



DX – It's time to make digital real

Goran Leci and Luis Llorente

2024-11-05, HRO CIGRE, 16. Symposium, Cavtat



1

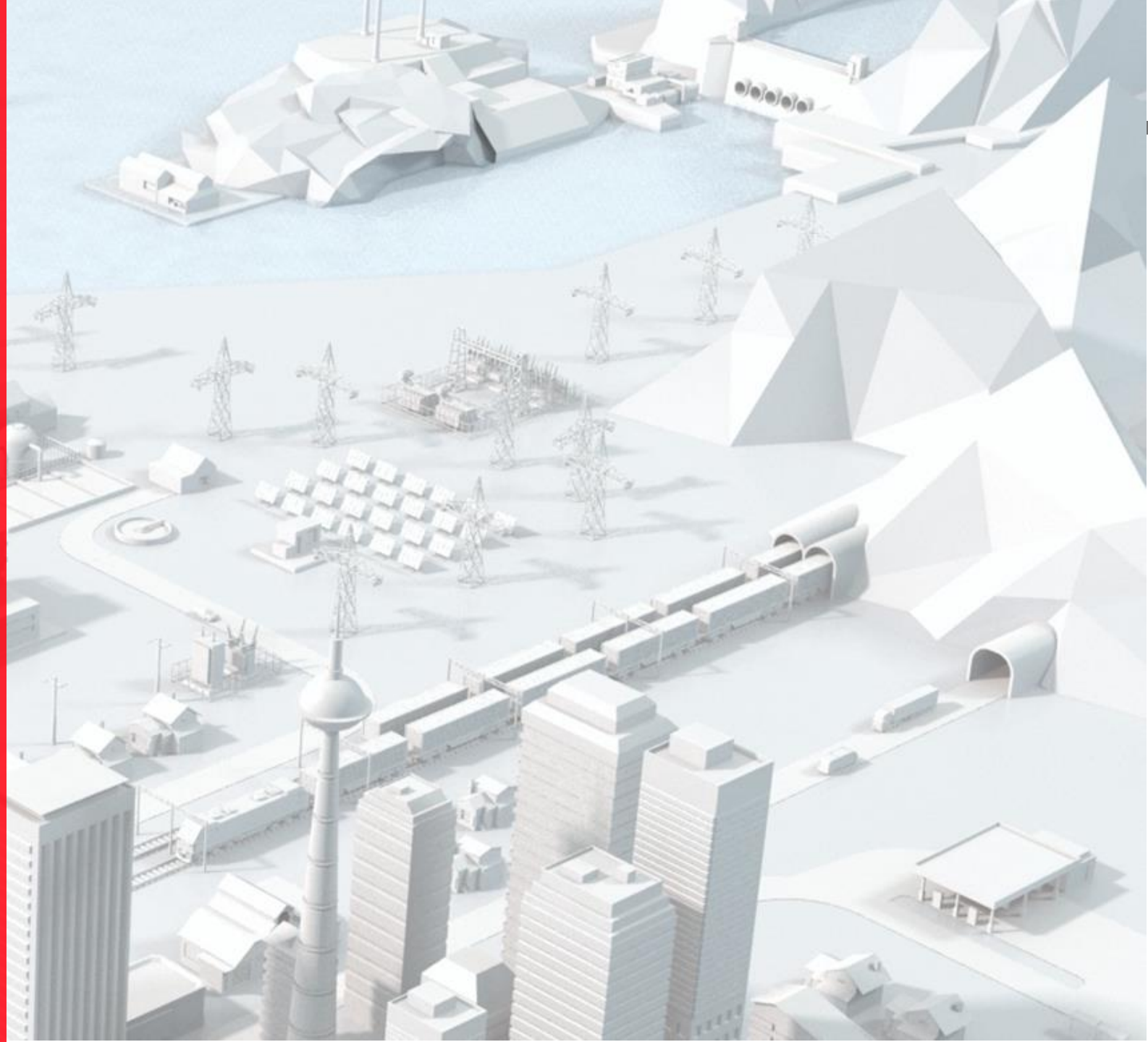
Market & technology trends

2

Digital transformation from the field to the boardroom

3

An end-to-end offering for the digital distribution grid



We serve customers across the energy value chain

Generation

- Offshore wind
- Onshore wind
- Solar
- Hydropower
- Conventional

Transmission and distribution

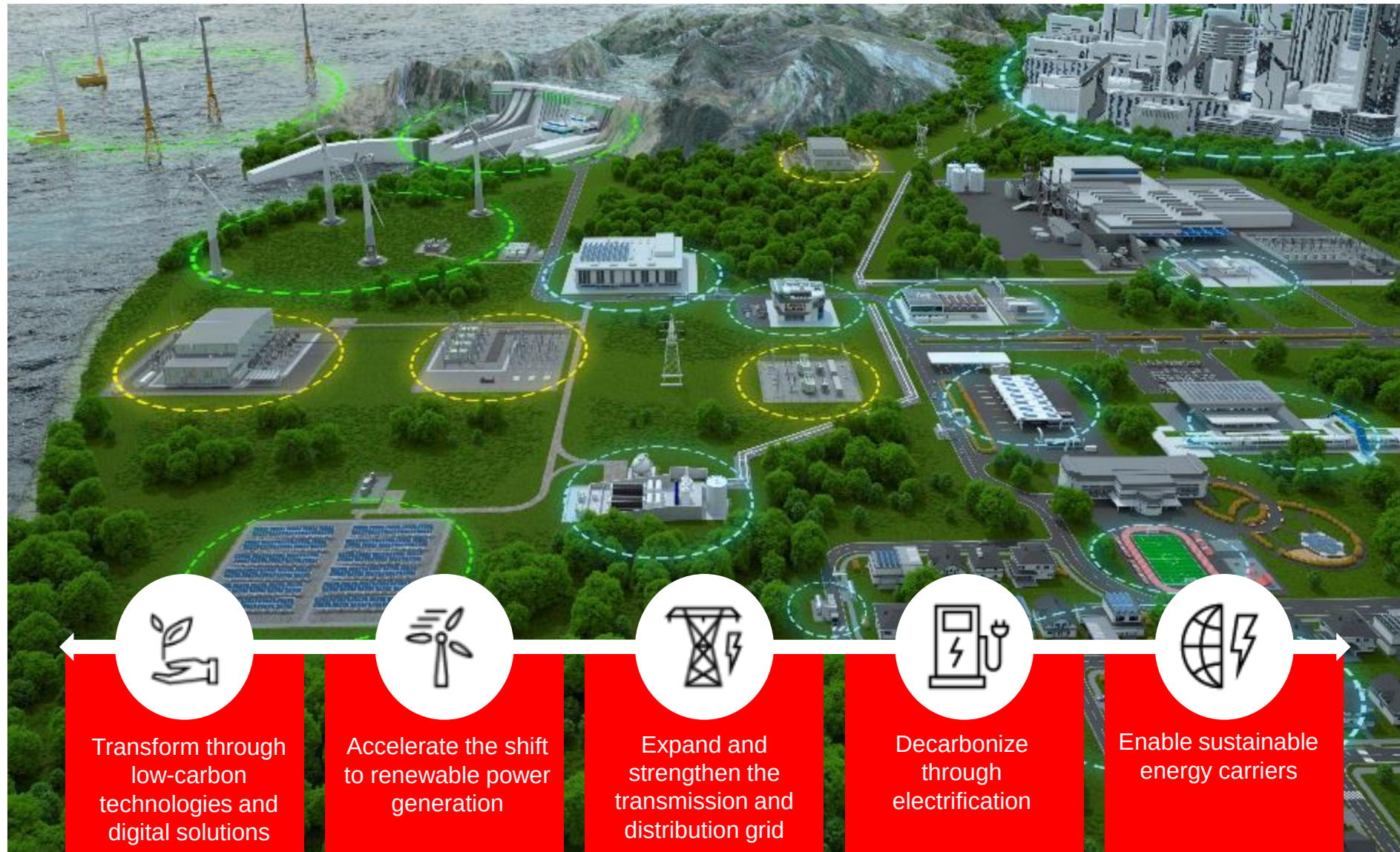
- Converter station
- Transmission substation
- Distribution substation

Consumption

- Hydrogen consumption
- Hydrogen production
- Data center
- Transportation (e-bus depot and rail station)
- Commercial by industry

Markets we serve

- Utilities
- Renewables
- Transportation
- Data centers
- Industries
- Buildings



The electricity system is in the midst of a transformation

3Ds lead the transition...

Decarbonization

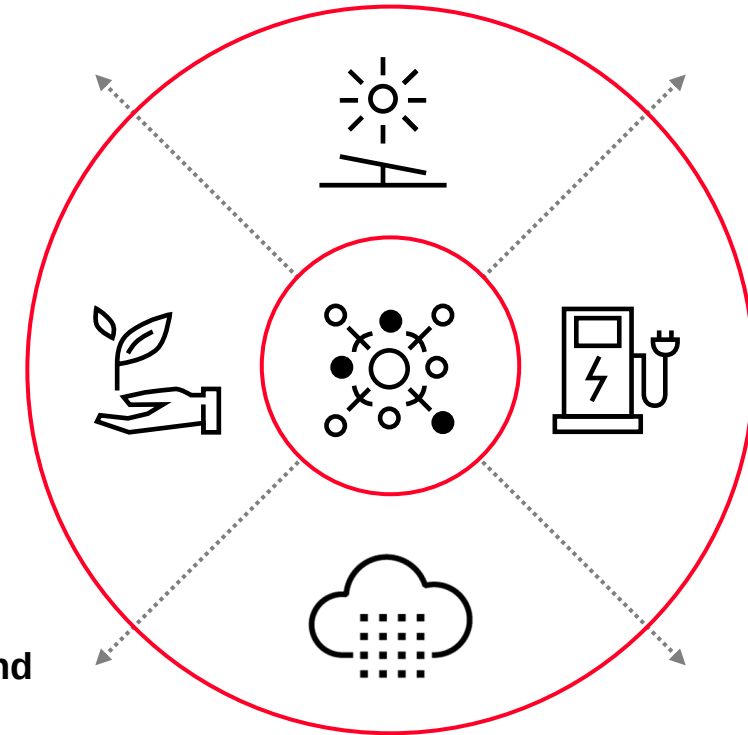
- Regulatory Frameworks: **Governments are enforcing stricter emissions targets and promoting renewable energy sources.**
- Technological Progress: **Advancements in renewable technologies make them more affordable and accessible.**

Decentralization

- Grid Resilience: **A decentralized grid can enhance reliability by reducing single points of failure and enabling local energy solutions.**
- Environmental Benefits: **Integrating DERs helps reduce transmission losses and supports local clean energy generation.**

Digitalization

- Data Utilization: **Big data and analytics optimize grid management, demand forecasting, and customer interactions.**
- IoT and Automation: **These tools facilitate predictive maintenance and operational efficiencies, reducing costs and enhancing service delivery.**



Fundamental technology areas for the power system evolution



Power Electronics



Digital technology and services



Sustainable products and solutions

“

Each clean GW that we add to the energy system needs to be balanced with an increase in grid capacity and flexibility to meet security, reliability, and resilience.

Highlights - Complete portfolio for all applications and environments



7-inch color touch screen display

Customizable hardware and an innovative web interface

Multi-application feeder protection and control Relion REF650

Feeder protection, control, and measurement

Directional overcurrent protection

Reverse power protection

Circuit-breaker control

Dimensions:

Front panel width	Front panel height	Back side width	Depth	Back side length
165 mm	240 mm	145 mm	228 mm	206 mm

Medium-voltage protection relay PSF640

EconIQ

Gas-insulated switchgear (GIS) ELK-03, 420 kV

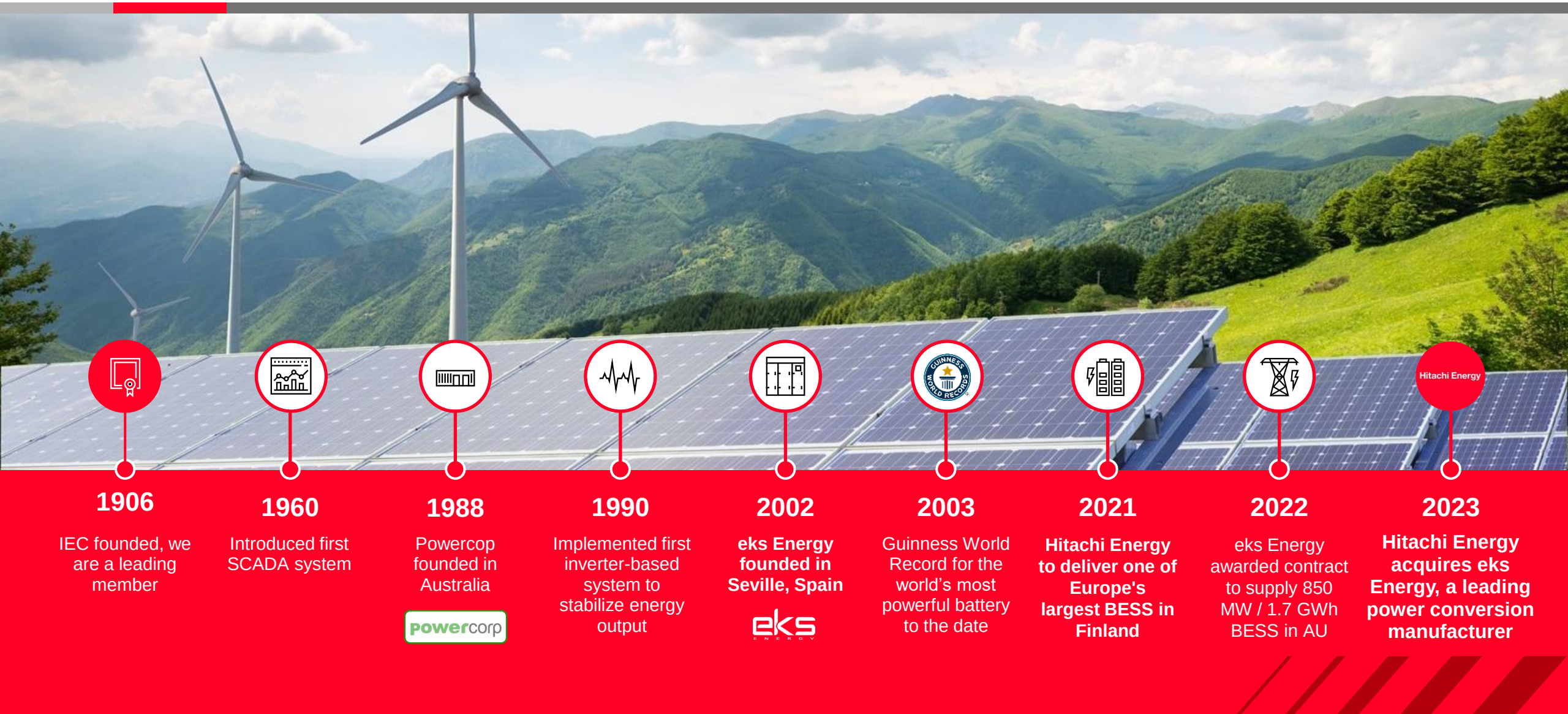
As a pioneer in energy management and optimization, Hitachi Energy is your trusted partner in the evolving global energy ecosystem.

Our Grid Edge Solutions are leading energy innovation and transition with 30+ years of experience and 300+ projects in energy storage and microgrids.

