ENERGY STORAGE MARKET OPPORTUNITIES AND POTENTIAL IN AFRICA

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SPEAKER

Luke Witmer

Wärtsilä

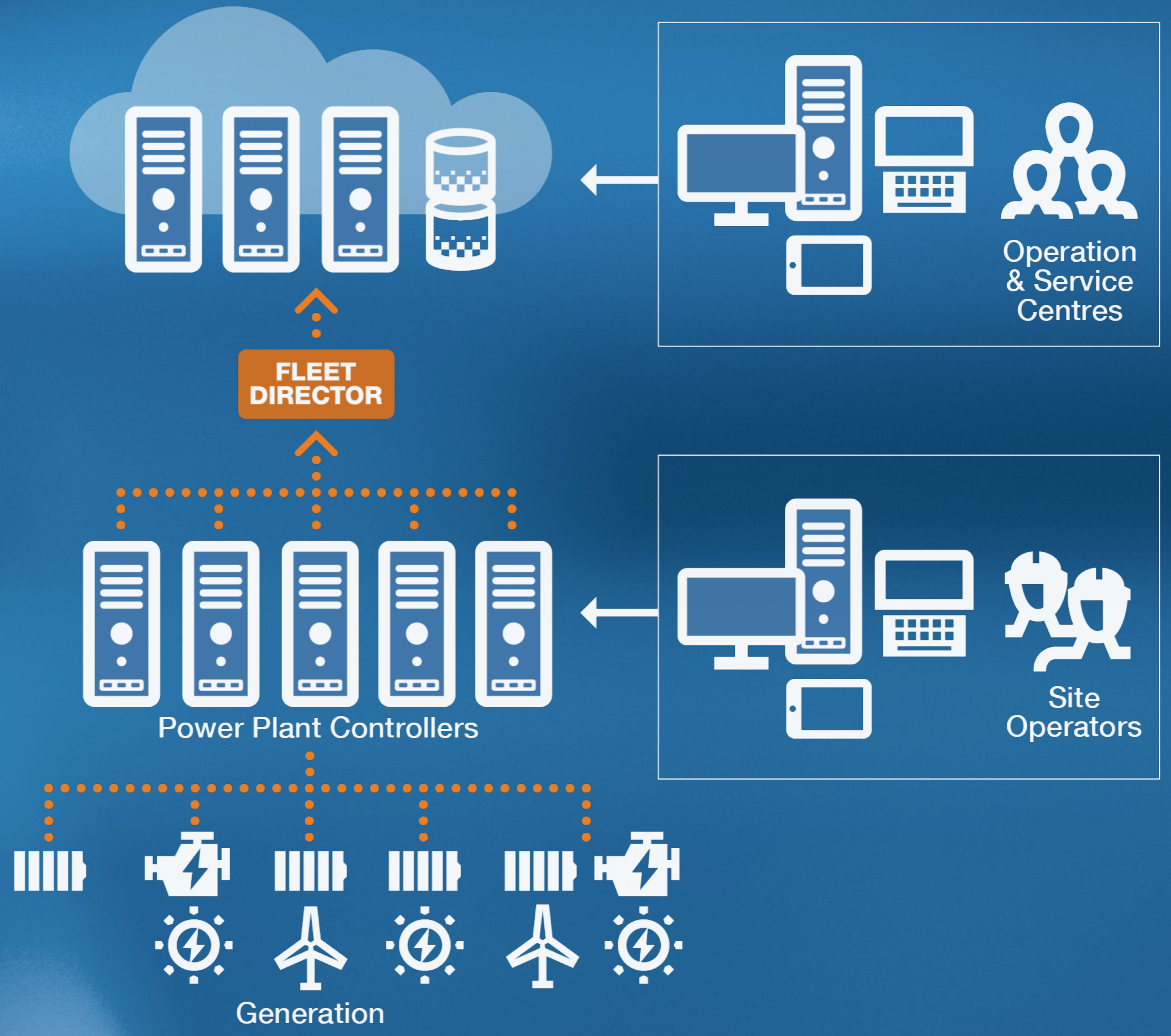
General Manager
Data Science

WHAT IS GEMS?

AN INTEGRATED SOFTWARE PLATFORM

THAT WÄRTSILÄ ENERGY STORAGE & OPTIMIZATION (ES&O) DEVELOPED FOR INTELLIGENTLY OPERATING LARGE POWER PLANTS, DISTRIBUTED ENERGY RESOURCES AND ISLAND MICROGRIDS.

