“Batteries – the backbone for renewable energy systems.”

Presented by:

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The backbone of renewable energy systems

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3 October 2024

AusIMM

Challenges in mining

How hybrid renewable power stations can help

Decarbonisation

- Carbon abatement is getting serious
- It takes time to deploy strategies and meet targets

Mine electrification

- Electrical loads are increasing
- Equipment is becoming more sophisticated and sensitive

Energy security

- Reliability and power quality
- Gas & diesel costs

88 power & gas
facilities worldwide

>650
employees globally

7M MMBTU/year
biomethane/RNG capacity

Key
- Remote energy
- Renewables
- RNG
- LNG
- Landfill gas
- Waste coal mine gas
- Office

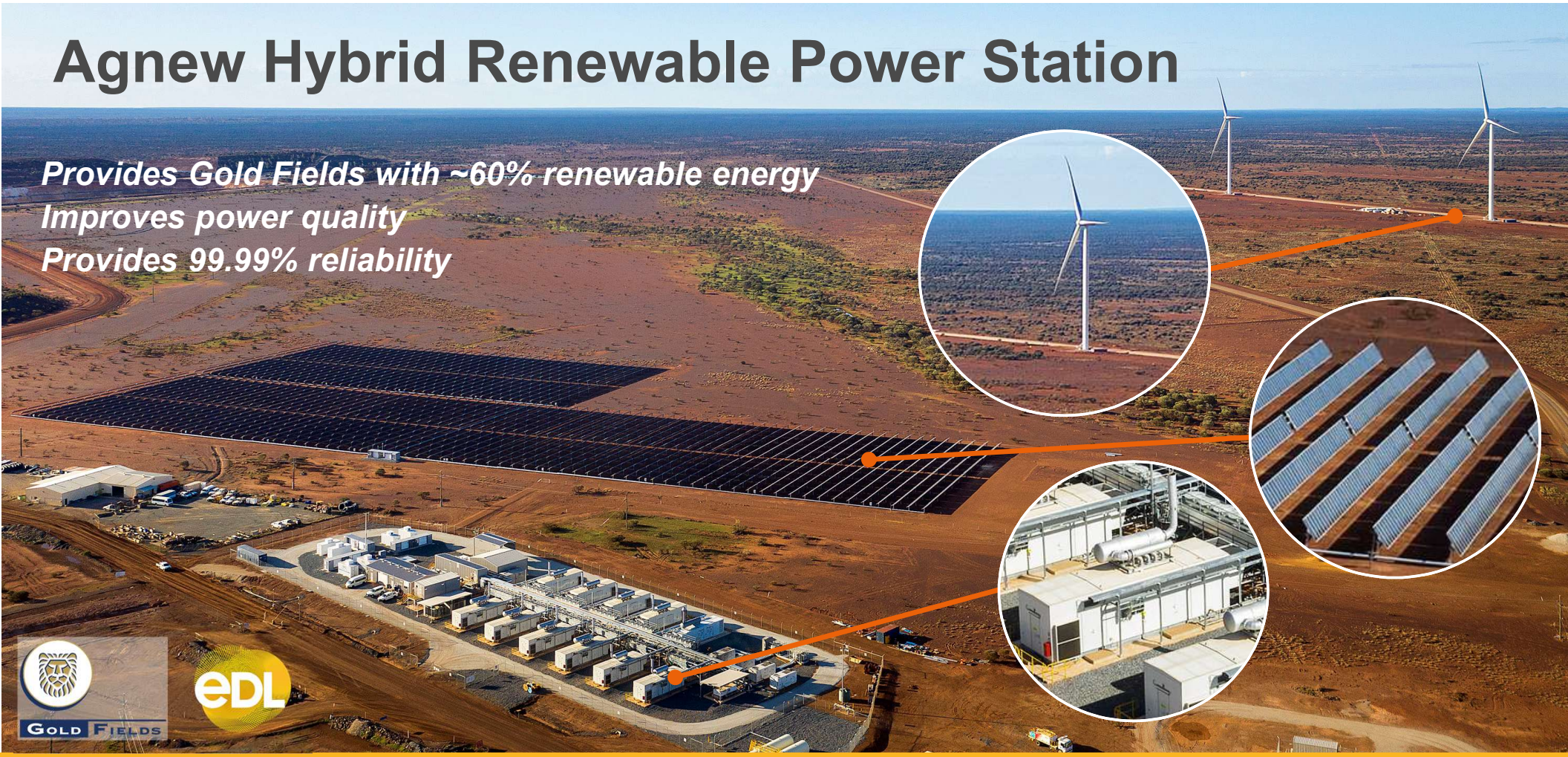
