A Larsen & Toubro Group Company

LTM



AI Foresight Trends Report

Utilities – 2026



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Decentralized Generation

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- OT Cybersecurity & Compliance

Transactive Grid

- Cognitive CX
- Customer Intelligence & Automation
- Revenue Integrity Intelligence
- Dynamic Demand Pricing
- Smart Energy Advisor

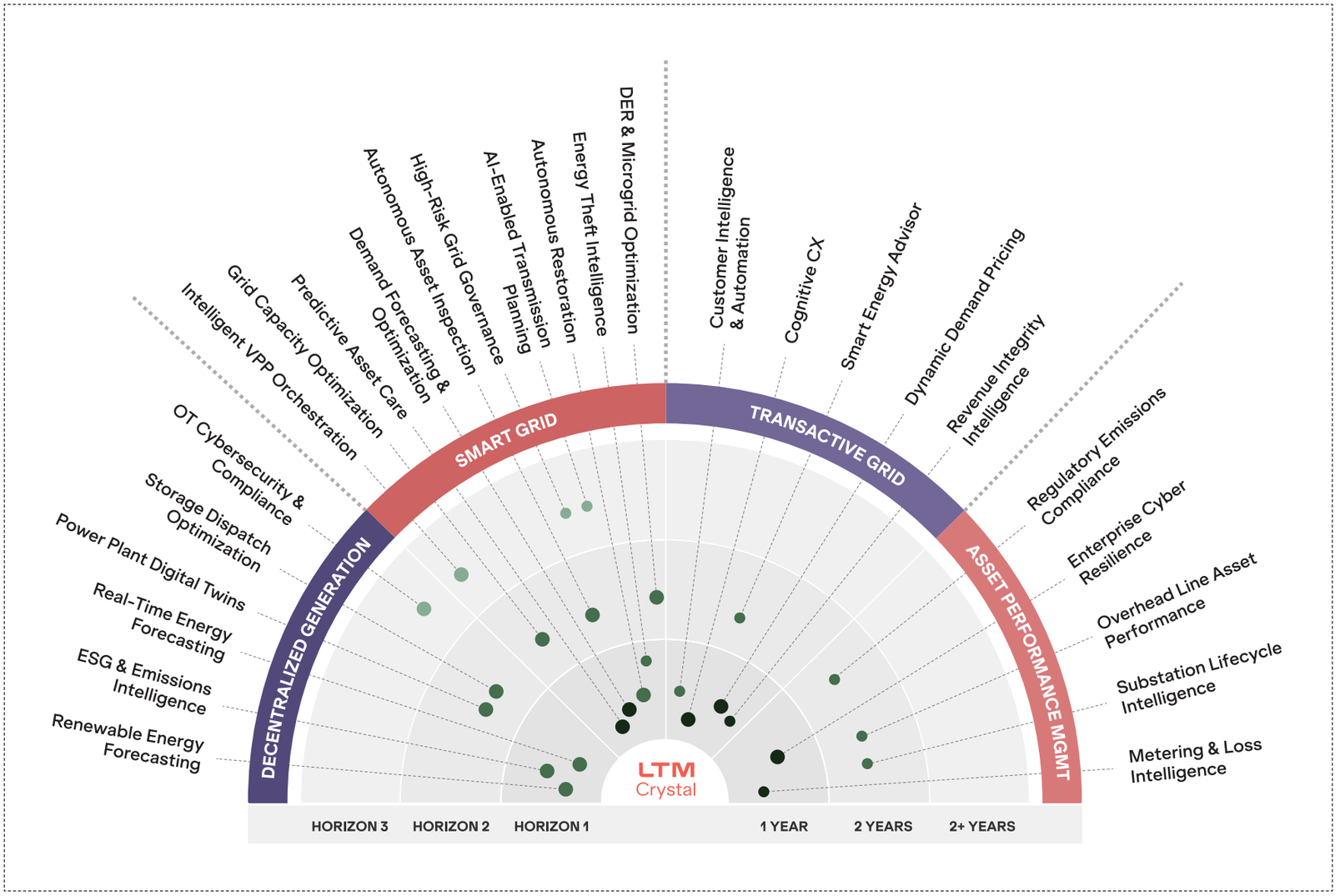
Smart Grid

- Predictive Asset Care
- Demand Forecasting & Optimization
- Autonomous Restoration
- Energy Theft Intelligence
- Grid Capacity Optimization
- Autonomous Asset Inspection
- DER & Microgrid Optimization
- High-Risk Grid Governance
- Intelligent VPP Orchestration
- AI-Enabled Transmission Planning

