Project “Zimbi”

A PV/Diesel Hybrid Power Case Study

CRONIMET
Power Solutions GmbH

CRONIMET Mining AG is Mining >>> Processing >>> Trading >>> Energy

1. **CRONIMET Mining Group**
2. Innovative Trade Finance: Commodity Energy Swap
3. Case Study “Zimbi” – PV/Diesel Hybrid Power
4. Contact

CRONIMET Mining Group

Intro

1. CRONIMET Mining Group
2. **Innovative Trade Finance: Commodity Energy Swap**
3. Case Study “Zimbi” – PV/Diesel Hybrid Power
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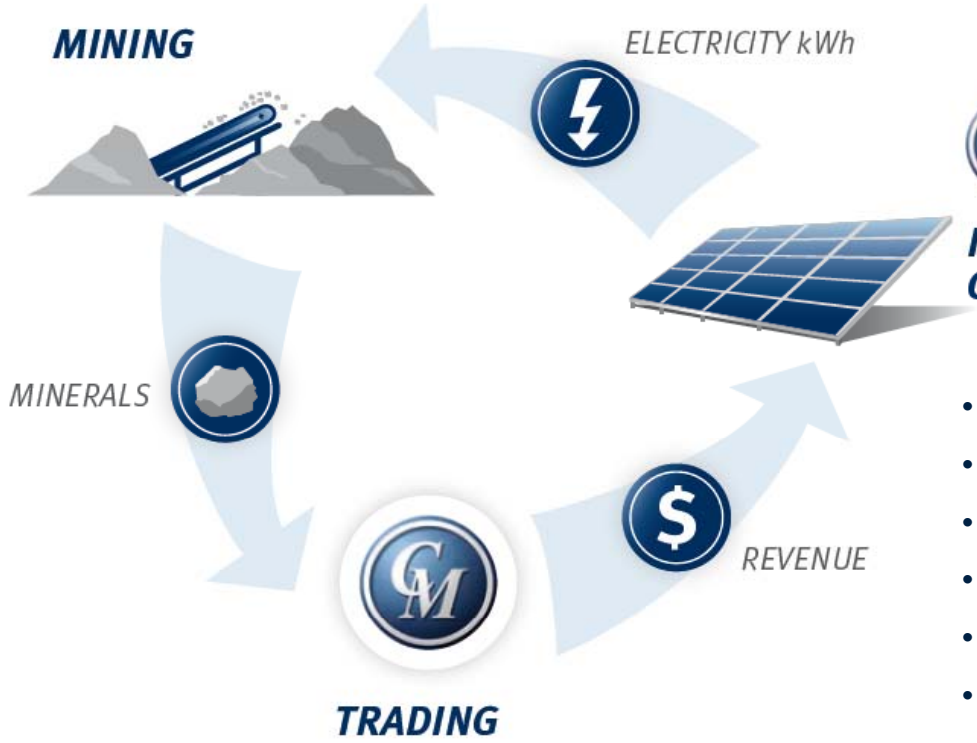
Innovative Trade Finance

Commodity for Energy Swap



- Innovative Trade Financing
- No Up-front Cost for Miner
- Secured PPA with Mineral Ore
- Energy Hedge against Diesel
- Lower Annual Opex for Miner
- Reduced Cash Conversion Cycle

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Case Study – “Zimbi”

Chromite Mine in South Africa

“We sought immediate diesel reduction and demanded lower opex”

Moritz Hill, Director, CRONIMET Chrome South Africa (Pty.) Ltd.

Chromite Mine, South Africa

CRONIMET Chrome South Africa (Pty.) Ltd.	
Location and Deposit	North Western Bushveld complex, 250 km NW of Johannesburg
Size	2,444.2 ha
Resources	5.6 Mt LG 6 and MG with 38% Cr203 (opencast) 33.0 Mt LG 6 with 43.6% Cr203 (underground)
Mining Right	30 years (granted in March 2010)
Processing	Up to 40 ktpm (opencast) By developing the underground mine up to 90 ktpm
Products	Mining Product: Chromium ores and concentrates
Energy Resource	Captive Diesel Fired Generators / Photovoltaic Hybrid
Energy Consumption	1.6 MVA

