Off-road Decarbonisation & Energy System Integration

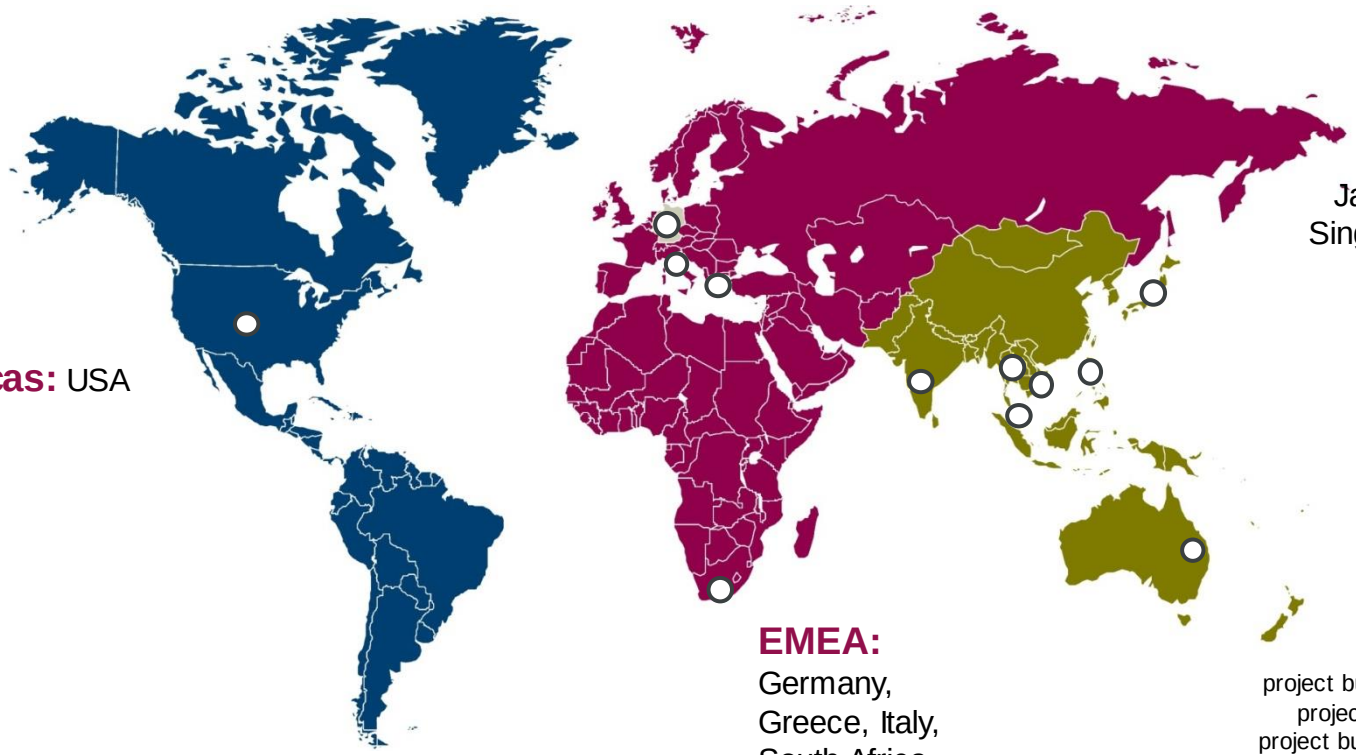
juwi AG – Amiram Roth-Deblon – 24th of March 2022

