



# AIR2VOLTS™ Technical Description

*Smarter Affordable Functional Effective Reliable*  
*power, where you want it, when you want it"*

# 6 UNDERGROUND COAL MINING CHALLENGES

1 - Maximising the economic extraction of coal.

2 - Minimising capital and operating costs.

3 - Managing resources in vast, complex underground mines.

4 - Complying with Health and Safety laws and regulations.

5 - Minimising risks to their lowest achievable form and controlling thereafter.

**6 - Maximising the benefits of technology.**



## ***THE PROBLEM FOCUS...***

*Any **reduction** in the installation and use of low, medium or high voltage cabling, equipment and infrastructure, assists in promoting positive outcomes for **CHALLENGES 1-5**.*

*However, without mains electric power, a negative outcome is observed for **CHALLENGE 6** -*

***“Maximising the benefits of technology”.***

*“The common problem with the roll out and wide usage of modern technologies underground, is the ability to provide the **nodes / monitors / detectors / tablets /cameras** with a power source.*

*Depending on where the nearest transformer is, this may require kilometres of cable work to be done. **This is a significant deterrent which normally restricts the use of technology in underground coal mines, to the minimum required by legislation.***

*Underground power is also prone to being turned off during section advances, maintenance, statutory testing processes or during incidents and accidents both on the surface or underground. The compressed air system has the benefit of being maintained during power outages with mains supply or backup generators.*

*The Air2Volts system of utilising the compressed air reticulation system to generate a small but geographically useful intrinsically safe electricity source, will assist underground mines roll out the technology needed for the future.”*



# AIR2VOLTS™

## “Solutions Reimagined”

Intrinsically Safe UPS with no requirement for mains power

Power generation unit with no moving parts

Can remain “powered” in an ERZ 0 atmosphere (Ex ia ma s)

Consumes only compressed air

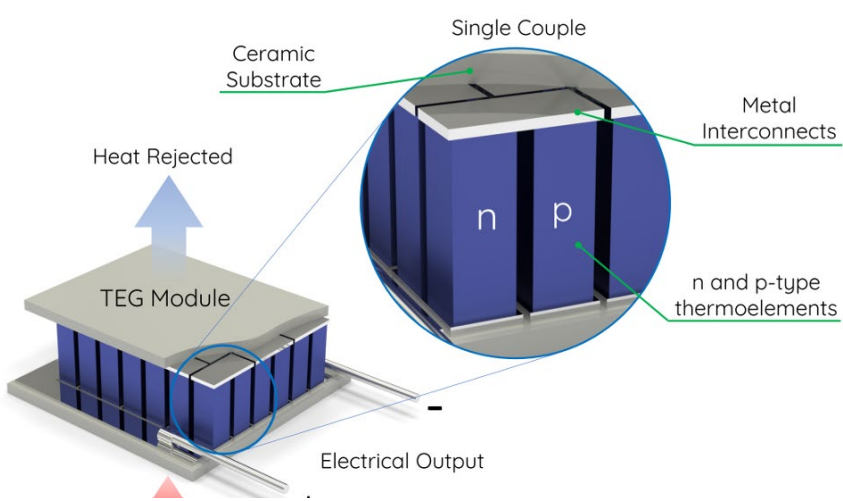
Wireless connectivity

Remote operation and management

SCADA integration

Energy saving features

Deployable without electric power



# Basics of Thermo-Electric Generation

Most combinations of dissimilar conductors can generate electricity, just like thermocouples.