Case Study – “Zimbi”

PV/Diesel Hybrid System (Thabazimbi)

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Thabazimbi PV Diesel Hybrid Plant

Location:	South Africa
Installed Diesel Power:	**1.6 MVA**
Voltage:	525V
Annual Diesel Burn (Liters)	1.9 million liters/yr
Annual Diesel Fuel Cost	$ 2.18 million/yr
Installed PV Power:	**1 MW**
PV Penetration Ratio:	60%
Annual PV Energy p.a.:	1,800,000 kWh
Ratio of PV to Total Energy:	up to 30%
Annual Diesel Savings:	**450,000 liters**
Planning, Development & Financing:	Three Months
Construction:	**Three Months**
Commissioning:	November 2012

From Concept to Commissioning in 6 Months

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Planning

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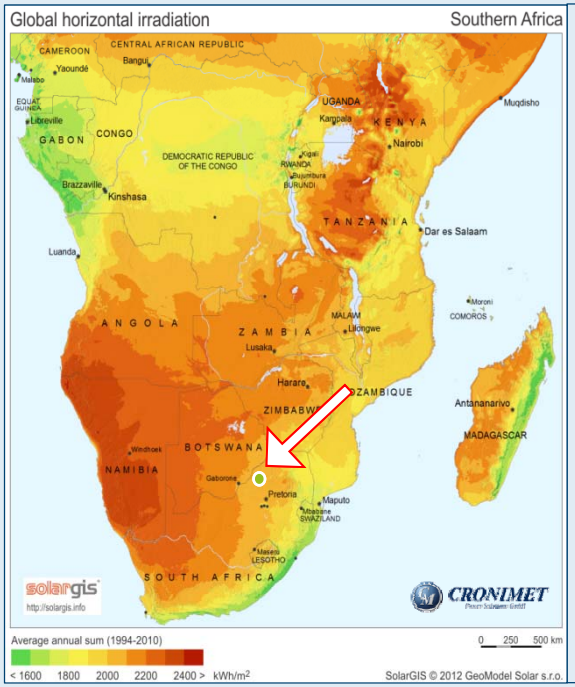

Solar irradiation energy yield (per year):	1850 kWh/kWp
1 MW of Photovoltaic (97% Availability)	x 1000 kWp
Total Annual Electricity from PV	**1,800,000 kWh**
Genset Efficiency Ratio (1/4 liter = 1kWh)	x 0.25
Annual Diesel Savings (liters)	**450,000 liters**
Cost of Diesel / liter (2012)	x $ 1.15 / liter
Annual Diesel Savings ($$$)	**$500,000**
PV Plant Expense (CAPEX)	**$2.66 million**

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Planning - Financial Feasibility

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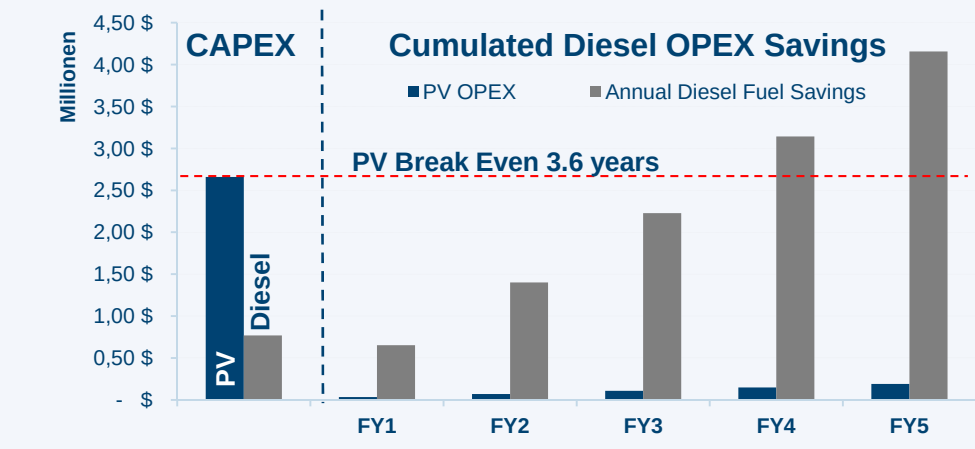
Simple PV Break Even vs. Diesel Operating Costs



Diesel gensets	2 x 800 kVA
PV Plant	1000 kWp
CAPEX	$ 2.66 million
O&M	1% of CAPEX
Diesel Price$_{(2012)}$	**$ 1.15 / liter**
Diesel Inflation p.a.	12%

Breakeven in just under four years!