Image credit: GOLD FIELDS

juwi Facts & Figures

Offices worldwide

juwi



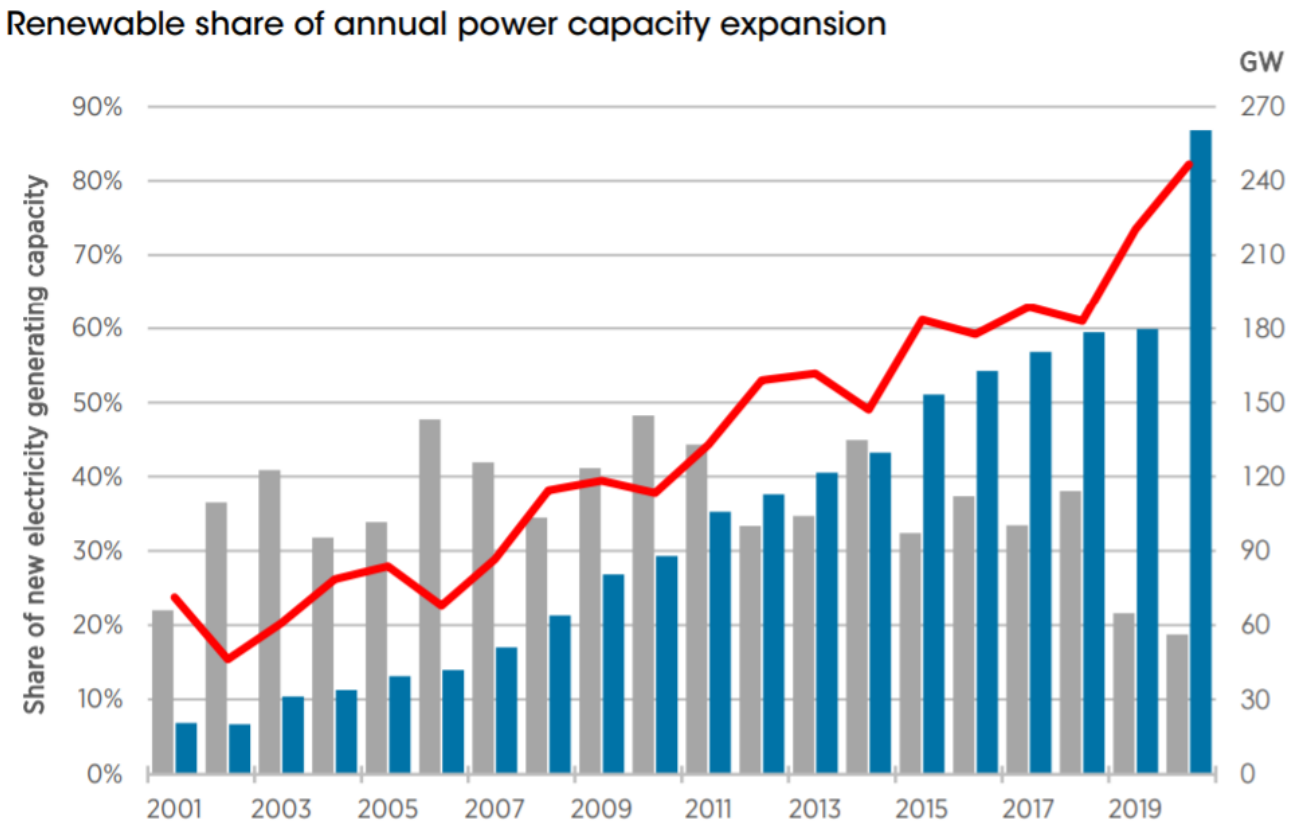
Americas: USA

EMEA:
Germany,
Greece, Italy,
South Africa

APAC:
Australia, India,
Japan, Philippines,
Singapore, Thailand,
Vietnam

juwi offices
project business in Germany
project business in EMEA
project business in Americas
project business in Asia

80% of all new capacity additions from renewables



Source: IRENA (International Renewable Energy agency)

