AVEVAWORLD

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UK Power Networks

Transition to a Distribution System Operator:
Endless use of technology for the transition to a DSO

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AGENDA

UK Power Networks

Digital Transformation for Distribution System Operator

UK Power Networks – The Company

DNO to DSO Transition Challenges

Industry Challenges

- Australia
- California
- United Kingdom

Customer Challenges

AVEVA and PowerRunner on AVEVA PI System

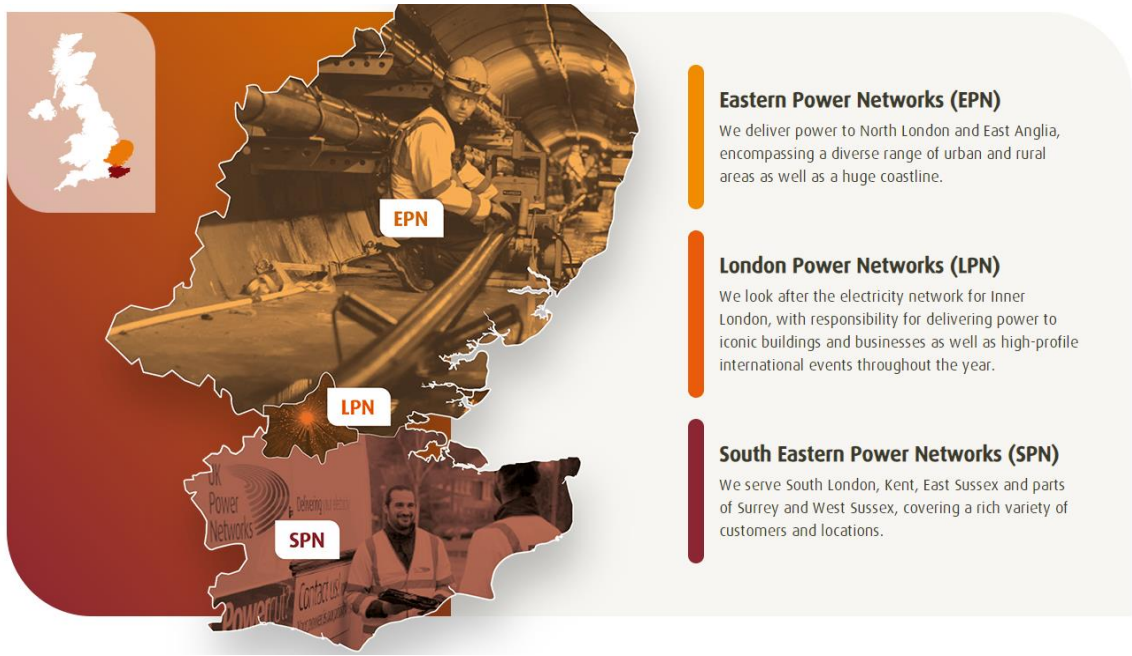
Use Cases

About UK Power Networks

UK's largest distribution company serving 8.3 million customers

- **Serves 3 major service territories around London**
  - EPN – Eastern Power Networks
  - LPN – London Power Networks
  - SPN – South Eastern Power Networks

- **UK Power Network's by the numbers**
  - **76,515 GWh** Electricity distributed – 18% of Great Britain's total electricity distribution
  - **9.5 GW** – Distributed generation on our network (DER)
  - **189,103 km** – Total length of overhead (45,637 km) and underground (143,466 km) network
  - **19 m** – People served – 29% of Great Britain's population
  - **13,316 MW** – Peak Demand



