by sourcing electricity from wind and solar as opposed to HFO generators. No government capex outlay required.</td></tr>
<tr><td>Public institutions: estimated 100% grid-connected</td><td>n/a</td></tr>
<tr><td>Small businesses and anchor loads: estimated 50% grid-connected</td><td>n/a</td></tr>
</table>

Positive impact on the beneficiaries at both community and mine level	Approximately 80 local jobs created during construction, reducing to approximately 5 during operation
GHG emissions savings	40,000 tonnes CO_2 equivalent emissions per annum

Lessons Learned

Expected major challenges & solutions	Contracting and site investigations during the COVID-19 Pandemic, restricting travel to Madagascar.	**Solution:** relying on local contractors and consultants, technology and a strong partnership with CBE's counterpart and offtaker
	Construction/permitting of the solar facility within the secondary zone of the aerodrome of an international airport. Limited national standards available to guide aeronautical studies	**Solution:** international standards were used as basis to develop a process in collaboration with Aviation Civile de Madagascar
	Integration of up to 60% renewable contribution onto an isolated, regional grid could render the grid unstable	**Solution:** power quality correction was implemented to support control of the renewable energy (RE) integration and a distributed energy requirement and set of network technical rules were developed in collaboration with the thermal power plant and offtaker to ensure stability and operability of the grid
Key recommendations	• Mines should establish partnerships with energy companies that have the track record to serve as long-term energy services partners • Mines should seek external partners with lower capital costs to fund renewable energy projects in order to focus their own capital investments on high-yielding mining activities • Mines should allow experts to take responsibility for complex hybrid projects – encompassing solar, battery, and wind technologies – for optimal energy and environmental outputs • Private companies can serve as catalysts for greening the generation profile of isolated regional grids at no additional cost to government, provided existing agreements for export of excess energy are in place	

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3.3 New H2o Resources Pty Ltd – Australia

This case study is an example of how old mining sites can be repurposed to generate electricity and water supply in off-grid, as well as in on-grid scenarios. In Ipswich, Queensland, Australia, the Haenke Coal Mine is planned to be repurposed by installing a renewable power plant and an Ilmenite Mine in Queensland, which will provide electricity to the community as well as to the Queensland Government. It is the first of such projects in the world and could be a potential solution for many abandoned mine sites.

Company
New H2o Resources Pty Ltd

Name of project
Haenke Coal Mine repurposing

Location of project
Ipswich, Queensland, Australia

Project period
Mar 2021 - end of 2022

Total project budget
EUR 50,000,000

Total Project Budget

	Amount in EUR	Financing organisation
Grant	15,000,000	ARENA
Debt	30,000,000	Australian Government Energy and Infrastructure Corporation and Queensland Investment Corporation
Equity	15,000,000	New H2o Resources

Stakeholders

Organisation	Role in the project
New H2o Resources Pty Ltd with Hydromine Pty Ltd	Project development & implementation
ARENA (Australian Renewable Energy Network Association) QIC (Queensland Investment Corporation) FIEDC (Australian government Infrastructure and Energy Development Corporation)	Project financing
Australian Government, Queensland Government, local council and communities, mining industry and power supply industry	Beneficiaries
CSIRO (Australian Government research organisation) University of Queensland – SMI (Sustainable Minerals Institute)	Other stakeholders

Context

Population of mining area & surrounding communities	3,000,000
Type of energy source before DRE system intervention	Coal fired power station immediately adjacent at Swanbank – now converted to gas.
Energy requirements of mine and community	This is a 1,000 MW base load supplier for southeast Queensland
Distance from the national grid	It is immediately on the grid with power lines overhead
Grid extension plans	Yes

DRE Solution

Type of renewable energy solution	• **Hydro:** minimum 50 MW expandable to 6 x 50 MW increments • **Solar farms:** 5 MW expandable to 1,000 MW • **Kinetic energy generator systems:** 20 MW expandable to 100 MW
Energy storage & backup power capacity	• Water storage of 45 MW and expandable • KEGS (Kinetic Energy Generator System) with own battery storage for 500 KV
Negotiation with the local community	• Ipswich Council supported and gave approvals • Owner is the major investor • Queensland Government approved and co-funding
Involvement of locals at different stages of the DRE project	• Local earth moving and civil contractor engaged and providing some investment • Power utility engaged from Government
Contractual regulation	• Comes under both Federal as it is above 30 MW and then State Government sections

