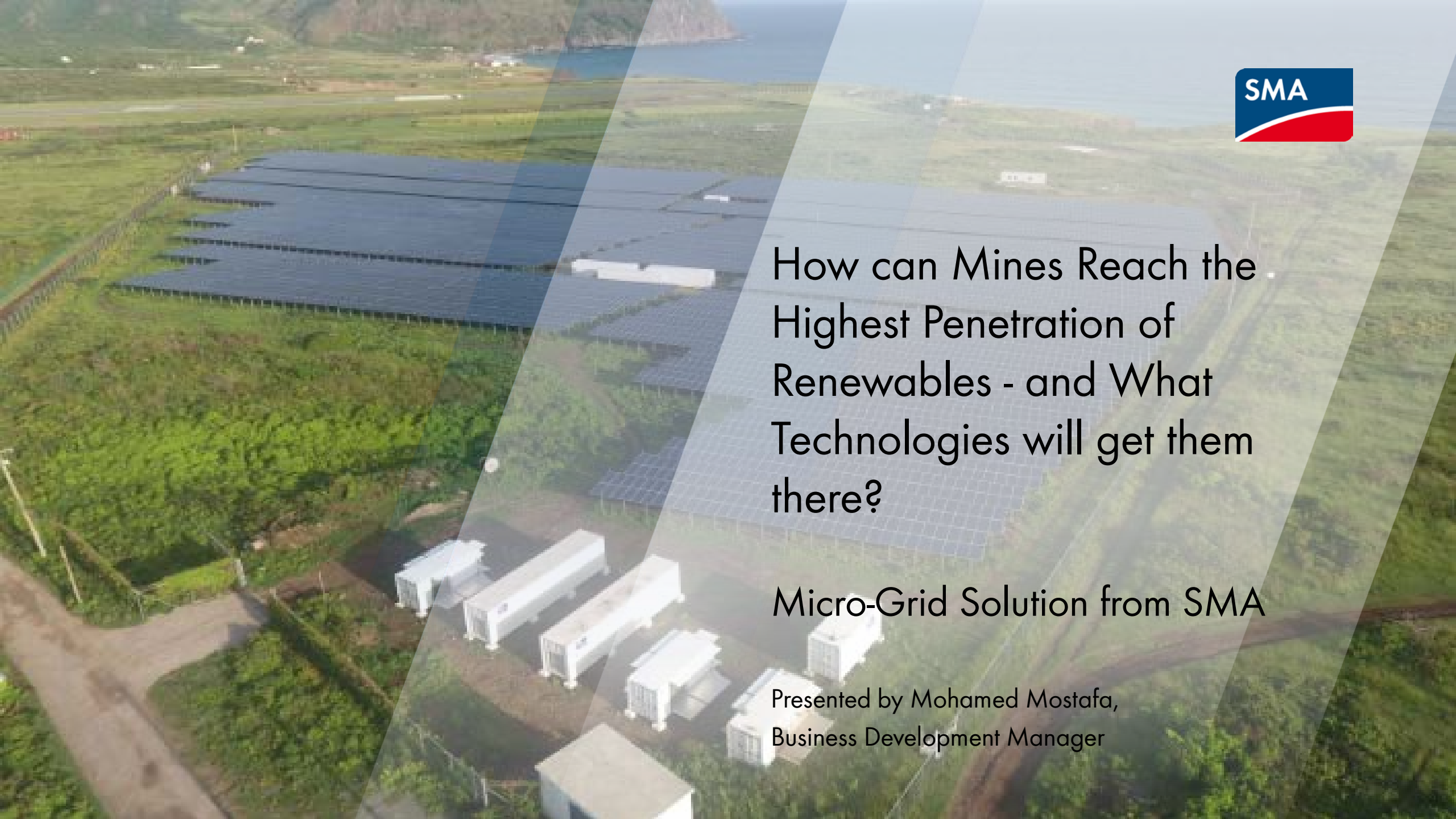

How can Mines Reach the Highest Penetration of Renewables - and What Technologies will get them there?