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Planning – Optimal PV Penetration

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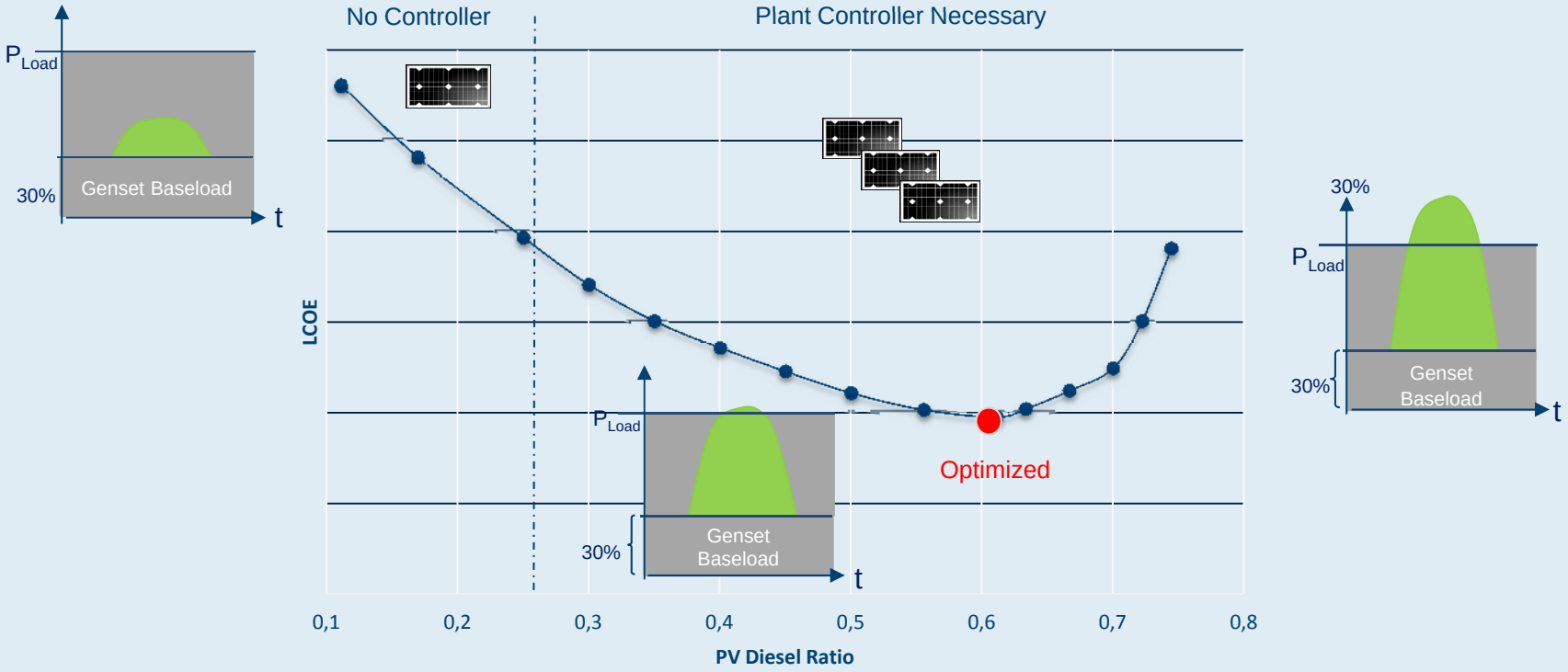