juwi‘s hybrid / mining project timeline

Australia

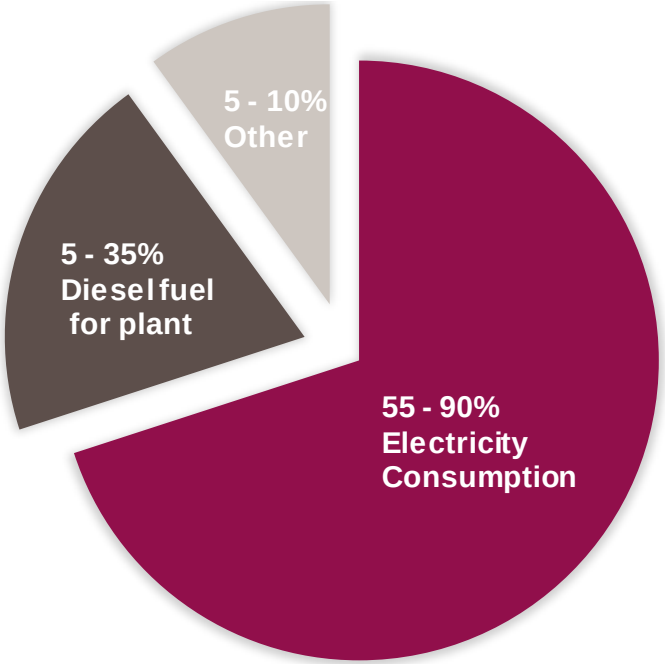
- 2016: **DeGrussa**: 10.6MW Solar + 6MW BESS + Diesel
- 2018: **Heron Island:** 0.4MW Solar + 0.6MWh BESS + Diesel
- 2019: **Agnew**: 4MW Solar + 18MW Wind + 12 MW BESS + Gas
- 2020: **Esperance:** 9MW Wind + 4MW Solar + 5.5MW BESS + Gas
- 2021: **Weipa:** 5MW Solar + Diesel
- 2021: **Gruyere**: 13.6MW Solar + 4.4MW BESS + Gas
- 2021: **Jabiru**: 4MW Solar + 4MW BESS + Gas
- 2021: **Jacinth Ambrosia**: 3.4MW Solar + Diesel
- 2022: **Northern Goldfields:** 38MW Solar + 10MW BESS + Gas

Africa

- 2021: **Elikhulu (South Africa):** 11.8MW PV + Grid
- 2021: **Sukari (Egypt):** 36MW PV + 7.5MW BESS + Diesel