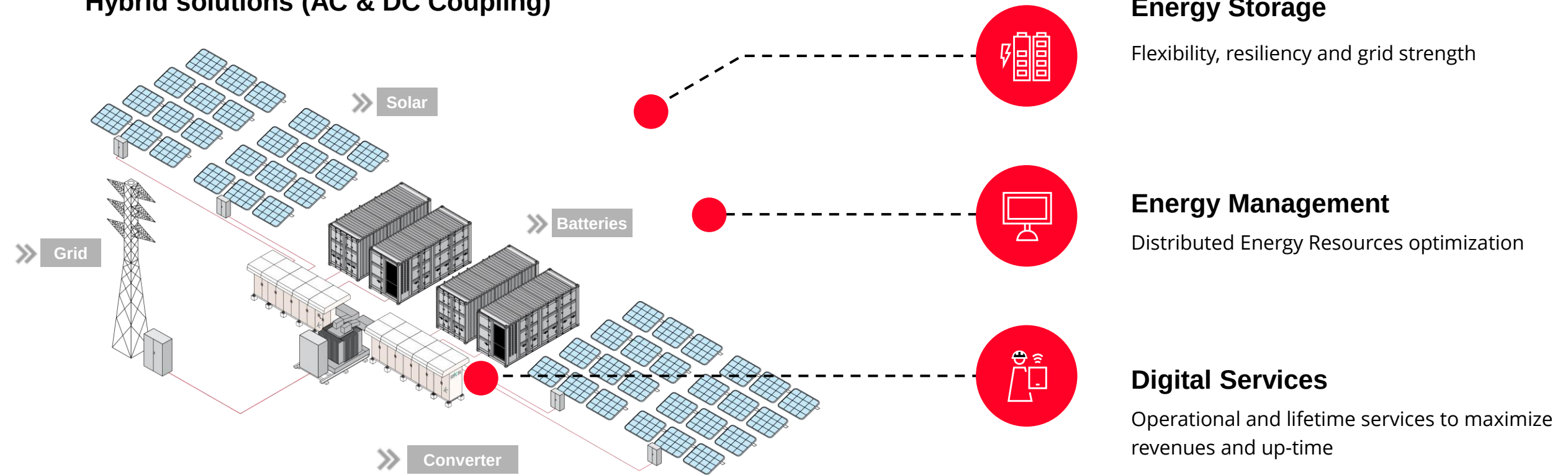
Helping customers increase profitability and unlock new revenue streams by reducing energy cost, maximizing renewables and lowering CO₂.



We're in this for the long-run



Hybrid solutions (AC & DC Coupling)



Ready for the next generation of energy storage and renewable energy systems

e-mesh value stack

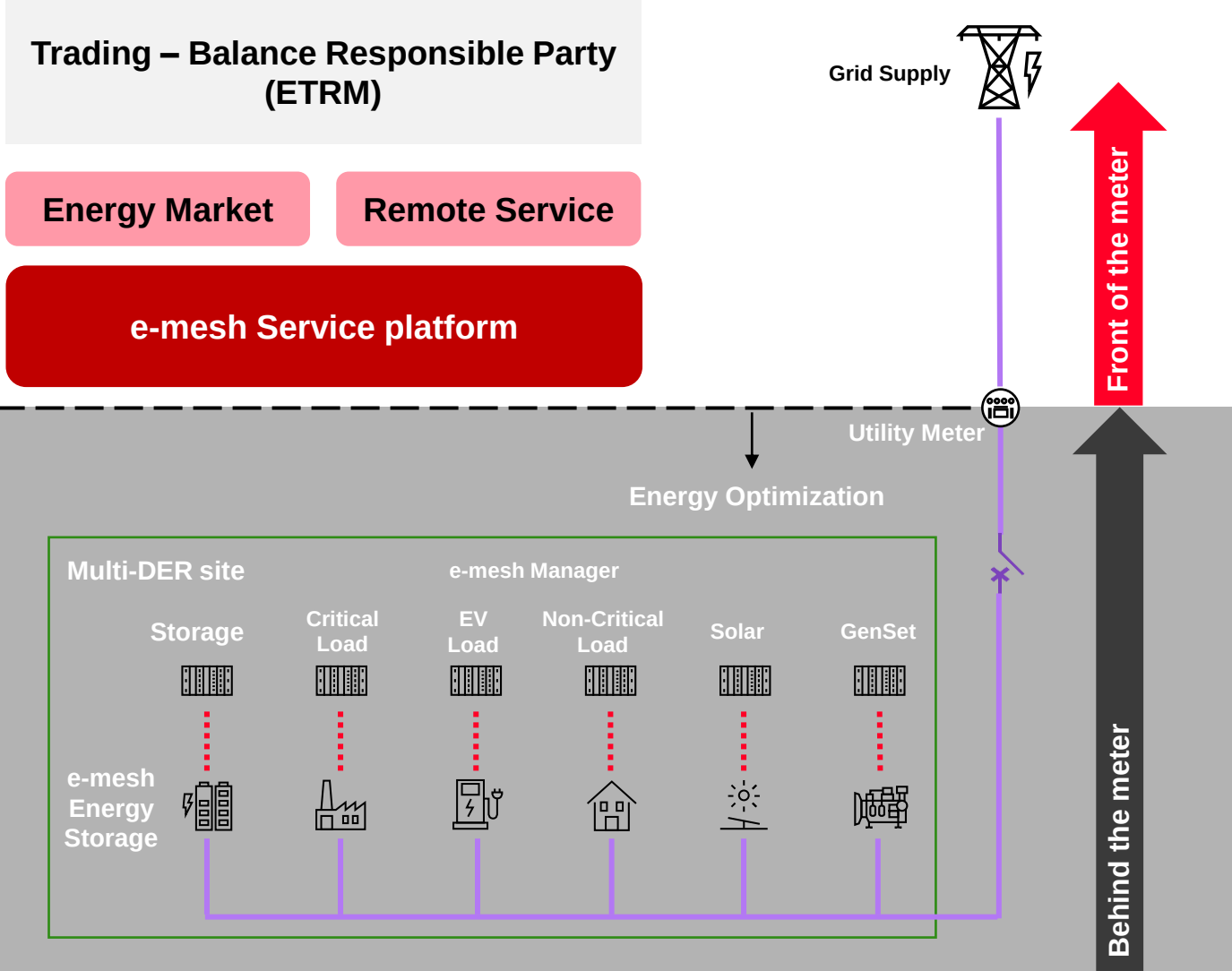
e-mesh Service
additional value streams for optimized business cases



e-mesh Manager
integration of RE, system optimization for max RE penetration: Energy management is the optimization of a full depot or site energy profile incl smart charging



e-mesh Energy Storage (BESS)
Site flexibility element for peak lopping, grid stabilization, islanding & resiliency



The ambitious project, led by Australia's Akaysha Energy, features battery energy storage system (BESS) that will act as a giant shock absorber, cushioning the electrical grid against instability.

The battery's large size ensures reliable power delivery even in the event of a major transmission outage of one of the lines feeding Sydney and surrounds.

About the project

- **Project:** Waratah BESS
- **Power:** 840 MW
- **Capacity:** 1680 MWh
- **Location:** Waratah, Australia
- **Completion date:** 2024

Customer benefits

- Achieving sustainability goals
- Reducing carbon emissions
- Increasing renewable energy storage
- Improving reliability and resiliency

Solution

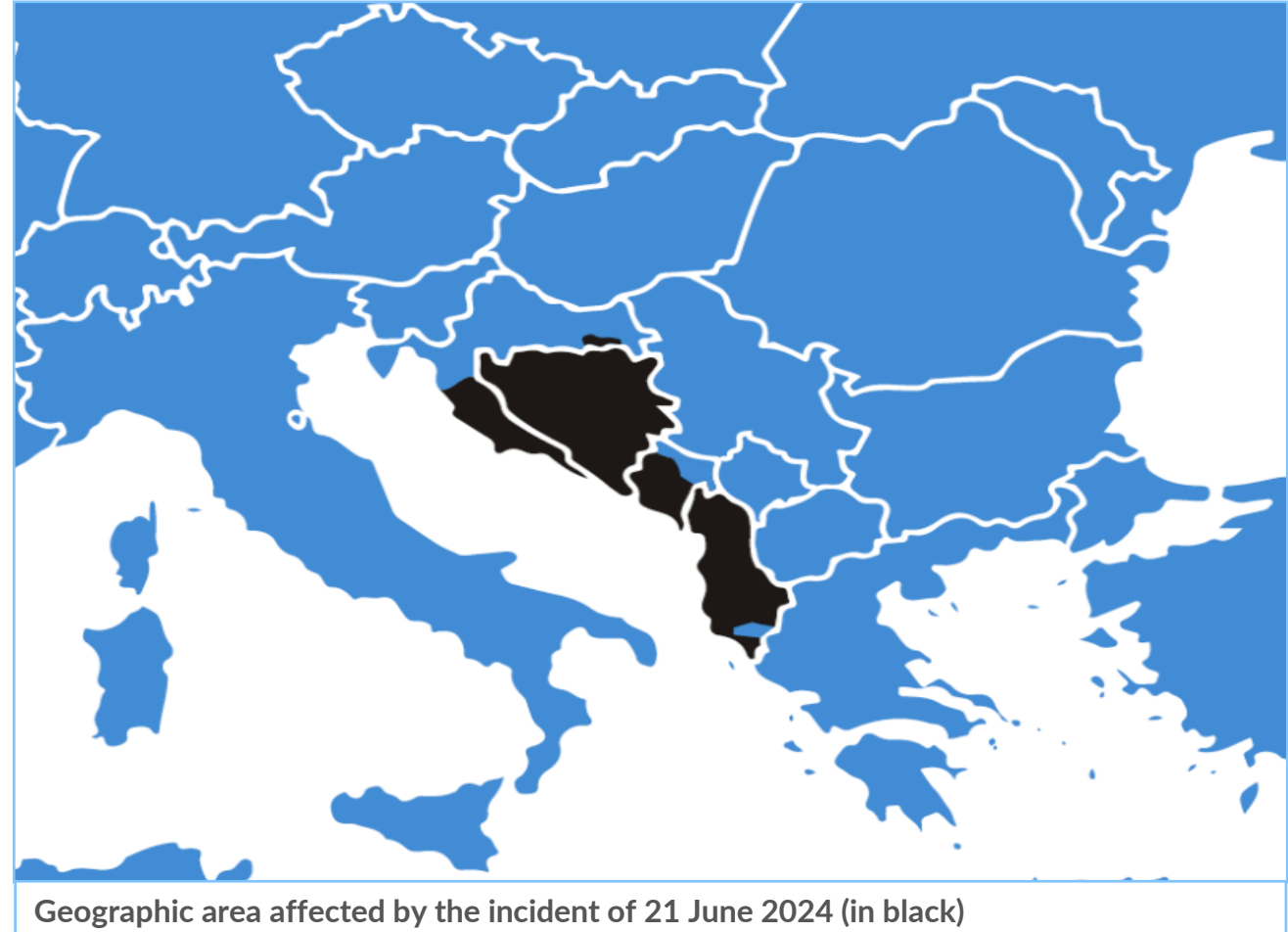
- Stand-alone BESS
- e-mesh Energy Storage
- e-mesh Manager
- e-mesh Service



Just before the incident, the affected area was importing about 2000 MW from neighboring countries and exporting 417 MW to Italy through the HVDC sub-sea cable between Montenegro and Italy (Monita).

Within a short period of time (at 12:09 and 12:22 CET), two unexpected tripping of overhead lines occurred.

Immediately after the second tripping at 12:22, the voltage started to drop in a wide area.

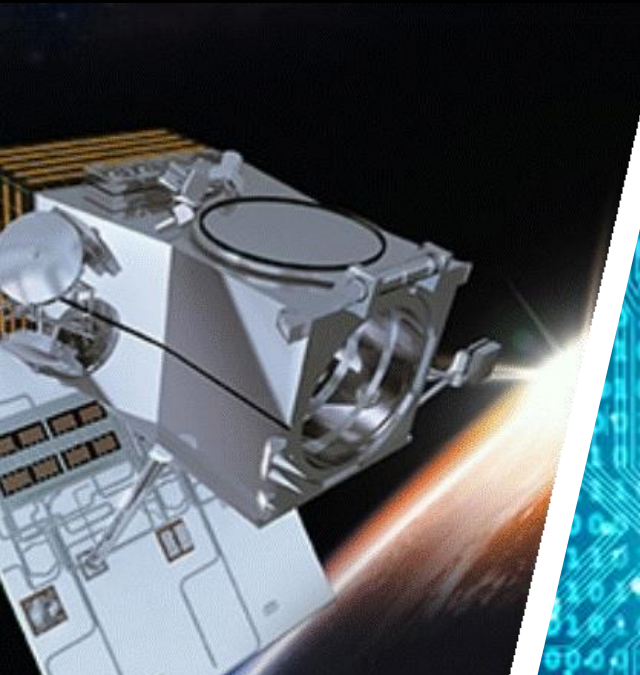


Geographic area affected by the incident of 21 June 2024 (in black)

Source: ENTSO-E, the European Network of Transmission System Operators for Electricity

Vegetation Manager. Enabling full visibility of risk & resiliency measures

Best-in-Class, Integrated Satellite
Technology with Maxar



Configurable Risk Models;
Algorithm Accuracy



Integrated, Closed Loop Planning
and Work Management



Mobility from Detection to
Planning to QC/Prevention



Highest Accuracy



Optimized Planning



360° Visibility at Scale



Simplified, Personalized UX

Hitachi Energy brings a **power industry perspective** to AI to maximize your investment in satellite resources and technology based on **deep industry knowledge** and **understanding of utility operations**. Our solution is **part of a broader portfolio** and was built from the ground up, **by vegetation managers for vegetation managers**.

1

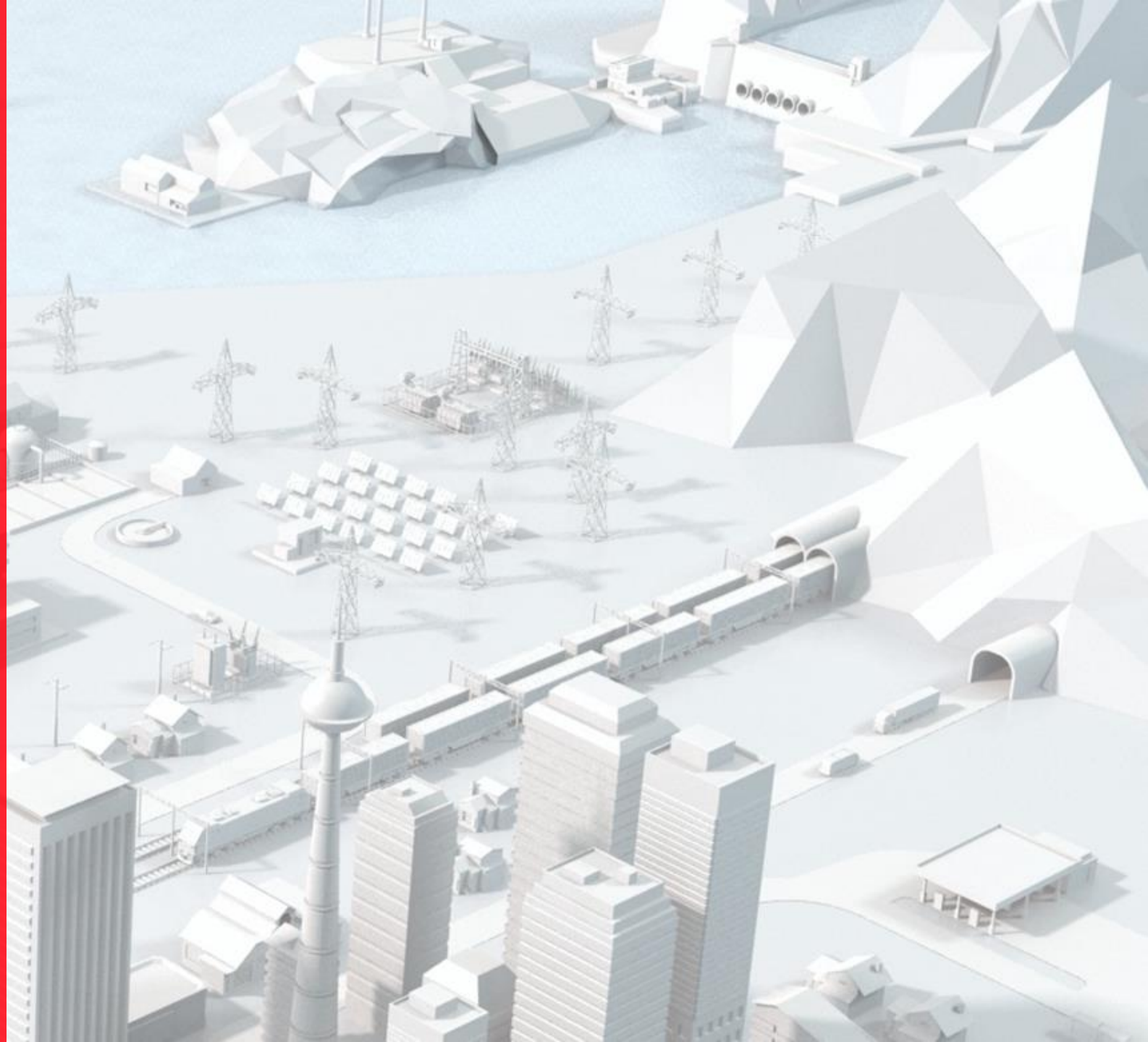
Market & technology trends

2

Digital transformation from
the field to the boardroom

3

An end-to-end offering for
the digital distribution grid



Digitalization unlocks real business value

Safety & Security



- Minimize risk
- Enhance safety
- Enable real-time remote monitoring
- Ensure secure and reliable communications