Micro-Grid Solution from SMA

Presented by Mohamed Mostafa,
Business Development Manager

Agenda

1 Basic Solution Objectives

2 Project References

3 Solution Features and Components

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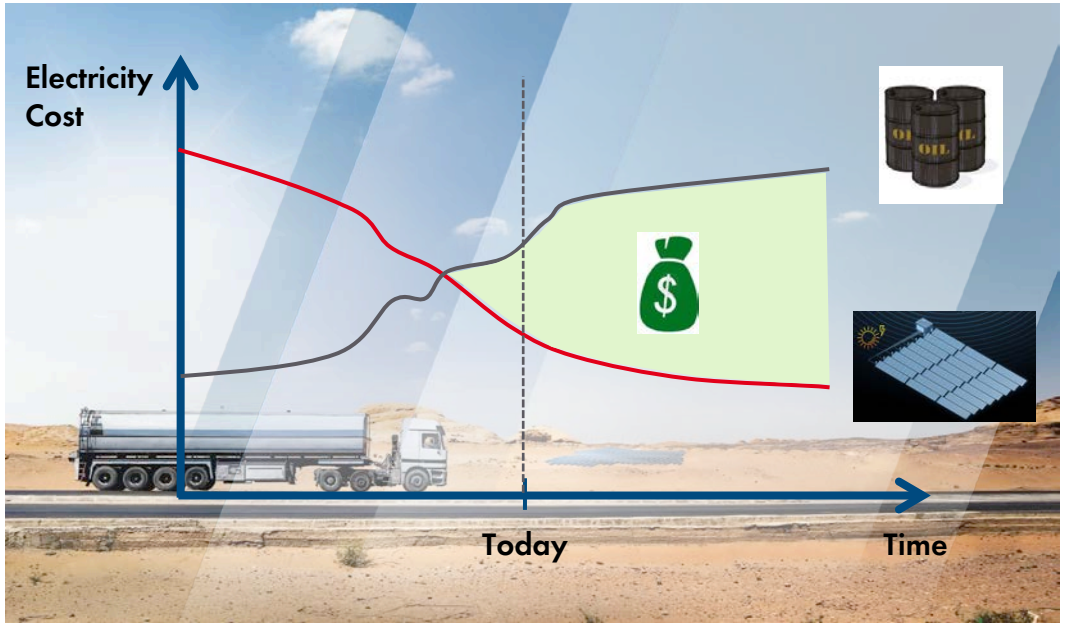
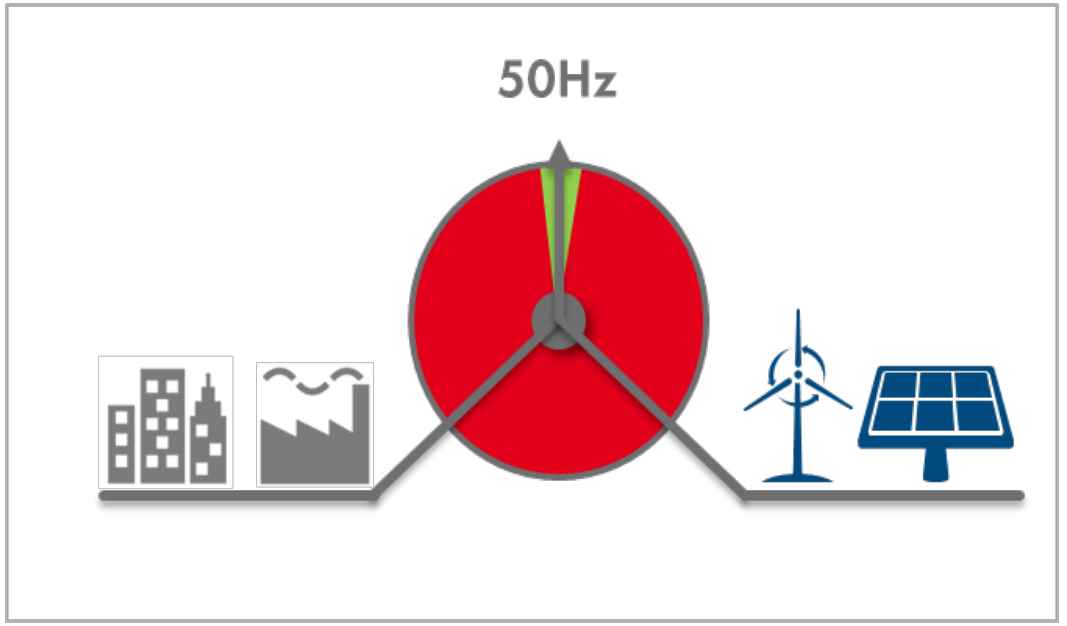
Micro Grid Solution Objectives