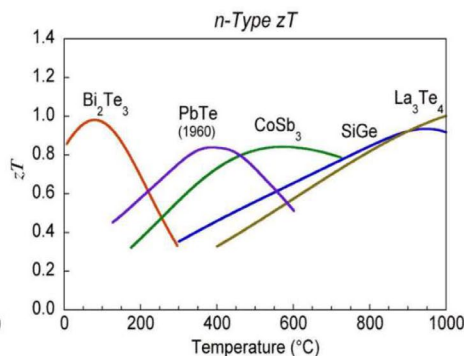
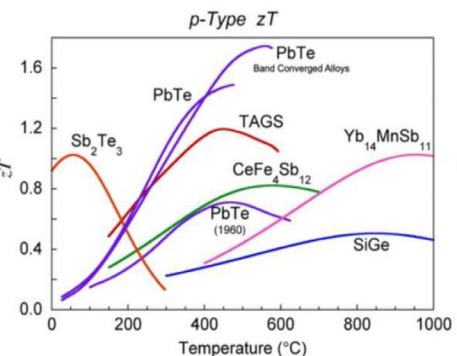
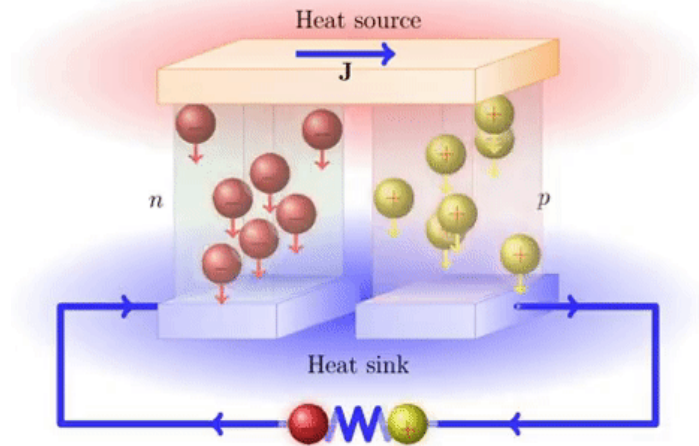
A good Figure Of Merit ( $zT$ ) is desirable, this results in more efficient generation.

F.O.M. varies with temperature – some materials are better for lower temperatures and others for higher temperatures ranges than others.

This can be calculated with -  
 $\sigma$  is electrical conductivity  
 $\alpha$  is Seebeck coefficient  
 $T$  is temperature,  
 $\kappa$  is thermal conductivity.

$$zT = \frac{\sigma \alpha^2 T}{\kappa}$$

P type SbTe (Antimony Telluride) & N type BiTe (Bismuth Telluride) semiconductors have an optimal F.O.M. for the operation at safe temperature ranges in hazardous explosive areas.





Energy  
Conversion  
Unit

TEG Array



## How AIR2VOLTS™ Generates Electrical Energy

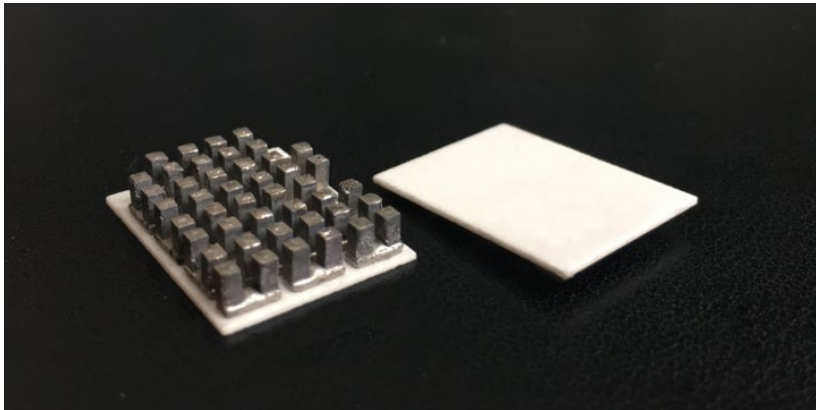
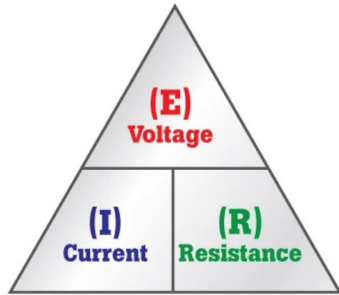
The internal Energy Conversion Unit creates a thermal gradient which is imposed onto the Thermoelectric Generator modules (TEGs)

TEGs generate power by the Seebeck Effect – reverse of Peltier Effect

Thermal differential between junctions of dissimilar materials causes charge to accumulate – many junctions can be arrayed to produce useful power outputs



# Why TEGs are perfect for hazardous explosive environments



TEGs are a 'high impedance' voltage source

Fundamentally power and current-limited – short circuit currents are quite low in typical devices – below IS limits

Short circuits do not present an ignition hazard

Reliant on thermal differential for power generation – no persistent power source present on shutdown