Outcomes

Mining operations powered by DRE solution	Total site	
Expected benefits after project implementation	• Net Zero Target demonstrated • Self-reliant on power and water needs with good income stream • Able to demonstrate new mine rehabilitation processes • Able to get interest from across mining companies and communities internationally	
Advancement in local community electrification status	Private households	Completed
	Public institutions	Completed
	Small businesses and anchor loads	Completed
Positive impact on the beneficiaries at both community and mine level	• 15 local jobs created • Community infrastructure: clean renewable power options demonstrated and water storage options • Range of other demonstration for hydrogen electrolysers and also how to reuse underground and surface coal mines	
GHG emissions savings	The mine was shut down, but the process would show that mines could now demonstrate > 75% reduction in GHG annual emissions, and the facility will last for many decades after mining completed	

Lessons Learned

Expected major challenges & solutions	• Getting buy-in from government and large mining companies to provide money and a site • H2o had access to senior executives, but some reluctance to proceed with initial studies. Some studies went to big hydro civil companies that did not know issues around coal mines surface and underground was seen as too risky
Key recommendations	Secured a site and convinced owner as well as the global issues around climate change and international funding was dramatically changing the political and business outlooks

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3.4 **Suntrace – Mali**

The Fekola Mine, operated by B2Gold, is located in Mali, close to the border to Senegal and the Fadougou village. The case study contains two elements:

Commercial aspect: Suntrace together with its partner BayWa r.e, were commissioned by B2Gold to support in implementing one of the world's largest off-grid PV-battery hybrid system in the mining industry. Prior to the implementation of the solar project, the mine's electricity was generated from heavy fuel oil generators. By adding the solar PV system with a total output of 36 MWp, 75% of the mines energy demand will be met during peak hours. Further, with the 15 MWh battery storage system as backup, the facility will continue to supply power to the 24-hour operating mine after sunset or during bad weather.

Community aspect: To integrate the community aspect in the project, B2Gold is working on powering over 700 households in the Fadougou village. Following the relocation of Fadougou due to its proximity to the Fekola mining operations, B2Gold, in consultation with the local community, constructed a new village as a means to address the potential social risks of its operations on the community. Additionally, the Fadougou village provides a complete water distribution system (16 filling points), public lighting, and several community facilities such as schools, a mosque, soccer fields, health and maternity centre, and a community market.[16] The PV-hybrid system by Suntrace and the solar panels in the village are not connected to each other. This is an example of having two separate systems instead of distributing electricity from one source. That provides some advantages as the mine and the community are not dependent on the respective energy demands. The following tables only describe the Suntrace project.

Company
Suntrace GmbH

Name of project
B2Gold Fekola Gold Mine

Location of project
Mali, Africa

Project period
Jan – Jun 2019: Feasibility Study

Jul 2019 – Mar 2021: Implementation

Apr 2021 – ongoing: Warranty & Operation Support

Total project budget
Confidential

Stakeholders

Organisation	Role in the project
Suntrace GmbH	• Owner's engineer • Engineering & Procurement & Project Management (EPPM) Contractor

16 B2Gold, Community-owned-project: Completion of new Fadougou, 2019 (online)

B2Gold	• Project owner • On-balance funding (100% equity) • Construction management
Fekola Gold mine	• Beneficiary

Context

Population of mining area & surrounding communities	n/a
Type of energy source before DRE system intervention	Heavy fuel oil fired thermal engine plant
Energy requirements of mine and community	During solar peak production, up to 75% of the mines electrical energy demand is powered by solar
Distance from the national grid	40 km
Grid extension plans	No

DRE Solution

Type of renewable energy solution	36 MWp solar PV plant with 17 MW battery capacity
Energy storage & backup power capacity	15 MWh battery backup power
Negotiation with the local community	Governmental stakeholder
Involvement of locals at different stages of the DRE project	Fadougou village