Path to Carbon Neutrality Gold Mining

Operational Emissions



Hybrid systems - Today

Sukari Gold Mine
2021/22

36 MWp

0 MW

7.5 MW
3.5 MWh

89 MW

48 MW

25% RE fraction
$ 9-13 mil / a saving

Hybrid systems - NEXT

Off-grid Gold Mine
2022 / 23

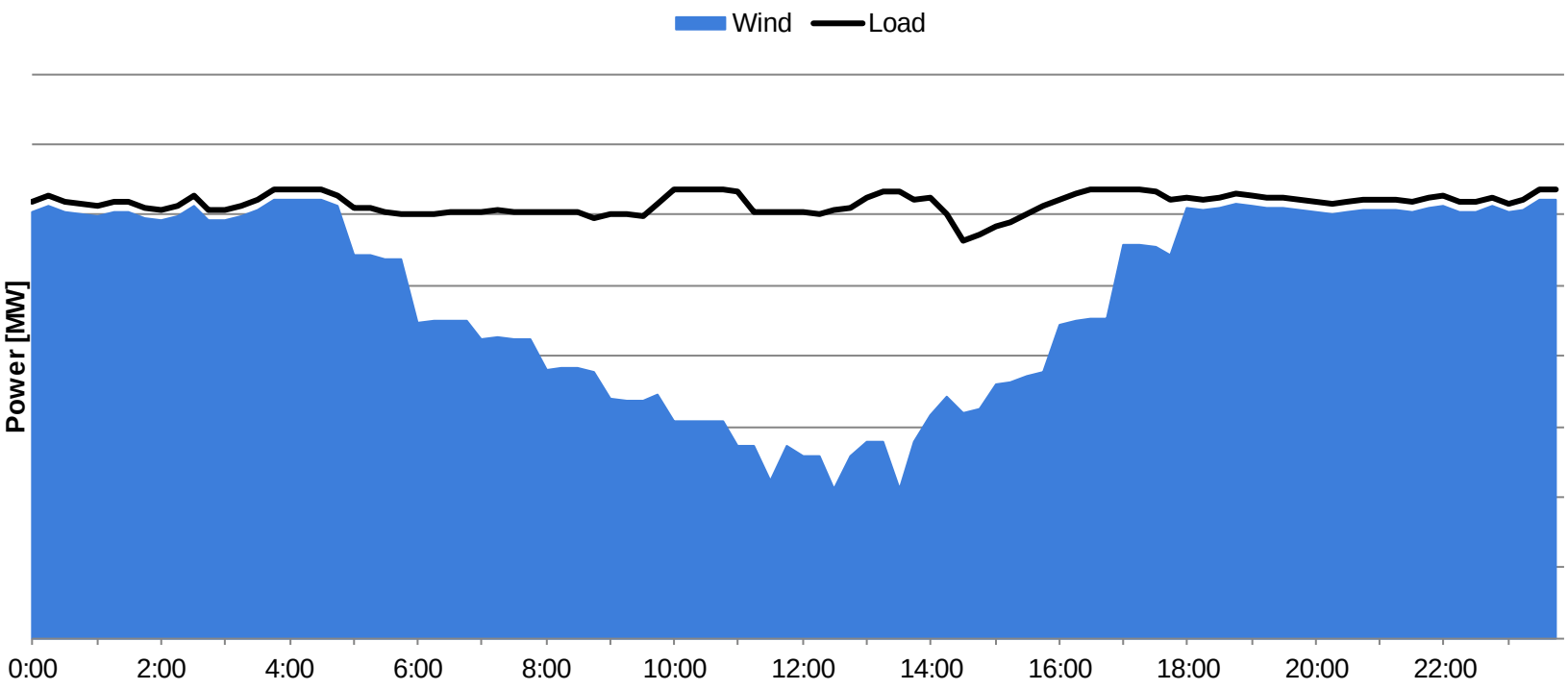
36 MWp		14 MWp
0 MW		24 MW
7.5 MW 3.5 MWh		13 MW 13 MWh
89 MW		15 MW
48 MW		13 MW