Saving Fuel / Increase Renewables



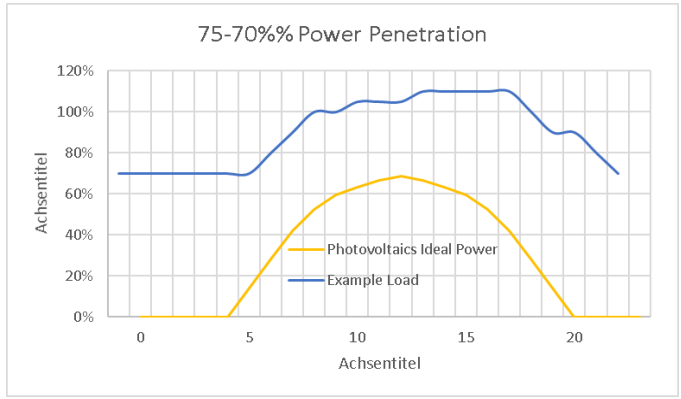
Keep/improve grid stability and availability



SMA Solution from low to maximum Penetration Level

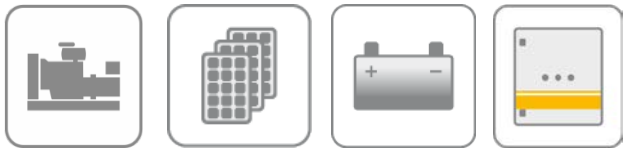
65% -80% PV Power
20 - 25% Energy

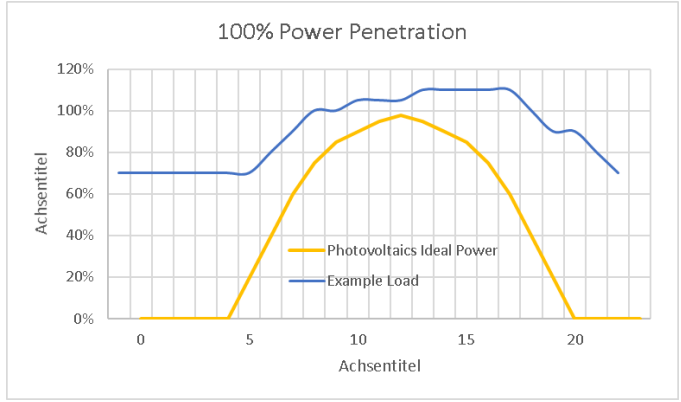
Control System of PV to follow the load



100% - 130% PV Power
30 - 40% Energy

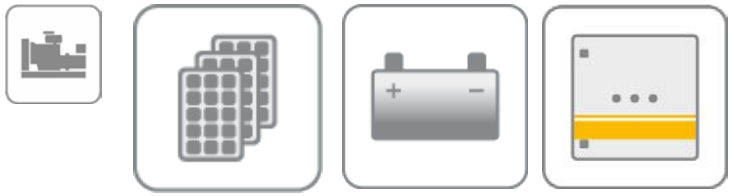
Control System & Short-term Storage

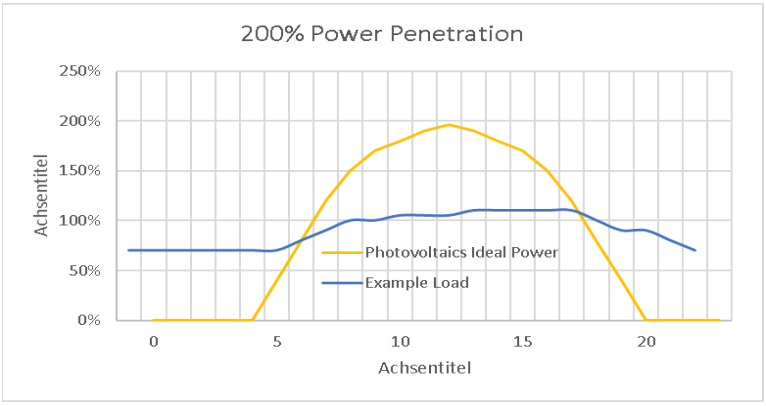




~200%-300% PV Power
50-70% Energy

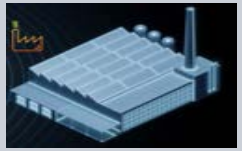
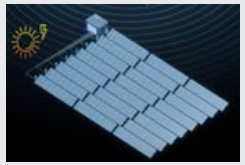
Control System & Long-term Storage





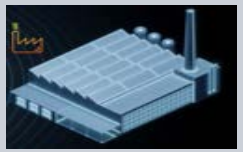
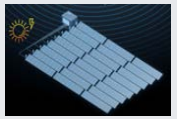
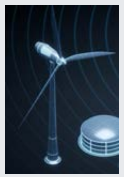
Increasing renewable penetrations will need Control System Coordination and Storage solution to

St. Eustatius II - Caribbean Island

MicroGrid Item	Values
	2 MW Load ~ 14GWh
	4 MW PV ~200% of the max load ~50% Energy Penetration
	2 MW Storage 4 MWh
	3 x 1 MVA Gensets
	Full Micro Grid Management

- Caribbean island reduces its diesel consumption by nearly 50%.
- The project was developed over three phases to reach the power share of 200%
- The owner is the electricity supplier on the island
- Pay-back time is less than 4 years