Australia **766MW**
51 sites

North America **153MW**
26 sites

United Kingdom & Greece **57MW**
11 sites

~3.8 million
tCO_2-e avoided p.a.

Agnew Hybrid Renewable Power Station



50-60% renewable energy

99.99% reliability

4MW solar

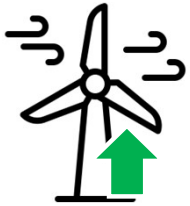
13MW/4MWh battery & microgrid

18MW wind generation

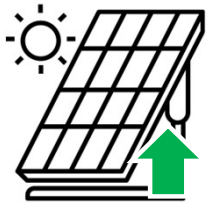
Thermal power 22MW gas & 3MW diesel

Hybrid Renewable Operating Philosophy

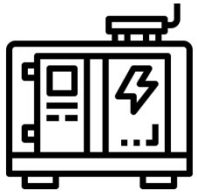
Maximise renewables whilst managing grid stability and reliability



Maximise wind penetration *(priority)*

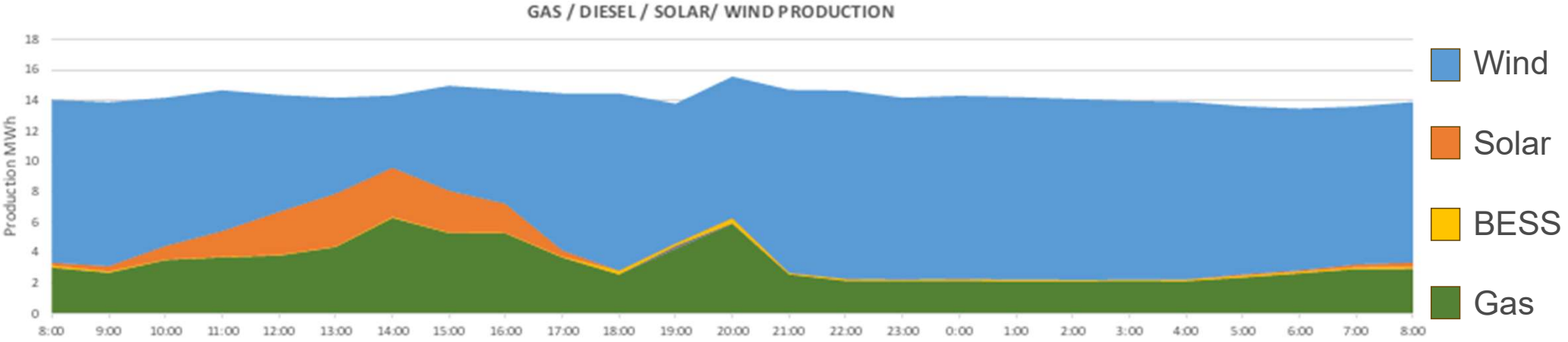


Maximise solar penetration *(flex to optimize system)*



Meet shortfall with gas/diesel generators

Battery manages grid stability & *'shifts'* renewable energy



How the battery saved the day...