Asset Performance Management

- Enterprise Cyber Resilience
- Metering & Loss Intelligence
- Substation Lifecycle Intelligence
- Overhead Line Asset Performance
- Regulatory Emissions Compliance

Utilities AI Trends Radar 2026



RATING	ADOPTION PHASE			MARKET POTENTIAL		
	EMERGING	IMPROVING	MATURE	LOW	MEDIUM	HIGH
	HORIZON 1		HORIZON 2		HORIZON 3	

Utilities AI Trends Radar — Rating Scale

HORIZON

HORIZON 1 (0 – 1 YEAR)

Relevant industry players are scaling the trend

HORIZON 2 (1 – 2 YEARS)

Relevant industry players have started incubating the trend to assess the potential, risk implications, and benefits

HORIZON 3 (2 – 2+ YEARS)

Emerging trends in research with potential for transformational change

MARKET POTENTIAL

LOW

Market potential indicates the expected revenue opportunity from the technology trend

MEDIUM

Market potential indicates the expected revenue opportunity from the technology trend

HIGH

Market potential indicates the expected revenue opportunity from the technology trend

ADOPTION PHASE

EMERGING

Trend is at its initial stages of adoption, with innovators and early adopters exploring its potential

IMPROVING

Adoption is increasing, and it has proven to have the potential to improve efficiency and effectiveness

MATURE

The trend has achieved widespread acceptance and usage among the general population or targeted audience

01

HORIZON 1

Renewable Energy Forecasting

Overview

AI-driven renewable energy forecasting applies Machine Learning (ML) to weather and historical generation data to deliver highly accurate solar and wind predictions. These insights stabilize grids, optimize storage, lower operational costs, and enhance energy trading by anticipating fluctuations. By better aligning supply with demand, it strengthens grid reliability, reduces dependence on non-renewables, and increases the financial value of renewable assets.

Highlights

AI-driven renewable energy forecasting is vital to manage the variability of wind and solar power. By analyzing weather, historical output, and IoT-generated data, it delivers highly accurate generation and demand predictions. This improves grid stability, optimizes storage, reduces fossil-fuel dependence, lowers operational costs, and enhances market decisions. AI identifies patterns too complex for human analysis, enabling proactive grid management and efficient resource allocation. It also resolves the 'store vs. sell' challenge by forecasting peak demand and future production, allowing batteries to charge and discharge at optimal times, ultimately improving overall energy system efficiency.

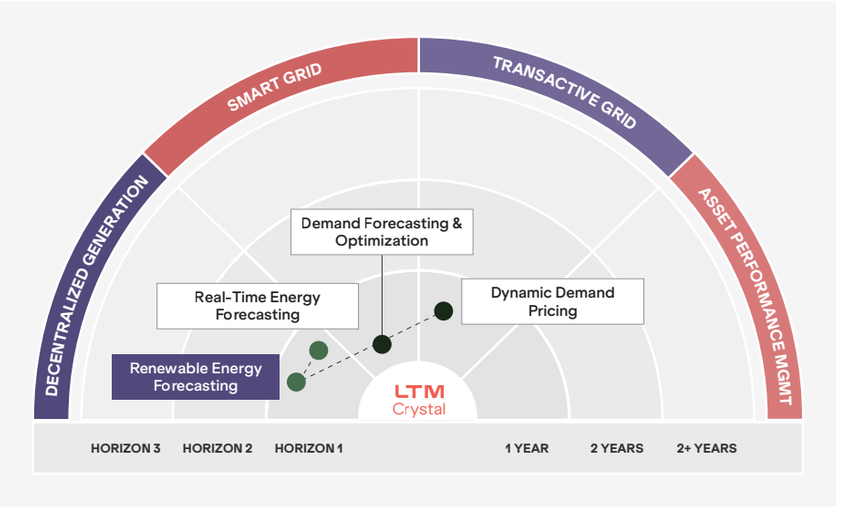
Key Technologies

Machine Learning: Analyzes weather and grid patterns, refining forecasts with new data.