The Changes in the UK Distribution landscape

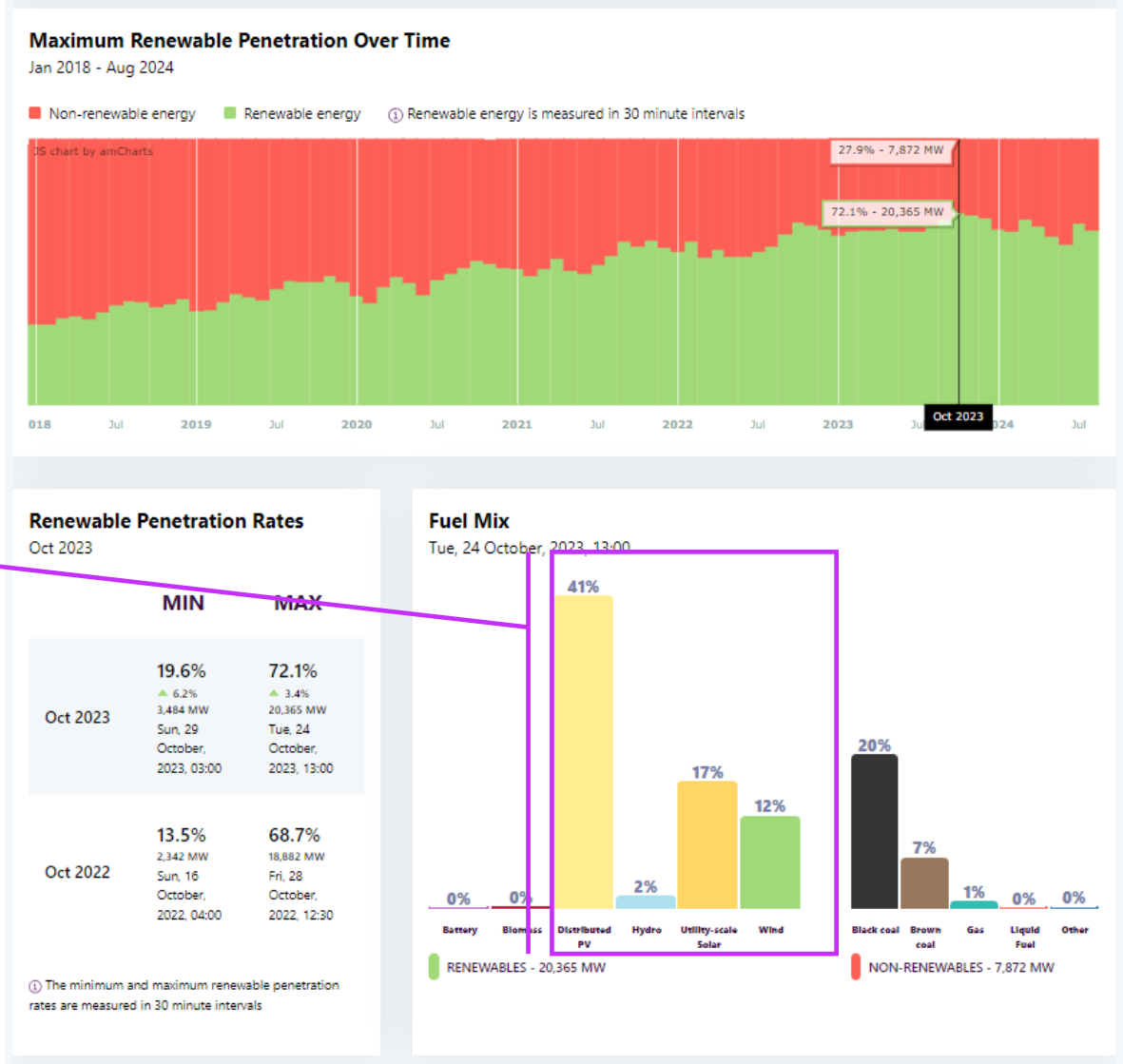
DNO to DSO transition

- The UK's Distribution Network Operators (DNOs) are transitioning to Distribution System Operators (DSOs) to meet the demands of a changing energy landscape

  - **Climate change regulations** – The UK government's "NetZero by 2050" legislation, as well as the EU's Renewable Energy Directive and Clean Energy Package, are driving the decarbonization of the energy sector
  - **Growing renewable energy** – The UK is moving towards "net zero", which will increase distributed generation (DER)
  - **Prosumer** – Business and consumers are increasingly using, creating, selling or storing energy
  - **New Technologies** – New technologies are giving consumers more control over how they use electricity, and energy storage technology is improving rapidly
  - **Cost-effectiveness** – The DNO model is not able to adequately support the new energy landscape and continue construction of passive distribution networks is not cost effective.

Australian Market Example

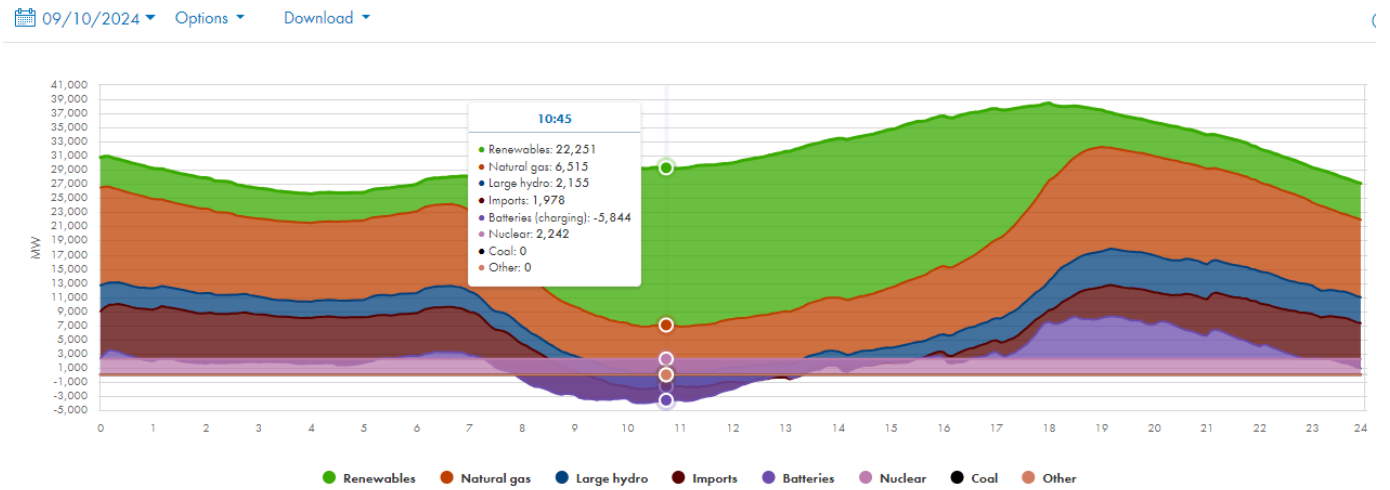
- **2030 Goal of 82% Renewables**
  - Currently 72%
- **Challenge for a DSO**
  - 41% behind the meter solar
  - Uncontrollable
  - Non-Dispatchable
  - Low voltage bi-directional power flow
  - Impossible to have adequate grid storage for these distributed PVs
  - Impact on power quality