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Planning - System Analysis

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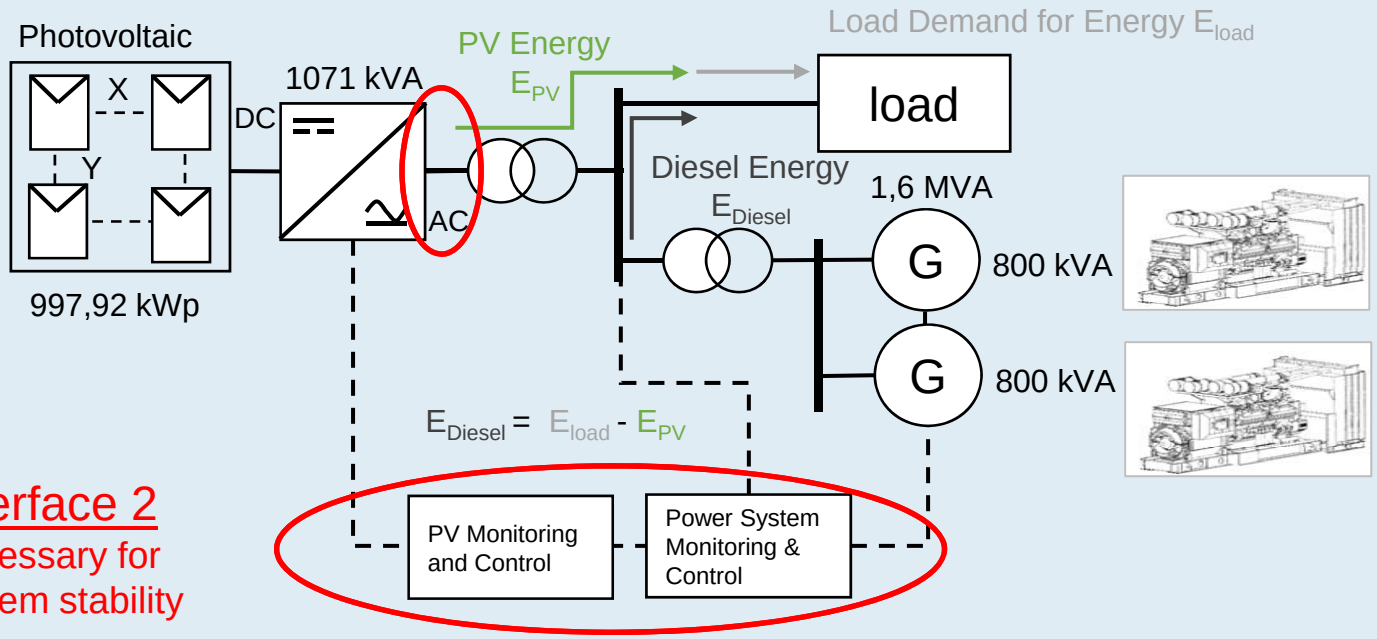
Interface 1

Industry proven grid connection: > 30GW in Germany alone



Interface 2

Necessary for system stability

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Planning - System Analysis

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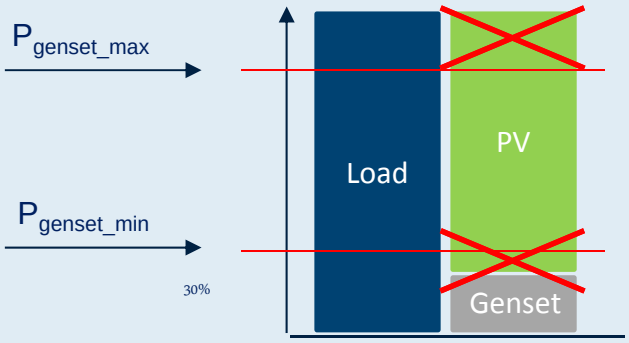
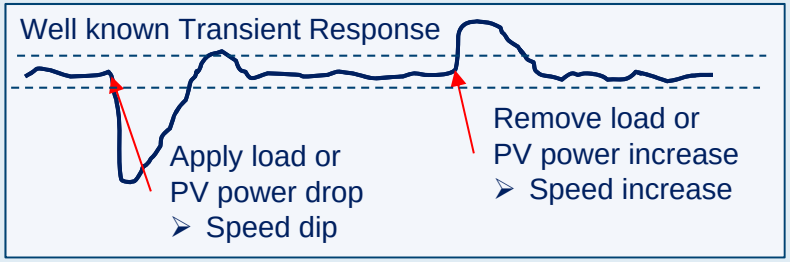
Static System Analysis

