Lessons Learnt from a Storage Based Microgrid Application

Powering Business Worldwide

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Agenda

- Brief introduction to Eaton
- Power Challenges in Africa
- Wadeville Case Study
- Business Case for Storage
- Role of Standards

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Our **vision** is to improve the quality of life and the environment through the use of power management technologies and services.

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Get to know our business.

Electrical Sector

2018 Sales $13.1 B

- **Electrical Products**
- **Electrical Systems & Services**

Industrial Sector

2018 Sales $8.5 B

- **Aerospace**
- **Hydraulics**
  - **Filtration**
- **Vehicle**
- **eMobility**

Total sales	**$21.6 Billion USD**
Net income	**$2.2 Billion USD**

- **Headquarters: Dublin, Ireland**
- **Chairman & CEO – Craig Arnold**
- **Key locations in Cleveland, United States; Shanghai, China; Morges, Switzerland; São Paulo, Brazil**
- **Regional engineering teams to support products and custom solutions**
- **Customers in more than 175 countries**
- **Approximately 99,000 employees**

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Eaton’s solid presence in Africa

Dedicated diverse team

- **700** employees
- More than 100 distributors throughout Africa
- **5** offices across the continent
- **2** service hubs
- Engineering Services
  - Study | Design | Build | Support

Regional manufacturing capability

- **200k ft²** of manufacturing space in South Africa and Morocco
- Africa based engineering services
- **BBBEE Level 1** certification

A broad portfolio supplemented by “made for Africa” products and services

- **IEC** and **UL** approved products
- Historical brands in Africa since **1927**
- Local manufacturing & engineering of Low Voltage, Medium Voltage and Power Quality products built for Africa

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A portfolio designed to meet your power management needs.

ELECTRICAL

Power distribution and circuit protection

Backup power protection

Lighting and security

Control and automation

Structural solutions and wiring devices

Solutions for harsh and hazardous environments

Engineering services

INDUSTRIAL

Aerospace – Hydraulic and fuel systems

Automotive – Engine air mgmt., traction control and fluid products

Truck – Commercial vehicle clutches and transmissions

Filtration – Liquid filtration solutions

Hydraulics – Fluid conveyance and power and motion control products

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Power Challenges in Africa

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Low Access and Reliability

	Electricity access %	Avg outage hours/year
Côte d'Ivoire	61.9	230
DR Congo	13.5	830
Ethiopia	27.2	570
Ghana	78.3	790
Kenya	36	420
Mozambique	21.9	80
Niger	15	1,400
Nigeria	56.4	4,600
Senegal	61	130
South Africa	86	50
Tanzania	18.9	670
Zambia	27.9	180

Source: https://qz.com/africa/1431213/africas-electricity-shortages-have-health-and-economic-costs/

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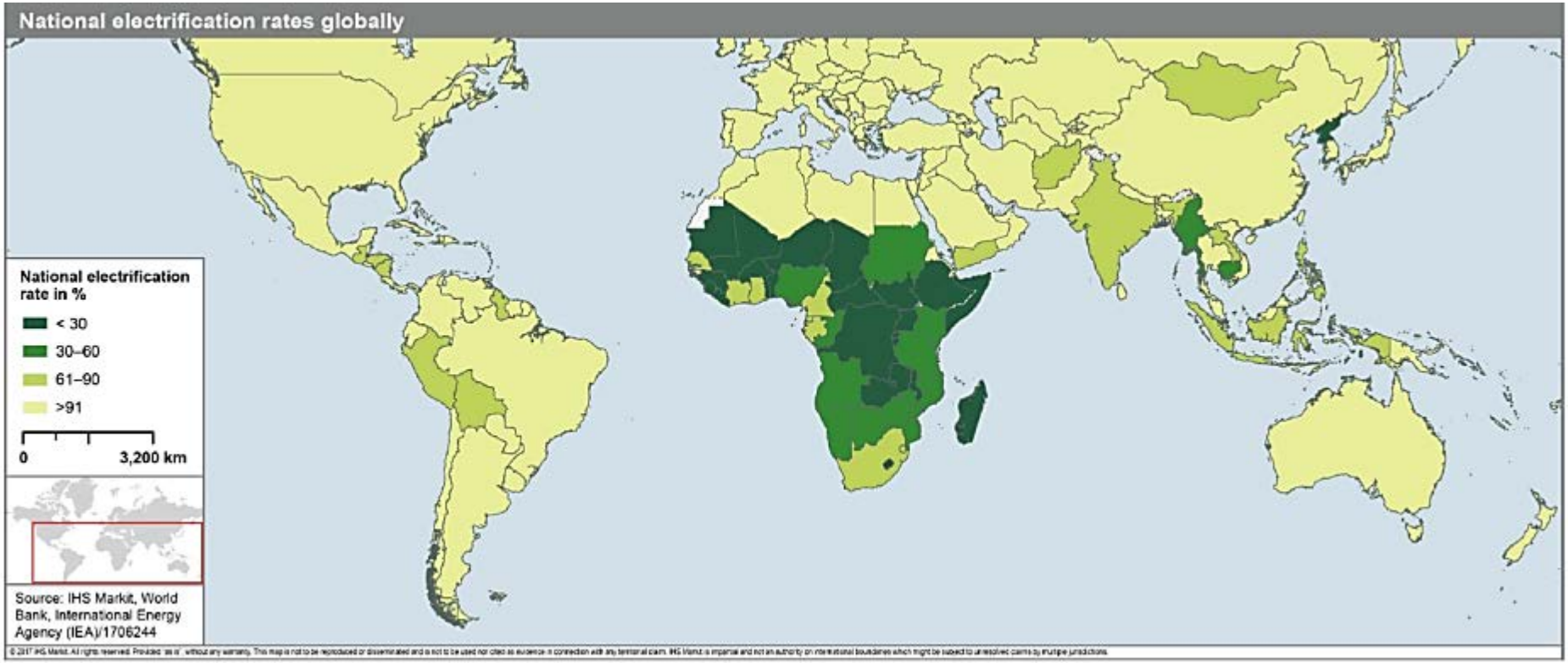
Global Energy Access