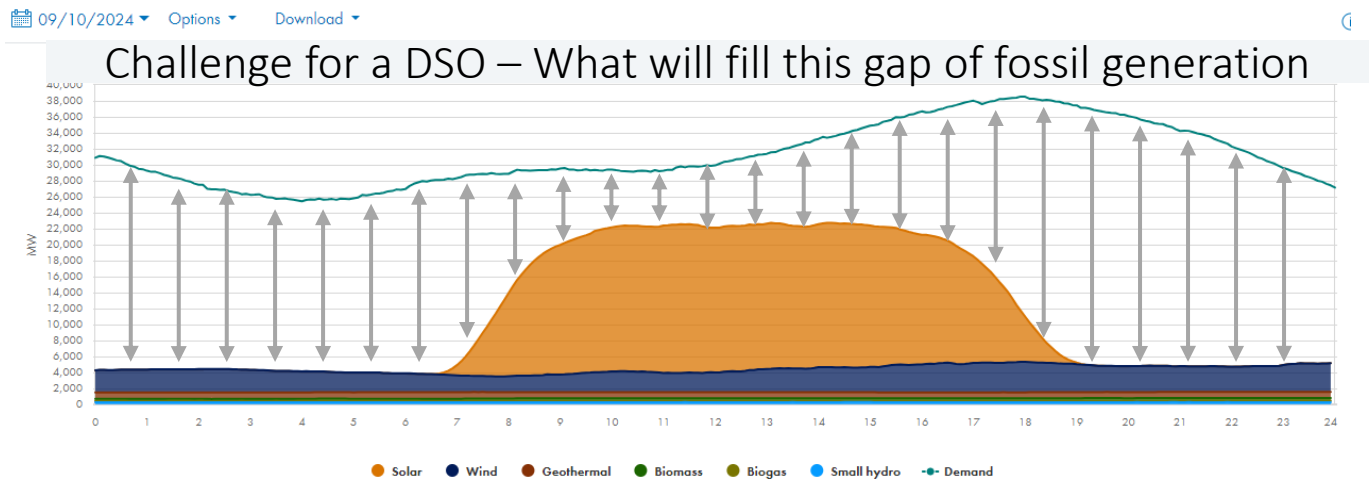


California Market Example

- **Goal of 100% Renewable/NetZero Generation**
  - 17,000 MW of BTM of PV (today)
  - 148,000 MW of renewable resources by 2045
  - 120 GW of new renewable generation (next 20 yrs)

- **Challenge for a DSO**
  - Customer reliability challenges for the DSO
    - Renewable reliability
    - Reliance on imports that will face the same constraints of growing renewables
    - Storage is currently a non-peaking dispatched asset
    - Forecasted demand growth
  - Similar impacts on BTM PV





UK Market Impacts to DSO Operations

UK Market

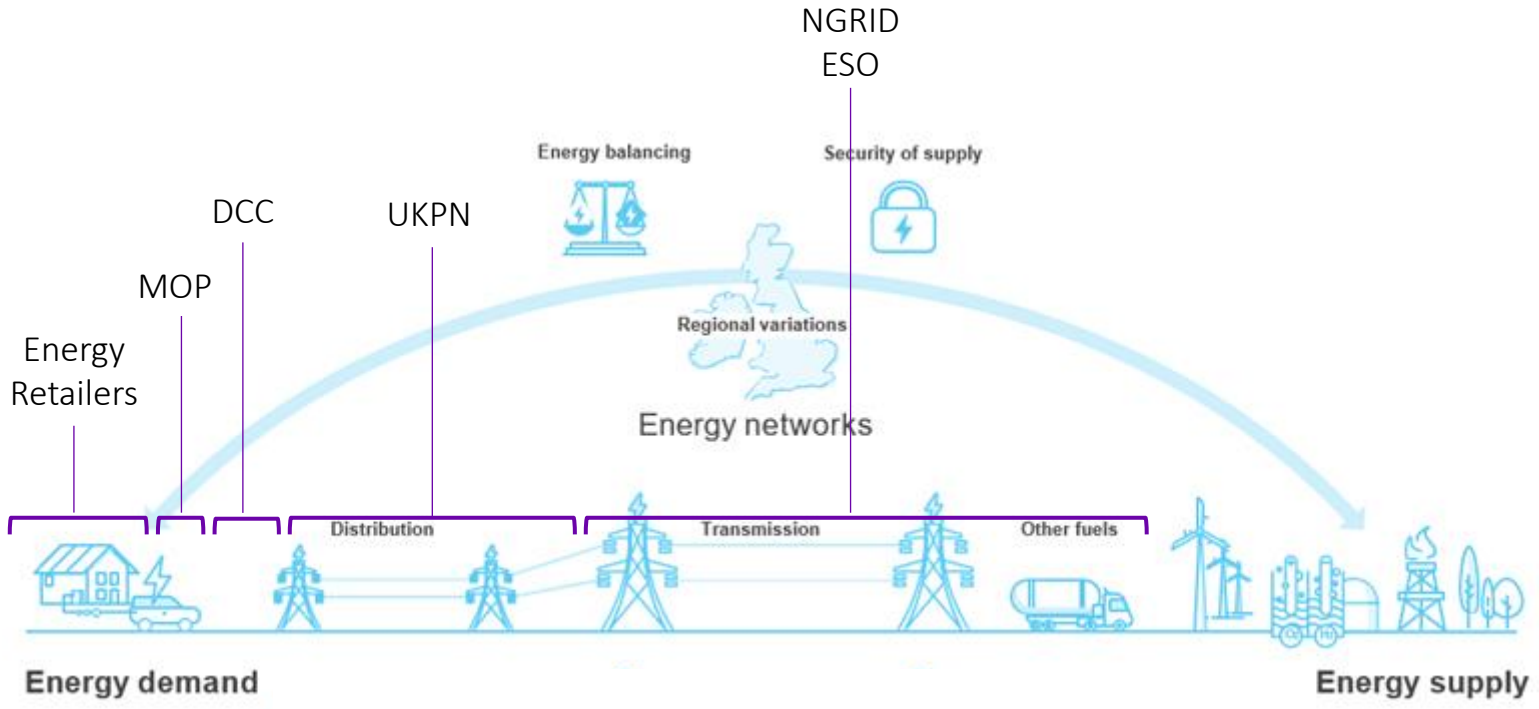
- Achieving "clean" electricity by 2035 through increasing wind, solar, and nuclear power
- 1.9GW solar deployed in 2023
  - 30% came from residential rooftop installations
  - 20% came from commercial rooftop installations
- Making 80% of new car sales "zero emission" by 2035
- Installing 600,000 electric heat pumps per year by 2028
- Financial penalties for power outages to the DSO