Outcomes

Mining operations powered by DRE solution	Gold mining operations	
Expected benefits after project implementation	The fuel savings are expected by 19% and 20% is reached.	
Advancement in local community electrification status	Private households	n/a
	Public institutions	n/a
	Small businesses and anchor loads	n/a
Positive impact on the beneficiaries at both community and mine level	Fadougou village was recentred with higher standards	
GHG emissions savings	Approximately 39,000 tonnes of CO_2 equivalent per year	

Lessons Learned

Expected major challenges faced and solutions	COVID19 – progress was delayed in mid-2020	**Solution:** a dedicated and continues project team was key to enable the necessary flexibility and persistence in pushing this project forward through a difficult COVID-19 2020 year
Key recommendations	• Project delivers projected performance at budgeted costs. • Fully operational – blueprint for other off-grid mining operations. • 5 year pay-back period approximately through fuel savings (diesel/HFO)	

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4. What the Experts are Saying

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What the Experts are Saying

Ms. Lungile Mashele, Energy Specialist and Council Member, South African Association for Energy Economics (SAAEE)

Mr. Daniel Rossi, Head of Power Generation CSV & Sustainability Projects, Enel Chile

DRE solutions provide a great opportunity for the mining sector, communities around and whole economies

Lungile Mashele: the deployment of DRE solutions can solve the issue of power outages, which are especially occurring on the African continent and hampering economic activities.

Daniel Rossi: the greatest benefits of DRE solutions in mining are decarbonisation and cost savings. Additionally, combining technologies and including energy storing options are particularly suited for mining activities.

Both experts see an increase in demand for DRE solutions in the mining sector

Daniel Rossi: mining companies have always focused on optimising and efficiency, therefore, also seeking energy supplies through renewable PPAs or contracts. Additionally, new legislation regarding energy efficiency for largest consumers will encourage and accelerate adoption of new technologies for greener processes.

Lungile Mashele: in South Africa, the introduction of the new regulation act, which allows generation of up to 100 MW without the requirement of a special license, is a great opportunity to engage in embedded generation.

Access to electricity is key, especially for mining activities

Lungile Mashele: energy access on small-scale, manual-based mining activities, allows miners to introduce high tech equipment which gets rid of possible child labour elements. Additionally, electricity has a positive effect on the life of the mine.

Daniel Rossi: regulations and the geographical circumstances permitting, sharing infrastructure is a very good measure to develop communities around the mine

Regulation and administrative issues are key challenges encountered

Daniel Rossi: clear responsibilities of each stakeholder and transparent communications need to be established. Questions such as: “Where do you draw the lines between? Sharing to what extent? Who’s responsible? And what if it fails and people are out of power?” are crucial. This is the determining factor of a project’s success or failure.

Lungile Mashele: regulations in some countries do not allow for the provision of electricity to the community. In such cases, there is the possibility to feed into the local grid, if available, which will then provide clean and affordable energy to communities. Otherwise, it is pragmatic to deploy solar panels to community facilities which are running daytime, such as schools.

Risk management plays a crucial role for industries

Daniel Rossi: sharing infrastructure is a very good risk management measure with positive impacts if there are good relations with stakeholders. It also directly contributes to the well-being of the environment in which mines are operating and adds to their reputational value as well. One can also use these shared infrastructures as pilot projects to test out technologies.

Lungile Mashele: cooperation between mining companies and surrounding communities creates mutual benefits, such as job creation and infrastructure development for the community and indirect security for the mine. Additionally, CSR measures will attract investors and contribute positively to the internal sustainability goals

Sustainable mining will be the mine of the future

Lungile Mashele: power generation combined with electricity sharing or embedded generation, installed by private companies, are going to open up entire new industries, due to an increased access to electricity in the country. It will have positive spinoffs, especially for industry surrounding the mine. If a mine only requires 80 MW, the other 20, it can sell to industry, to farms, to other mines etc. Thus, it is mostly an industrial movement, therefore, leaving the national utility and the municipality to ultimately supply the residential customers.

Daniel Rossi: clients of the mining companies are constantly looking at their own supply chain and how sustainable their supply chain is. Thus, mining companies which have deployed DRE solutions have a competitive advantage. Sustainable mining strategies are driving the decision making in terms of DRE solution implementation because now companies are not only looking exclusively at the IRR or NPV of a certain investment but must add to the formula the overall decarbonisation strategy and how it influences opportunity-cost evaluations.


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