GEMS DEPLOYMENTS

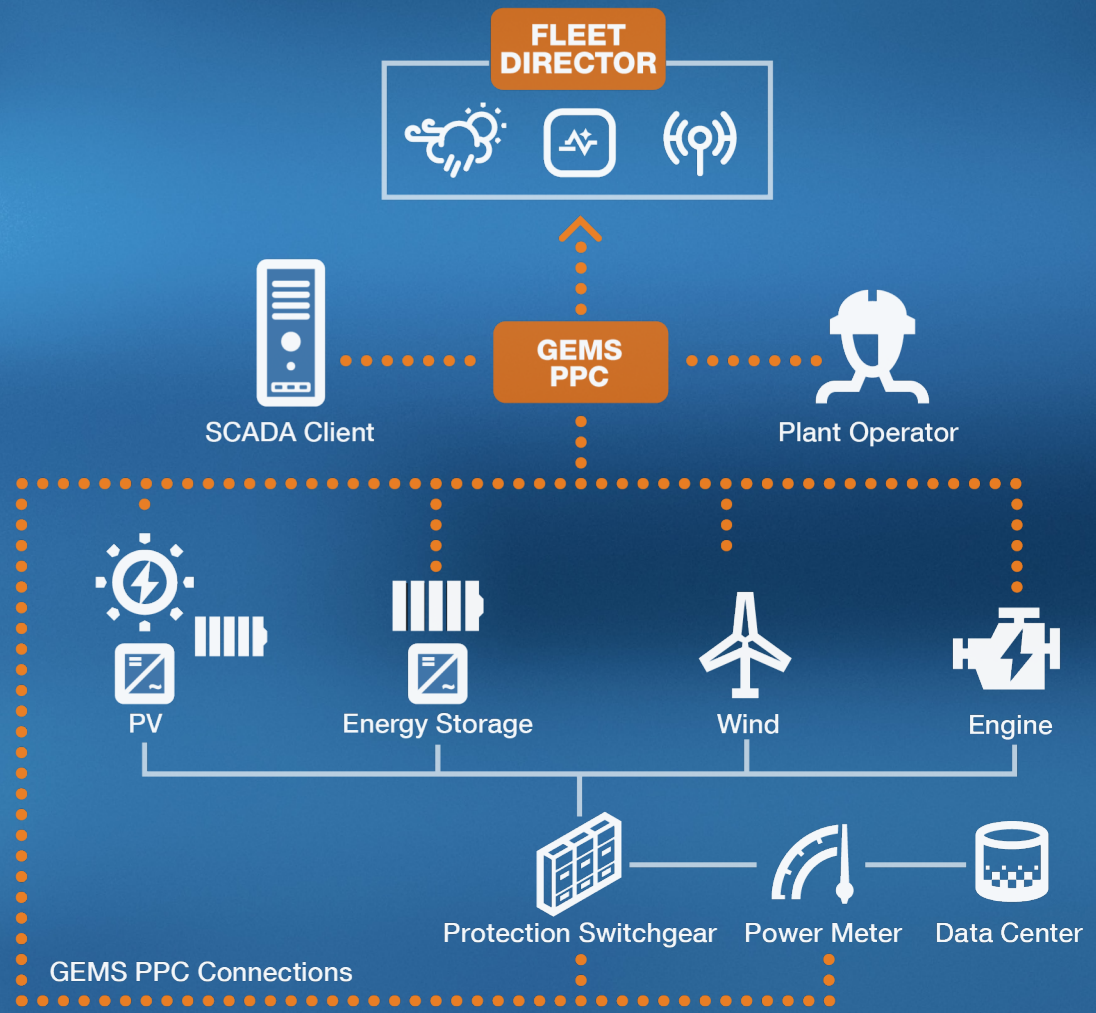


GEMS PPC

- Dispatch Optimization
- Tertiary Control
- Secondary Control
- Emergency
- Local HMI
- Load Forecast
- Renewable Forecast

GEMS FLEET DIRECTOR

- Weather Forecast Subscription
- Data Storage and Analytics
- Remote O&M



GRID CONTROL, INTEGRATION AND OPTIMISATION

Boosts wind penetration from ~20% to 33% with addition of energy storage and GEMS control system

Eliminates the dependency on HFO; **fuel consumption decreased by 5%**

Delivers both economic and environmental benefits; **CO_2 emission decreased by 8%**

Dispatch optimization, solving unit commitment

Tertiary control, **secondary** control

Spinning reserves compliance (N-1)

Load forecasting, **renewable forecasts**

Grid forming **battery inverters**

ESS rated power **less than average island load**

Spinning reserves, automatic (un)curtailment of renewables, and automated engine dispatch for the island of Bonaire, population ~19,000

HFO

The **existing power plant** is running on 5 HFO engines, 3 back up diesel engines

The **6 MW / 6 MWh energy storage** system includes batteries, inverters and power electronics

Integrates 12 **wind** turbines while simultaneously optimising multiple generation assets

GRID CONTROL, INTEGRATION AND OPTIMISATION

- Boosts **renewable energy consumption**
- **Eliminates the dependency** on 17,000 liters of diesel per month
- Delivers both **economic and environmental benefits**
- **Dispatch optimization**, solving unit commitment
- **Tertiary** control, **secondary** control
- **Spinning reserves** compliance (N-1)
- Load forecasting, **renewable forecasts**
- Grid forming **battery inverters**
- Capable of operating grid **without diesel gensets running**

Enabling 100% renewables for the island of Graciosa, population ~4,000.

The Graciosa Hybrid Renewable Power Plant will enable **1 MW** of **solar, 4.5 MW** of **wind power** and **6 MW / 3.2 MWh energy storage**

Integrates renewable energy sources while simultaneously optimising multiple generation assets

FEKOLA MINE, MALI

MICROGRID CONTROL AT A REMOTE OFF-GRID AFRICAN MINE

- **GEMS** to optimise energy production at a fuel-dependent, energy-intensive operational mining facility
- **Short payback** period with long-term savings
- Maximised **asset efficiency** and hybrid system optimsation for improved power reliability
- Sustainable **clean energy** solution: reduced carbon emissions and operational costs
- Delivery expected **late 2020**

17.3 MW / 15.4 MWh energy storage solution for a remote off-grid mine

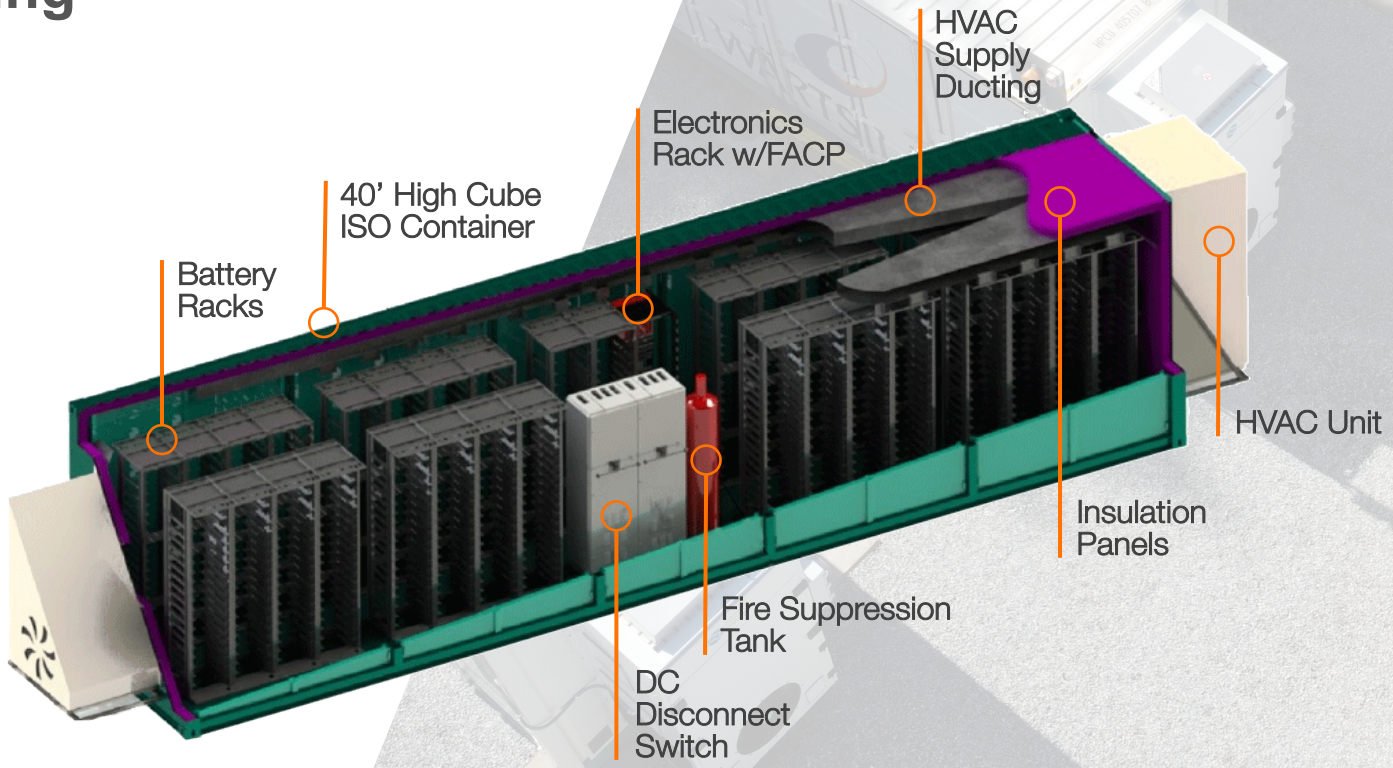
Integrates multiple generation assets, including **30 MW** of **solar** and **64 MW of engine generators**