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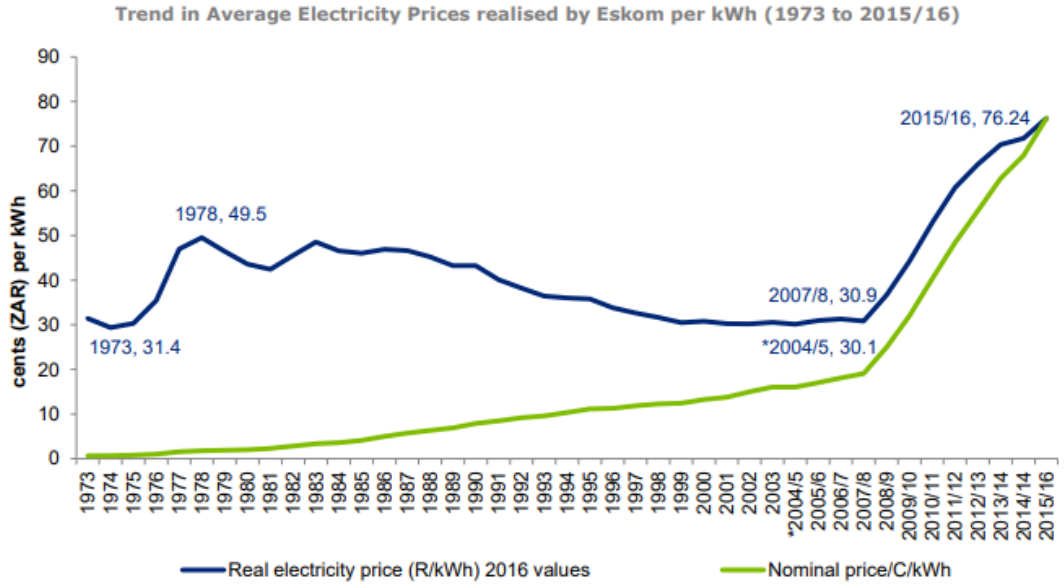
Rising Costs of Electricity



Source: Deloitte Analysis, Eskom data and 2011 annual report
Note: In 2004/5 Eskom change financial year from calendar year (year-ending 31 December) to year-ending 31 March

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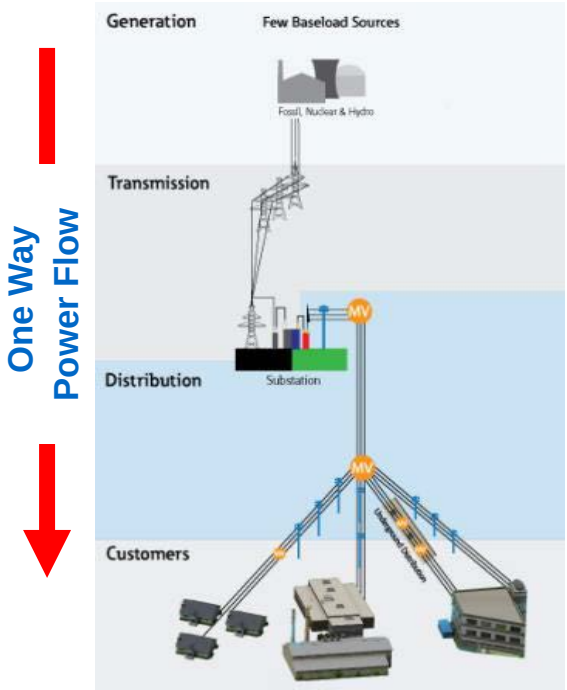
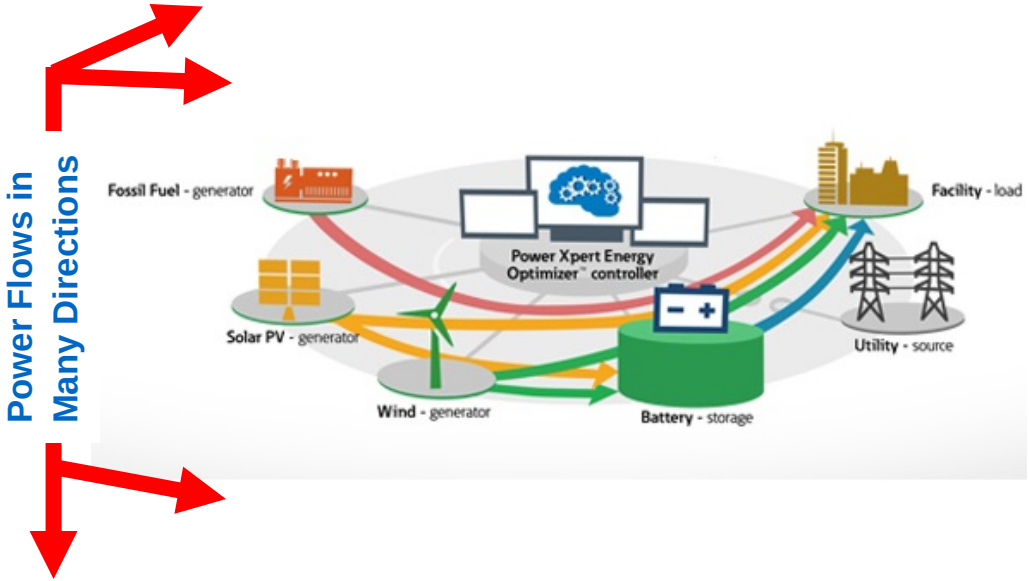
Evolving Power Sector Landscape:

Historical Typical Power Grid



Decentralized Grid



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Intro to Microgrids

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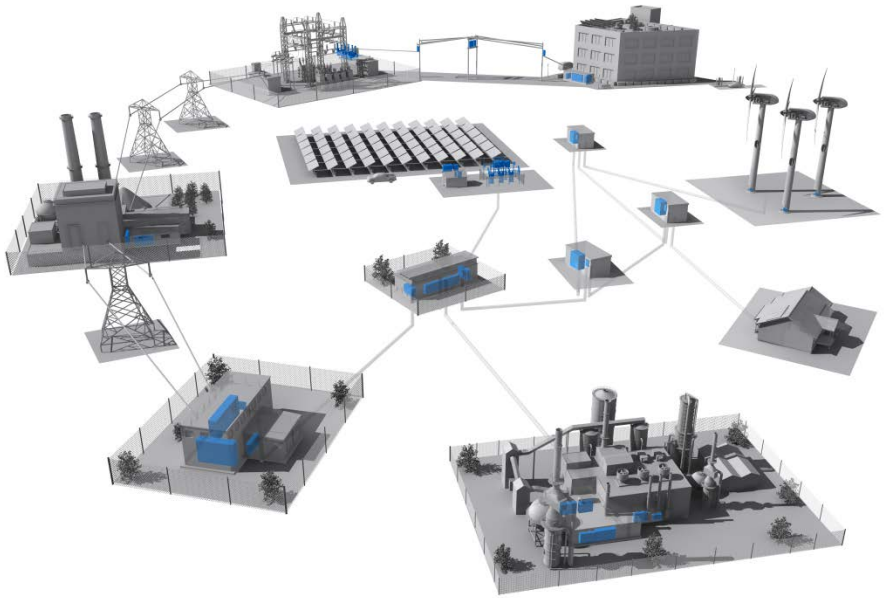
What is a Microgrid?