Flexibility

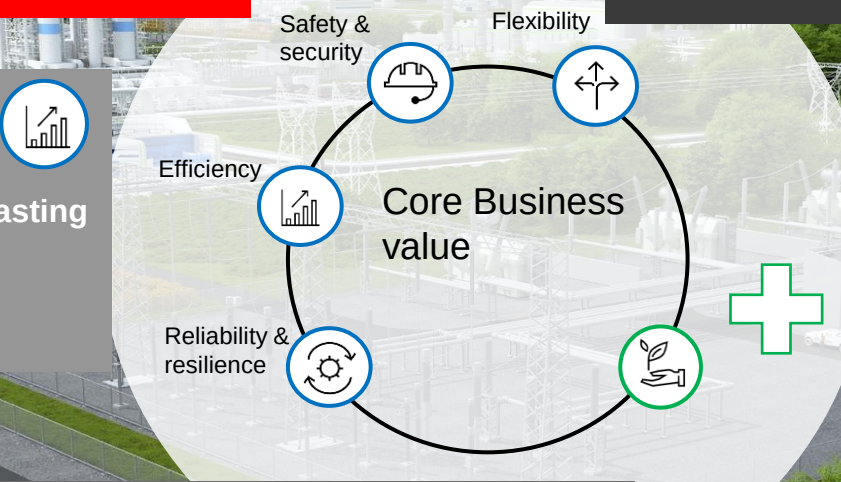


- Decrease complexity
- Reduce uncertainty
- Enable new revenue streams
- Maximize agility

Efficiency



- Advanced analytics and forecasting
- Save time and travel
- Increased productivity
- Reduce O&M Cost



Supporting Sustainability Goals



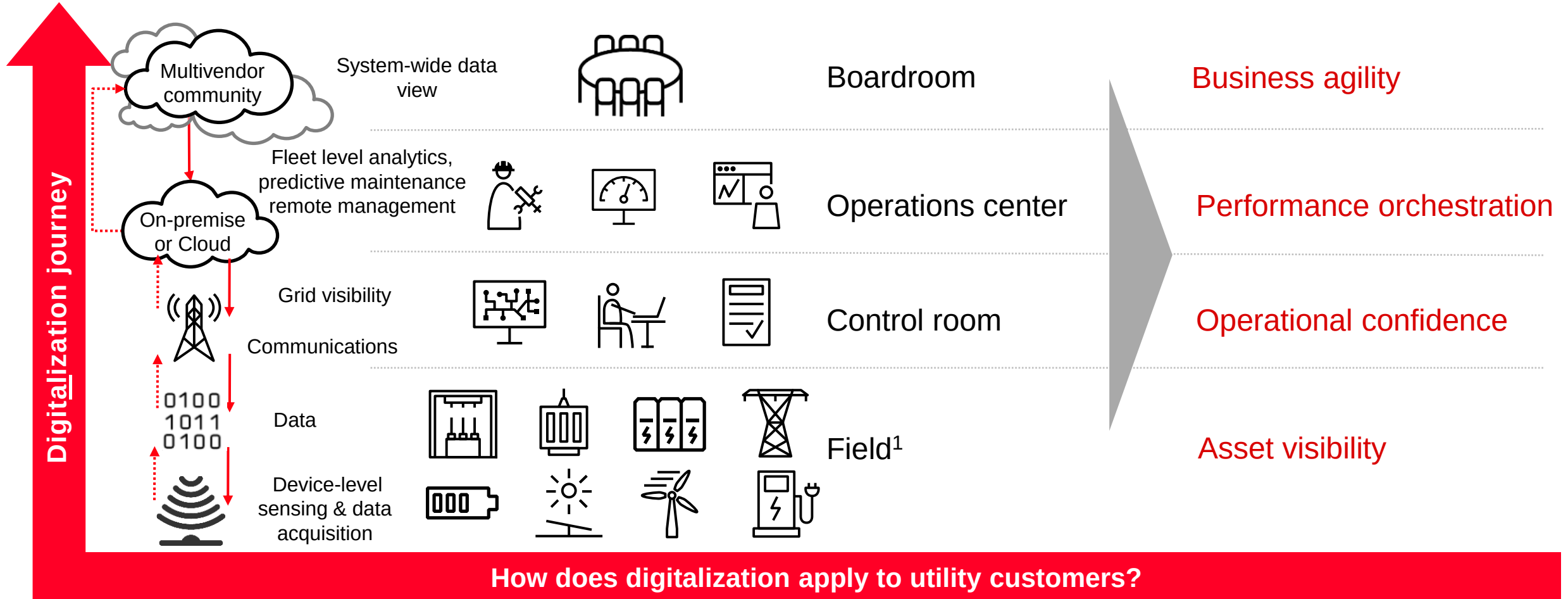
- Optimized project planning
- Integration of renewable energy resources
- Emissions reduction & Reduced truck rolls
- Track and trade renewable energy credits

Reliability & Resilience



- Predict failures
- Visibility into asset state & condition
- Achieve higher levels of automation
- Enhance local power support

Increased visibility enables the migration from asset focus to system-level analysis



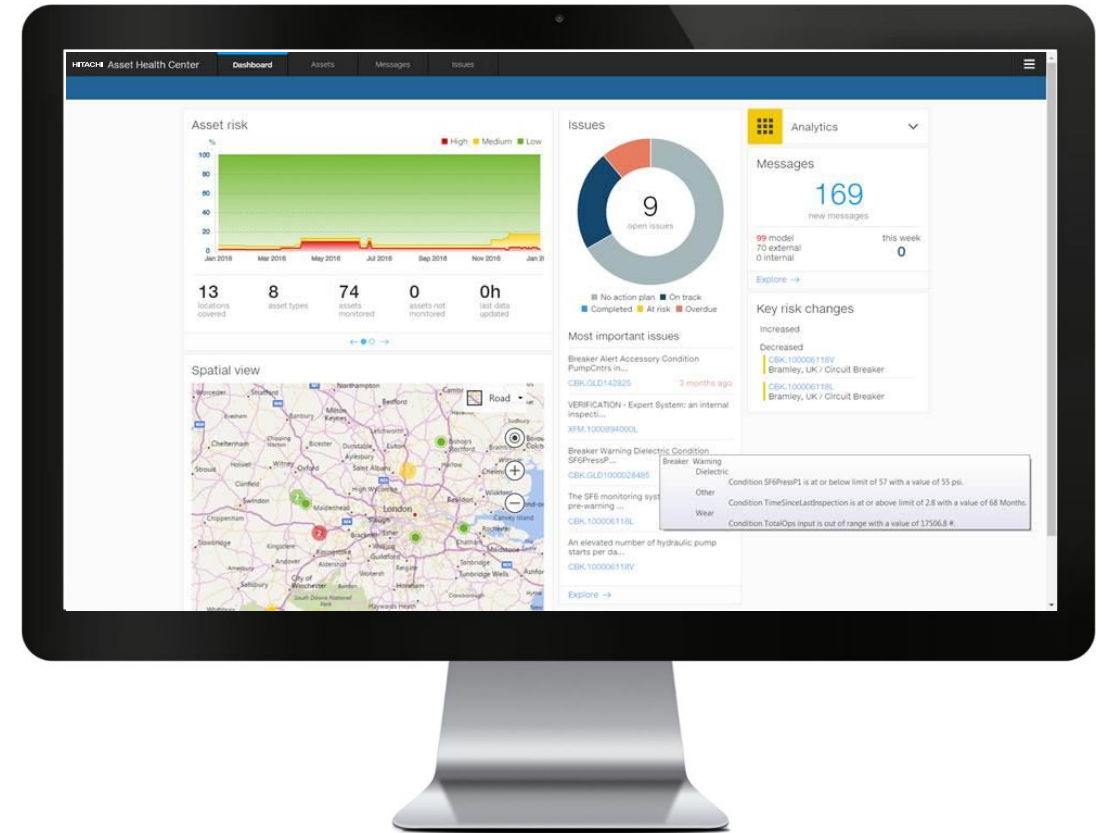
Data driven operations – from time based to predictive maintenance

Advanced analytics allow for a fleet wide view of the assets and bring value from predictive failure analysis

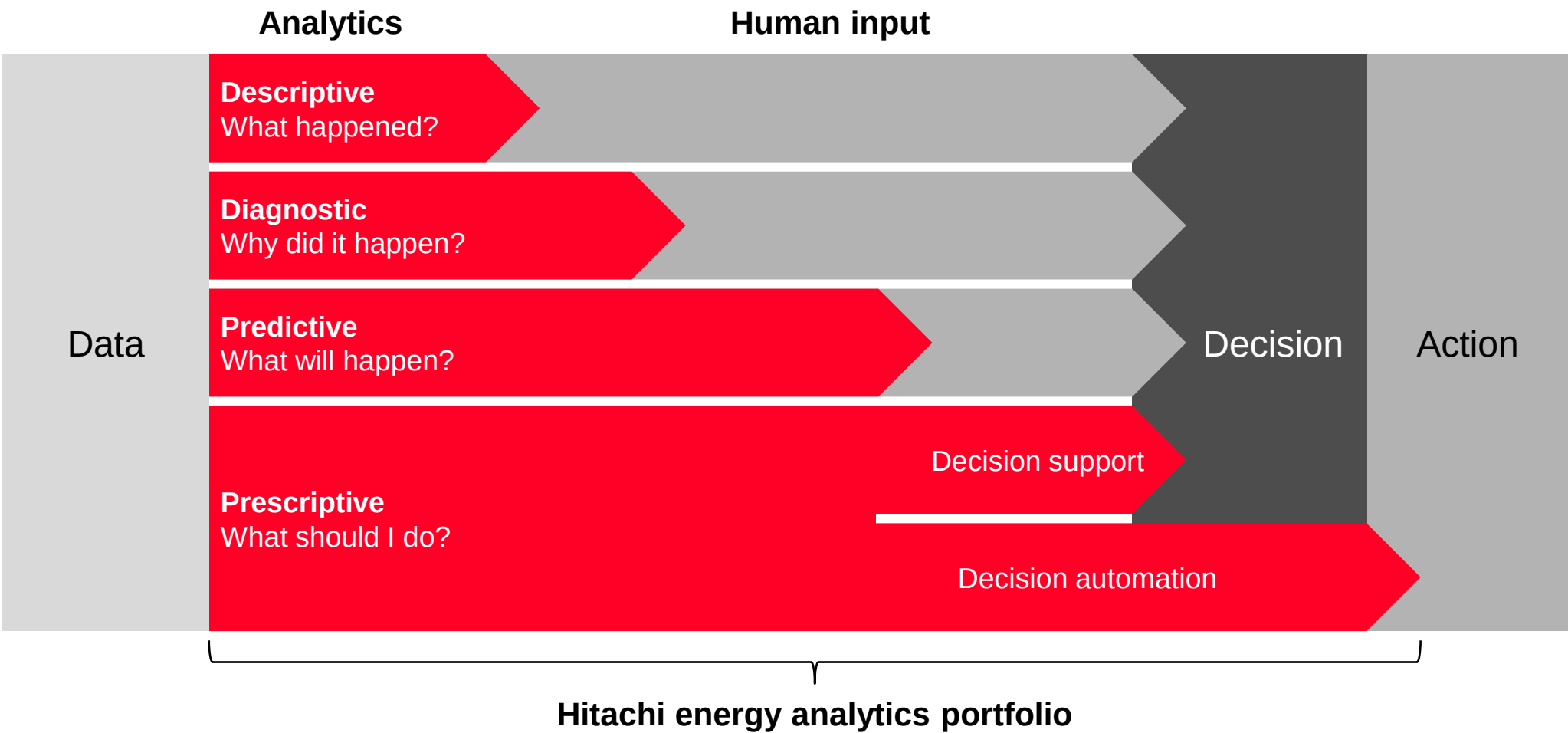
Predictive analytics software

...allows to programmatically:

- Consolidate information from a variety of sources
- Determine current condition of electrical assets
- Predict and assess at-risk assets
- Provide recommendations for corrective action
- Prioritize actions across the fleet and aid in creation of Work Requests

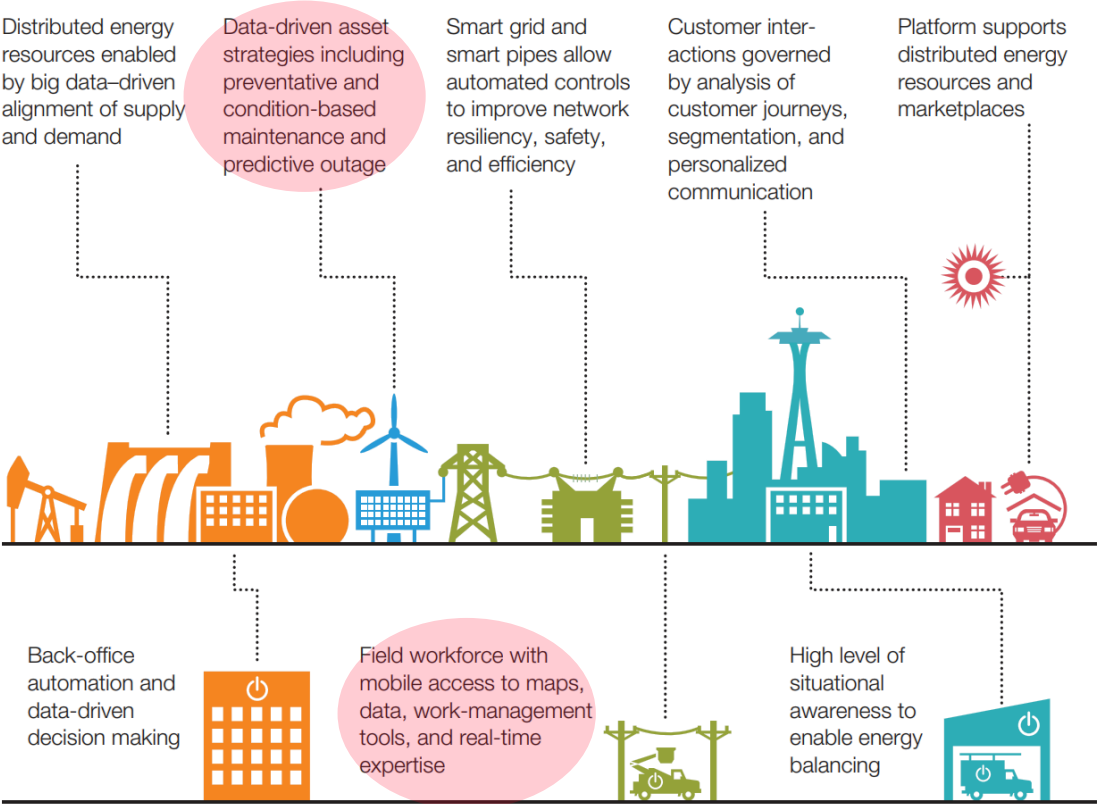


How we go from data to action?



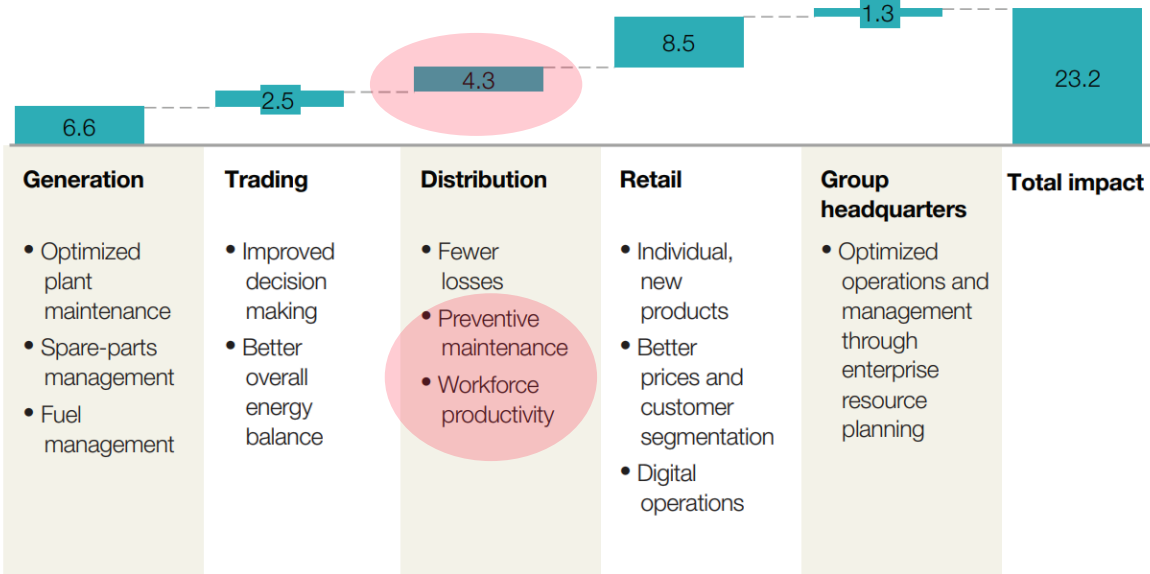
Conservative estimates supported by analysis of real-life cases suggest that digital optimization can boost utilities' profitability significantly

Opportunities all along the value chain



Digitization has demonstrated impact on utility earnings

Improvement areas, case study, EBIT,¹%



¹Earnings before interest and taxes.