Case study - how hybrid technology provides reliable power for mines

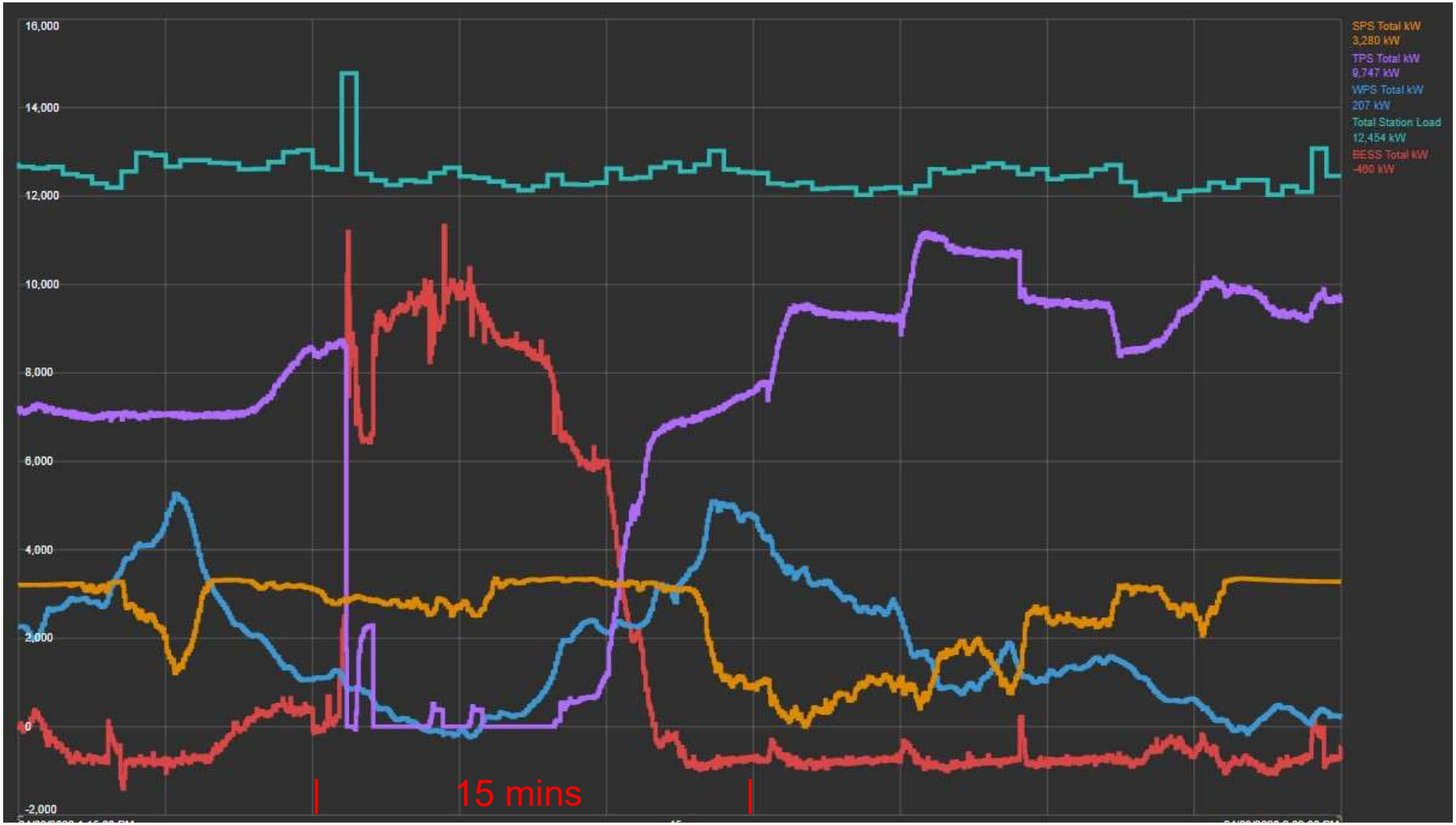
Station suddenly went silent
(a swiss cheese event)

- Unexpected large load start
- 5x gas generators went into overload; tripped off
- Period of low wind