Microgrids are stand-alone power generation, distribution and storage systems that work with or independently from the main utility grid to help businesses, campuses and communities to:

- Maintain reliable supply of power
- Reduce operating costs
- Optimize energy usage
- Reduce carbon emissions



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Benefits of a Microgrid

Decrease costs

Help avoid peak charges

Reduce the reliance on expensive fuels like diesel

Eliminate costs associated with unexpected power loss or load shaving

Increase Reliability

Give continuity of supply

Enable grid stability and efficiency

Reduce CO2

Facilitate the wider adoption and deployment of renewable power generation

Increase autonomy

Effectively manage power and generation assets to meet your sites individual needs

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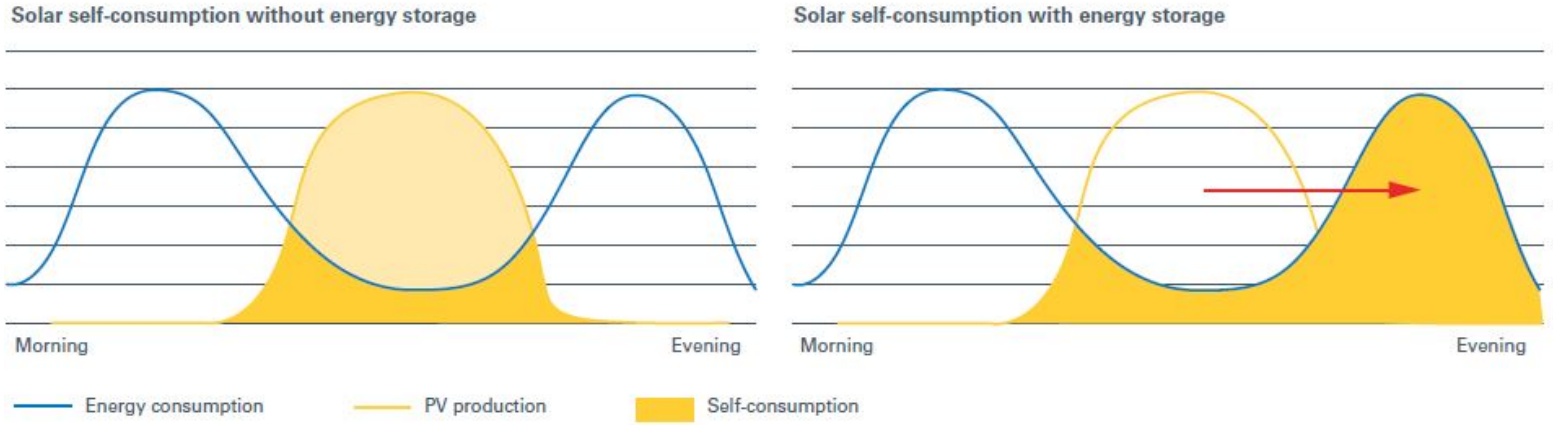
Why not solar alone?

Microgrids	VS	Solar Alone
Energy dispatchable		Renewables are intermittent, not dispatchable
Excess solar stored for later use – and keeps solar on even when grid goes off.		Excess solar curtailed by rule or when grid goes out
Configurable for many load profiles		Load profile must track sun to capture value



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Key Challenges at Eaton's Wadeville facility:

Unreliable Energy Supply

High Cost of Electricity

Due to ageing infrastructure we experienced increased in load shedding due to:

- Cable faults
- Scheduled maintenance of the grid

As a manufacturing facility we faced:

- Increase energy charges impacted by seasonality and peak time
- Network demand charges

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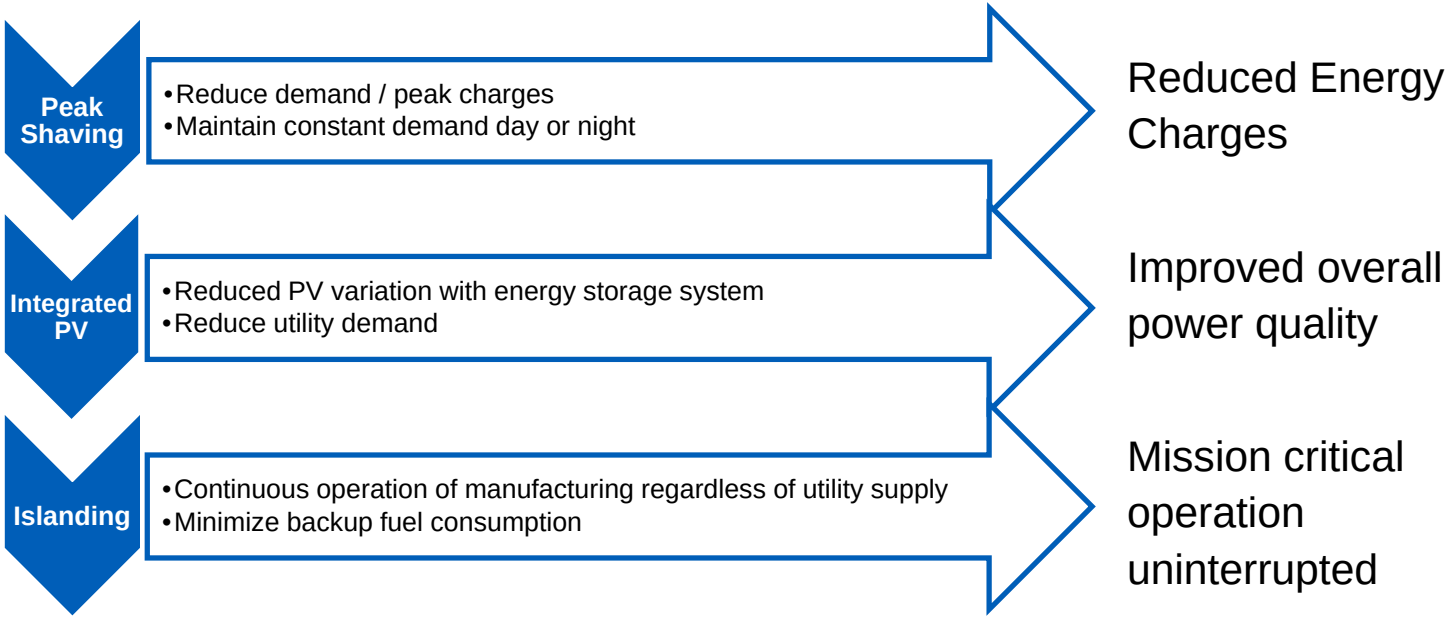
Business Case for Wadeville Plant