Internet of Thinking: Real-time sensors capture weather and turbine performance data.

Edge Computing: Provides scalable processing to support advanced AI forecasting models.

Digital Twins: AI-driven digital models test and predict system behavior safely.



HORIZON 1	ADOPTION PHASE	MARKET POTENTIAL
	IMPROVING	HIGH

Featured Story

An American utility major needed to revamp its processes and systems to forecast load and distributed energy resource (DER) growth. LTM modernized internal workflows through multiple coordinated tracks. The initiative delivered significant benefits, including USD 6.5 million annual margin gains, 40% effort reduction, and savings of 350,000 labor hours per year.

Key Takeaway

AI is expected to transform renewable energy by turning uncertainty into precise solar and wind forecasts, enabling a future where efficiency, reliability, and profitability strengthen the sector's growth.

02 HORIZON 1

ESG & Emissions Intelligence

Overview

AI-driven systems are reshaping emissions management by replacing periodic, manual reporting with proactive, real-time oversight. Using ML, IoT sensors, and Predictive Emission Monitoring Systems (PEMS), power generators can automate data gathering, enhance accuracy, and detect anomalies early. This leads to maintaining transparent and compliant Environmental, Social, and Governance (ESG) reporting, thereby transforming environmental performance into a continuous, strategic operational function.

Highlights

AI-driven emissions monitoring and ESG reporting enable power generators to shift from slow, manual, retrospective disclosures to real-time, accurate, and actionable sustainability intelligence. As stringent regulations and data-heavy frameworks like Corporate Sustainability Reporting Directive (CSRD) and Task Force on Climate-related Financial Disclosures (TCFD) become standard, AI eliminates inefficiencies in data collection, compliance, and operational optimization. It strengthens ESG scoring, supports better capital allocation, and enhances transparency. With rising expectations for accountability, organizations must ensure AI systems remain auditable, transparent, and ethically governed. This would empower sustainability leaders, stakeholders, and regulators in progressing toward carbon-neutral, high-integrity operations.

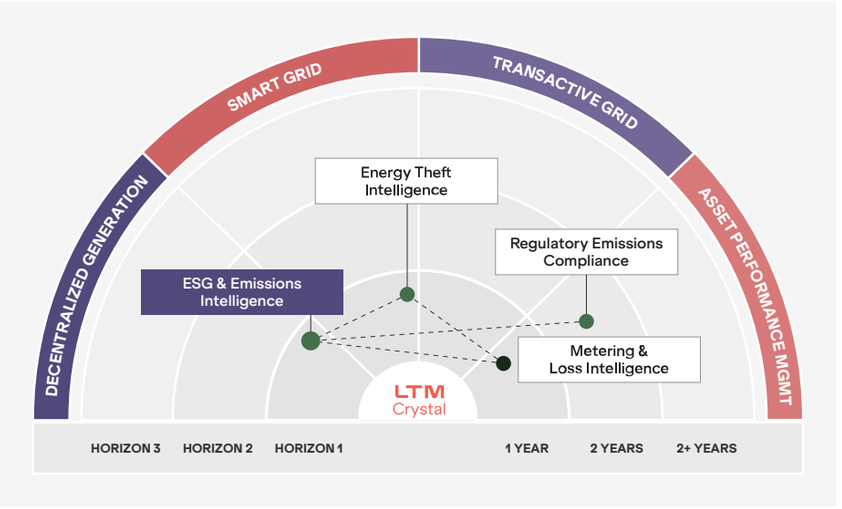
Key Technologies

Internet of Thinking: Smart sensors capture real-time emissions and energy data.