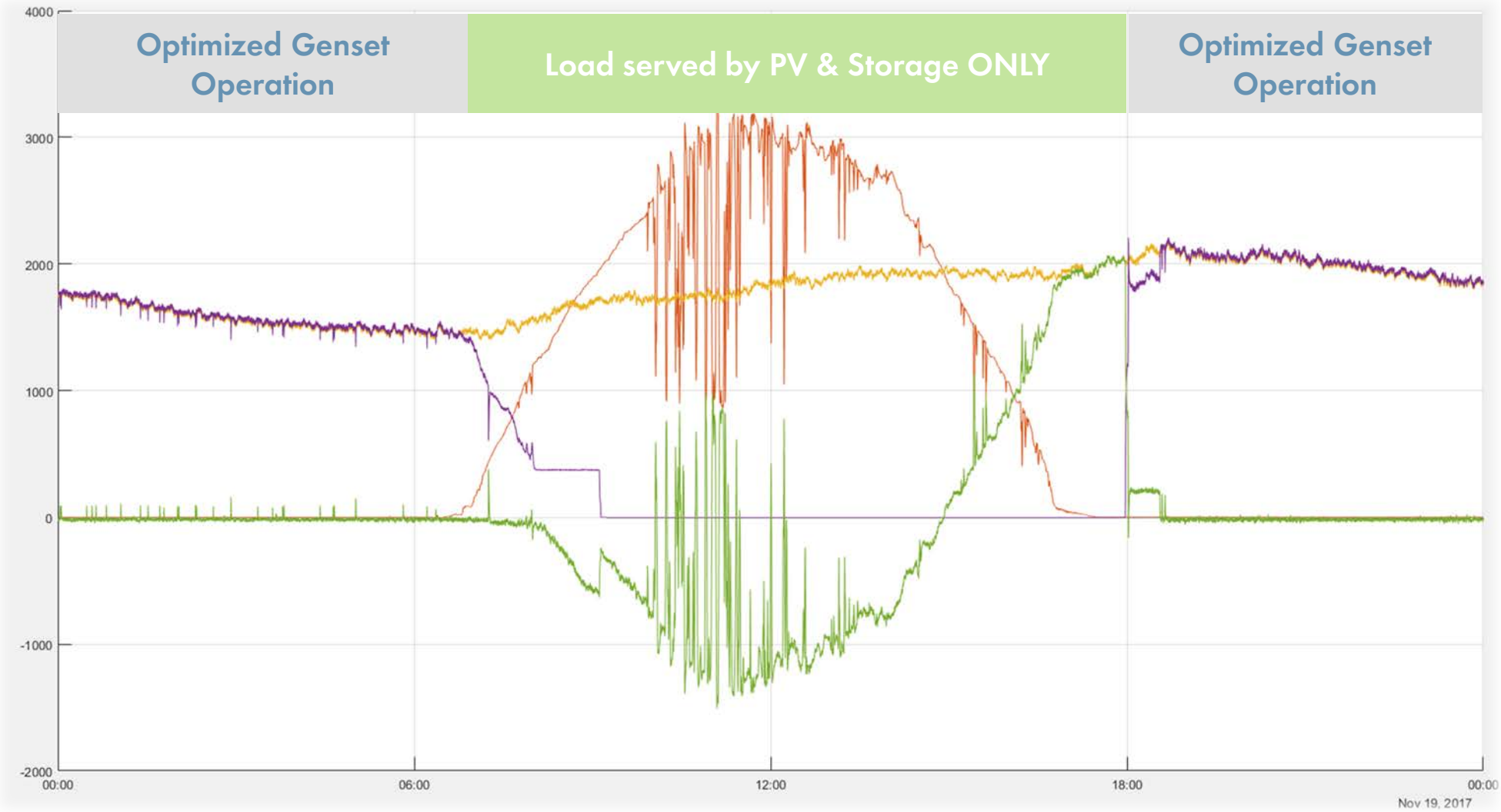
EDL Agnew Hybrid Renewable Power Station
Gold Fields' Agnew Gold Mine – Western Australia

MicroGrid Item	Values
	Installed generation capacity 56MW
 	4 MW Solar PV + 18MW Wind >50% Renewable Energy Penetration
	13 MW/4 MWh Battery System
	9 x 2MW Gas Generators and 2 x 1.6MW Diesel Generators
	Advanced microgrid control system (non-SMA) SMA Storage Site Controller only

- Mining site in AUS
- The hybrid renewable project is owned and operated by EDL
- SMA supplied Sunny Central Solar and Sunny Central Storage inverters

Video for St. Eustatius II - Caribbean Island

Sample Day on the Island Electricity Operation



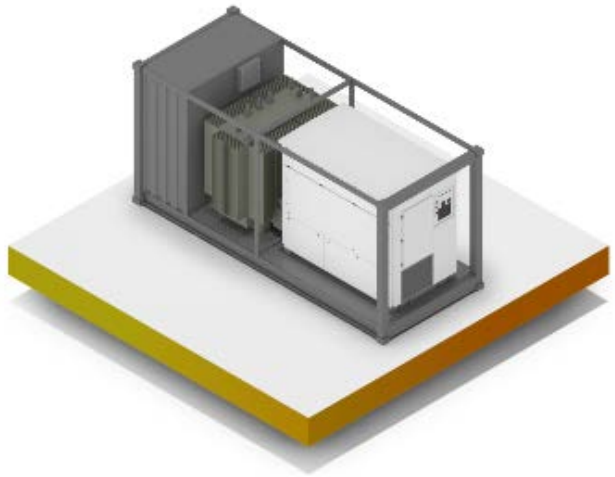
50MW/60MVA Grid Frequency Regulation – UK