1

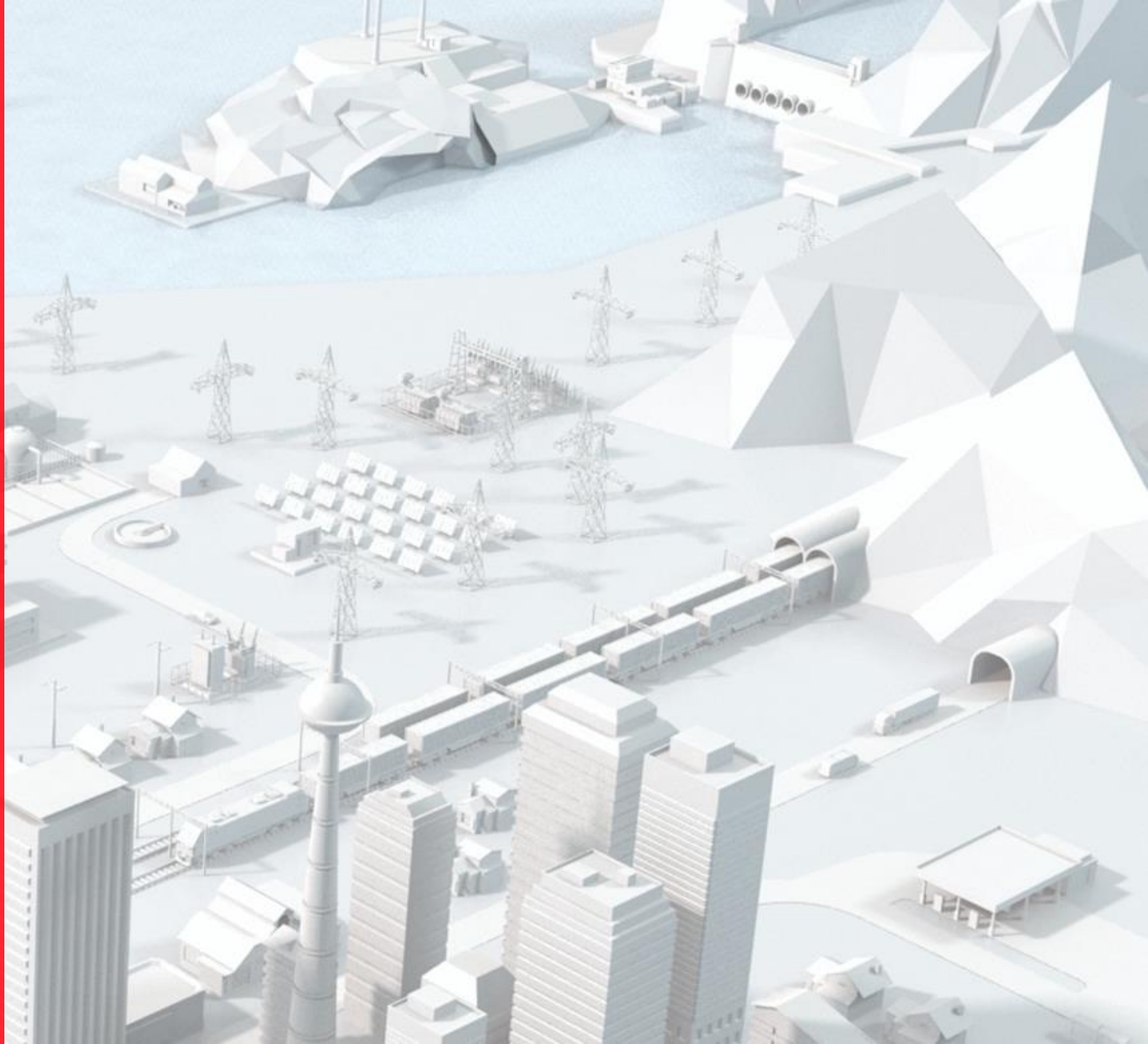
Market & technology trends

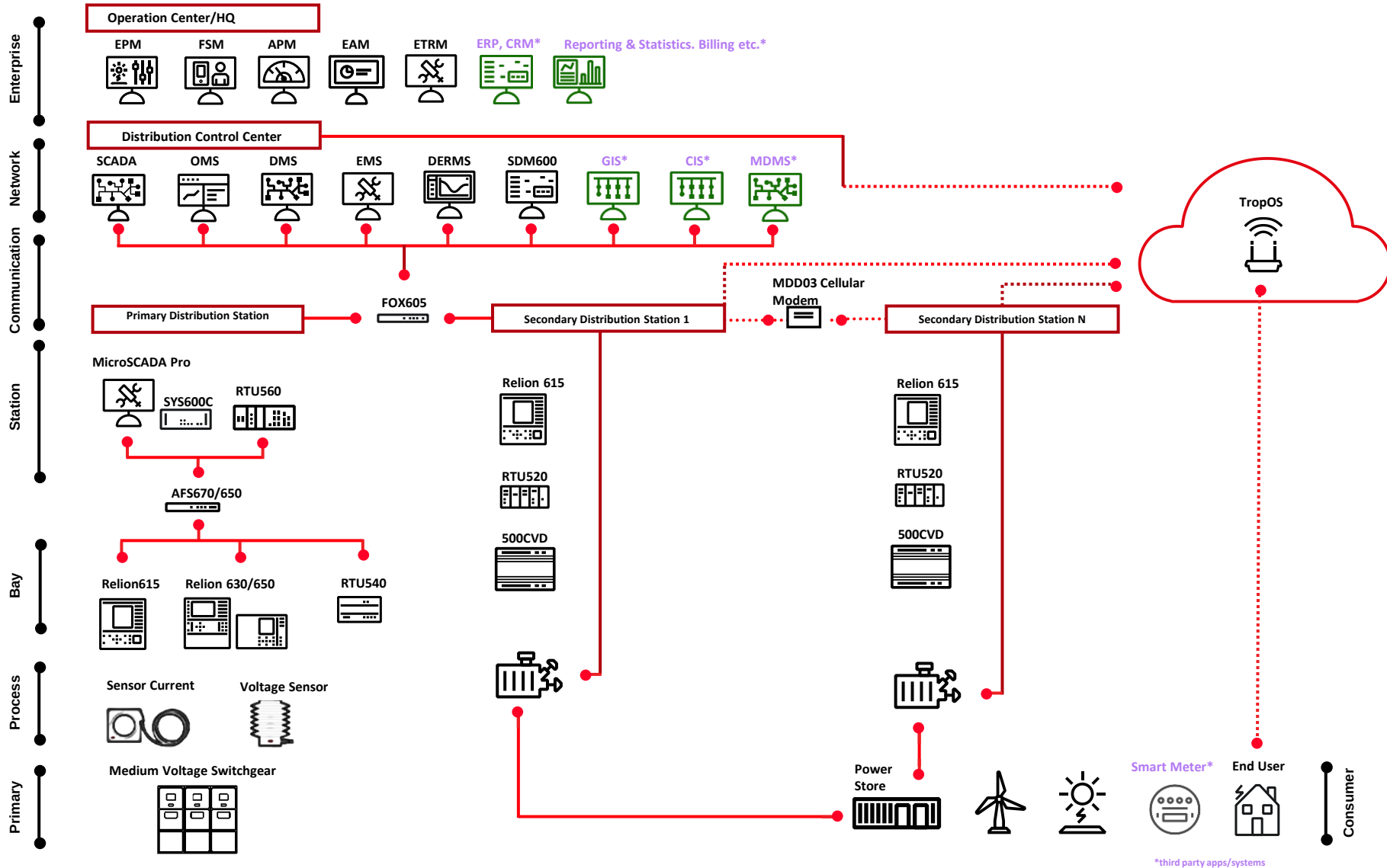
2

Digital transformation from
the field to the boardroom

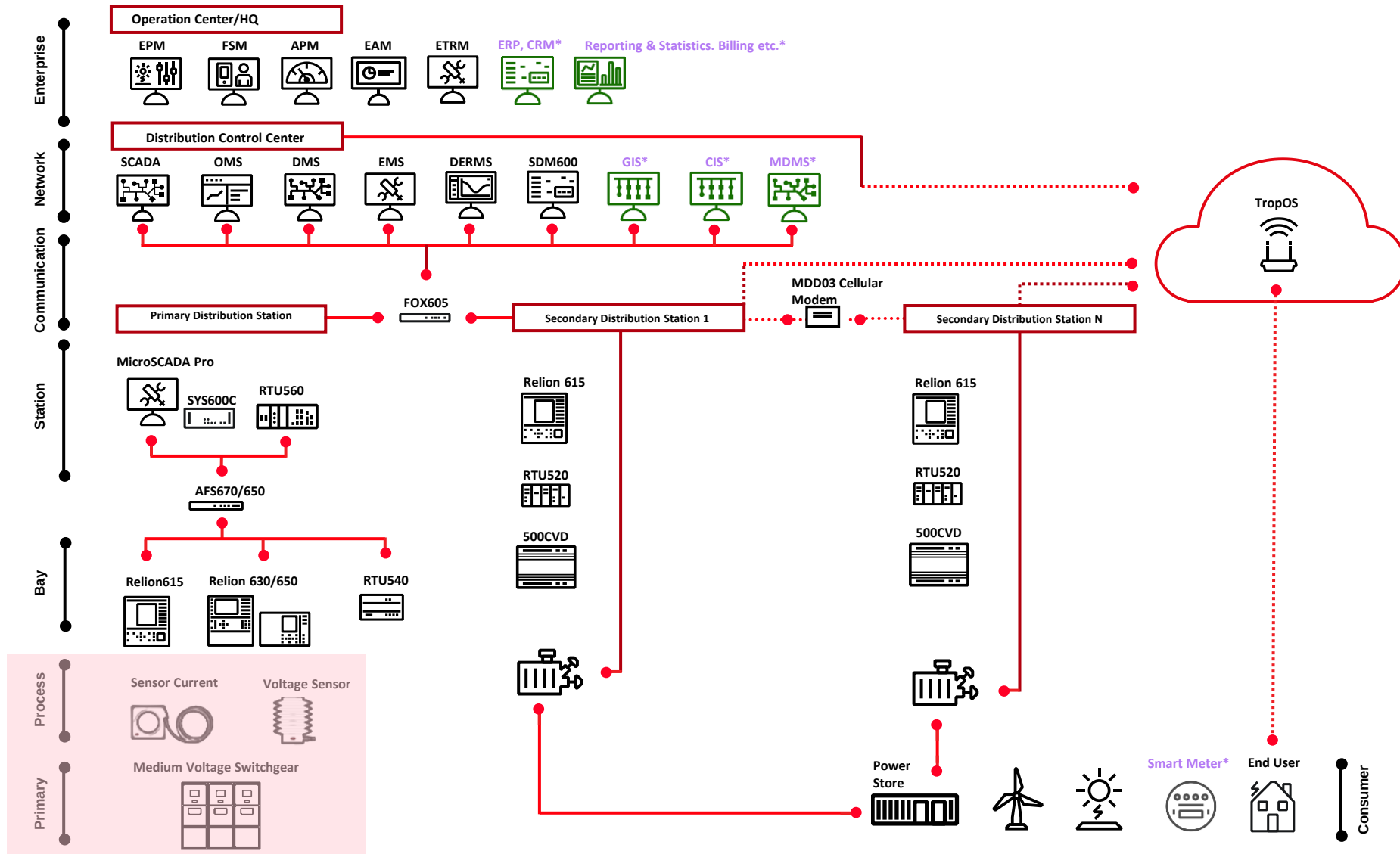
3

An end-to-end offering for
the digital distribution grid

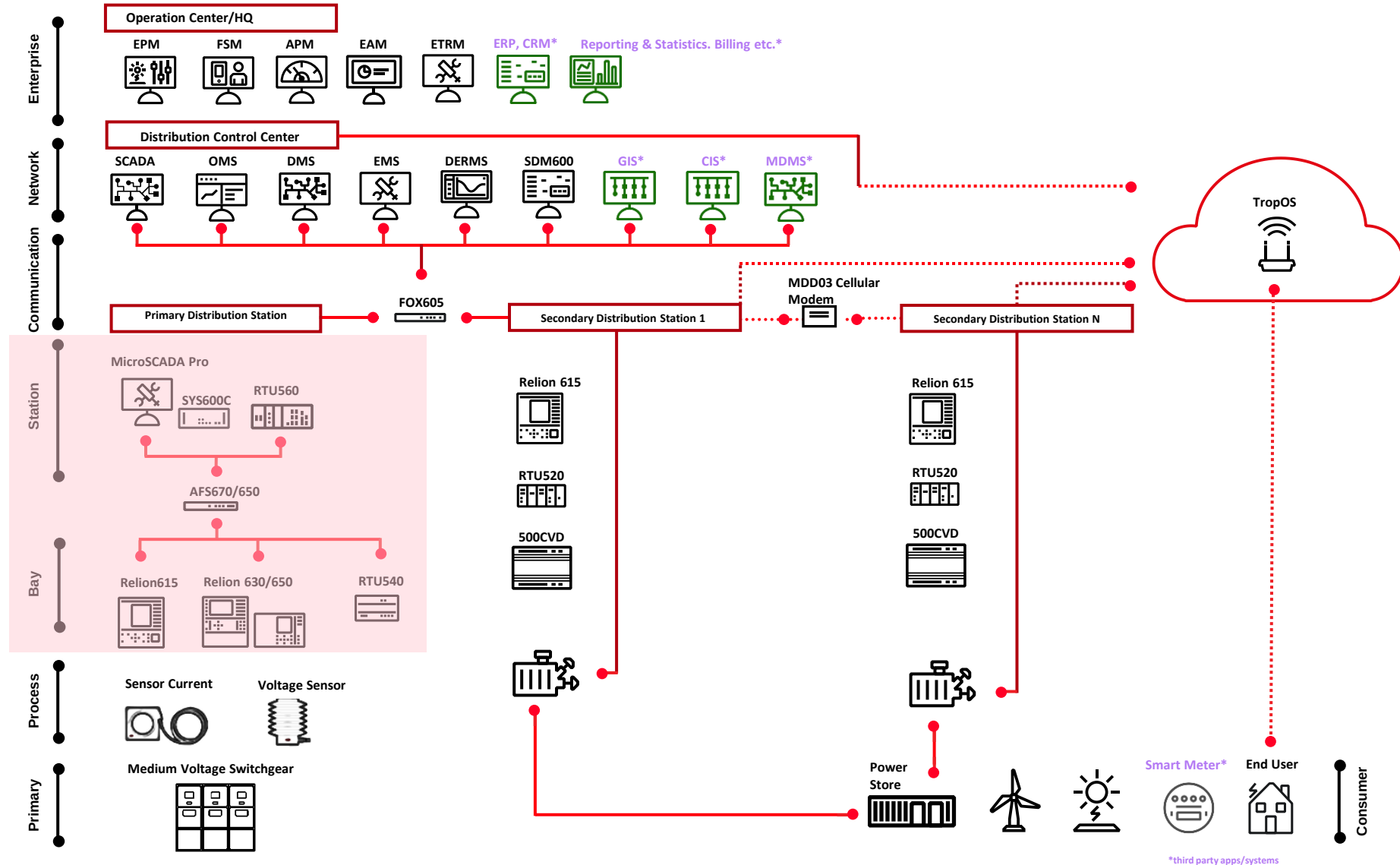




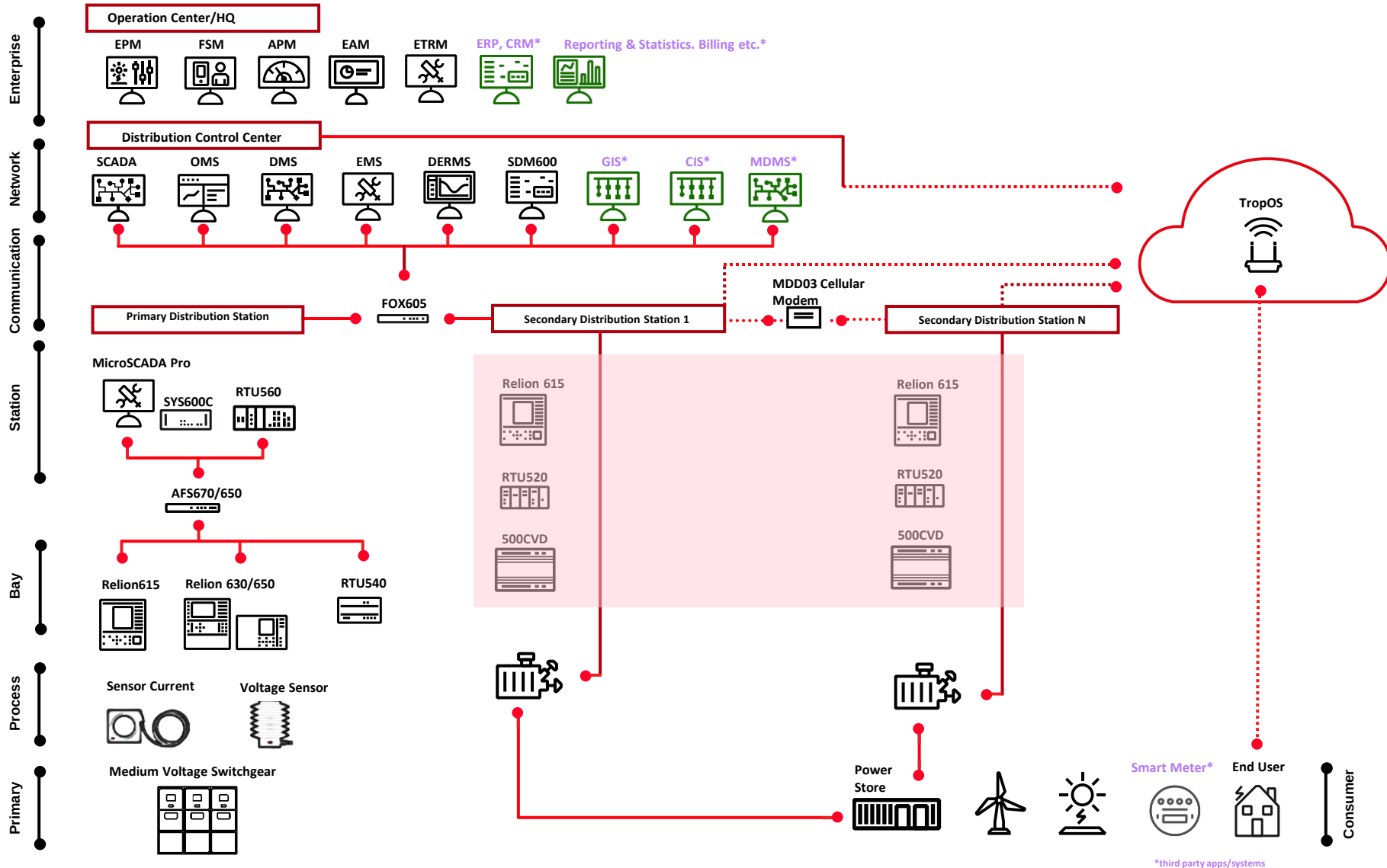
An end-to-end offering for the digital distribution grid