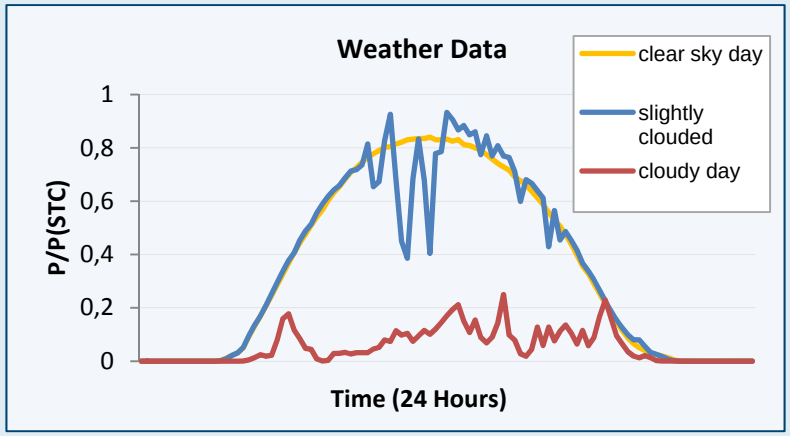
- PV must not influence system stability
  - Sufficient Spinning reserve
- PV must not damage the Diesel Generator
  - Base Load of 30% at all times



Dynamic Behavior of Diesel Power System



Dynamic Behavior of PV Power Plant



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Financing – Discounted Diesel Savings Analysis

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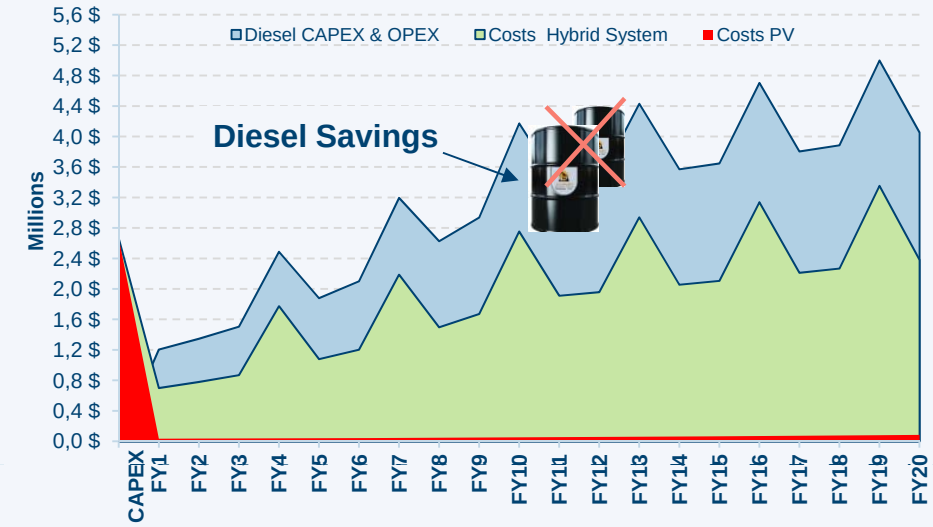
Annual Day-time Energy Cost Savings



Key Value Drivers

Total Annual Litres	1,900,000
Total Annual Daytime Litres	1,051,200
Diesel Price/Litre (Year 1)	$ 1,15/L
Annual Diesel Inflation	12%
PV Investment (CAPEX)	$ 2.66 million
PV Plant Operating (Year 1)	$ 34,000
Annual Diesel Savings	450,000
Plant Operating Life	20-years
NPV @ 15% Discount Rate:	$ 3,150,000

NPV of Diesel Savings = $ 3 million

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Construction & System Integration

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Onsite System Integration Period of Two Months

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Completed 1 MW PV - 1.6 MWA Diesel Hybrid Power System

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Operating Since November 2012