Battery kicked in (grid forming mode)
No power disruption to customer

Station fully back online and healthy within 20 minutes

Analysis of the event



Customer

Gas

Solar

Wind

BESS

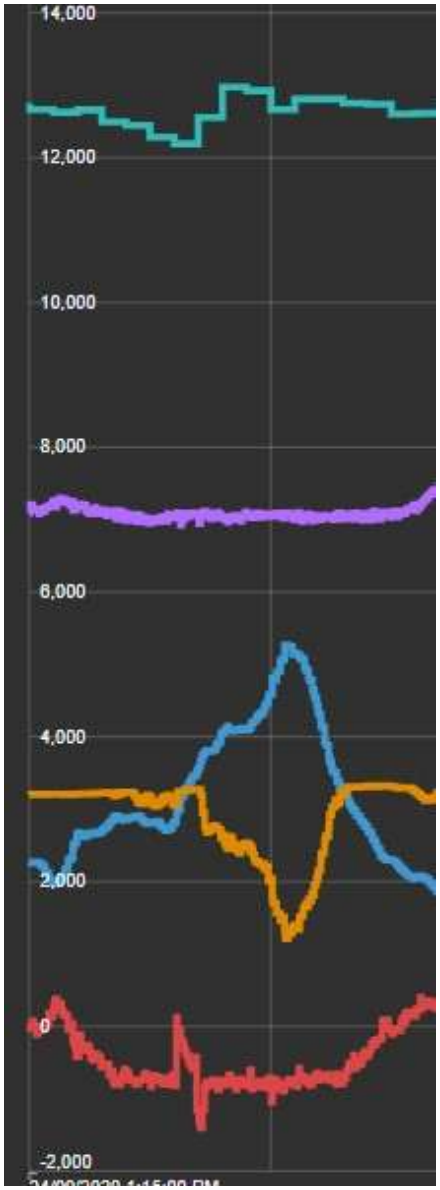
Before event

Customer load about 12.5MW