Three main use cases enabled by storage:



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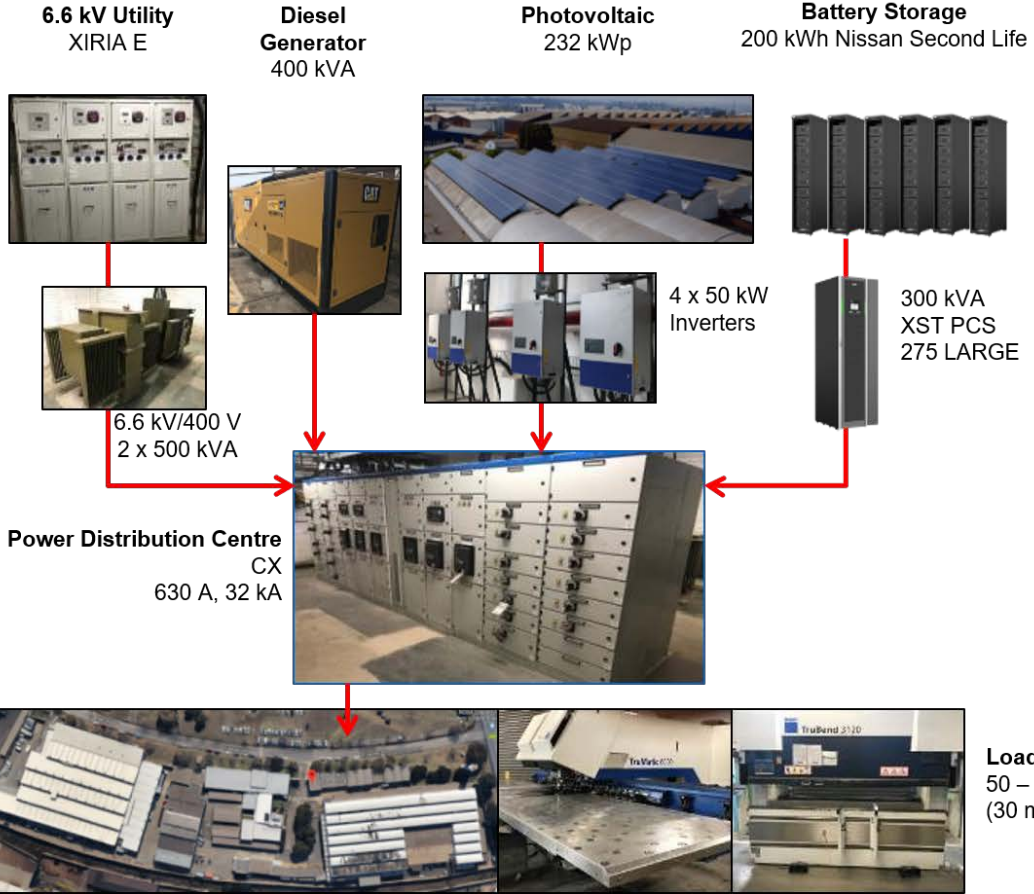
Key Hardware Components of the Wadeville Microgrid



Sources

- Utility
- 400 kVA Generator
- 200 kW Photovoltaic
- 275 kW Battery Storage (200 kWh)

Loads

- 50 – 375 kVA (30 min readings)
- 70 kW compressor

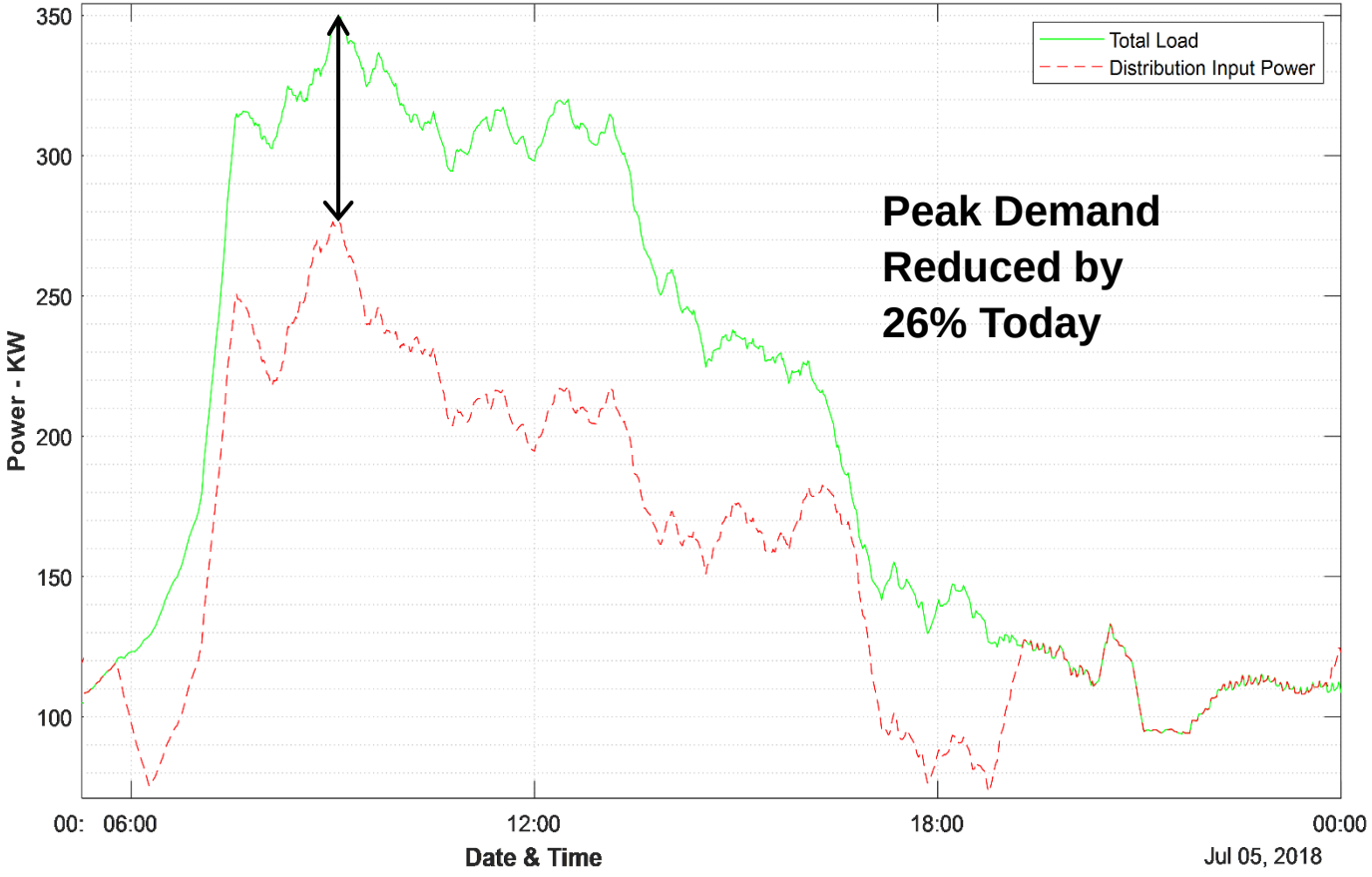
Use Cases (partial list)