25% RE fraction
$ 9-13 mil / a saving

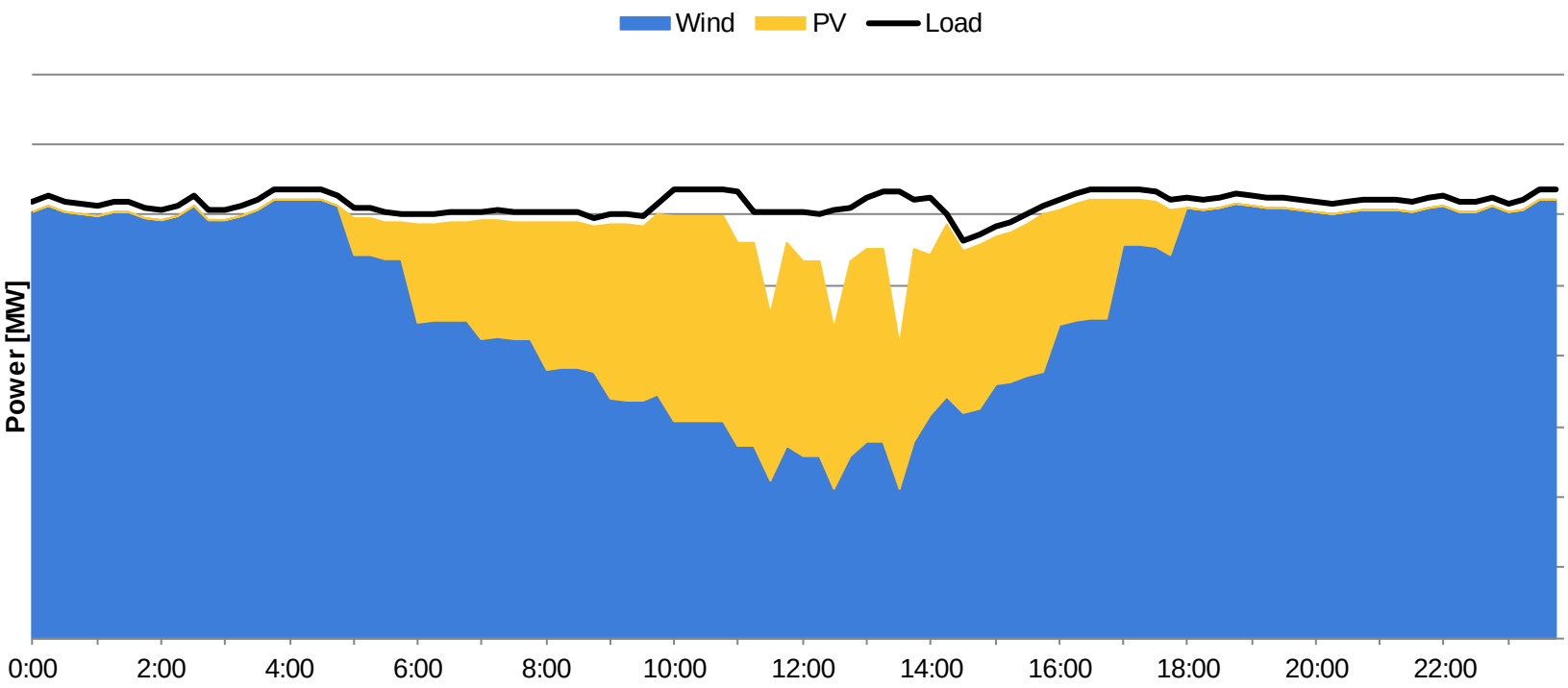
=

85% RE fraction
$ 14 mil / a saving

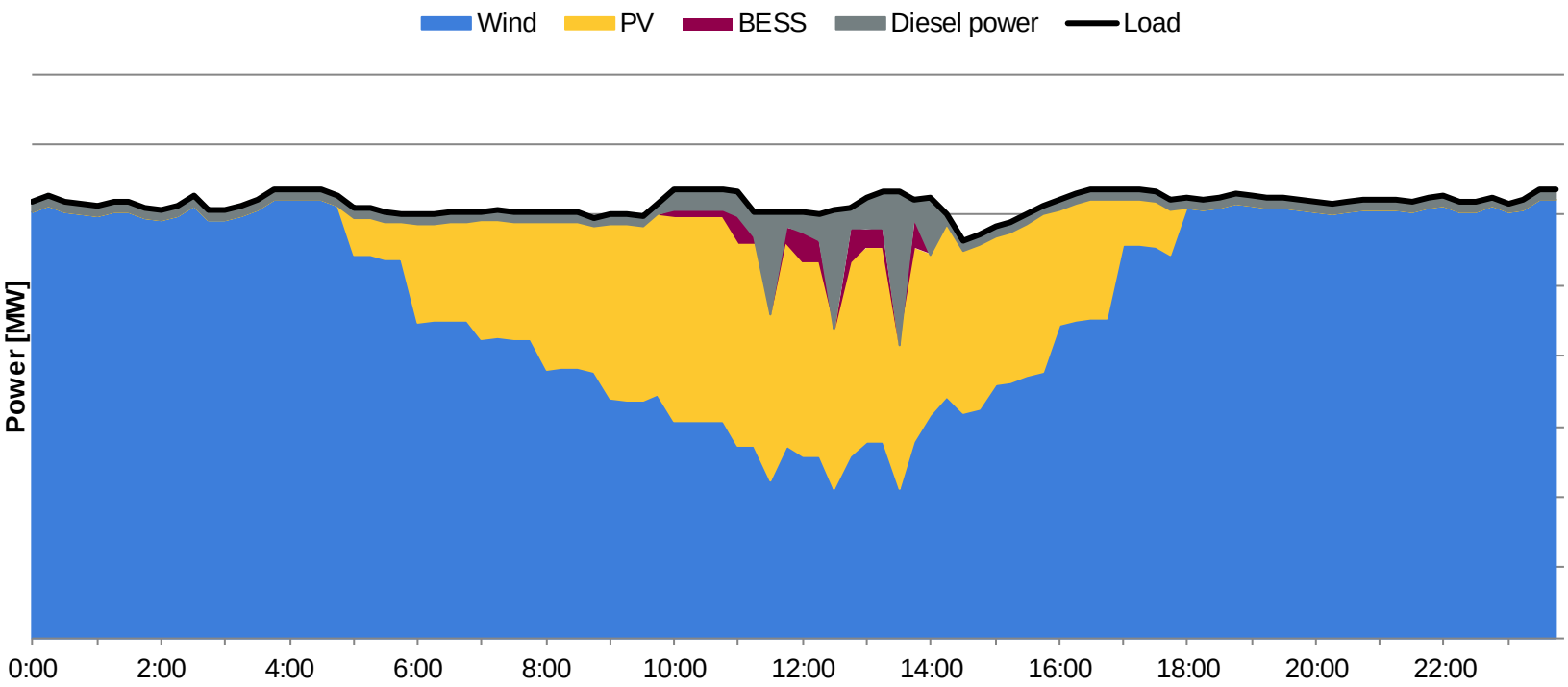
Daily wind generation profile



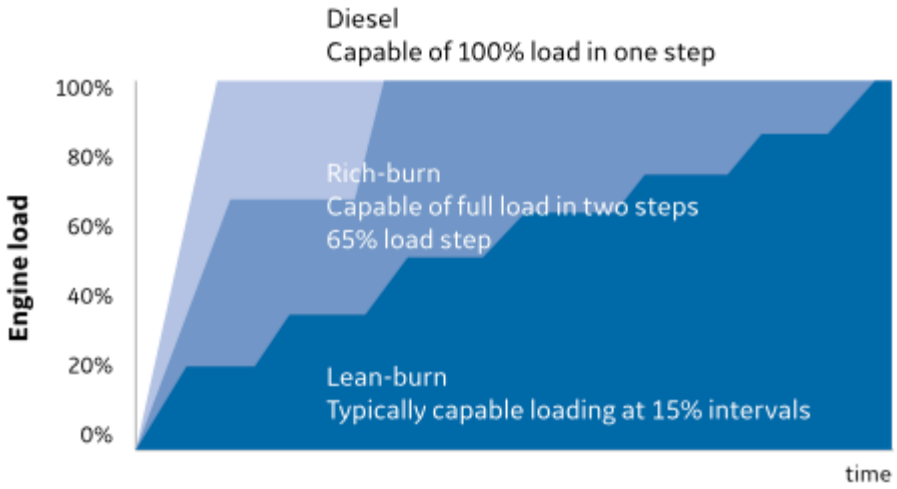
Daily solar and wind generation profile



Adding Battery and Diesel to fill gaps

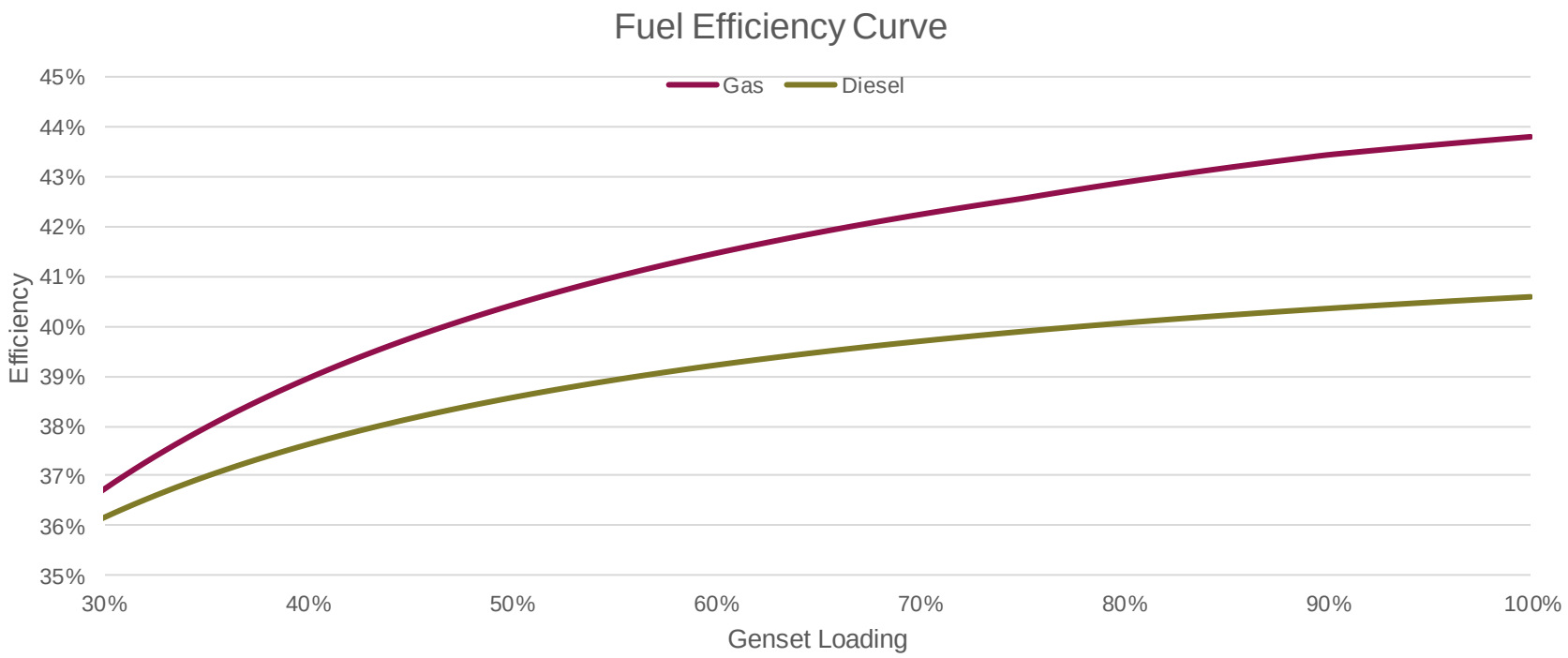


Load Step Issues – Gas vs Diesel



0-100% Load	
Diesel	<20 Sec
Recip Gas (Rich)	>5 min
Recip Gas (Lean)	>10 min
Turbine Gas	>15 min

Fuel Efficiency – Diesel&Gas similar at low load



Renewable energy & electric fleets are partners

- Significant reduction in CO_2 emissions
- Lower fleet maintenance costs
- Less underground ventilation
- Less underground cooling
- Healthier work environment

- Electric fleets can act as flexible loads
- Fleet batteries can reduce stationary battery needs
- Electric fleets add economies of scale for renewables

Image credit: Epiroc

Case study - Remote mine in the Canadian arctic targeting 100% RE

Design and techno-economic analysis of a high penetration to 100% renewable energy power system at a remote off-grid mine in Northern Canada

juwi Die Energie ist da

REM M.Sc. Renewable Energy Management ALBERT-LUDWIGS-UNIVERSITÄT FREIBURG

UNI FREIBURG

- A greenfield mine site in development issued a study into the options to fully power a site in the arctic with renewables

1. Even in the arctic a 90% RE system would provide the lowest cost of energy for stationary power and fleet.
2. 100% renewable energy would cost only ~23% more than a full diesel option.
3. RE costs could be further reduced with an enhanced variable mining design.
4. High contribution RE systems are cheaper, but their higher CAPEX is a hurdle.
5. Fossil fuel is more costly but OPEX driven, with less CAPEX upfront.