CONTAINER STANDARDIZATION

A cost-effective solution for meeting customer energy needs while **adequately protecting** their hardware assets

The standardized storage enclosure consists of one ISO 40' unit and includes:

- Batteries
- Safety system
- Fire Safety System
- Power distribution
- Air conditioning system



GEMS UI FEATURES

Real-time visibility at one second intervals

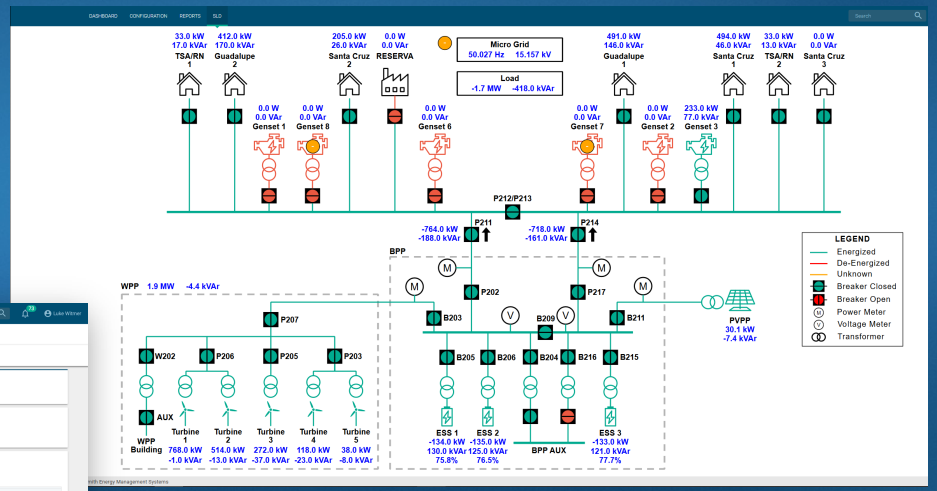
- Global Fleet
- Plant
- Equipment