- Peak Power Limiting / Load Leveling
- Renewable Firming
- Load Shifting
- Resiliency: Islanded operation optimizing renewables

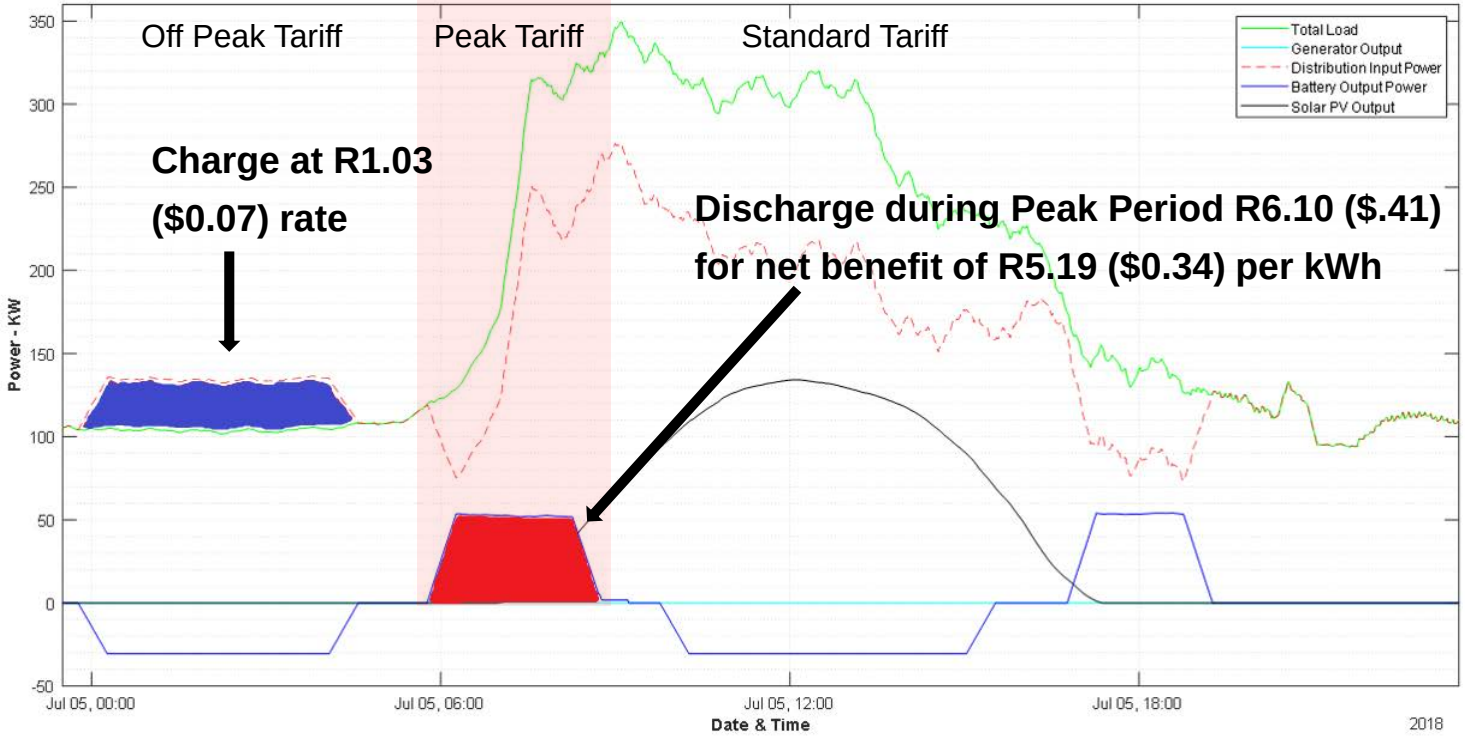
Business Case for Storage

Value Stream 1: Tariff Optimization – Max Demand Reduction

Reduces Maximum Demand Charges



Value Stream 2: Tariff Optimization – Energy Arbitrage
Reduce Grid Consumption when Costs are Highest