20MW / 35MVA Grid Support– USA

Solution Features to Reach Highest Rate of Renewable

Virtual Synchronous Machine with BESS Genset OFF Mode

Reduces the number of running (must run) generator down to zero

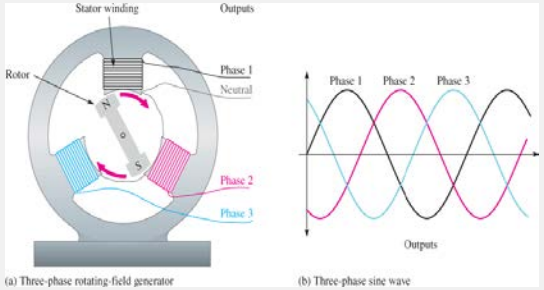


Micro-Grid Management
Overall Local Grid Management

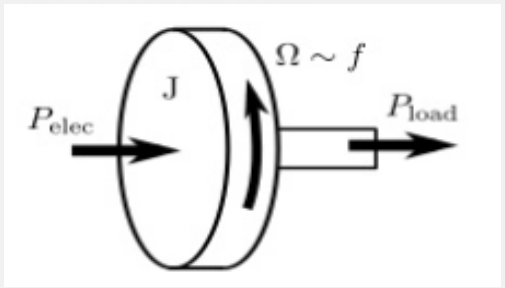
Manages and coordinates all resources in a micro-grid