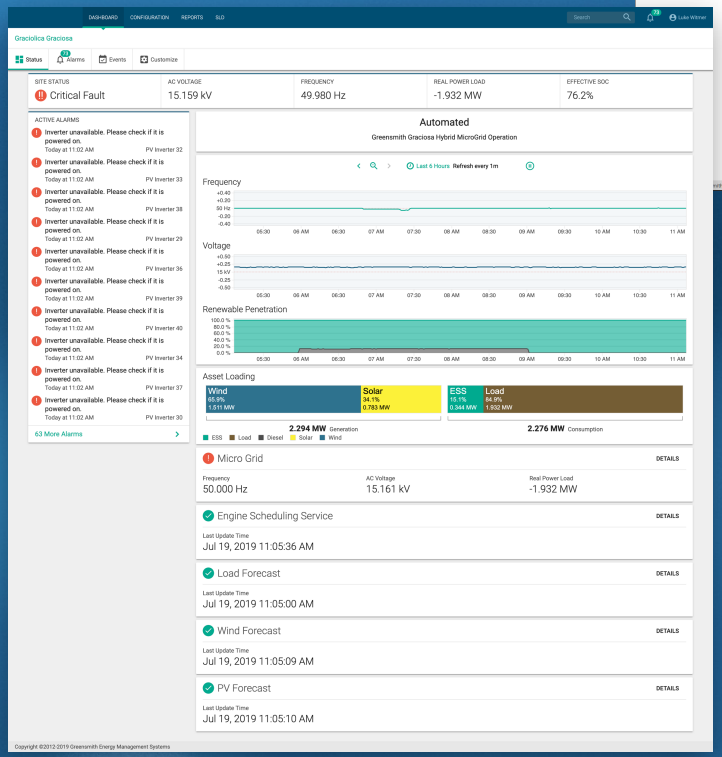
Historian and data reports

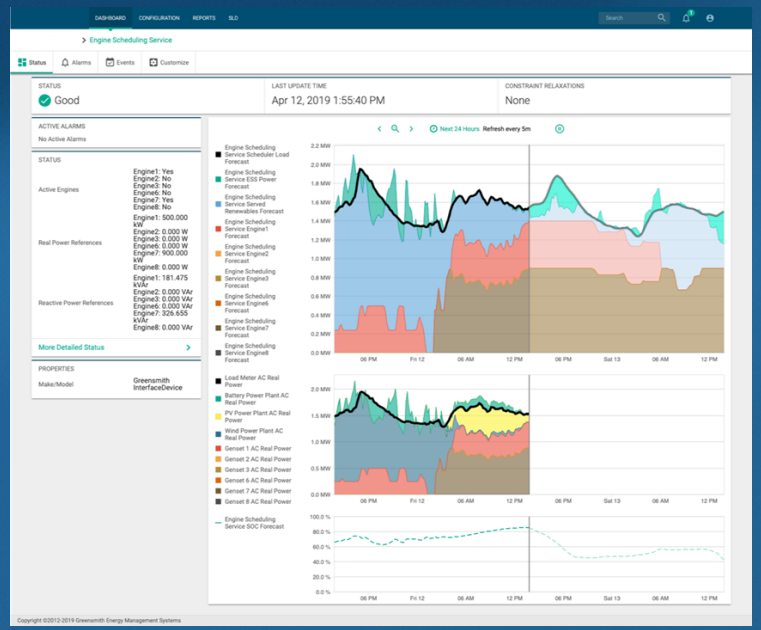
Alerts and push notifications

Automation configurations

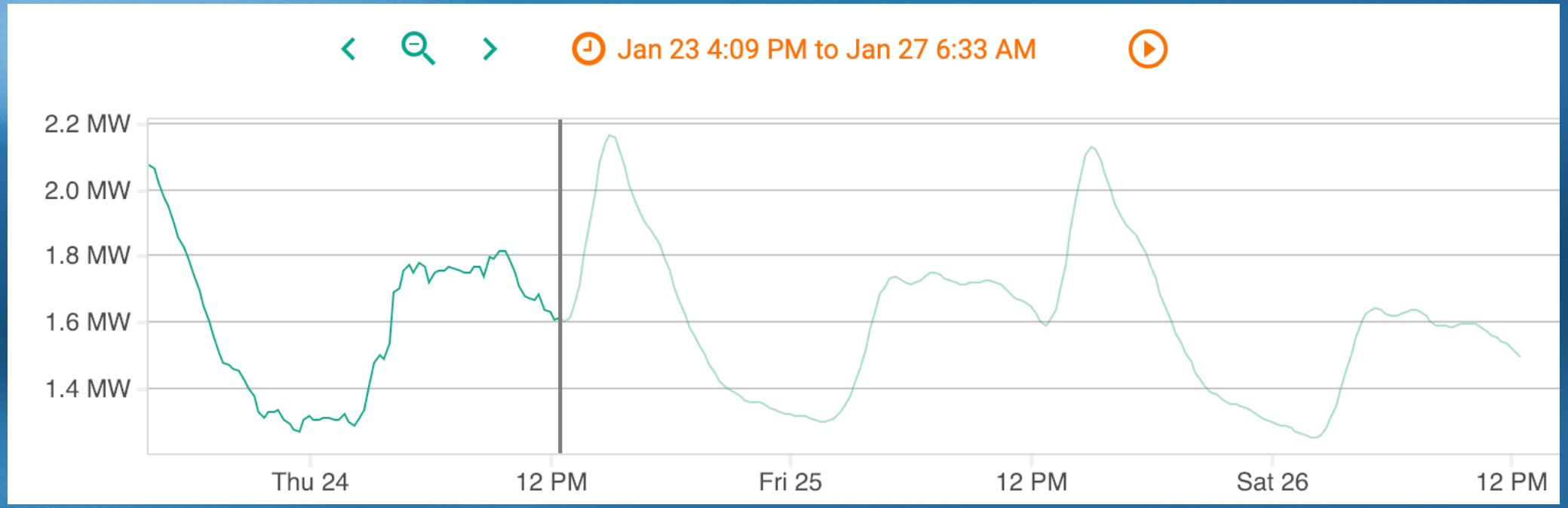
Machine learning monitoring







LOAD FORECASTING

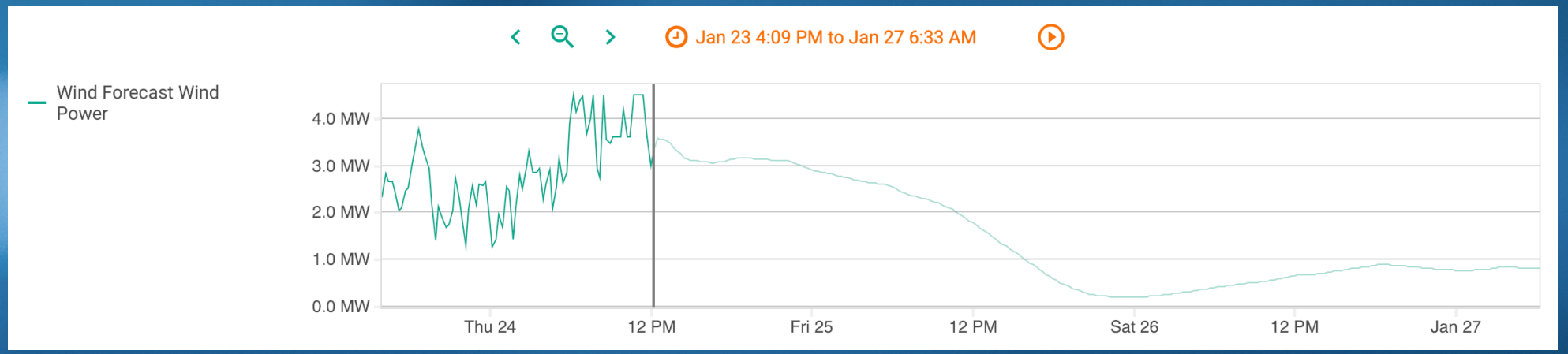


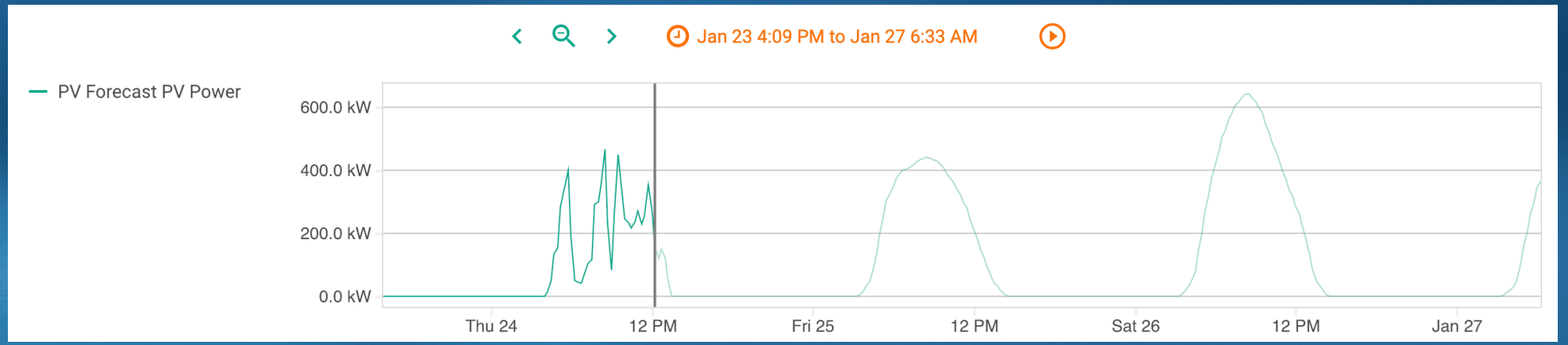
48-HOUR 5-MINUTE
RESOLUTION OUTLOOK

STATE-OF-THE-ART
MACHINE LEARNING METHODS