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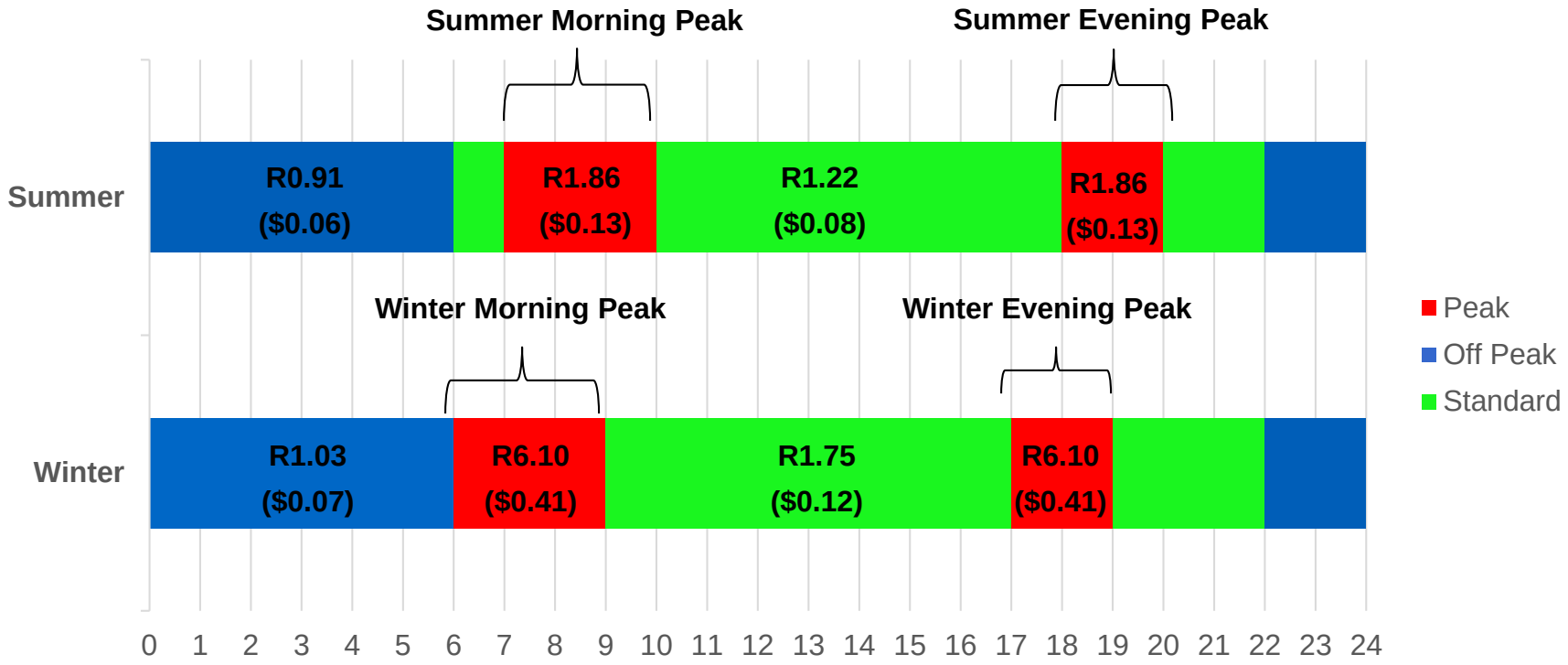