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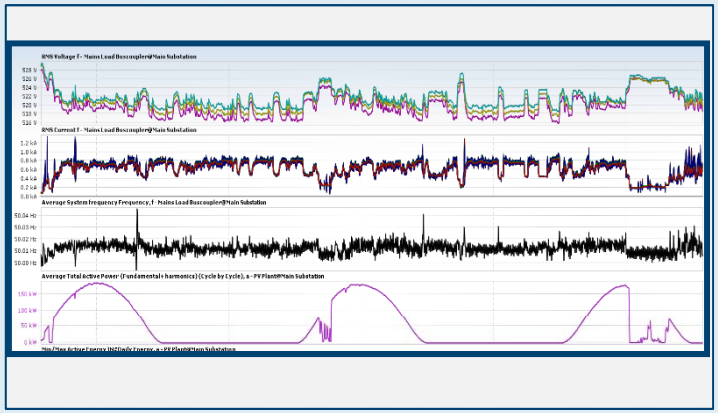
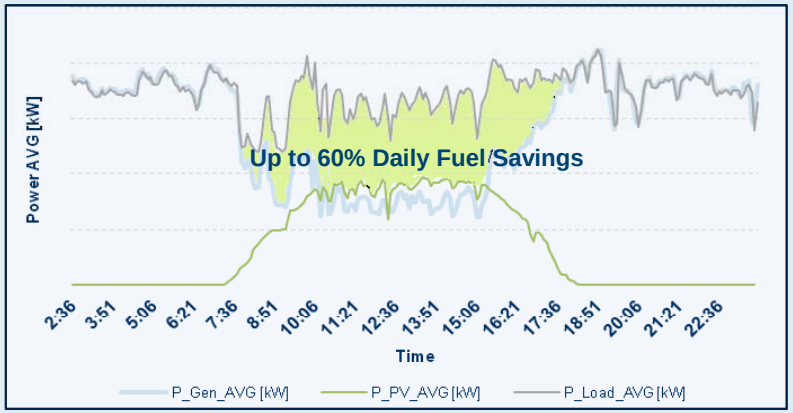
PV Power Plant Control



High Daily Fuel Savings



Case Study – “Zimbi”

Operating Since November 2012

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Proof Of Concept

› Successful Operation since November 2012

Maintenance

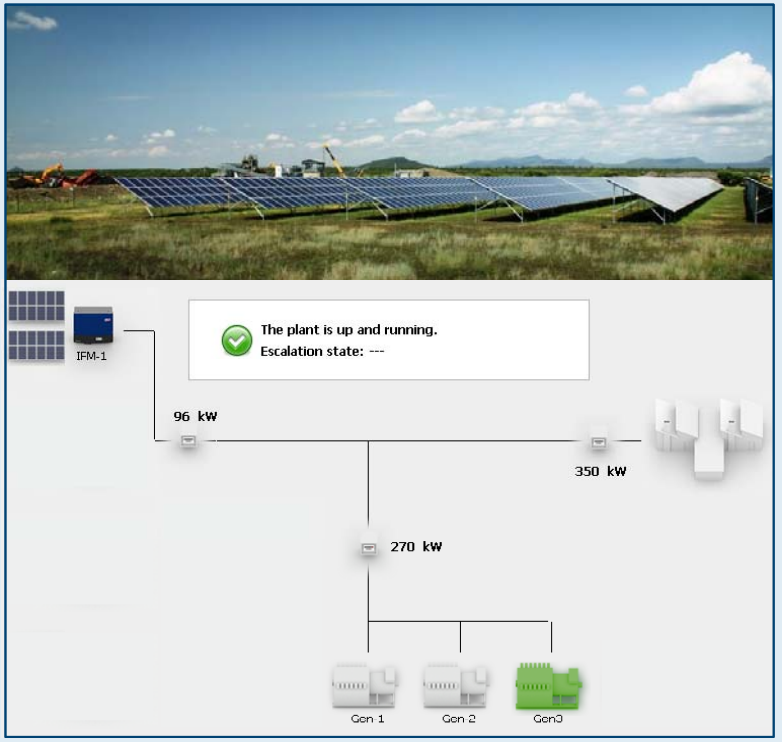
› Panel cleaning in dry season necessary two times a month

› Cleaning of substation and inverter fans four times per year

Operational Experience

› Data Analysis and asset management due to power data logging (Solar, Power, efficiency)

› Online Monitoring provides worldwide service access to reduce travel costs



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Thank You

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