FOR UNPREDICTABLE LOADS OF INDUSTRIAL PROCESSES, HUMAN SCHEDULING INTERFACE IS AVAILABLE
FOR SEAMLESS INTEGRATION

RENEWABLE FORECASTING

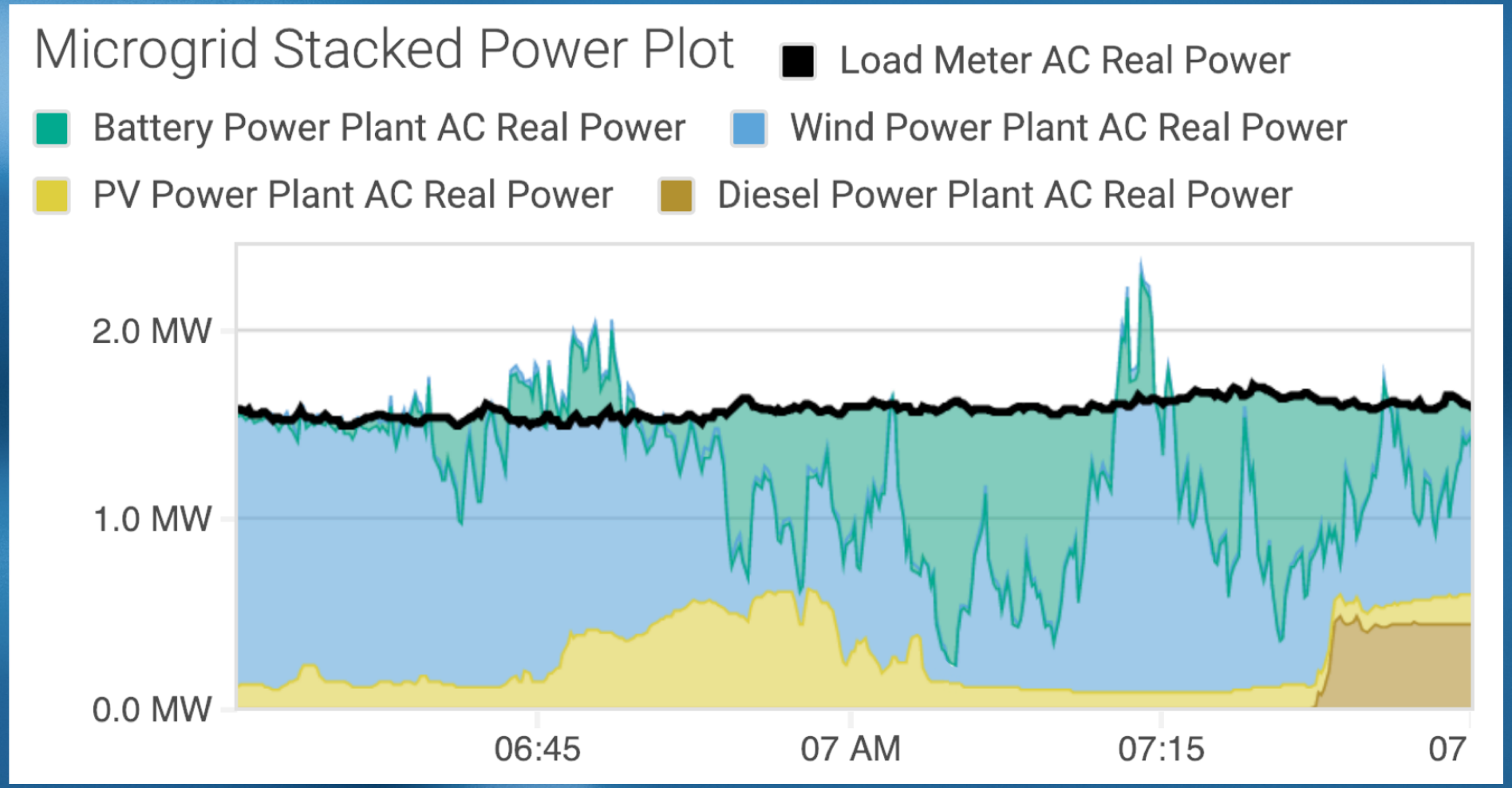


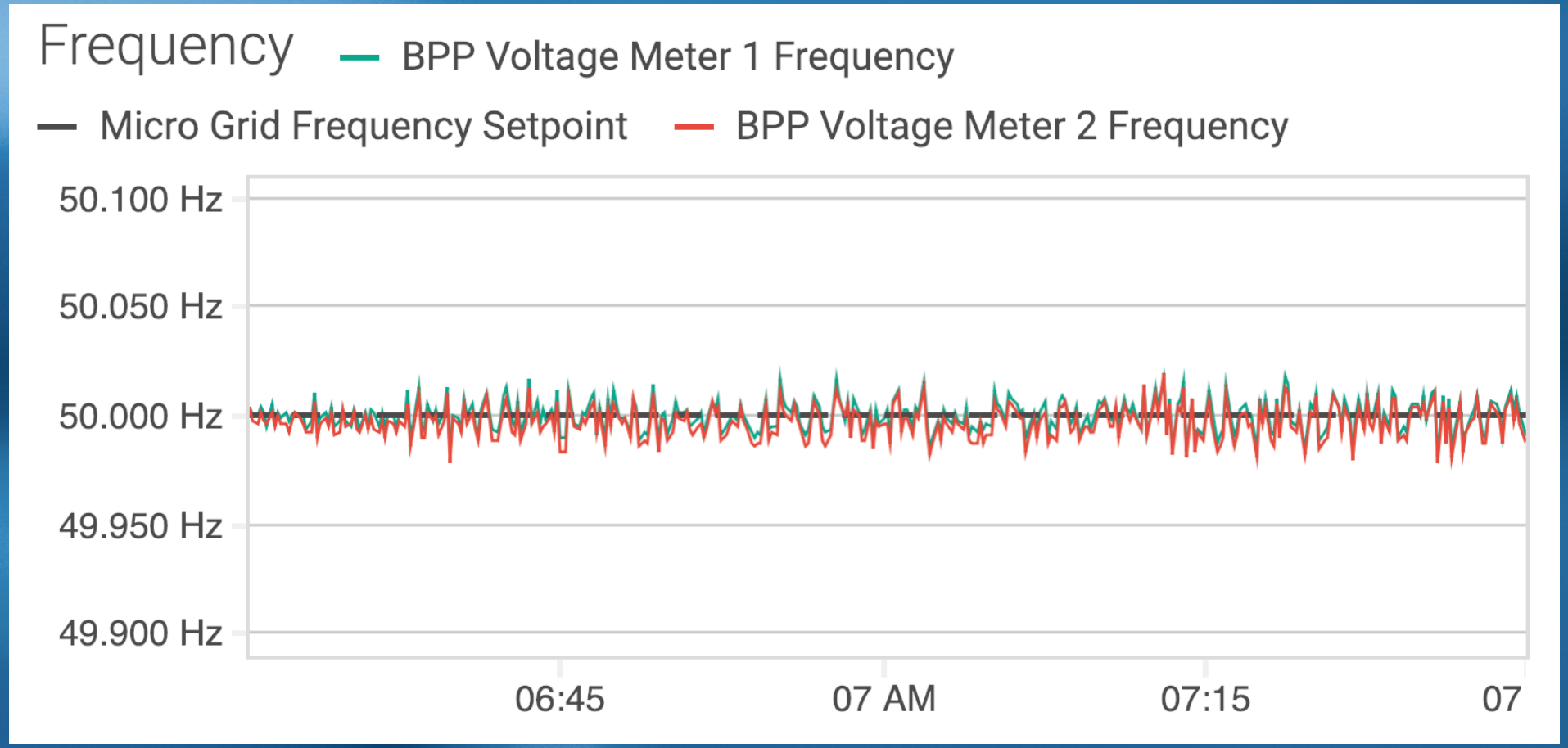


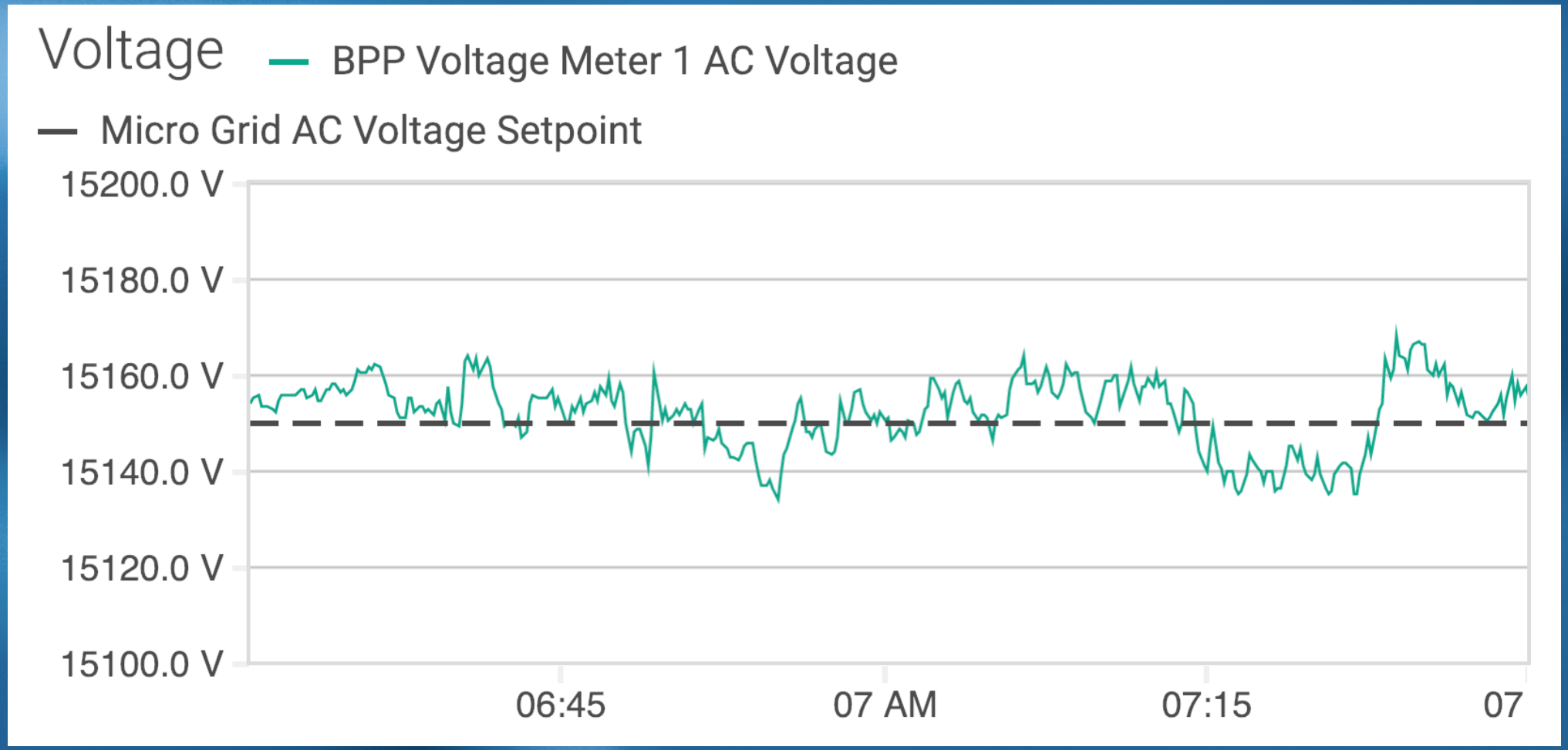
MULTI-DAY OUTLOOK
AT HOURLY RESOLUTION

5-MINUTE RESOLUTION
FOR HOUR AHEAD

ROBUST ARCHITECTURE
ON-SITE ON THE PPC


Microgrid Stacked Power Plot
Load Meter AC Real Power
Battery Power Plant AC Real Power
Wind Power Plant AC Real Power
PV Power Plant AC Real Power
Diesel Power Plant AC Real Power
2.0 MW
1.0 MW
0.0 MW
06:45
07 AM
07:15
07


Frequency
BPP Voltage Meter 1 Frequency
Micro Grid Frequency Setpoint
BPP Voltage Meter 2 Frequency
50.100 Hz
50.050 Hz
50.000 Hz
49.950 Hz
49.900 Hz
06:45
07 AM
07:15
07


Voltage
BPP Voltage Meter 1 AC Voltage
Micro Grid AC Voltage Setpoint
15200.0 V
15180.0 V
15160.0 V
15140.0 V
15120.0 V
15100.0 V
06:45
07 AM
07:15
07