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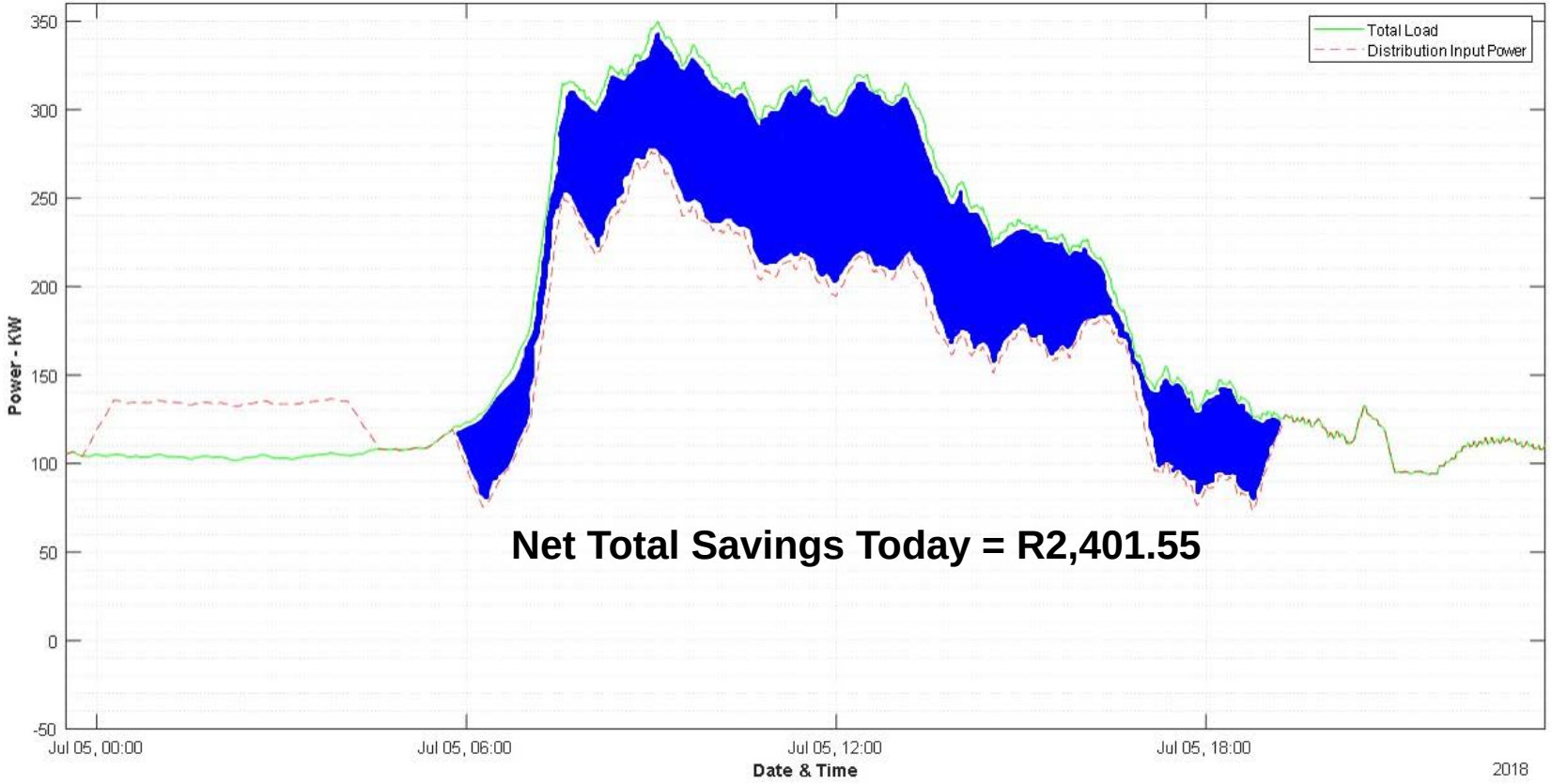
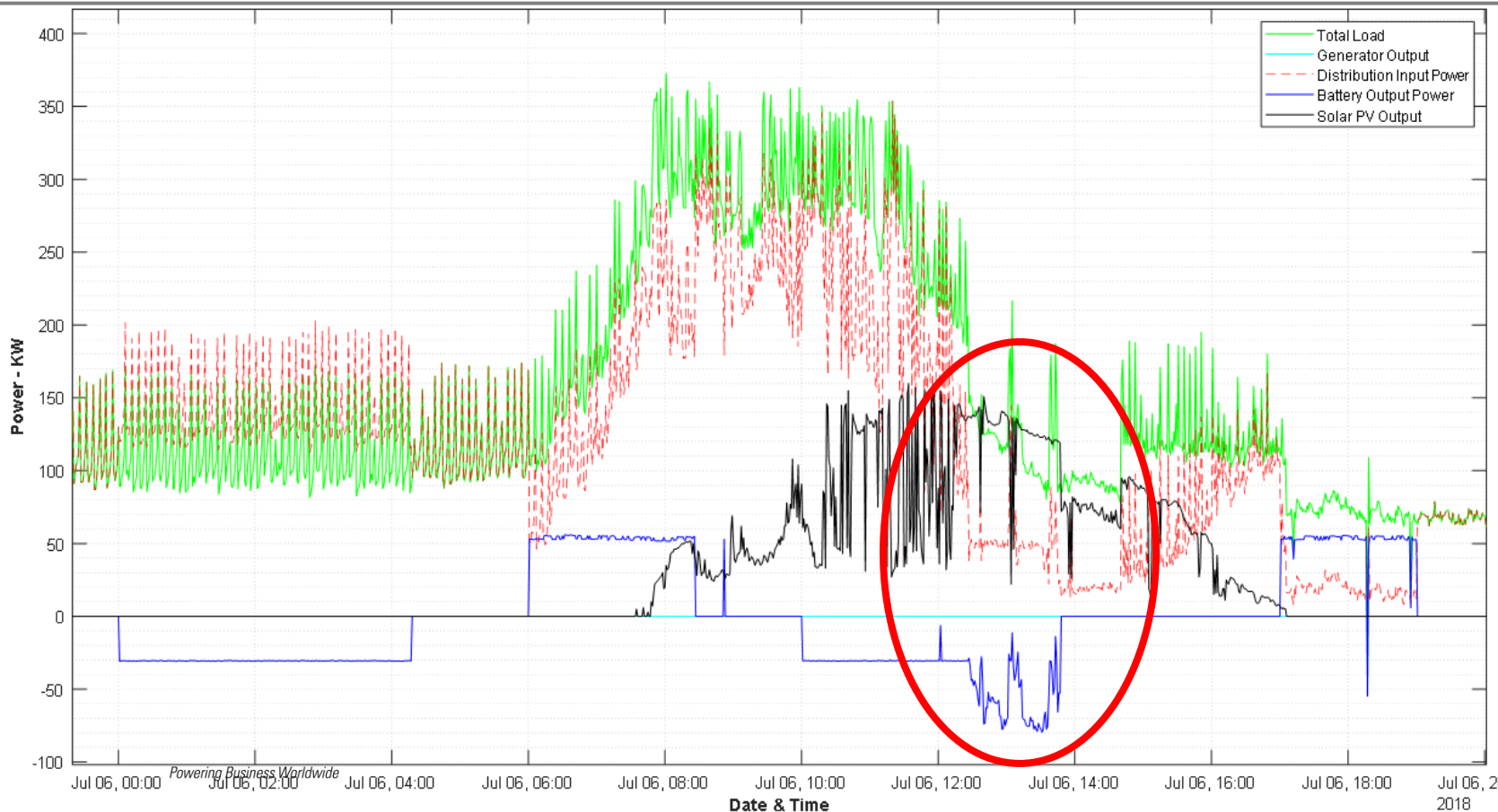
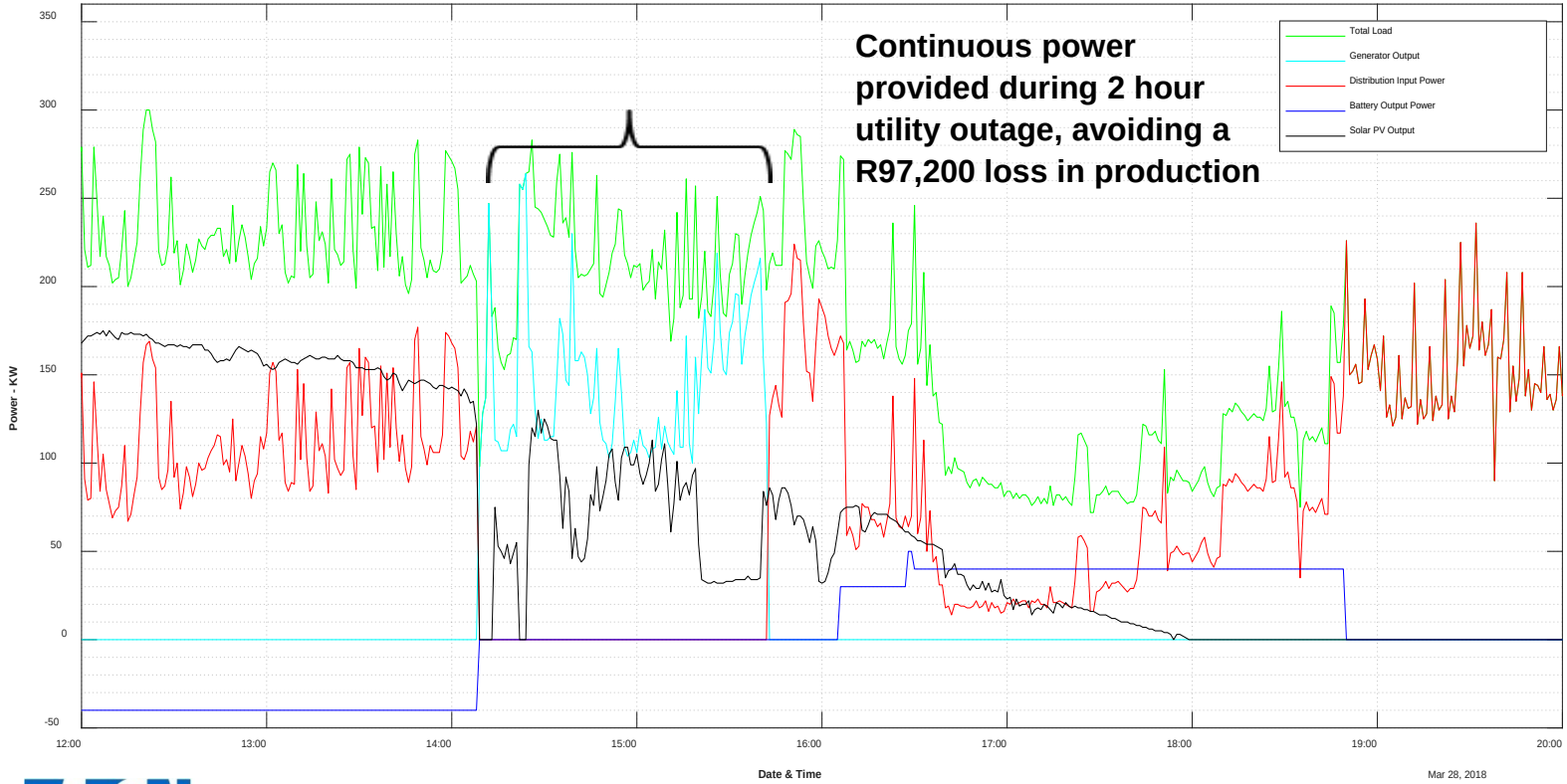
Value Stream 3: Renewable Maximization
Solar PV and Storage Reduce Total Grid Consumption