- **Intermittent power** - This can cause grid imbalances and instability.
- **Reverse power flow** -The grid was designed for power to flow from large centralized facilities to end-users
- **Infrastructure upgrades** - Existing infrastructure, such as substations and transformers, may not be able to handle the decentralized nature of solar producers.
- **Grid security** - A distributed grid with many generation points can have multiple points of vulnerability.
- **Peak demand** - Residential charging often occurs when people return home, which is when peak power demand already exists.
- **Utility revenue models** - The influx of solar producers can disrupt traditional utility revenue models.
- **Cost shifting** - Homeowners who install solar panels may shift the cost of infrastructure to other ratepayers.
- **Grid maintenance costs** - As homeowners install solar panels, grid maintenance costs may increase for everyone else.

AVEVA and "PowerRunner on PI System" Project

PowerRunner on PI System
Low Voltage Analytics

- Situational Awareness from the substation to the meter and behind-the-meter
- Asset Data Quality
- Network Model Management
- Aggregate Load Analytics
- Asset Limit Analysis
- Event/Alarm Analytics
- System Voltage Analysis
- Asset Health Dashboard
- System Reliability Reporting
- Intra-hour Asset Forecasts
- Virtual SCADA Asset Forecasts



PowerRunner on PI System

AVEVA PI System

PowerRunner on PI System extends Situational Awareness to Distribution Assets

The PI System is the leading operational data store in the Power and Transmission markets

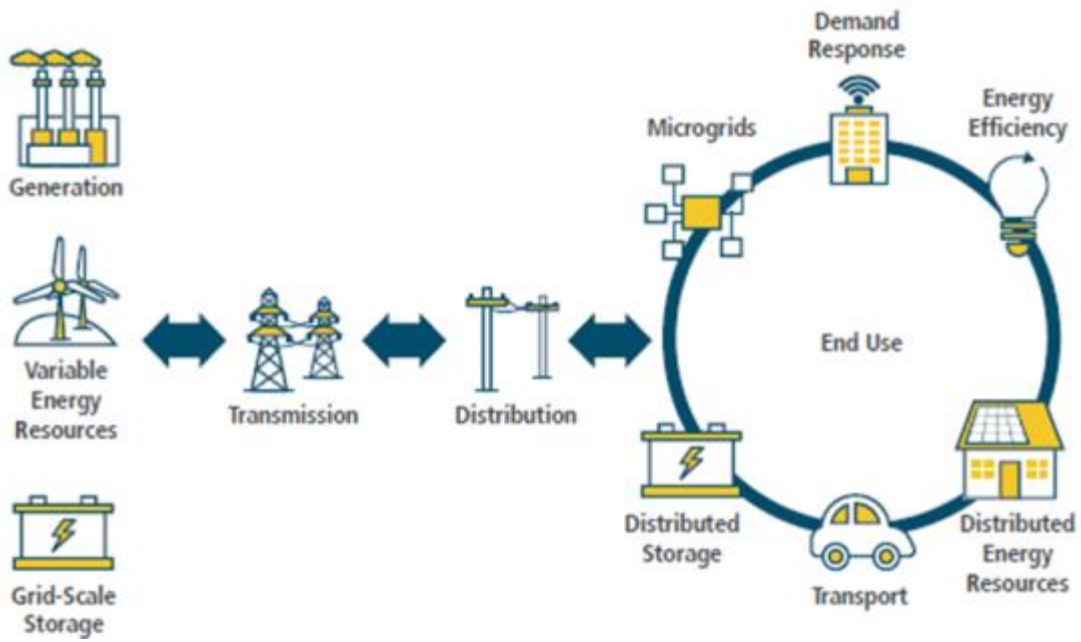
DSOs
Empowering the Future: From Networks to Smart Systems

UK Power Networks
Delivering your electricity

Eventually, **ALL** distribution Utilities will want to become a DSO – enabling the customers to connect and use their DERs

To achieve this, DSOs need to operate the network and plan for upgrades. This requires data-driven decision making.

- Manage the integration of distributed energy resources
- Optimize the distribution system with digital technologies
- Integration of additional stakeholders
- Enable greater data for improved decision making
- Enhance network maintenance and operations for integration and resiliency



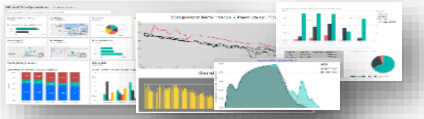
What is required?