5x gas generators online at 85% loading

Solar actively controlled to optimise gas engine efficiency

Battery charging



Customer

Gas

Solar

Wind

BESS

During event

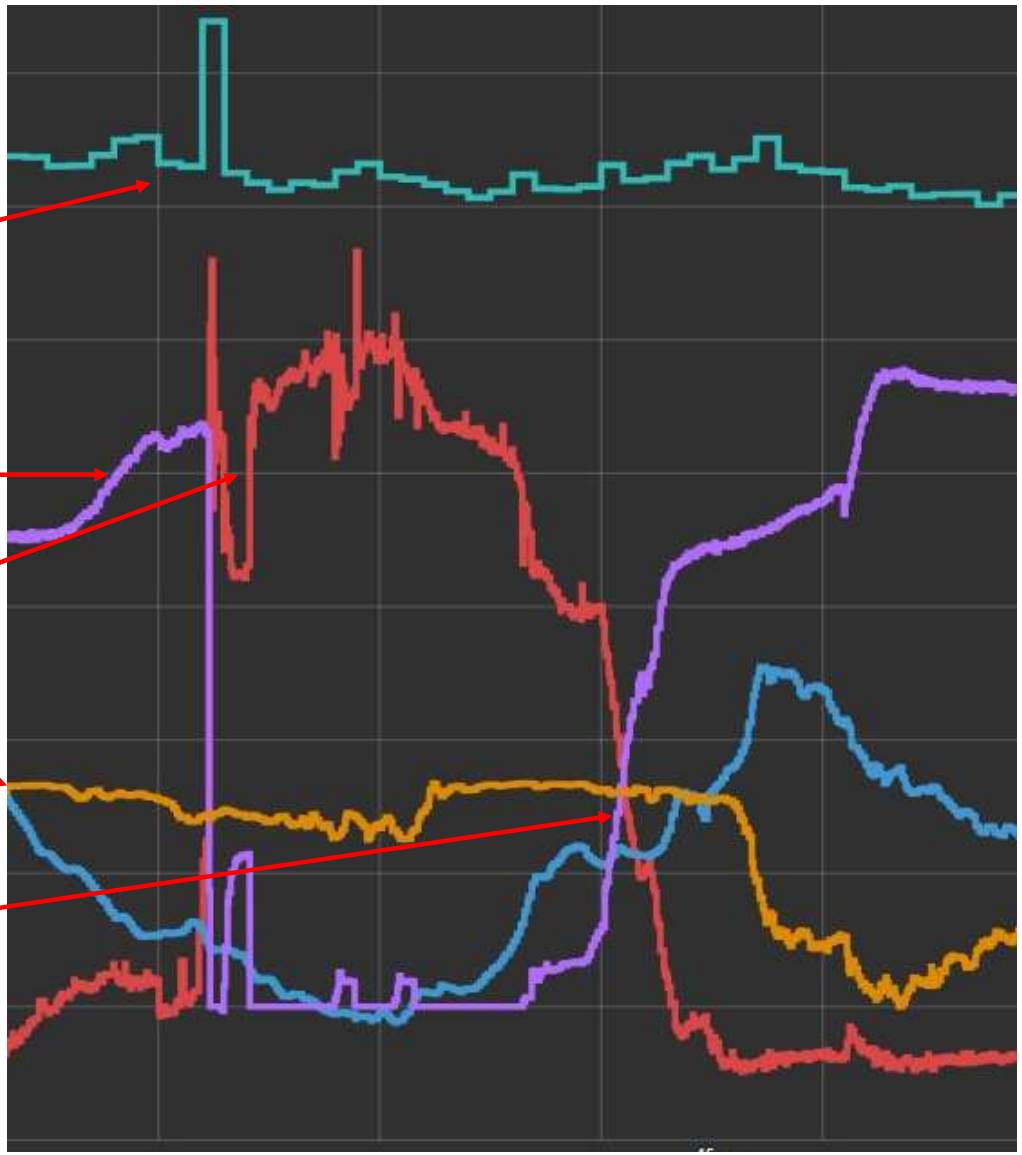
Unexpected large load starts

Gas engines overload and trip off.