Lessons learned

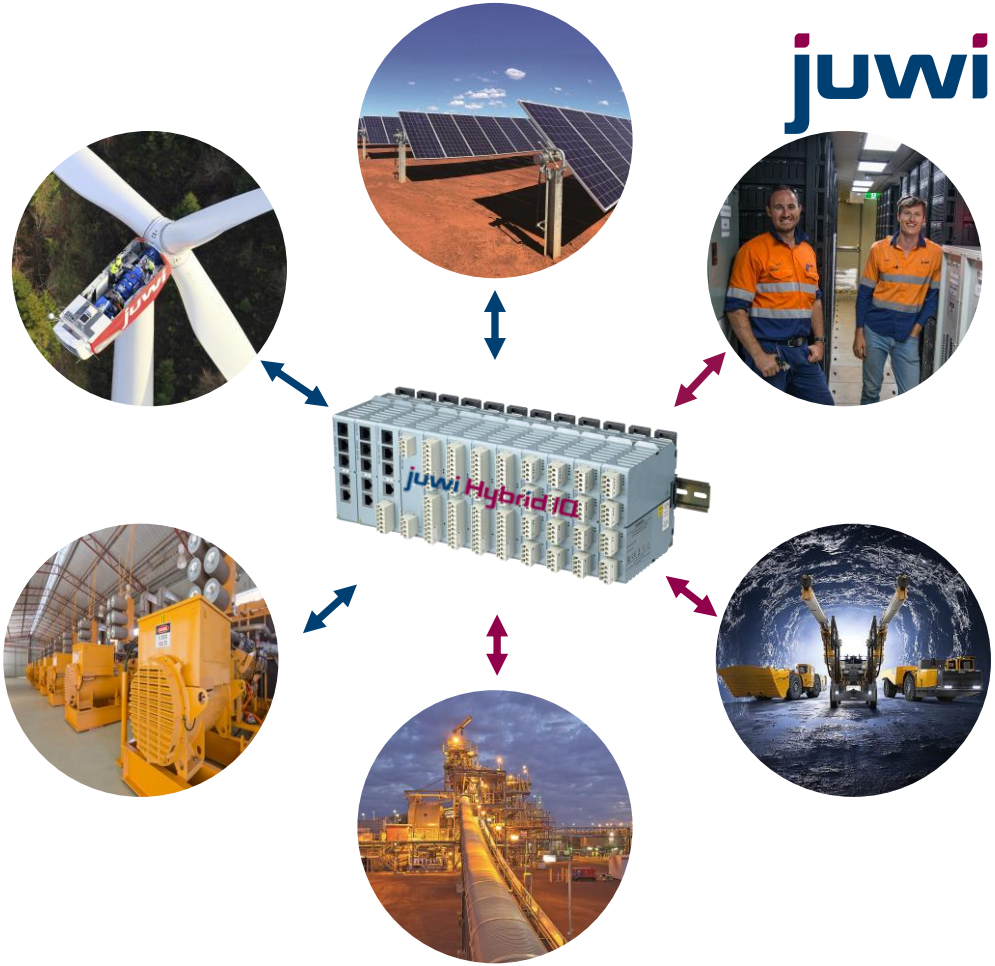
- Batteries provide synthetic inertia up to full genset off-mode
- Gensets with high step load capability are beneficial (diesel)
- Gensets with lower minimum genset loading are beneficial
- Consider variable operations to fully utilize solar and wind
- Evaluate fleet charging with excess renewable energy

High renewable energy

1. ***Deliver the lowest costs***
2. ***Mitigate fuel price exposure***
3. ***Increase resilience***

juwi Hybrid IQ

- Adapts to changing power system and operational methods
- Optimizes for lowest cash operating cost and CO_2 savings
- Enables electric fleets
- Provides detailed reporting and analysis



Does it work in practice?

James Koerting
Manager: Energy
Gold Fields

"juwi delivered the solar PV system, which included a cloud forecasting and a microgrid control system for the solar farm integration. This was completed on-time and provided the expected fuel savings without hindering system reliability. Gold Fields is very happy with the flagship Agnew project, which serves as a case study for similar projects in the mining sector." (2020)

Peter Gordon
Electrical Superintendent
Sandfire Resources

"Now after more than 1 year of operation I can confirm that the hybrid system is running smoothly, delivers substantial diesel savings and the power quality and reliability are as good or better than before." (2017)

Future Developments

- Above ground & heavy haulage fleet decarbonisation
- Electrification vs H2
- Battery vs trolley based power
- Battery charging vs battery swapping
- Battery chemistries
- Thermal & gravity energy storage

- Usage of sourced H2 vs on site green H2 production
- On site hydrogen usage in reciprocating engines vs fuel cells

Thank You

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