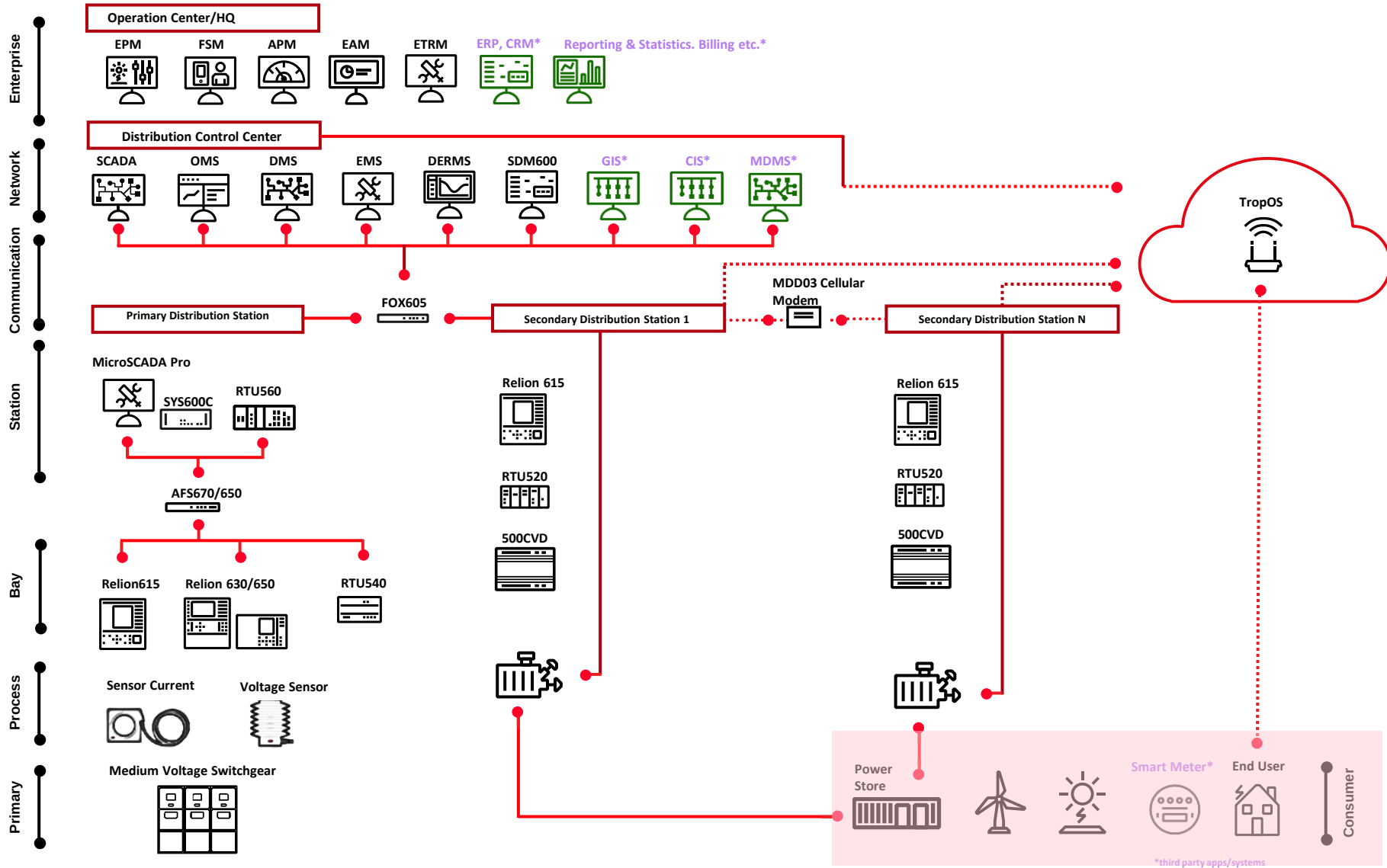
*third party apps/systems

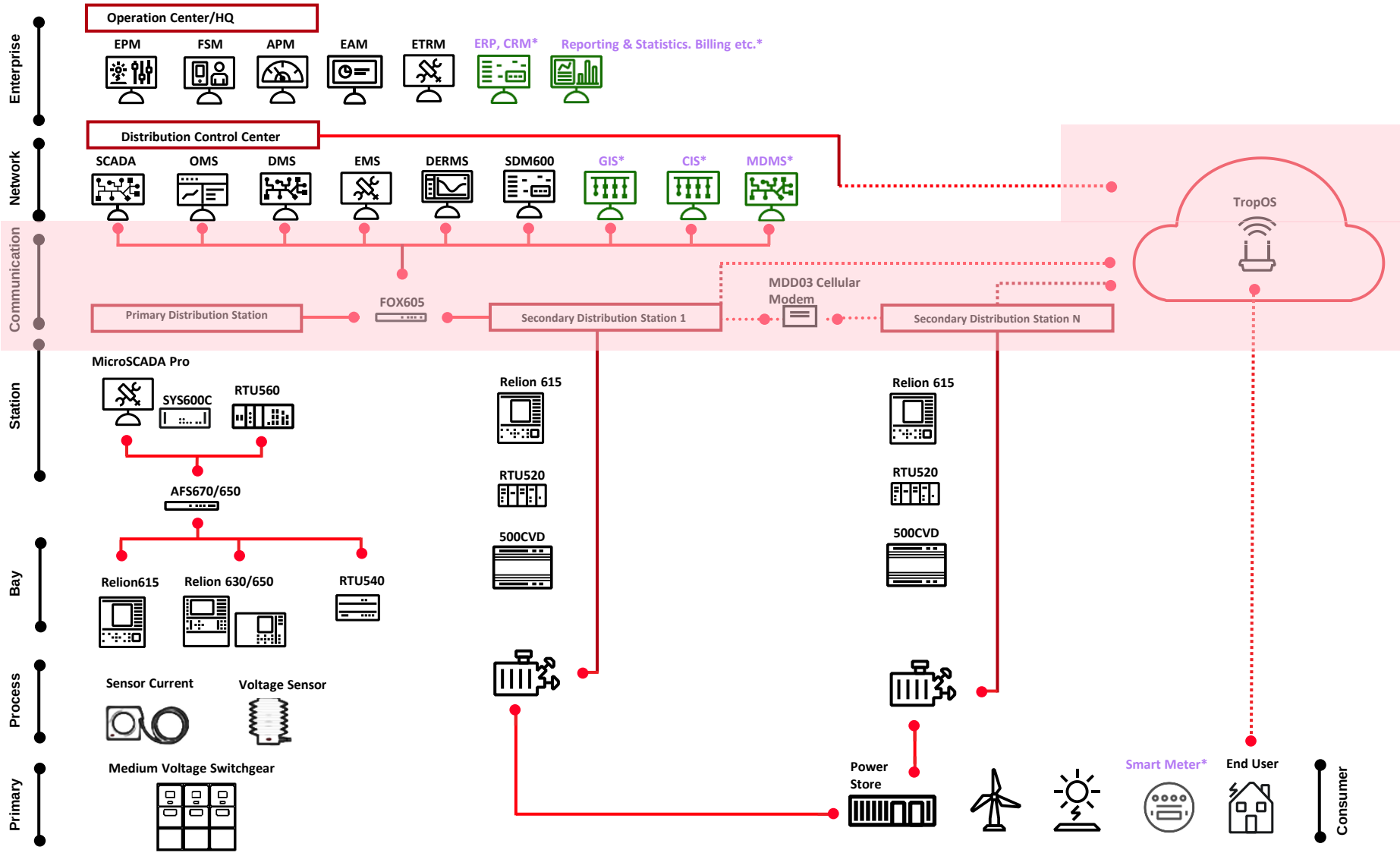


An end-to-end offering for the digital distribution grid

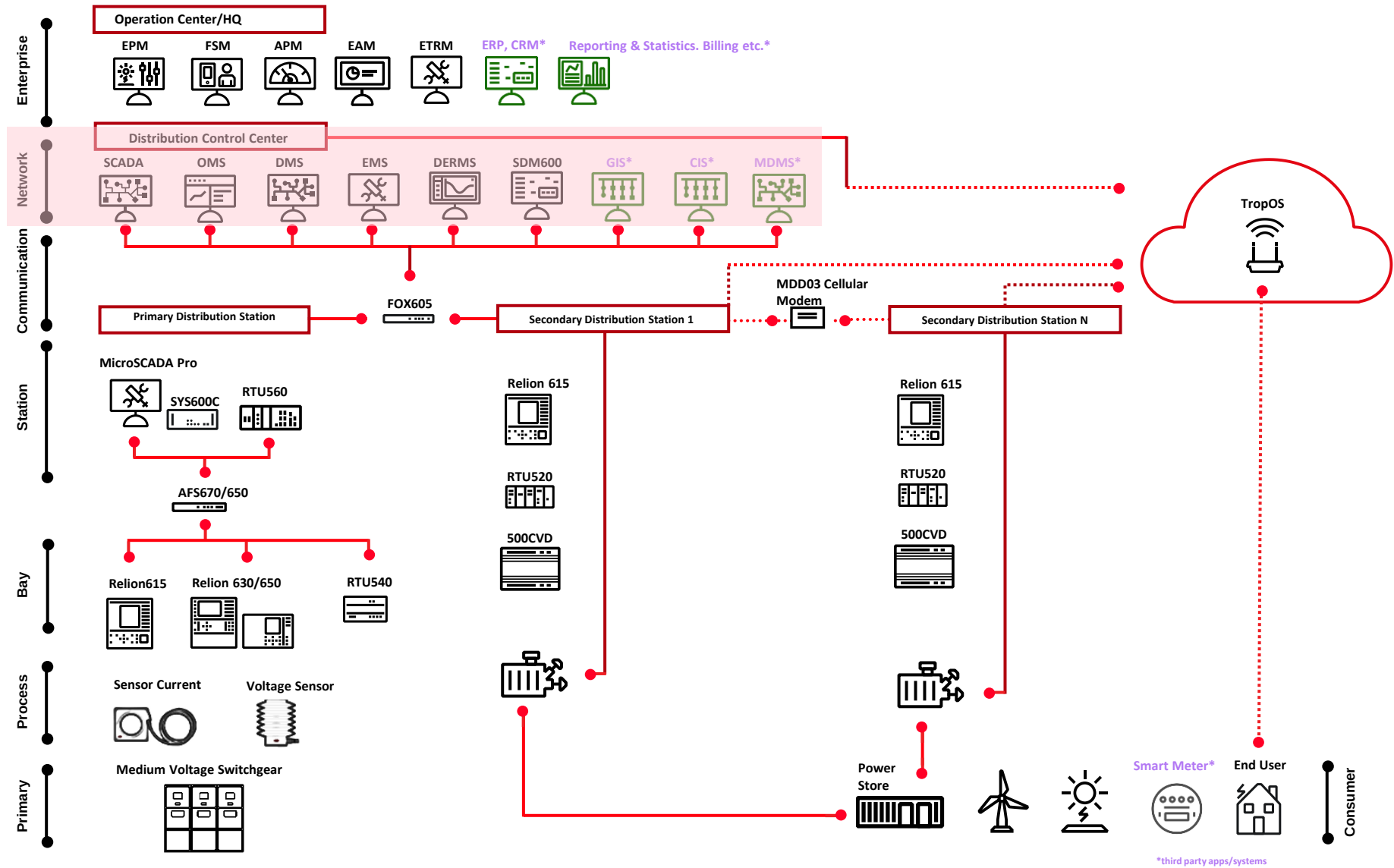


*third party apps/systems





*third party apps/systems



*third party apps/systems

Efficiently, reliably and safely operate the grid providing operational confidence and grid resilience