Value Stream 3: Renewable Maximization
Storing Excess Solar



Value Stream 4: Outage Avoidance
Eliminate Production Losses Due to Power Outages



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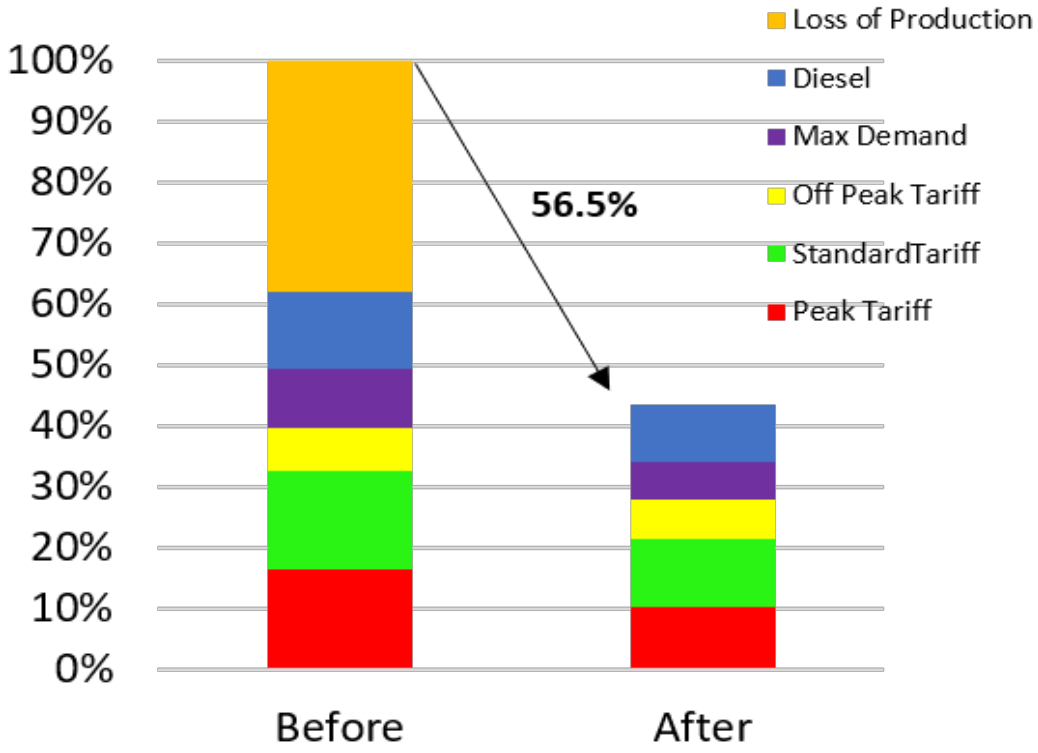
Combining the value streams over 12 months leads to significant savings
(Wadeville Microgrid generates 56% Operational Savings)



Multiple value streams stacked to reach a high ROI, and breakeven expected in less than 5 years


URKUNDE

ES IST UNS EINE BESONDERE EHRE,

EATON

IM RAHMEN DES

INDUSTRIAL ENERGY EFFICIENCY AWARD

IM JAHR 2019 ALS GEWINNER IN DER KATEGORIE ENERGIEWIRTSCHAFT AUSZUZEICHNEN.

Arno Reich
Senior Vice President, Industry, Energy & Logistics
HANNOVER MESSE & CeMAT events,
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Markus A.W. Hoehner
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EuPD Research Sustainable Management GmbH

HANNOVER MESSE

EuPD Research

Deutsche Messe

Role of Standards

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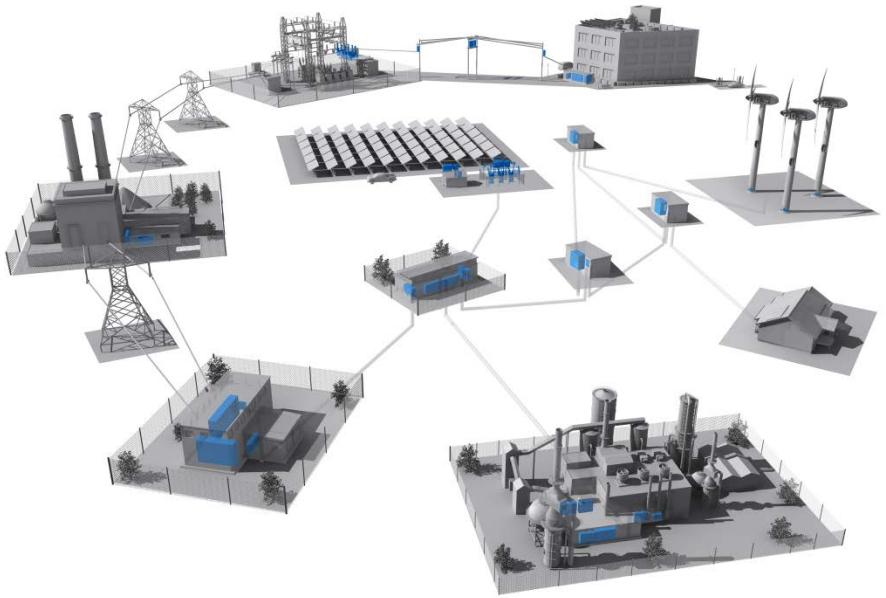
Microgrid & Storage Standards & Guidelines

Standards play a key role in the design, installation, and operation of Microgrids and Embedded Generation Systems

- IEEE 2030.7; 2030.8
- IEEE 1547.3; 1547.4
- IEC 62933: 1 - 5
- SANS 10142 & NRS 097



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Implications of Limited Standards in Storage

- Difficulty for customers to align needs with suitable battery technology for application
- Challenges with regulation and compliance
- Push for commoditization of energy storage systems based on price not function

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Conclusion: We Need Consensus on Standards

- Ensure consistency
  - Quality assurance
  - Safety
- Increase consumer and utility confidence
- Assess different energy storage offerings against a common benchmark

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