- The transition to create a more sustainable and decentralized energy system, a solution that can accept, manage and leverage from a range of new assets and participants to provide analytics, monitoring and situational awareness across all voltage levels including the low voltage network.

PowerRunner AVEVA

Enterprise Grid Solution

Enterprise Level Monitoring
Engineering & Planning



Reporting Applications
KPIs, Dashboards
Benchmarking, Mobility

Business Applications
ERP, Outage Management, GIS,
Work & Asset Management

PowerRunner
AMI Data at Scale

Distribution Grid Analytics AMI
Grid Analytics

CONNECT

Enterprise Operational Infrastructure – AVEVA PI System

Generation

Transmission

New Low Voltage Distribution Infrastructure

Substation Data Integration (non SCADA)

Distribution Automation Devices (non SCADA)

Distribution DMS/ADMS

IEC61850
C37.118
COMTRADE
DNP 3.0

Grid Application	Advanced Sensing and Measurement Technology
Protection and Control	Line Protection Relay, Transformer Protection Relay, Bus Protection Relay, Circuit Breaker Protection Relay, Feeder Protection Relay
Monitoring & Control	Smart Recloser, Recloser Control, Voltage Regulator Control, Capacitor Bank Control, PQ Monitor, Smart Switch
Asset Condition Monitoring	Dissolved Gas Monitor, Moisture Monitor, Circuit Breaker Condition Monitor, Load Tap Changer Monitor
Fault Indicators and Sensors	Overhead Fault Indicator, Underground Fault Indicator
Metering	Smart Meter, Power Quality Meter, Revenue Meter

New Data Sources

Distributed Energy Resources

Distributed Energy
- Solar
- Wind

Energy Storage
- Batteries
- EV

Microgrids
Grid sensors

AMI Meter Data

At-the-meter
- Load
- Generation
- Voltage
- Etc.

Behind-the-meter
- Load
- Generation
- Sensor data

Prosumer

Behind-the-meter
- Solar
- Storage
- Sensor data
- EV
- Thermostats

Operational Data Infrastructure

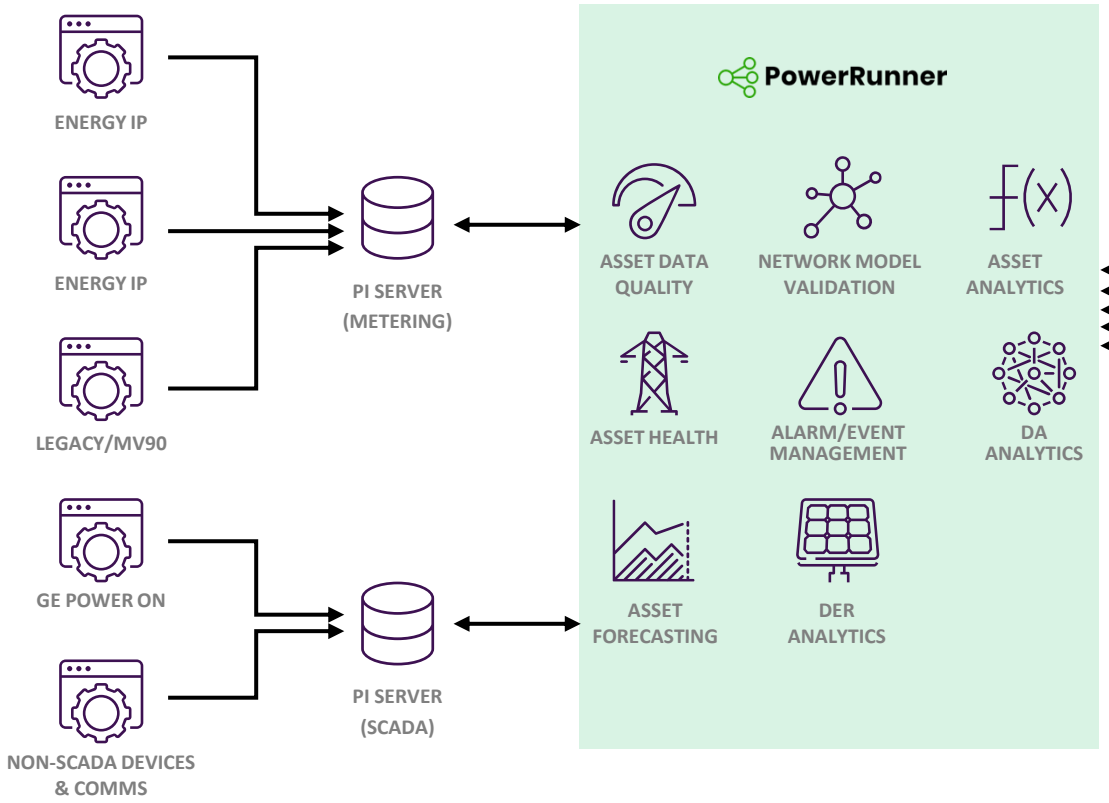
8,300,000 Meters → 10 Interval, Registers, Alarms → 30 Minute Data →
40,000 SCADA & RTUs/Sensors → 10 Digital States & Analog Values → 5 Minute Average →