Main components

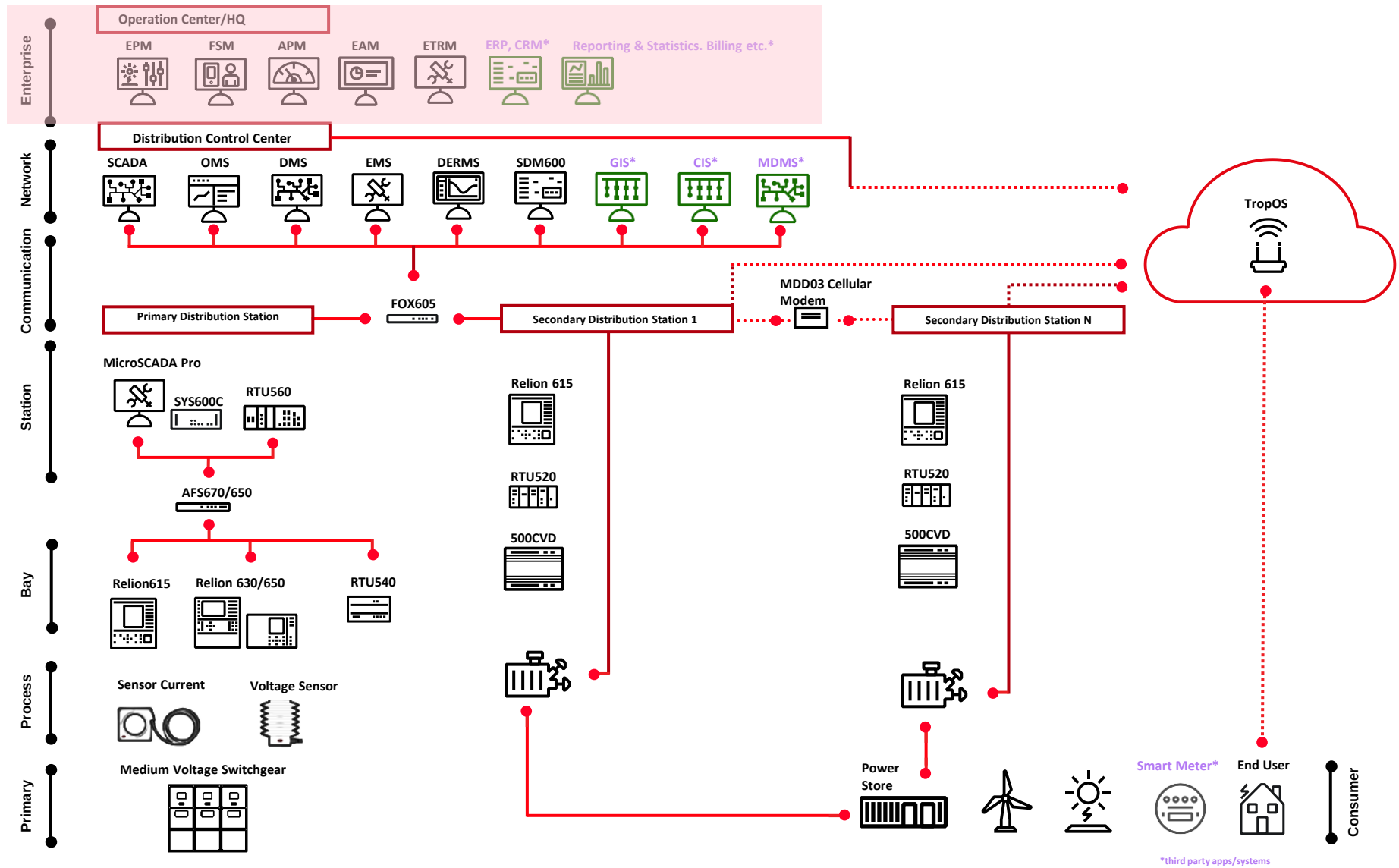
- SCADA: real-time comms towards RTUs, IEDs, SASSs, DCSs
- OMS: customer trouble call, crew dispatch, and switch order management.
- DMS: distribution network analysis
- EMS: transmission and sub-transmission network analysis
- DERMS: small, distributed renewable generation mgmt.
- A combination of the above in what is called an **Advanced DMS**

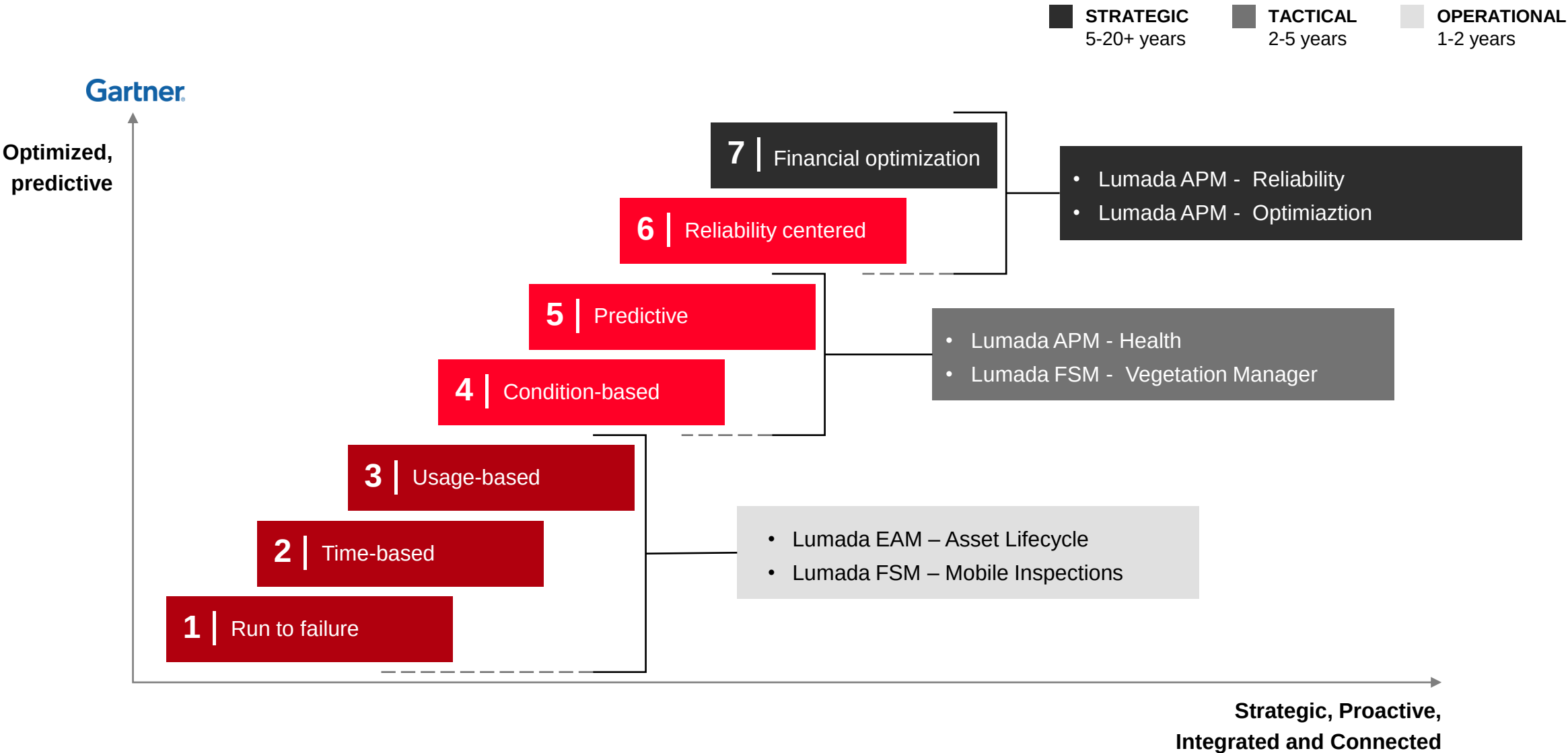


SCADA = Supervisory, Control And Data Acquisition; OMS = Outage Management System; DMS = Distribution Management System; EMS = Energy Management System; DERMS = Distributed Energy Resources Management System, ADMS = Advanced Distribution Management System; RTU = Remote Terminal Unit; IED = Intelligent Electronic Device; SAS = Substation automation System; DCS = Distributed Control System

Network Manager ADMS solution footprint

ADMS Analytics				
Common Graphical User Interface				
Outage Management	SCADA	Network Applications		DERMS
Trouble Call Management Outage Prediction Operations Management ETR Management Crew Management Referrals Switch Order Management	Data acquisition Alarming Trending Event Processing Real-time calculations Integrated data engineering Historian	Load Allocation Unbalanced Load Flow Predictive Load Flow Real-time Impedance Calculation Peak Daily Power Flow Simulation Mode Power Flow State Estimation Short Circuit Analysis Fault Location	Restoration Switching Analysis FLISR Volt-VAR Optimization Overload Reduction Switching Load Forecast Generation Forecast	DER Program Management Optimal Power Flow Volt/Var Control DER Forecasting DER Optimization Distribution Markets
Common Data Model, Simulation Mode, Case Study Mode and Operator Training Simulator				
SCADA Communications		External Adaptors & Data Exchange		DER Communications





Lumada EAM (Asset Management)

- Assets & maintenance strategy
- Work management planning & scheduling
- Inventory & warehouse management
- Supplier & procurement management
- Project planning and budgeting
- Financial accounting and asset depreciation
- HR and employee skills management



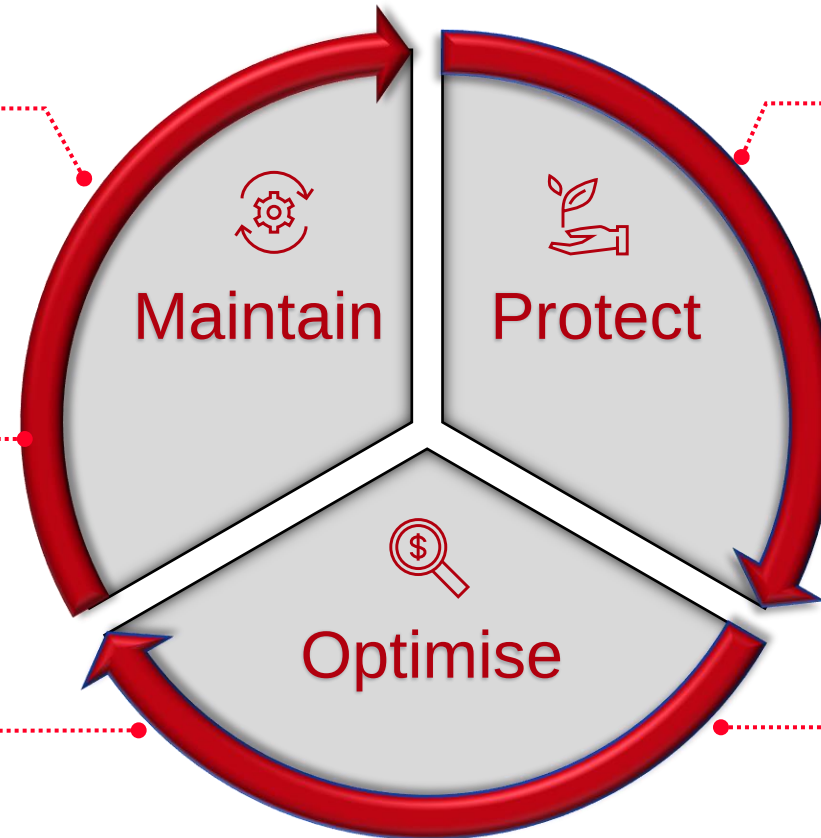
Lumada FSM (Mobile Field Services)

- Conduct offline maintenance and inspection activities in the field
- Defect reporting and digital field capture
- Optimized crew planning & scheduling



Hitachi Vegetation Management

- High resolution integrated satellite threat detection monitoring
- AI engine for growth / encroachment modelling & species evaluation
- Offline GIS mobile apps for field patrol, damage assessment and field planning
- Back-office risk-based cut planning & budgeting



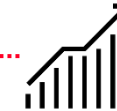
Lumada APM Health

- Health Scores
- Automated Fault Analysis
- Pre-configured library of 175+ models
- Physics-based, ML/AI and Statistical models



Lumada APM Reliability

- Risk-based reliability-centred maintenance
- Failure-mode Effects & Criticality Analysis (FMECA)
- Quantitative & Qualitative Risk Analysis
- Intervention Modelling Framework



Lumada APM Optimization

- Constrained Optimization
- What-if Scenario tool
- Maintain, Repair or Replace Decision Support
- Return on Investment (ROI) analysis



Maximising asset operational efficiency is what we do

Time, usage and condition-based maintenance. Lumada EAM and FSM



Solution Overview

Enabling and automating best-in-class asset lifecycle management, work planning and execution, supplier and procurement management, inventory management, project planning and budgeting, financial accounting and personnel management.

Customer Challenges



Data and system proliferation



Profitability

Rising operational, vendor and supply chain costs



Spending justification

Regulatory scrutiny increasing



Transitioning workforce

Retirement of highly qualified and skilled personnel creates greater risk

20% improvement in **labor productivity**

10% reduction in **asset running costs**

Key Benefits



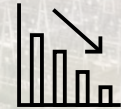
Single source of truth



Workforce efficiency and productivity



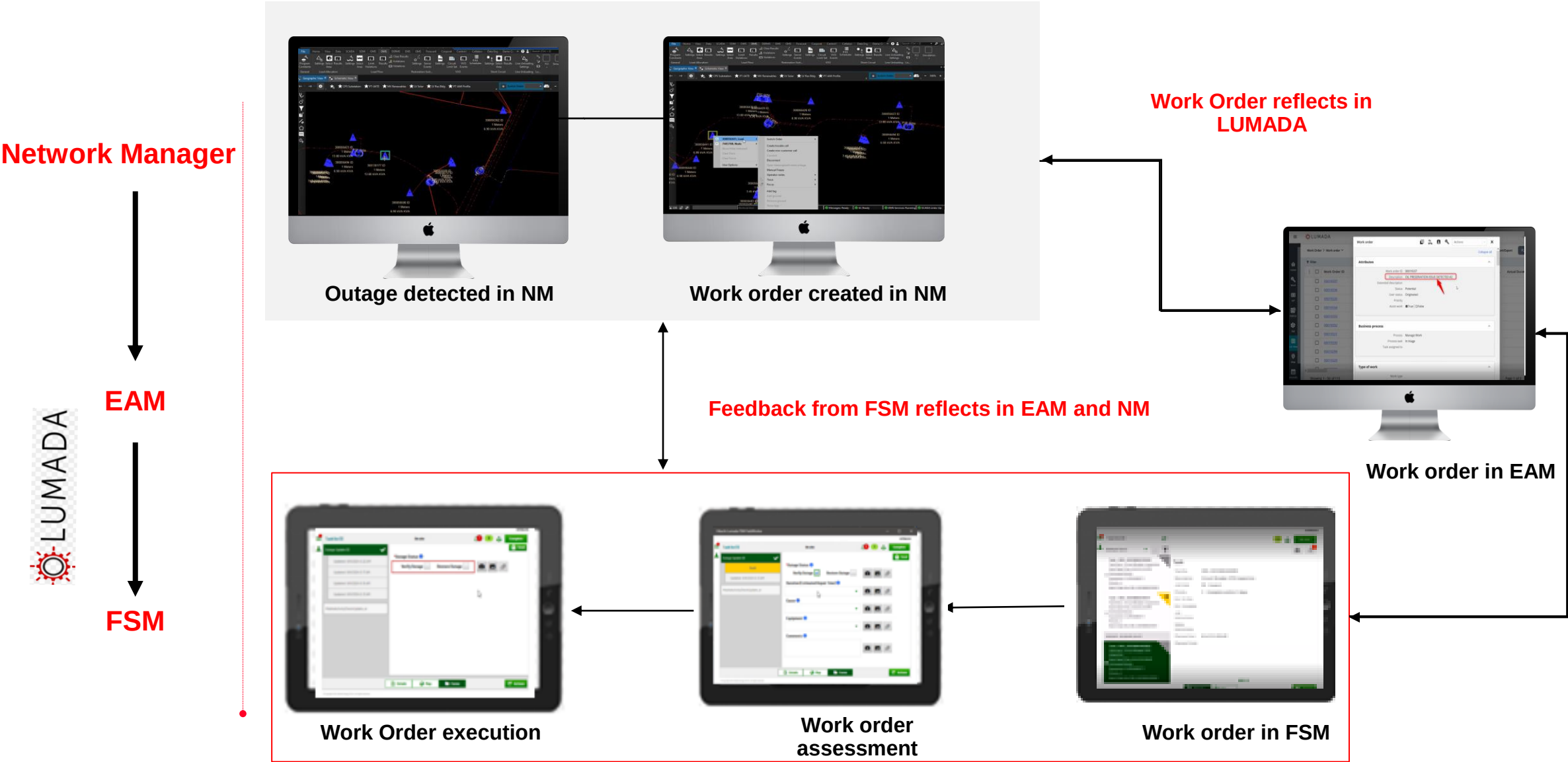
Improved sustainability



Lower operating costs

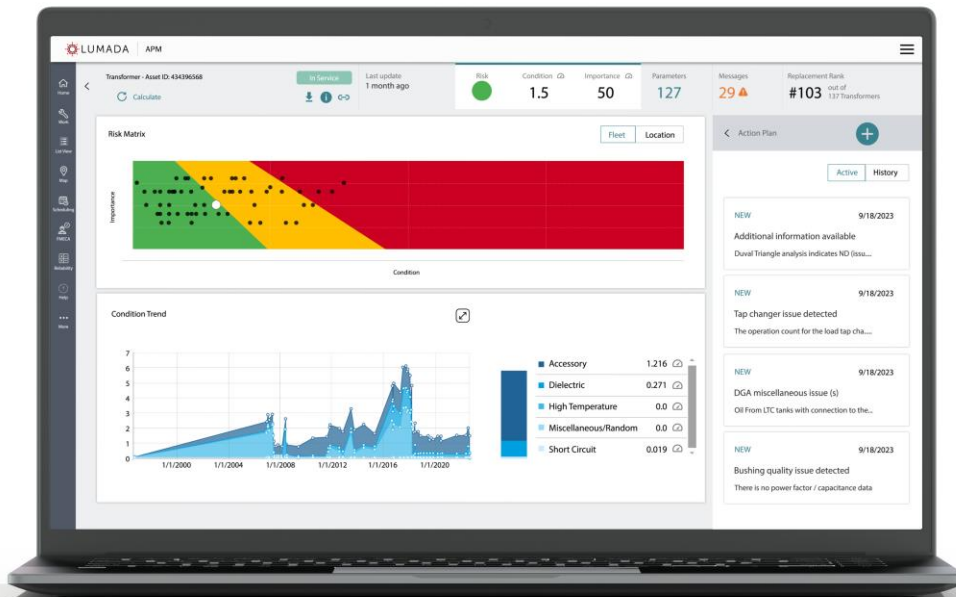
Use Case: Outage Lifecycle management – LUMADA

Network Manager





Visualize **asset condition** through data-driven modeling and prognostics.