System Design
How much Different Resources and Storage System are needed

Genset Off Mode – Virtual Synchronous Machine – Basic Idea

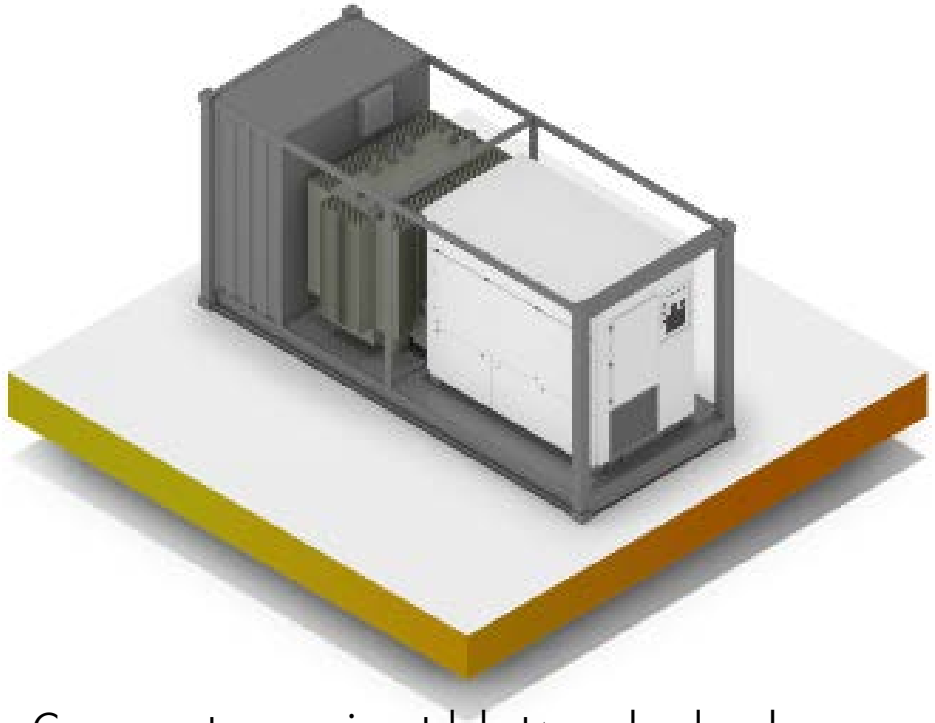


Voltage Control



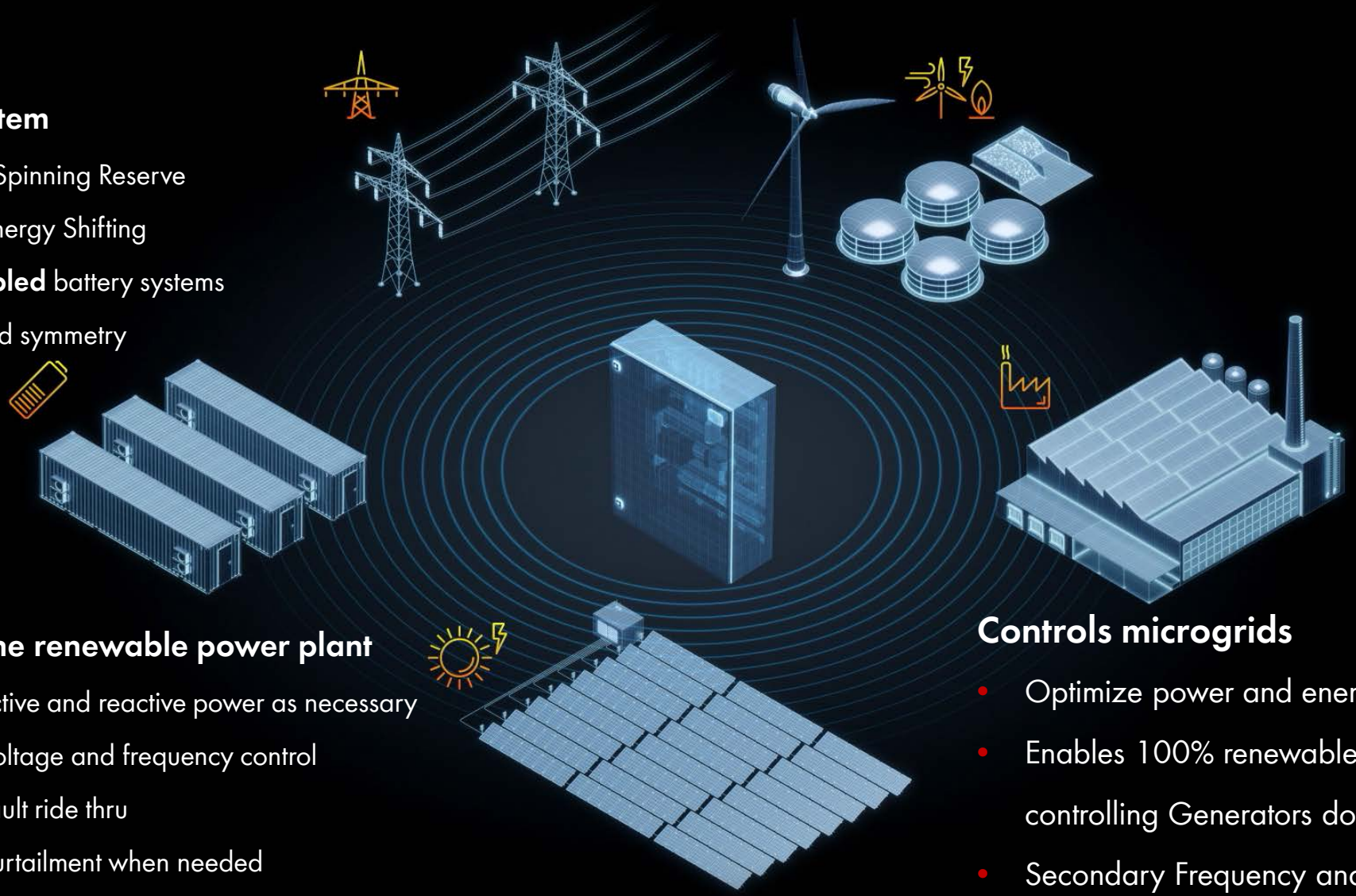
Frequency / Speed Control

- Voltage and Frequency Control
- Inertia like behavior



- Compensate any mismatch between load and generation instantaneously
- Provides backup and black start services

Micro-Grid Management – Power Plant Manager



Controls the battery system

- Primary Control Reserve / Spinning Reserve
- Rampe Rate Control and Energy Shifting
- Supports AC- and **DC-coupled** battery systems
- Controls state of charge and symmetry

Manages the renewable power plant

- Controls active and reactive power as necessary
- Supports voltage and frequency control
- Manage fault ride thru
- Manage curtailment when needed