Cannot go into a runaway condition

Can completely model operation – no unexpected behaviors

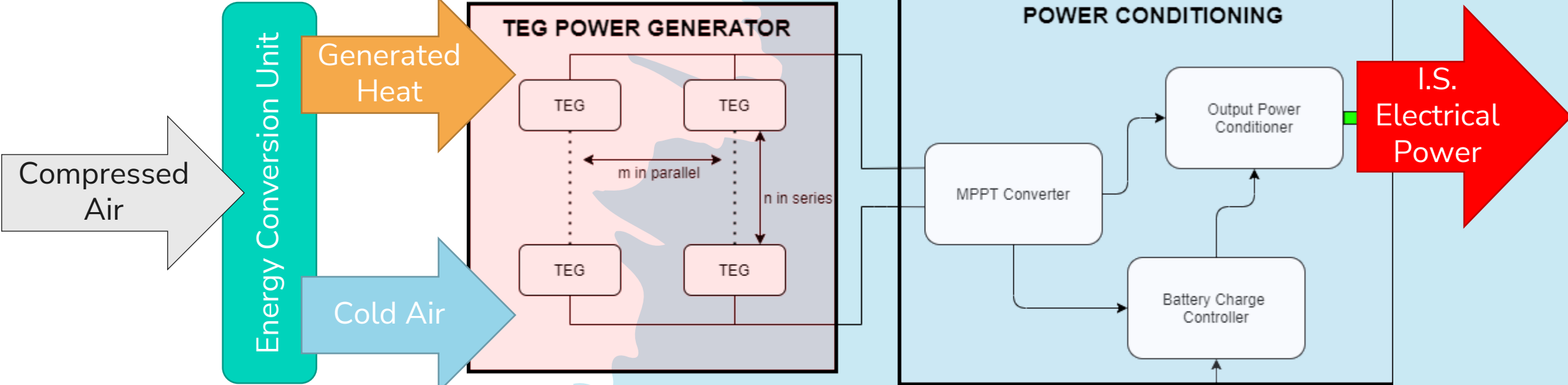
Compact power generation structure with no moving parts

Voltage drop, capacitance and inductance parameters of cables become almost irrelevant as the UPS can be installed at the point of usage.