Battery responds immediately and holds up station

Solar stays steady to support Wind dies off

Gas engines come back online battery output decreases



Customer

Gas

Solar

Wind

BESS

After event

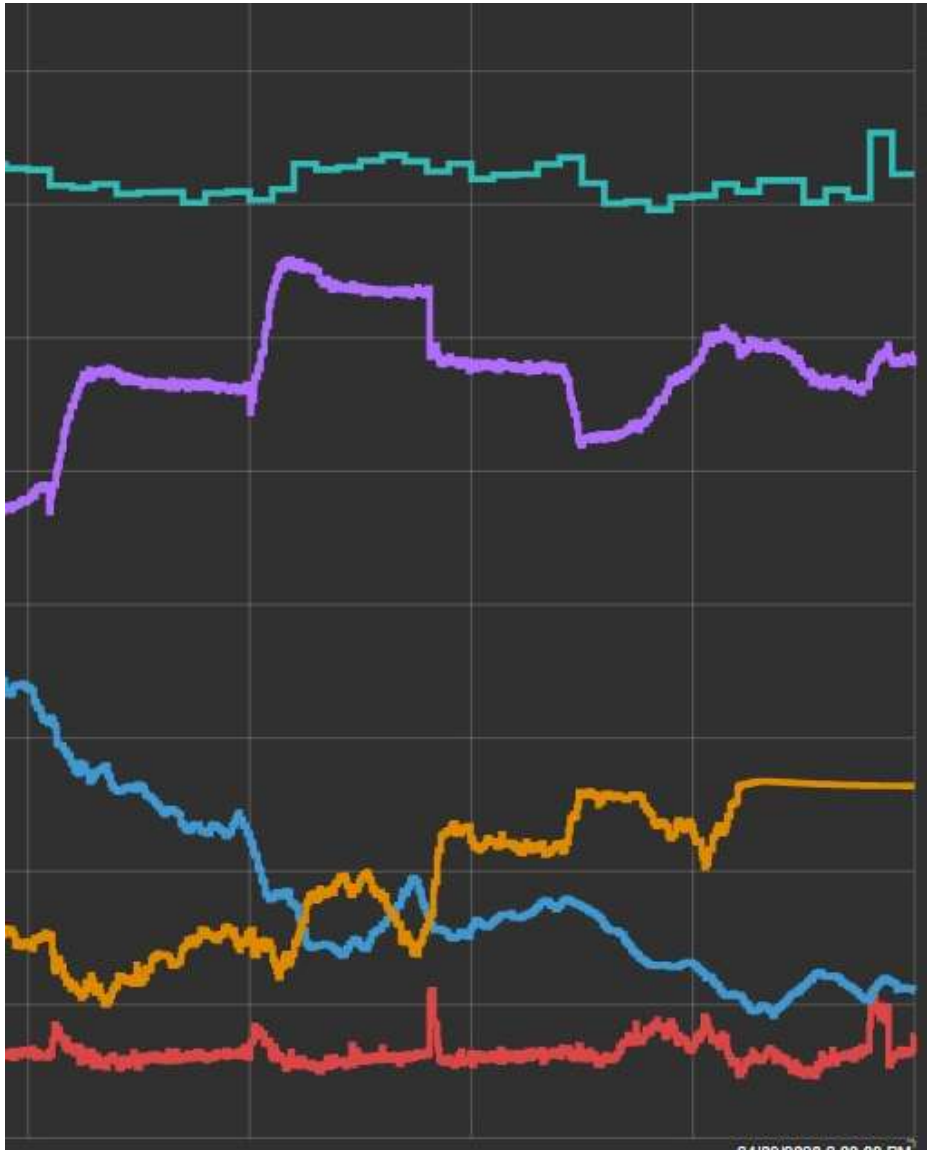
No disruption to customer power

Gas generators come back online and settle back into service

Wind generation continues to move around

Solar actively controlled

Battery reverts charging



Customer

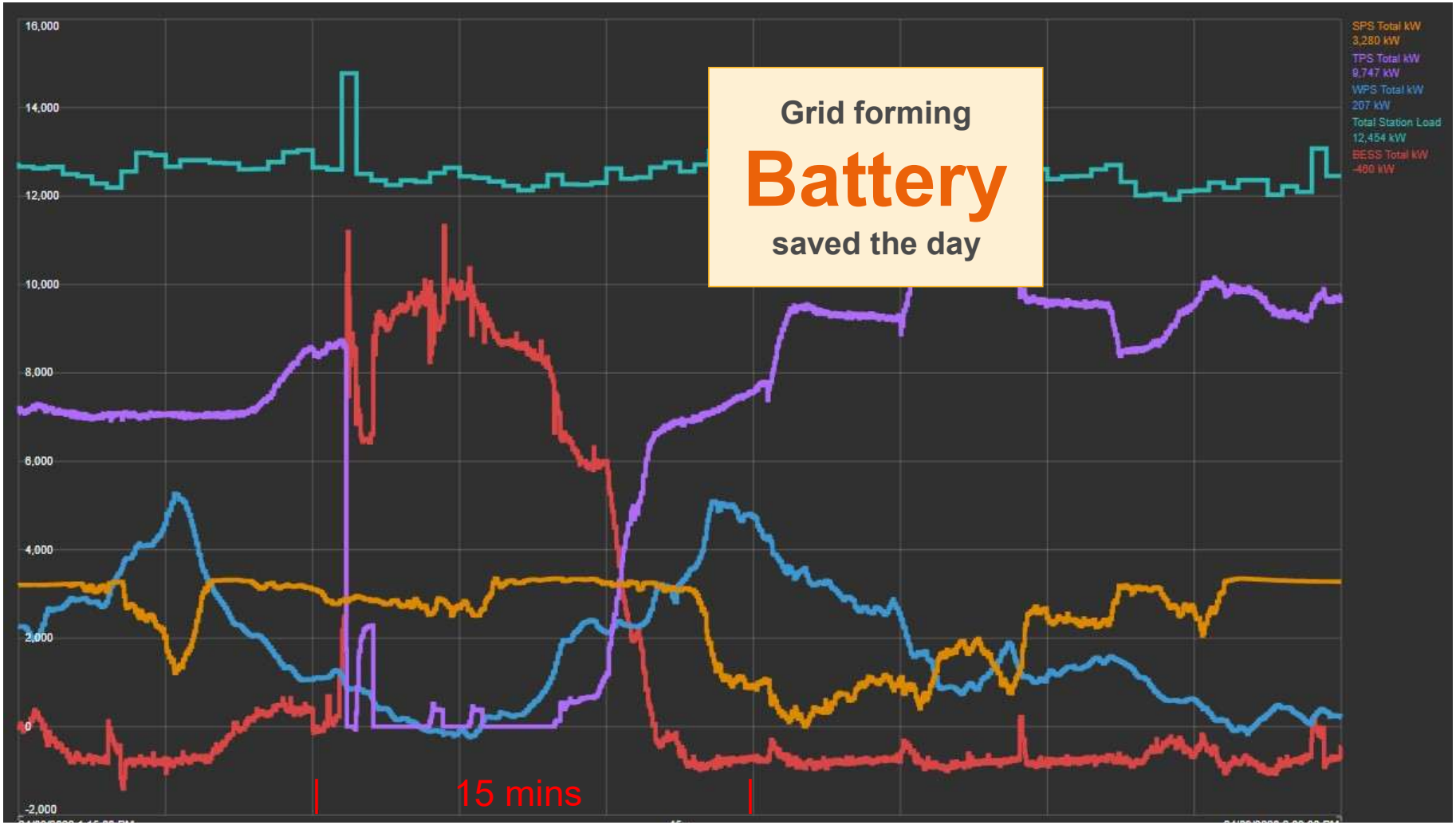
Gas

Solar

Wind

BESS

Analysis of the event



Current trends for hybrid renewables