Maximize availability

Monitor indicators, model asset degradation

Prevent catastrophic failure

Automated fault analysis via probability of failure (PoF)

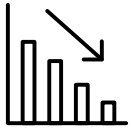
Predictive maintenance

Prescriptive recommendations

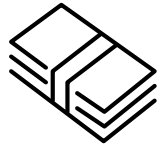
175+ pre-configured models

Industry and manufacturer agnostic

Actual customer savings and operational improvements



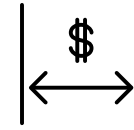
\$14.7M reduction in catastrophic events (avoided asset failure)³



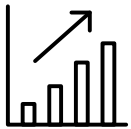
\$1.1M reduction in unplanned outages²



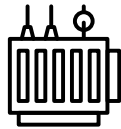
\$2.1M reduction in planned outage costs²



Capex & working capital optimization – **\$1.7M**



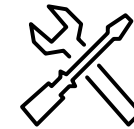
Recuperated costs equaling almost **2x** initial investment¹



15% improvement in asset availability²



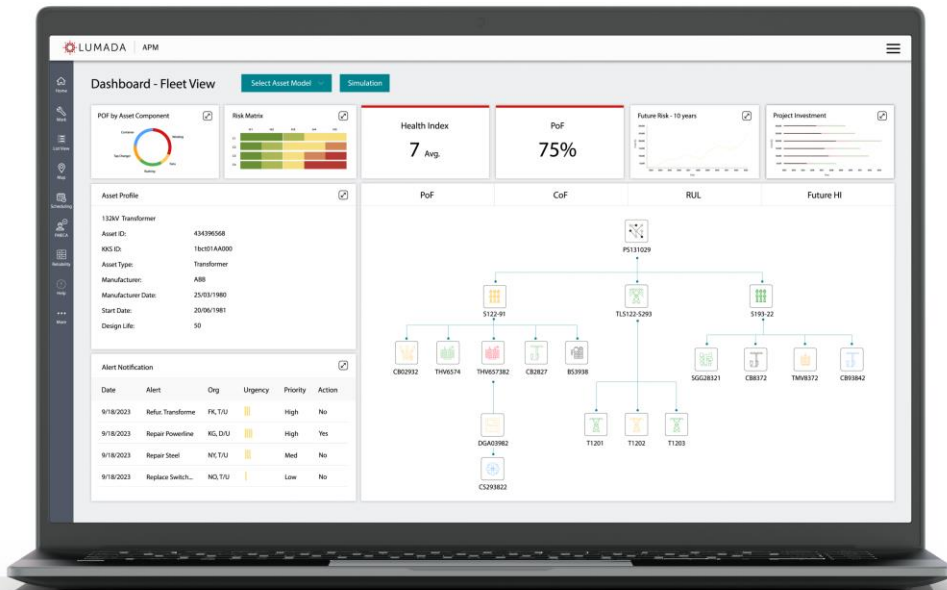
20% improvement in labor productivity²



10% reduction in asset running costs²



Implement **system reliability** engineering methodologies.



Evaluate system and fleet risk
Analyze consequences of potential asset failures

Simulate intervention strategies
Explore trade-offs

Prioritize maintenance spend and actions
Determine asset criticality, create future risk profiles

Failure-mode effects and criticality analysis

Intervention modeling framework



Optimize **portfolio resources** to balance performance, risk and cost.



Model business scenarios with constraints
Analyze with budget, personnel, and time constraints

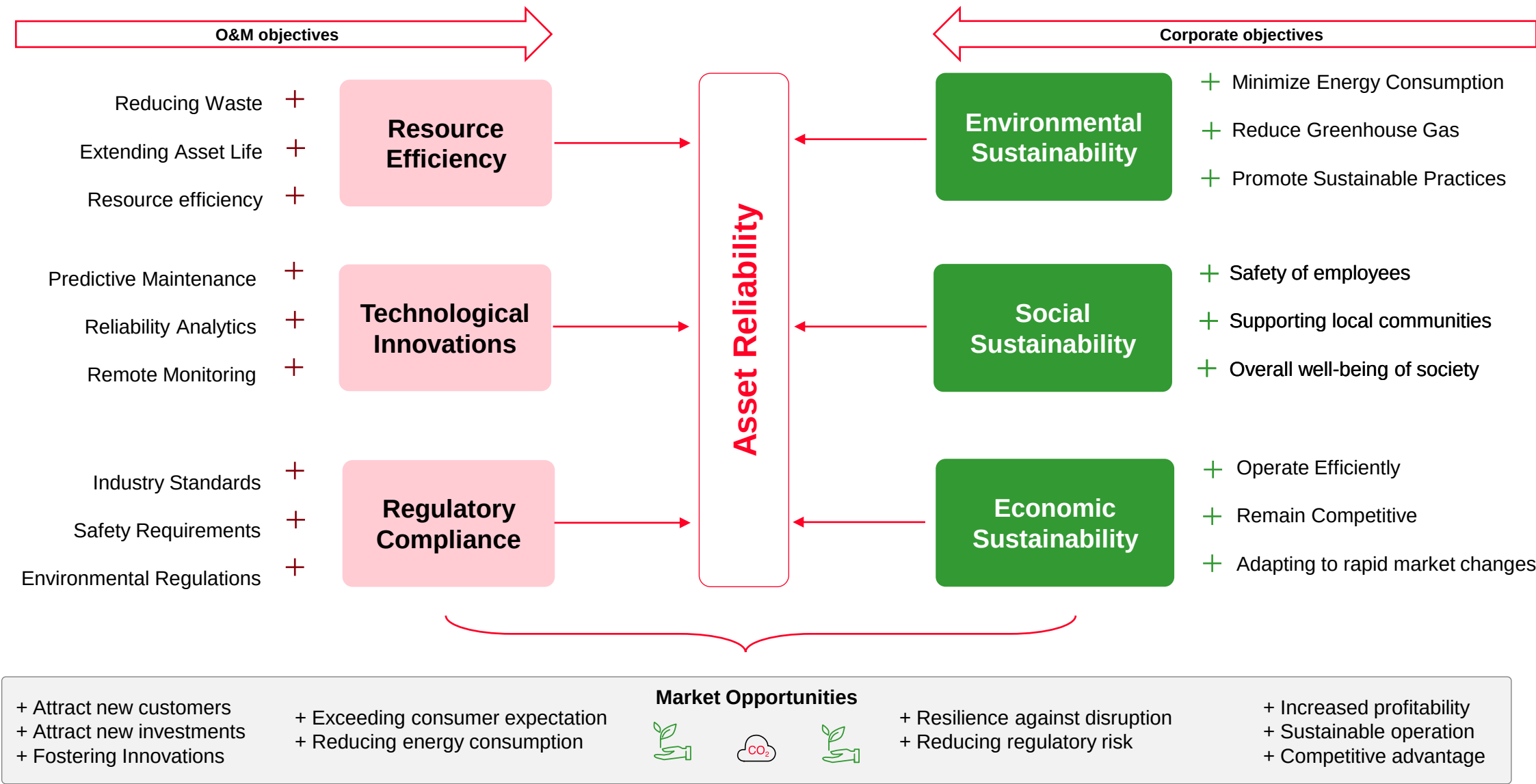
Optimize lifecycle costs
Reduce total cost of asset ownership

Quantify value and ROI
Long-term capital planning

'Maintain, Repair, Replace' decision support

What-if scenario analysis

Advantages of using Lumada APM Reliability and Optimization



APM Reliability & Optimization typical value driven Use Cases

What?



- Optimize OpEx and CapEx investments for parts of their allowed Totex expenditures
- Tap into additional funding sources for energy transition



- Define Ten-year development plan using planned and approved projects
- Generate reports from system identifying project costs and benefits



- Adopt Time based or Condition based Maintenance based on asset criticality and failure modes
- Optimize interventions based on functional hierarchy (bays/ circuits)



- Revise maintenance strategies for aging assets to account for project delays in planned replacements due to supply chain backlog



- Optimize investments in de-carbonization and F-Gas regulation using strategies that optimize based on GHG reduction, Remaining Useful Life and available SF6 free supply constraints



- Reduce development effort to add new expert models by allowing SMEs to author models in APM-Reliability that can be deployed in APM-H

How?

- Reliability Models
- Intervention strategies and scenarios
- Constrained Prioritization

- Reliability Models
- Portfolio scenarios
- Constrained Prioritization
- Project Formulation
- Project Prioritization
- Paginated reports

- Reliability Models
- Scenarios
- Intervention strategies

- Reliability Models
- Approved Projects
- Project Tracking

- GHG based Reliability Models
- Cost models for recycled vs. virgin SF6
- Constrained prioritization

- Configurable Reliability Models
- Export proforma models from APM-R
- Deploy proforma models in APM-H

Working with a large T&D utility company in APAC. World-class **reliability rate of >99.999%**
2,7million customers over a **17.000 km** network.

Unplanned power interruption duration of **1 minute** per year per customer (average three years).

Customer is using our APM Reliability solution to reduce Maintenance cost while maintaining reliability at >99.999%

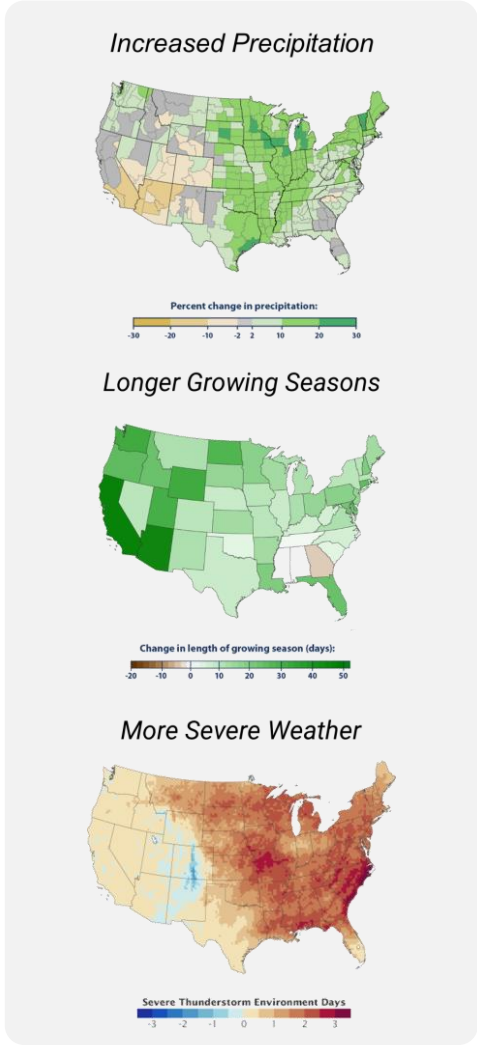
They've included over **150.000 assets** of **70 asset types**.

- Switchgear from 11kV to 400kV
- Transformers from 11kV/0,380kV to 500kV/400kV
- Cables from 0,380kV to 400kV
- OHL from 0,380kV to 400kV

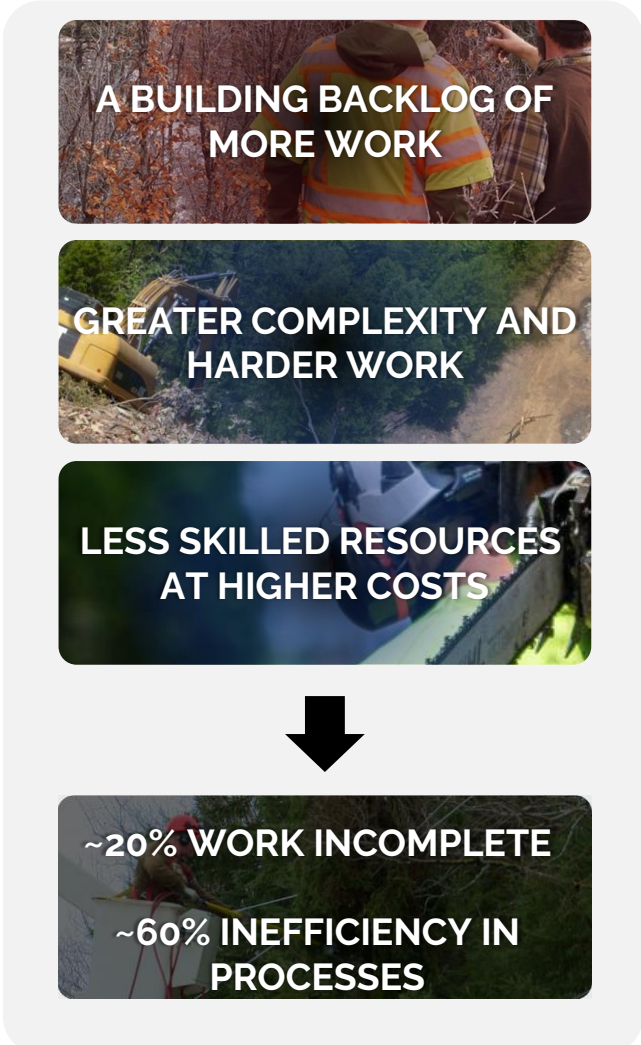
Up to now, they have been able to demonstrate savings of **up to 11 Million Euros** during the first year of operation.

The calculated ROI **<2 years**

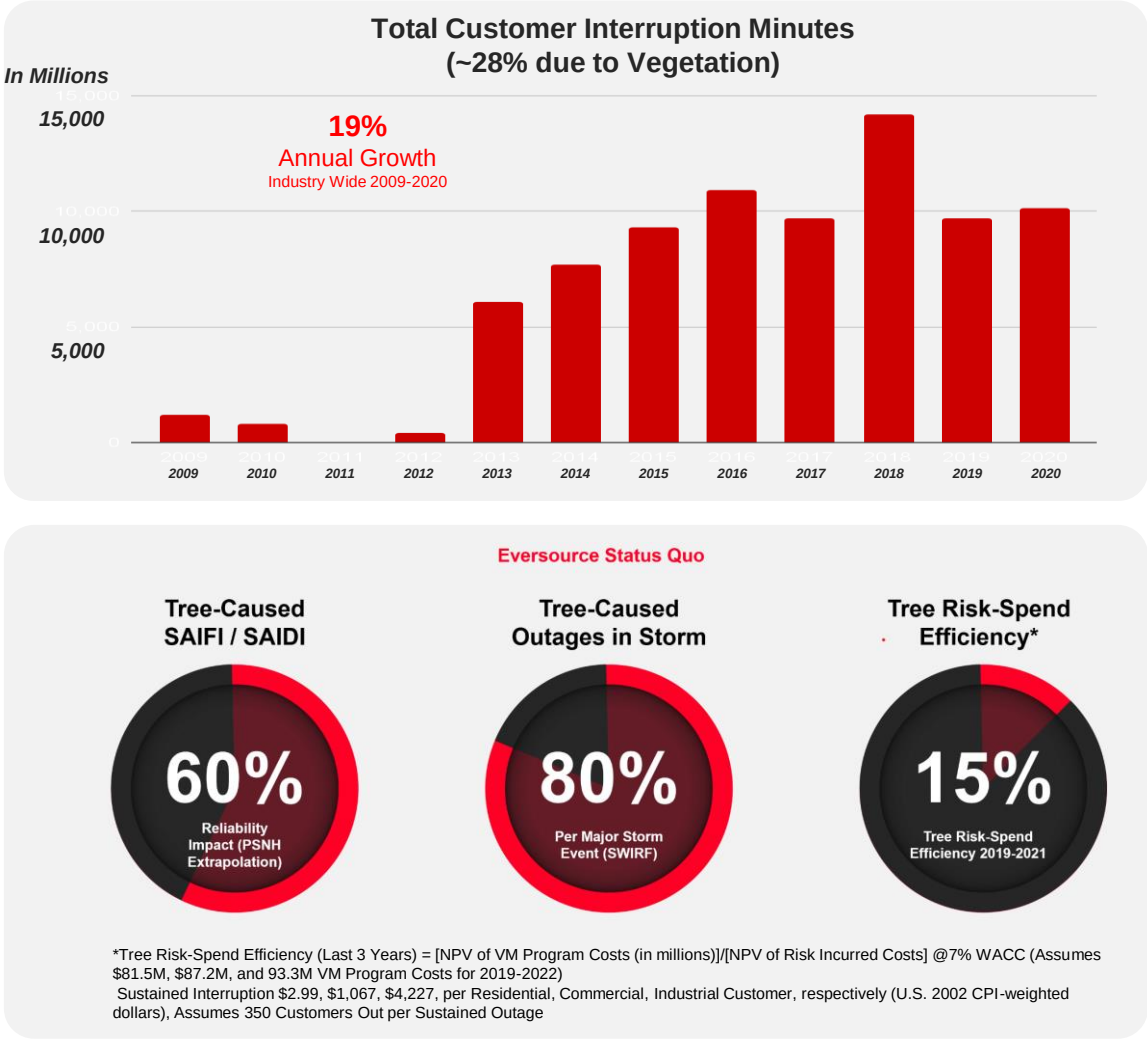
Driving Forces



Challenges



Consequences



Paper-Based

Inspect

1. Travel
2. Takeoff
3. Record
4. Write
5. Land/Park
6. Travel

Plan

7. Playback
8. Document
9. Assess
10. Prioritize
11. Review
12. Compile
13. Assign

Prepare

14. Travel
15. Validate
16. Draw
17. Document
18. Travel
19. DB Entry
20. Scan/Send
21. MVA Review
22. Compile
23. Send

Work

24. Print
25. Travel
26. Deliver
27. Work
28. Sign-Off
29. Travel-crew
30. Travel-office
31. Scan/Send
32. MVA Signoff
33. Admin Steps
34. Send