4,176,000,000 Daily Measurements

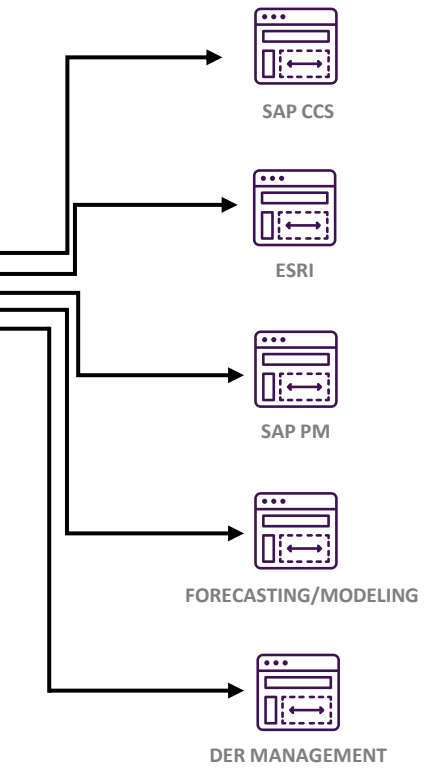
OPERATIONAL TECHNOLOGY (OT) DATA

AMI interval data
- kWh (delivered)
- kWh (received)
- kVAh
- Voltage
- Alarms

SCADA data
- kW per phase
- Amps per phase
- Volts per phase
- Breaker status
- Alarms



INFORMATIONAL TECHNOLOGY (IT) DATA



- Customer data (attributes)
- Substation
- Feeder
- Rate Category
- City, County, Zip

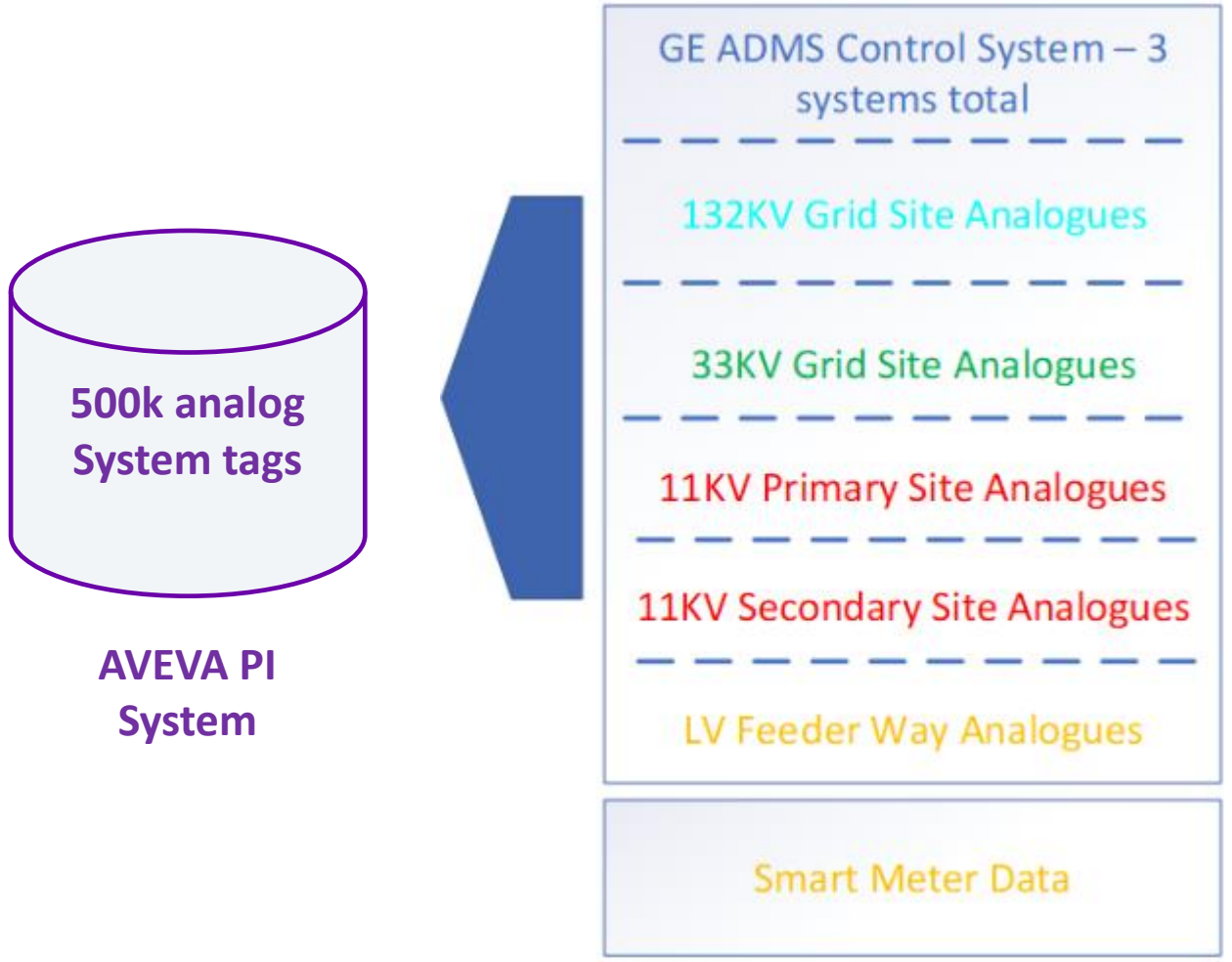
- Asset Attribute Data
- Asset Parameters
- Geo Codes
- Limit Ratings