Risk



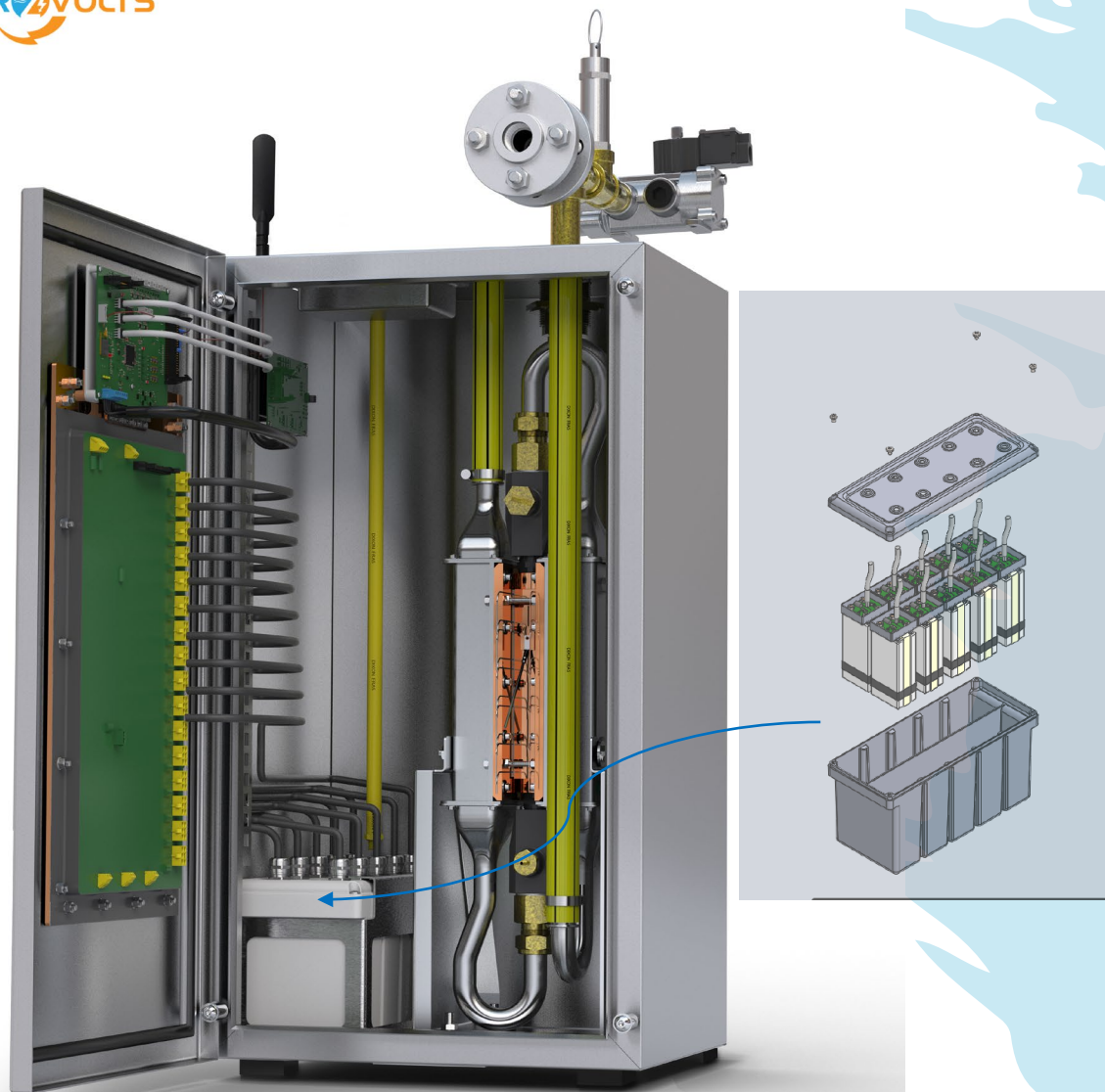
# Design Architecture



- Intrinsically Safe Electronics
- Fail-Safe Pressure Release
- Special Protection for TEG Operation
- Redundant Safety Critical Components



## Internal Battery Packs



Using LiFePO4 cells – a better choice than Li-ion-

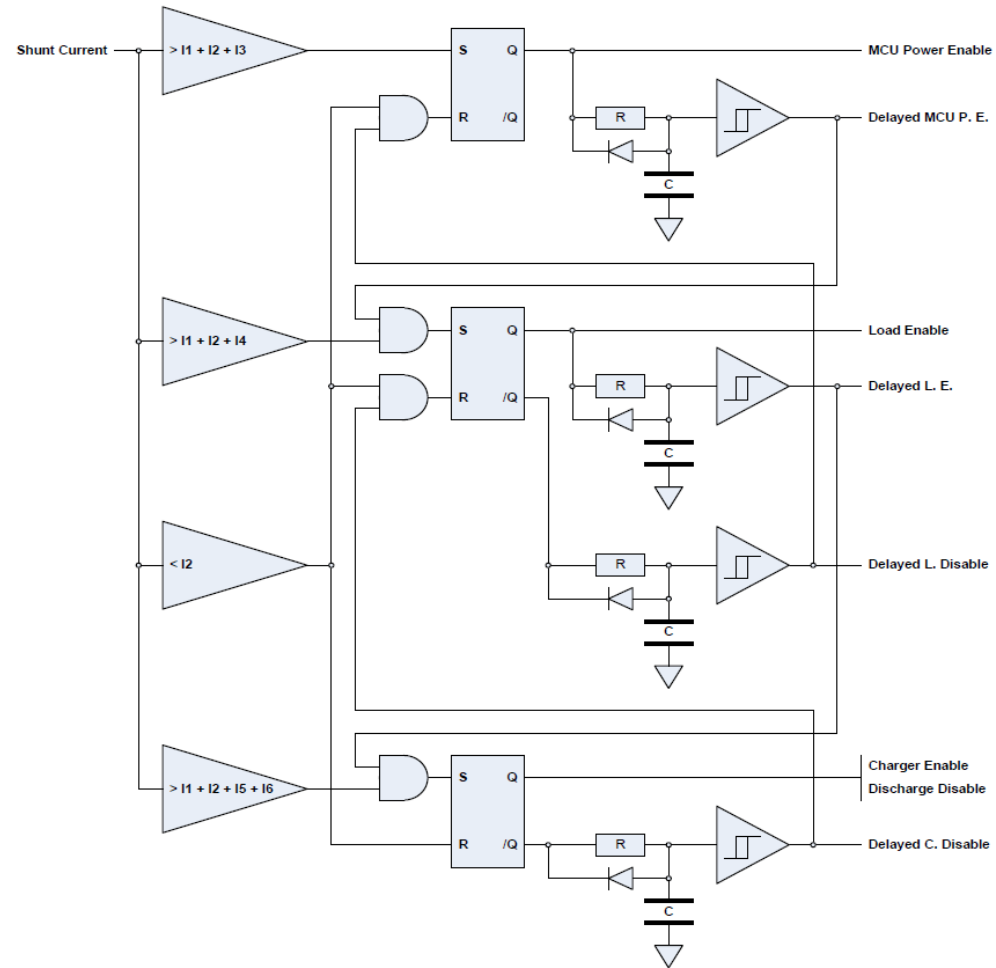
- Longer life – more charge cycles
- High efficiency +90%
- Stable at high temperature
- Do not catch fire or explode with internal or external faults
- Non-toxic

Batteries are housed in sealed, leak proof compartments inaccessible to users within the IS environment.