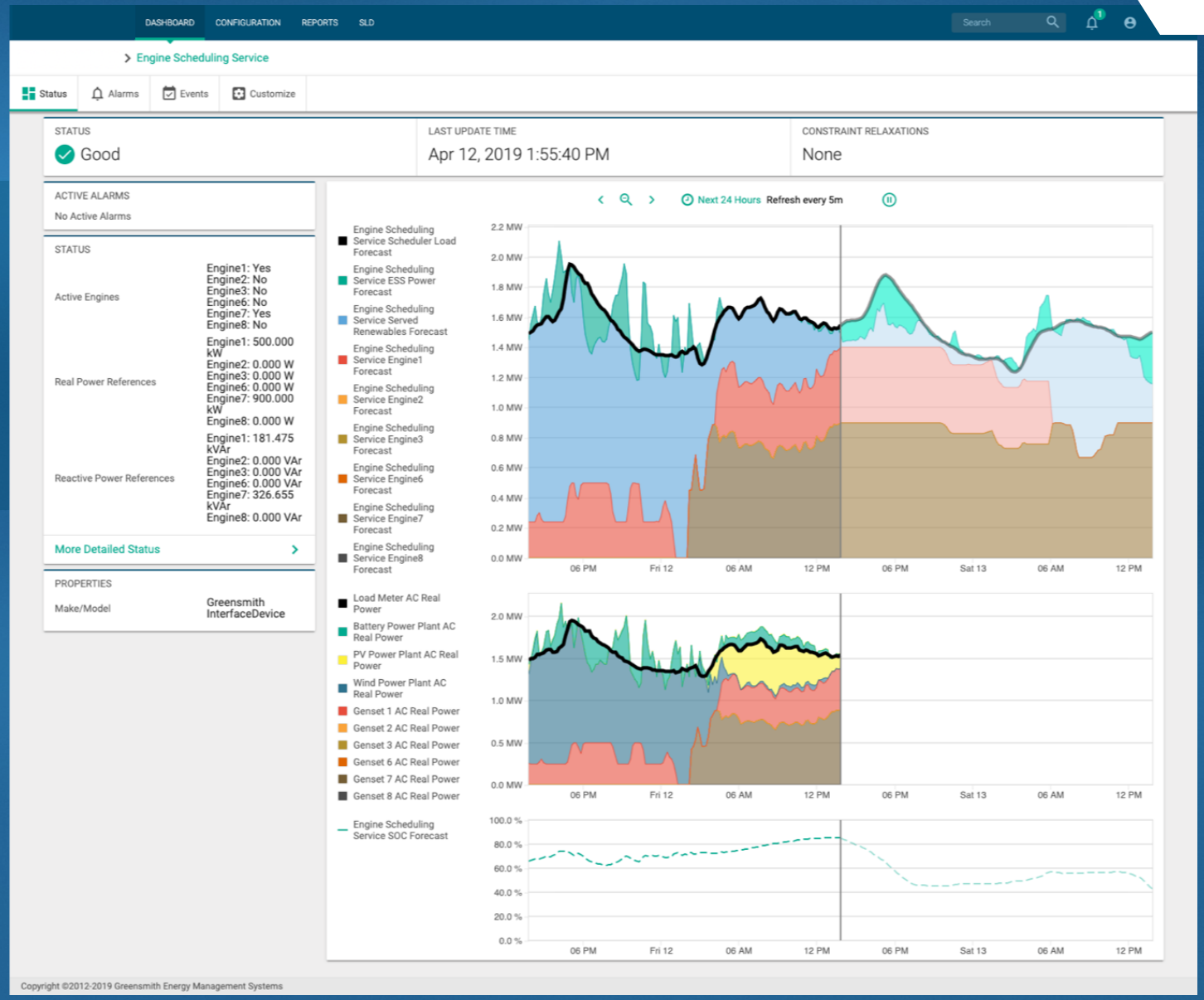
TERTIARY CONTROL: ENGINES + STORAGE + RE

GEMS OPTIMIZATION MODULES SOLVES:

- Economic Dispatch Problem
- Unit Commitment Problem

ENGINE SCHEDULING BASED ON ROLLING **24-HOUR FORECASTS**

5-MINUTE SCHEDULE UPDATE INTERVAL



TERTIARY CONTROL: ENGINES + STORAGE + RE

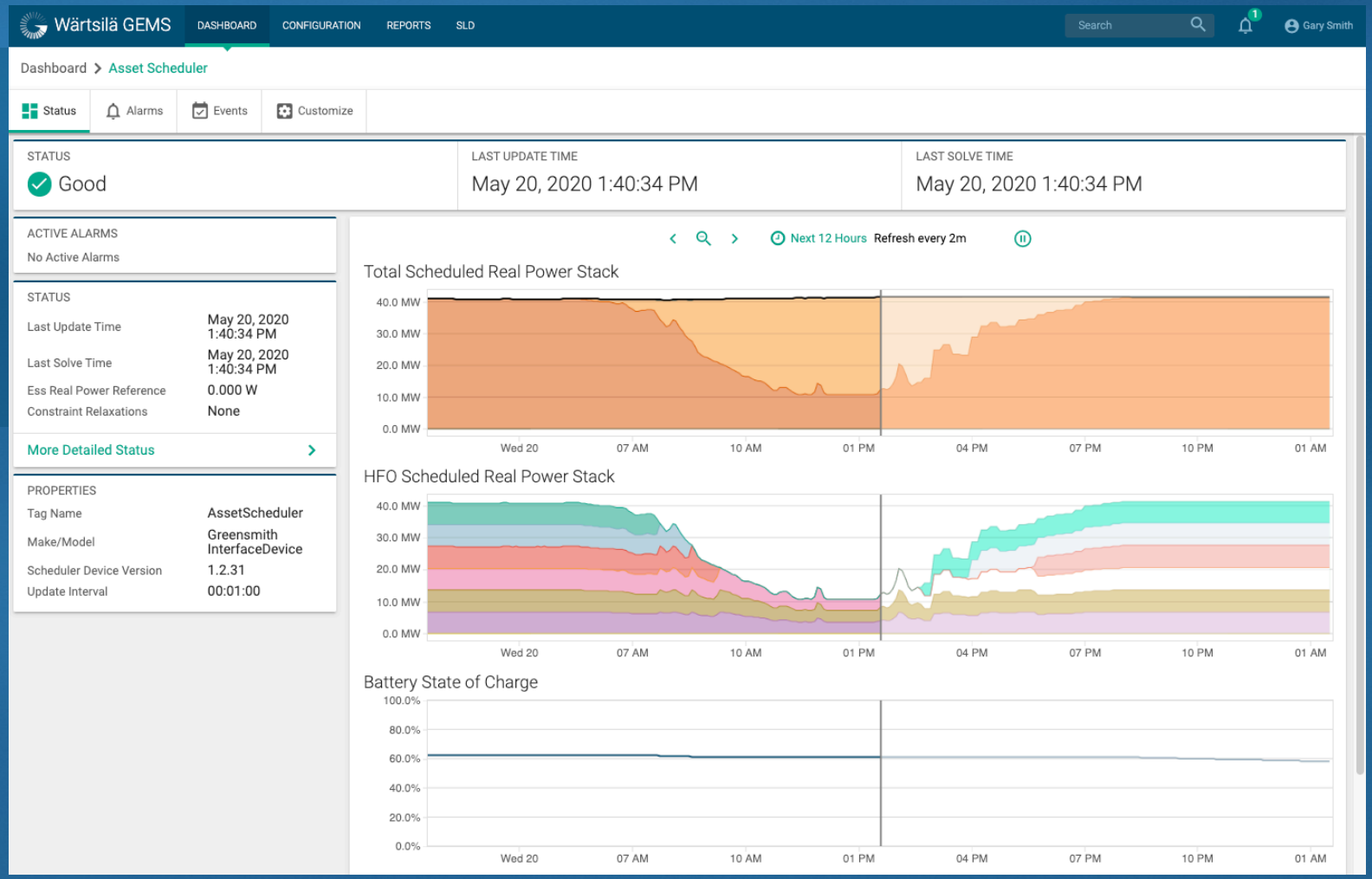
FEKOLA PROJECT:

GEMS OPTIMIZATION MODULES SOLVES:

- Economic Dispatch Problem
- Unit Commitment Problem

ENGINE SCHEDULING BASED ON ROLLING **FORECASTS**, E.G.12-HOURS AHEAD

5-MINUTE RESOLUTION SCHEDULING

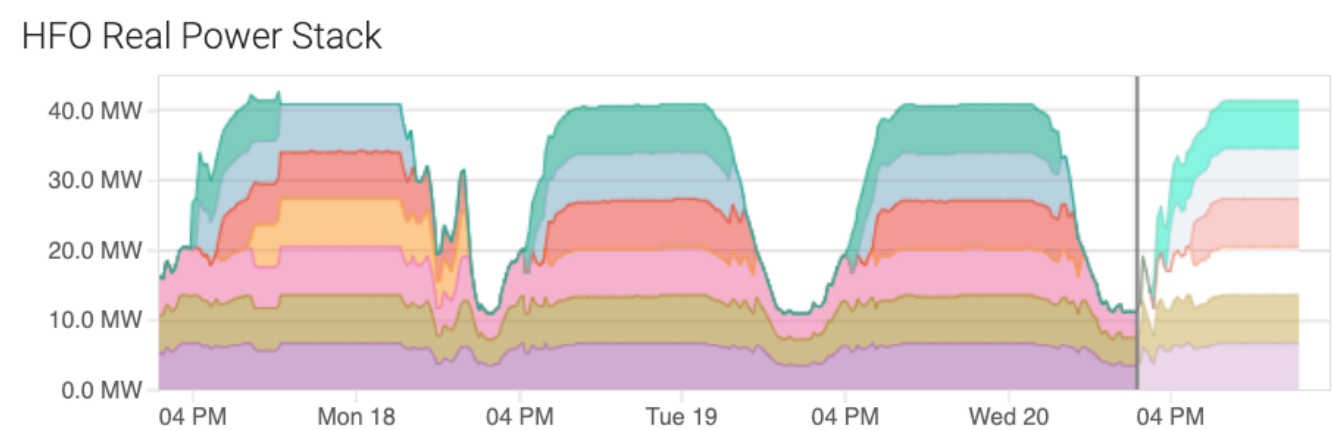


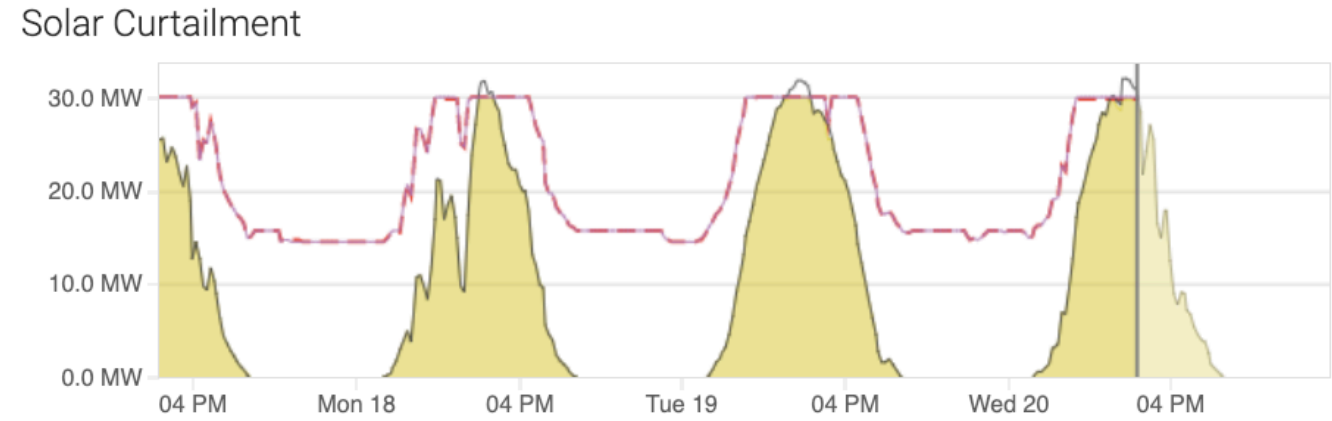
GEMS OPTIMIZATION MODULES SOLVES:

- Economic Dispatch Problem
- Unit Commitment Problem

AUTOMATED CURTAILMENT

- Reserve Requirements
- Operational Constraints





5-MINUTE RESOLUTION SCHEDULING

ENGINE SCHEDULING BASED ON ROLLING **FORECASTS**, E.G.12-HOURS AHEAD

TRANSPARENCY

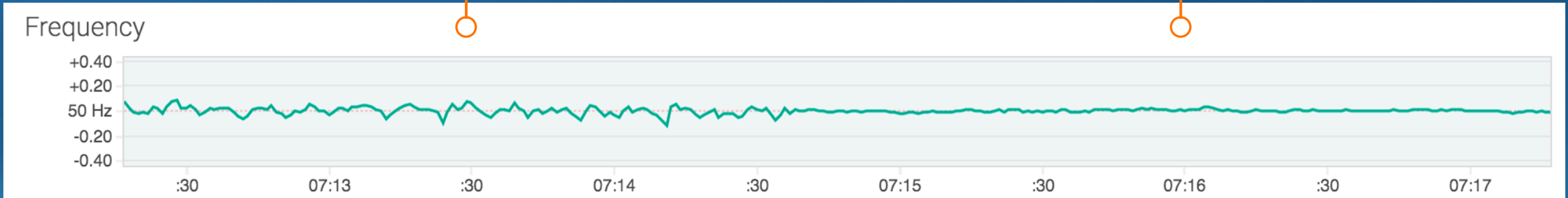
AI AND **MACHINE LEARNING**


WÄRTSILÄ

GRID FREQUENCY AND **VOLTAGE** MAINTAINED BY ALL GRID FORMING ASSETS (DIESEL GENERATORS AND VSG CAPABLE GRIDSOLV UNITS IN DROOP MODE)

DIESEL GENERATORS ONLY

DIESEL GENERATORS WITH BATTERY IN VSG MODE



ROBUST CONTROL ARCHITECTURE OF:

- Primary Control (droop) to rapidly stabilize Frequency and Voltage
- Secondary Control to maintain F and V targets
- Tertiary Control to optimize dispatch, curtailment, and battery SOC

GEMS HIGHLIGHTS

SINGLE SW PLATFORM for energy storage, wind, solar, engine and hybrid power plant operations—it is an OS

INTELLIGENT OPERATIONS by combining industrial control with modern machine learning

HARDWARE NEUTRAL PLUG-IN ARCHITECTURE for equipment including batteries, PCS, and engine generators from different vendors

DISTRIBUTED COMPUTING by combing **ON-SITE** Power Plant Controls with **OFF-SITE** solution cloud

PLATFORM AS ASERVICE natively supports application extensions, customization and system integration