- Planning Data
- Forecast v Actuals

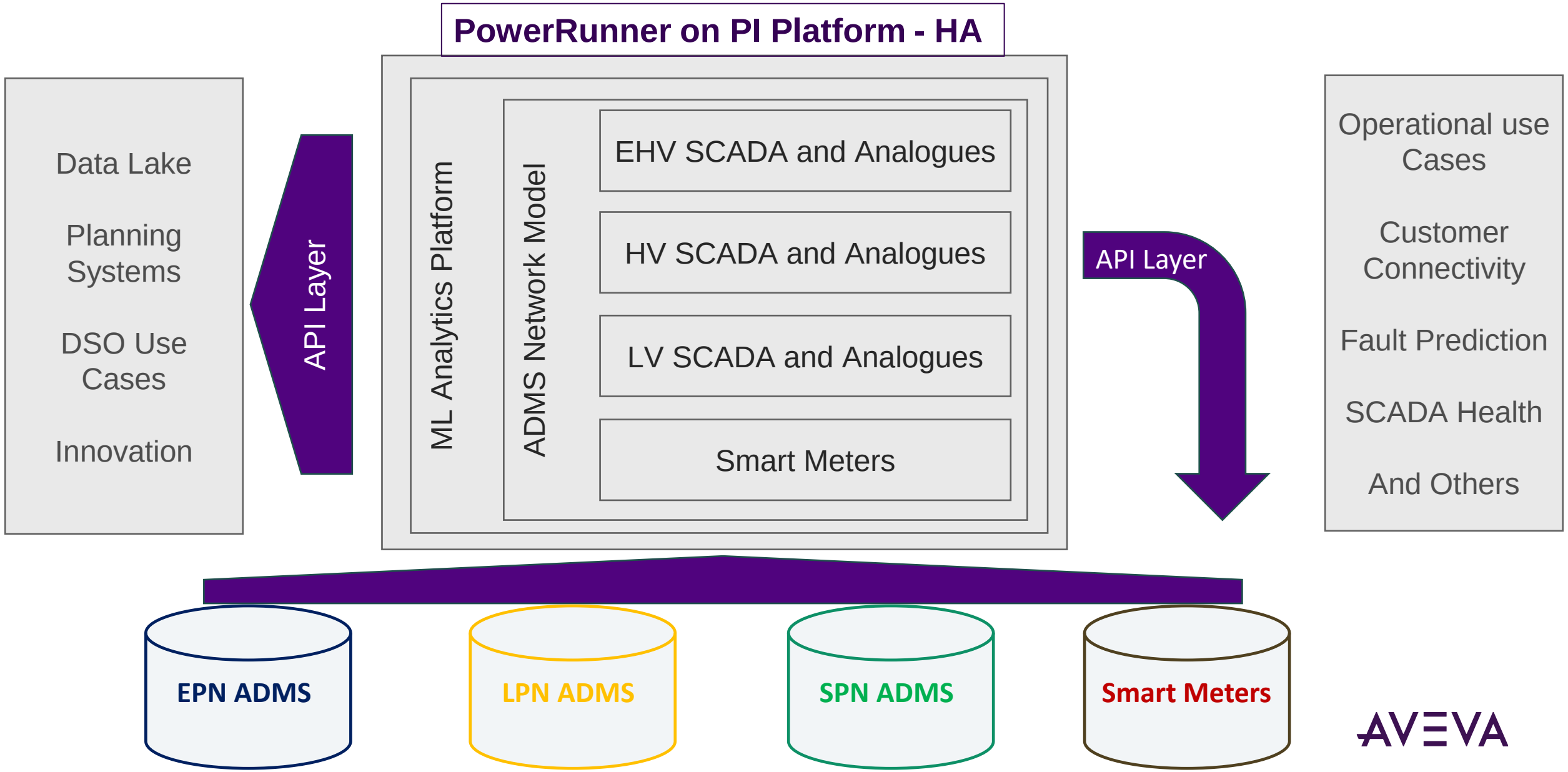
- DER Asset Data
- DER Type (solar, wind, etc.)
- DER Output (Nameplate kW)
- DER Voltage

Where we are coming from – Enriching Data with Context

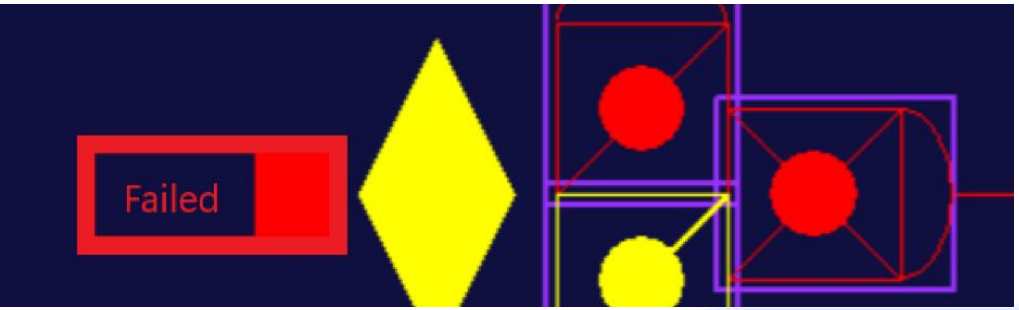
- Only analogue data sent to the PI System
- Only Source is GE ADMS
- Key information for DSO, Planning and Operational Use cases limited by only analogue data being available – incomplete data set
- Analogue data stored in a hierarchy-based Asset Framework
- Smart Meter Data and digital states not included