Individually fused cell arrays – batteries are unconditionally safe from short circuit overcurrent events.

900Wh battery capacity (720Wh at EOL) provides > 20-hour continuous operation at full load with total air supply failure.

# Unique Operating Concepts



Operation from compressed air, no electrical hazard.



Total galvanic isolation from other systems.



Installation and operation entirely within Zone 0.



Relocatable and re-deployable. Ease of installation.



No requirement for costly power delivery infrastructure



Auto air shut off valve for energy saving.  
Battery cycling with light loads.



Reserve TEG generation capability can recharge batteries even under full operating load.



Continued operation when UG power is lost. Battery backup UPS on absence of compressed air only.



Wi-Fi 802.11 a/b/g/n 2.4 & 5GHz

Modbus TCP over Wi-Fi

Modbus RTU over RS485

# Communication's



No more gate road Wi-Fi black spots, due to no electrical power available for nodes.



Integral screen & keypad provide immediate user access for viewing device status & system control

Isolated RS-485 interface allows straightforward integration into existing data networks using standard communications & power bus, integration into SCADA network.

Wi-Fi module to allow wireless access & remote network control or integration.

Full monitoring of internal device parameters available –

- TEG temperature status
- Power generation level
- Load power demand
- Battery charge level
- Remote power-up/down
- Compressed air temperature and pressure
- Compressed air shut off valve

# AIR2VOLTS™ Unique Advantages

- AIR2VOLTS™, the only I.S power supply / UPS, that can be installed and remain fully operational in an ERZO atmosphere.
- Enables the expandability of mine Wi-Fi systems to ensure whole of mine coverage, not just where electric power is available.
- Reduces activity installing HV cables and Transformer Substations with people exposed to unnecessary risk.
- Reduced risk of electrical hazards as the only UPS that is fully intrinsically safe, remaining fully operational in a Zone 0.
- Reduced capital and operational expenses.
- Alternative reliable power supply for lifesaving monitoring and communications equipment underground, during and after mine emergencies, emergency escape or power outages.
- Eliminate Wi-Fi “blackspots” adding to mine unscheduled downtime, with increased Wi-Fi tracking communications ability, with key mine maintenance or statutory personnel, during operational breakdowns or mine statutory inspection situations.
- Enables the ability to rethink the way a mines electrical infrastructure is planned and deployed.

# AIR2VOLTS™ Additional Uses

- Emergency escape I.S. LED lighting on egress roadways, COBS, CABA refill areas.
- I.S. LED lighting at sumps or remote areas for safety and ease of inspection.
- Underground roadway intersection, traffic control I.S. block lights without access to power.
- I.S. Wi-Fi cameras for production areas, conveyors trouble areas and emergency escape routes.
- Remote environmental gas, noise, dpm and dust monitoring without access to power.
- Gas monitoring at or in Emergency Refuge Chambers, Change Over Bases (COBs) and or Fresh Air Bases (FABs) strategically positioned at legislated intervals throughout the mine workings for emergency escape and or refuge.
- Real time strata support monitoring in older vulnerable mine workings without access to power.

# 3 Workable Solutions

## Solution #1

- Development and Longwall travel roads lack of Wi-Fi tracking?
- With the compressed air service running the length of the mine roadway, use AIR2VOLTS at each required location to power the Wi-Fi nodes.
- No electrical reticulation required.

## Solution #2

- No nearby or available electric power at the CABA refill stations, FAB's, or COB's for gas monitoring or personal tracking?
- AIR2VOLTS uses the compressed air at these locations, to generate power for environmental gas monitoring, lighting and or tracking.
- No electrical reticulation required.

## Solution #3

- Gas Monitoring required in remote locations of mine or where electric power sources are not available?
- AIR2VOLTS can power the gas monitoring using the mines compressed air reticulation anywhere in the mine, including Zone 0.
- No electrical reticulation required.



**AIR2VOLTS™** enabling whole of mine connectivity, by utilizing one of its most available and reliable sources of energy, compressed air.

**AIR2VOLTS™** uninterruptible power generation supplies (UPS), offering an alternative and reliable solution, for powering intrinsically safe critical and non-critical mine environmental monitoring, communications and digital network systems.

**AIR2VOLTS™**, a convenient, uninterruptible power supply, for underground roadways geographically too remote for electrical reticulation, areas without ease of access to electrical reticulation, or as an economically viable solution to powering monitoring and communications equipment, in today's smart mines.