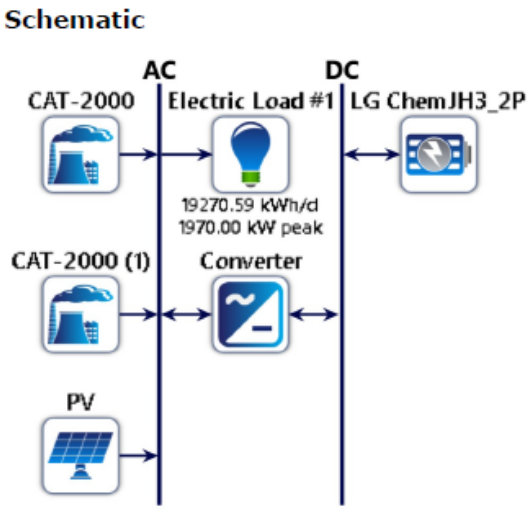
Controls microgrids

- Optimize power and energy flow
- Enables 100% renewable energy supply by controlling Generators down to ZERO
- Secondary Frequency and Voltage Control

Engineering Services

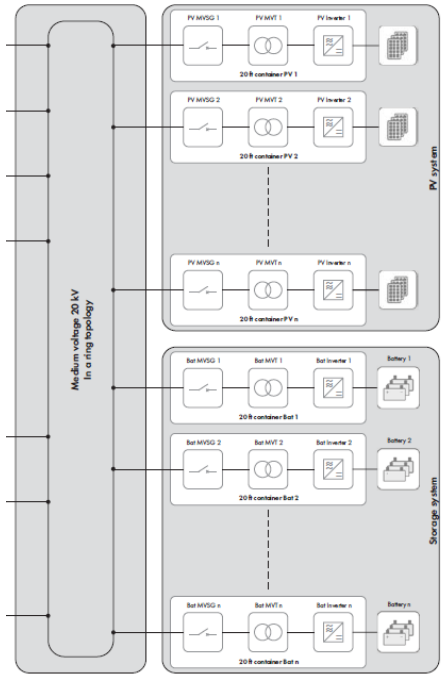
High Level Economical Sizing

E.g. Homer Simulation or similar



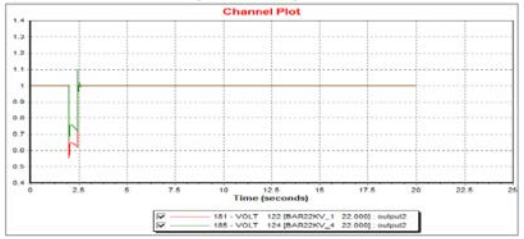
Detailed Design and SLD

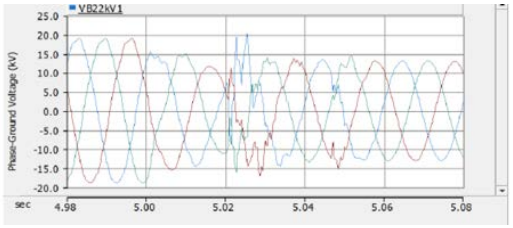
Simulink / E-Plan



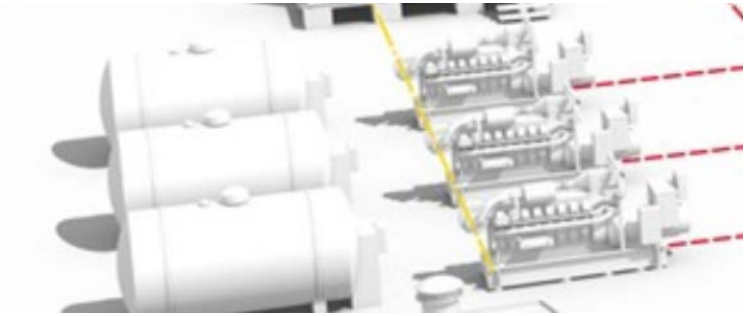
Grid Impact Study

PSSE/DigSilent/PSCAD





Summary: Replacing the rotating generators with smart control system and storage systems allows for more PV penetration and improve the quality of supply



Thank you for watching!

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