Where we are heading – Enriching Data with Context



Use Case – RTU Health and Monitoring

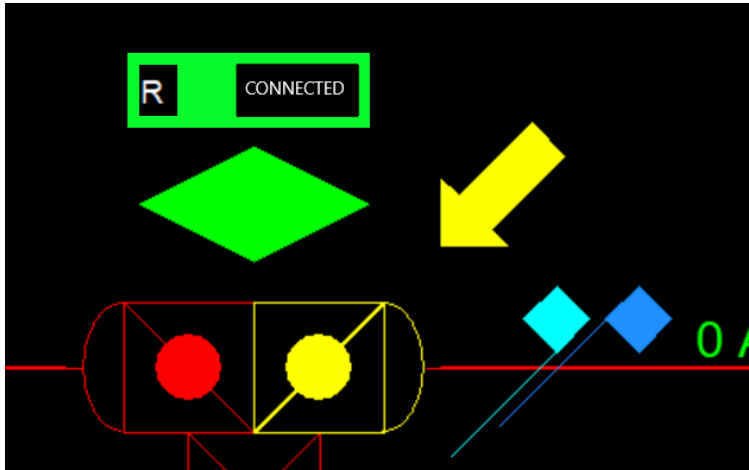


Failed SCADA

- UKPN has 45,000 RTU's across its areas – this number continues to grow
- Team of OT engineers ensure that defective SCADA is identified, and work order created
- Automated systems like APRS, PORT and ANM rely on healthy analogue data 24/7 to ensure customers are restored and generation can be managed
- Almost impossible to manually spot signs of pre-failure of SCADA

Auto Detection and Work Order Creation :

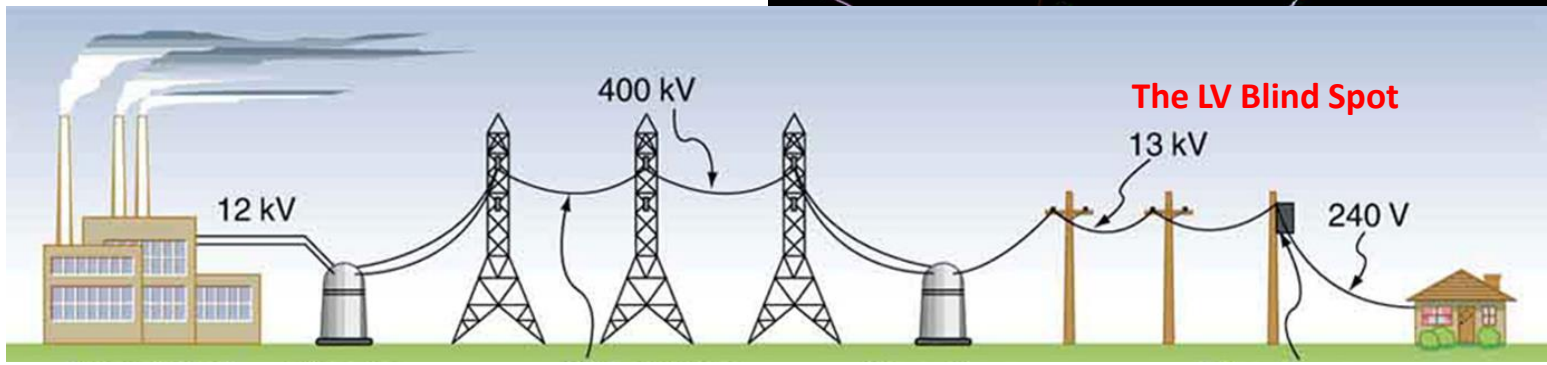
- With Network Model and all digital and analogue states PowerRunner on PI System is able to auto detect and raise work order
- Pre-failure detection possible using ML trends and rules to fix the defective item before it impacts customers or distributed generation
- Runs 24/7 to match system needs and can keep up with RTU growth without needing a larger team
- Analysis on failure areas of SCADA for wider view of comms strategy and needs



Use Case – Proactive LV Operations

LV Network is now the key performance area to improve but its too large to use the same strategies deployed on higher voltages.

- Using full network model, HV and LV SCADA and Smart Meter data modelled to the supply point new capabilities are available:
  - Mapping customer to phases for better management of customers and quicker operational decisions
  - Impedance model and voltage alarms allow for proactive detection of LV faults reducing outages and costs
  - Clearer understanding DER behavior on LV leading to better network utilization
- Contextual mix of data creates a platform for innovation going forward



PowerRunner AVEVA

TRANSMISSION AND DISTRIBUTION | UNITED KINGDOM

UKPN prepares for a sustainable future as a DSO by increasing digitalization of its smart grid

Challenge

- Be the best performing UK DNO and DSO
- Allow for more flexibility on the grid for more DERs to be connected without impacting safety and network reliability
- The requirements for DNOs to support DSOs need to develop and use their network more efficiently
- Resource intensive data wrangling – too much data for skilled operatives to process in real time

Solution

- Deployed AVEVA PowerRunner on AVEVA PI System to streamline data collection, access and advanced analytics focused on grid modernization.

Results

- **Single source of truth for OT/IT data & analytics**
- **Advanced Analytics for RTU health, transformer load management, network connectivity, predictive failure**
- **Improved planning data**
- **Improve proactive maintenance of assets**

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Thank you!

Questions?

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