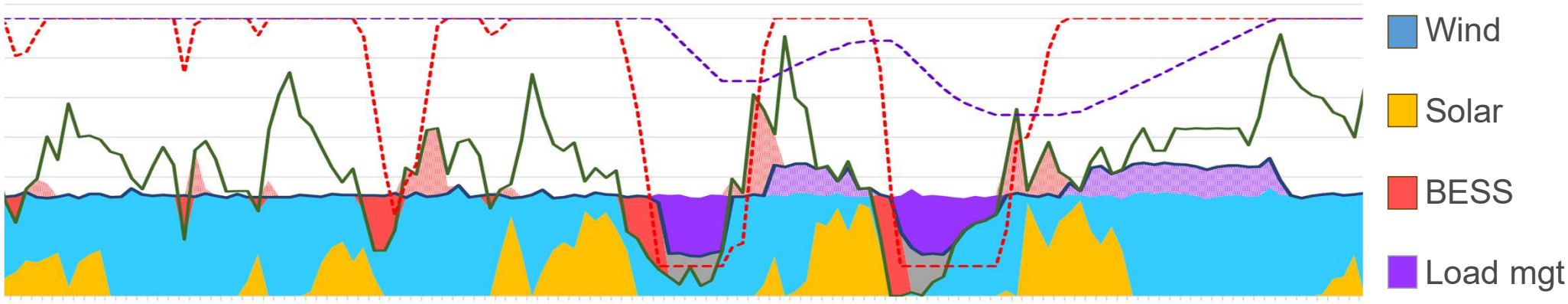
Reliable 80%+ renewable energy microgrids for mines are here

Rapid cost decrease:
Battery & solar equipment

Sophisticated modelling
Real world data and learnings applied

Reliable & long duration batteries:
Grid forming inverters & storage economic

Integrated & optimized with mines
Demand management & RE forecasting

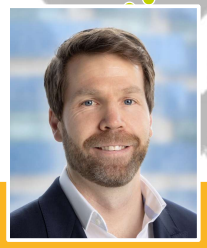


Australia

45 power & gas
facilities

~400
employees

Geoff Hobley
General Manager – Remote Energy



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