Audit/Report

35. Travel
36. Audit
37. Review
38. Document
39. Travel
40. DB Close

Artifacts of Paper or Manual Processes

- ❑ Creates safety and reliability issues
- ❑ Easily optimized, replaced, or automated
- ❑ ~ **65%** of all work

Essential Work

- ❑ Not easily automated, optimized or removed
- ❑ Critical to the job
- ❑ ~ **35%** of all work

Paper-less

1. Inspect (From space)

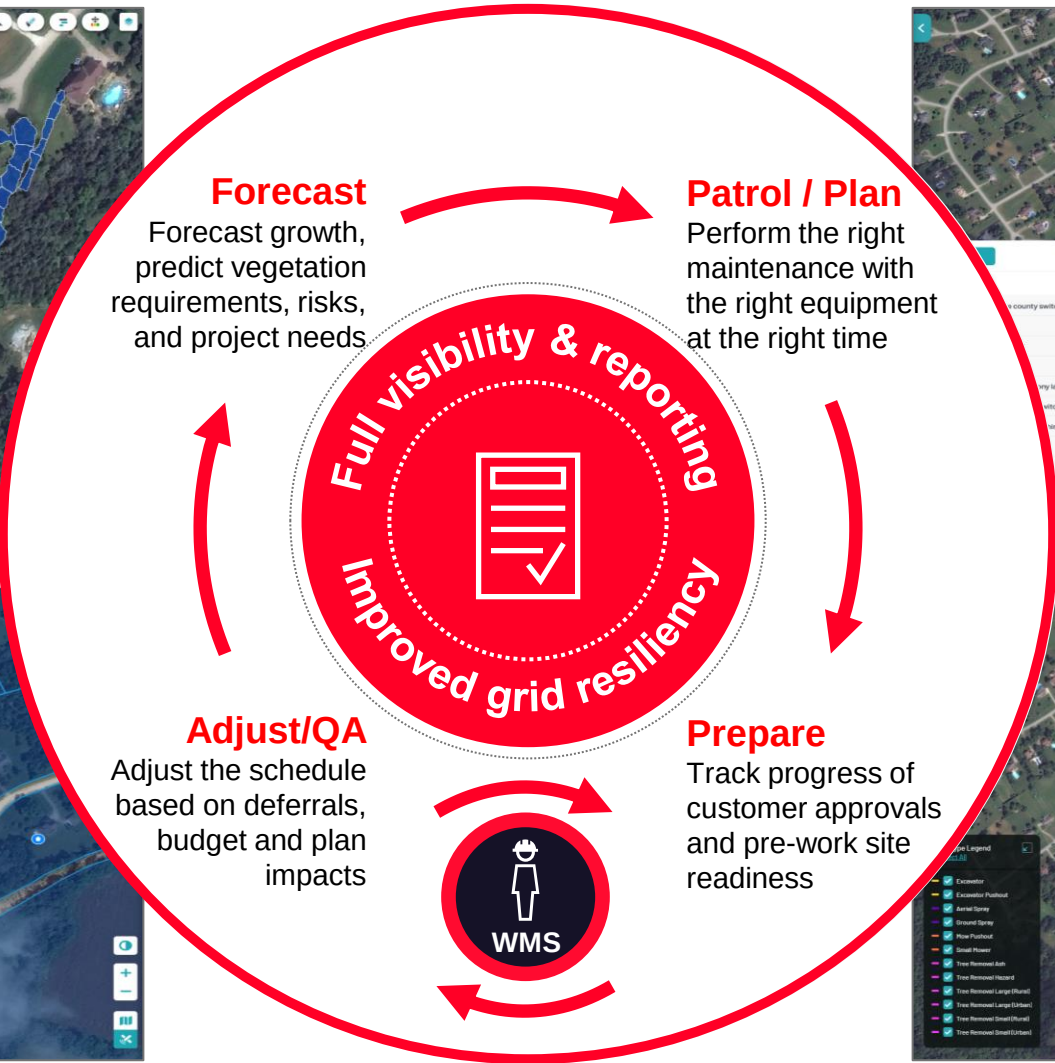
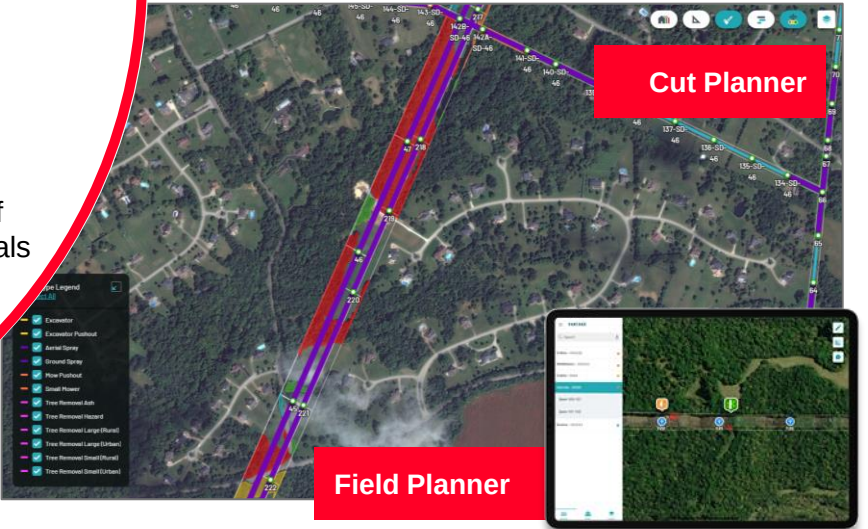
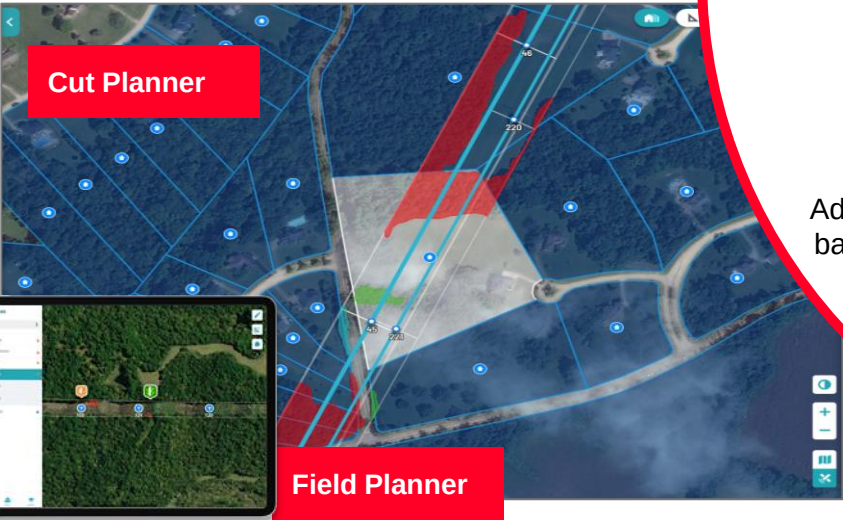
2. Assess
3. Review
- Work & Assignment

4. Travel
5. Validate
6. Edit
7. MVA Review

8. Travel
9. Work
10. Travel
11. Sign-Off

12. Travel
13. Audit
14. Close
15. Report

Vegetation Manager. Enabling full visibility of risk & resiliency measures



40+ Repeatable & Applicable Use Cases



**Detect Off-ROW
Fall-in Risks**



**Changed
Conditions**



**Detect
Blow-in Risk**



**Inspect Poor
Visibility Areas**



**Evaluate Yard-
Tree Conditions**



**Disease & Decay
Detection**



**Work Progress
Tracking**



**Detect
Grow-In Risk**



**Audit
Contractor Work**



**Intervention
Timing**



**Detect
Bird's Nests**



**Asset Map
Correction**



**Sensitive
Customer Locating**



**Capital Plan
Visibility**



**Detect Corridor
Encroachments**



**Easement Rights
Visualization**



**Work Constraints
Visualization**



**Species
Identification**



**Wrk Pkg Mark-Up
& Automation**



**Equipment
Mobility Mapping**

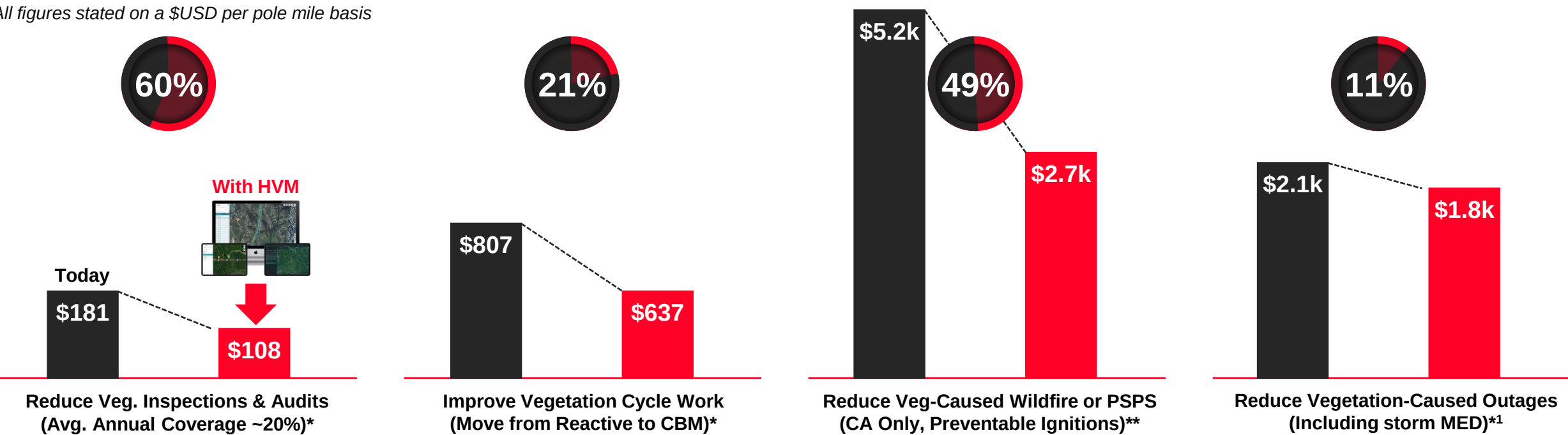


**Wildfire Fuels
Mapping**

Protecting the services on which civilization rests while enabling broad and extensive utility benefits with significant NPV

Following the satellite capture of vegetation, it becomes possible to predict growth at the individual tree level and assess vegetation health. As managers continue the collection journey, HVM continuously improves the accuracy of its trending whereby customers no longer need to follow any type of inspection pattern or cycle as HVM's condition-based prediction is of such accuracy it is precisely known when the asset will reach the customer-defined minimum acceptable risk.

All figures stated on a \$USD per pole mile basis



*: Based on 6.7mm T&D pole miles in the United States **: Based on 170k T&D pole miles in California

Source: Customer Survey, FERC Form-1, EIA-861, CPUC, CalOES 1: Major Event Day as defined by IEEE Standard 1366

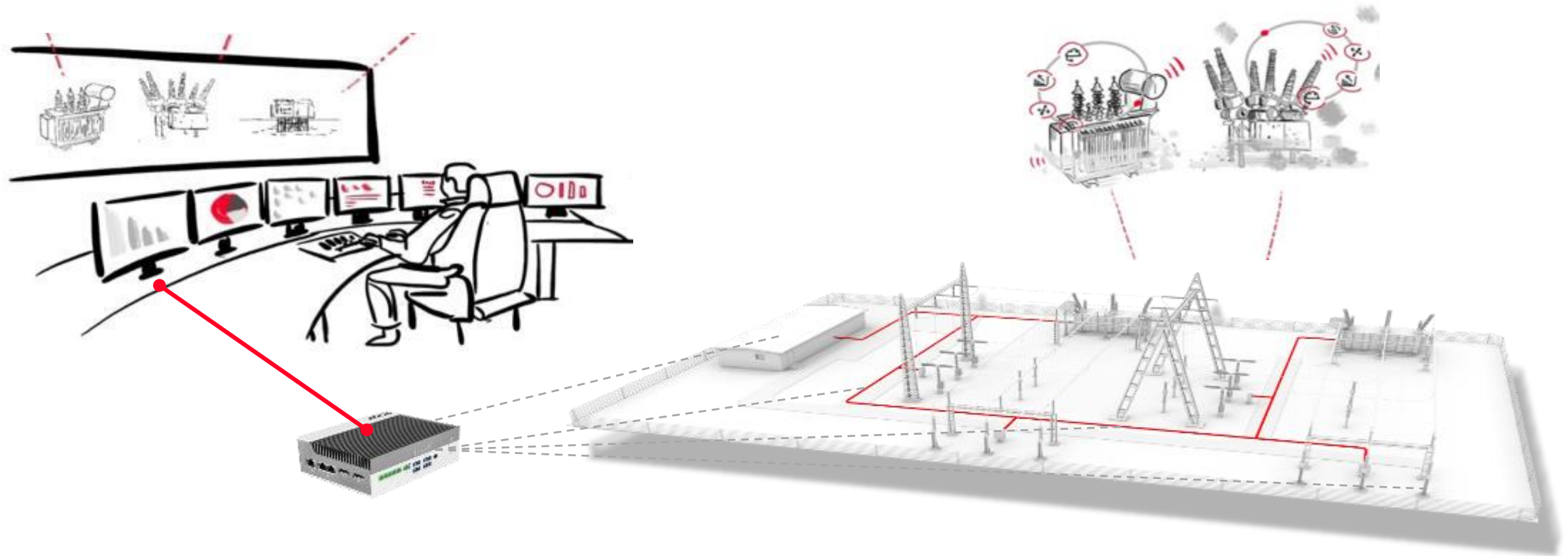
Optimizing resources and mitigating risk advances environmental, social and economic sustainability.

- 01** Decrease energy consumption throughout the lifecycle while minimizing material waste
- 02** Reduce asset carbon emissions and environment incident risk while improving safety
- 03** Enable a paperless, efficient organization in the field with fewer truck rolls, less fuel consumption

“ Asset and maintenance management drives **safe, compliant and sustainable** operations. **”**



Visibility from the asset to the control room, across the entire life cycle



Plan



Build



Operate



Maintain

The energy transition is a challenge bigger than one company

This is a global challenge that spans industries, countries, societies, and companies

Collaboration and co-creation through trusted and sustainable partnerships are key to developing the solutions our world needs

A sustainable energy future for all is one that is inclusive, equitable, and just

We achieve more, together in partnership



Thank you!

Follow us



hitachienergy.com



linkedin.com/company/hitachienergy



facebook.com/hitachienergy.global



instagram.com/hitachienergy



x.com/hitachienergy



youtube.com/c/hitachienergy





HITACHI
Inspire the Next 