Machine Learning: Forecasts emissions, energy demand, and potential equipment failures.

Digital Twins: Simulate scenarios to optimize operations and predict emissions.

Computer Vision: Analyzes drone and satellite visuals to detect emissions.



HORIZON 1	ADOPTION PHASE	MARKET POTENTIAL
	IMPROVING	HIGH

Featured Story

A Canadian oil and gas company struggled with manual, time-consuming monitoring of flaring, water use, and air emissions for National Pollutant Release Inventory (NPRI) and partner compliance. LTM implemented AI-driven automated data entry, real-time alerts, bulk uploads, and detailed reporting through Enterprise Sustainability Management (ESM). The solution improved accuracy, reduced manual effort, ensured QA/QC compliance, and minimized non-compliance risks.

Key Takeaway

AI is expected to evolve ESG into autonomous, real-time intelligence layers, streamlining compliance and amplifying impact. Organizations that pair AI with human governance will lead in transparency and sustainability performance.

03 HORIZON 1

Real-Time Energy Forecasting

Overview

AI-driven load forecasting uses ML, deep learning, and IoT data to analyze complex real-time grid conditions. By accurately predicting demand spikes and renewable generation (compared to traditional methods), it enables smarter resource allocation, lowers operational costs, and supports higher, more stable integration of renewable energy sources. Forecast accuracy is crucial to reduce costs and ensure grid reliability.

Highlights

Traditional statistical methods such as Autoregressive Integrated Moving Average (ARIMA) struggle to handle complex, non-linear, and high-frequency data, leading to errors in forecasting. AI overcomes these limitations, adapts to evolving datasets, and delivers accurate predictions. Renewable sources like wind and solar add further complexity due to their intermittent, weather-driven nature. ML and deep learning (DL) models analyze vast, non-stationary datasets such as satellite imagery and real-time weather to deliver significantly accurate forecasts. Providing higher accuracy, AI reduces grid imbalance, operational costs, and enables a self-healing power grid.

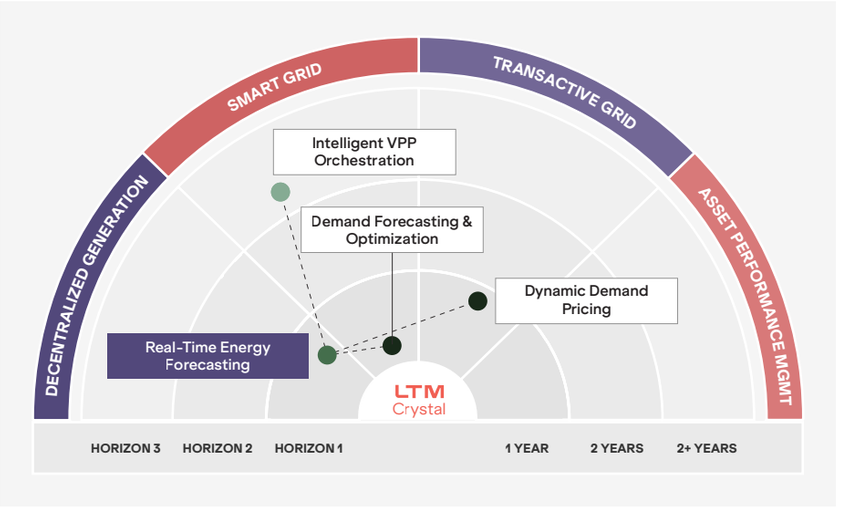
Key Technologies

Generative AI: Improves load forecasting using complex data for precise real-time predictions.

Machine Learning: Analyzes historical consumption, weather, and time data to predict future electricity demand.

Adaptive AI: Continuously recalibrates forecasts as load behavior and grid conditions change.

Edge AI: Runs localized forecasting at substations/feeders to prevent overload and latency issues.



HORIZON 1	ADOPTION PHASE	MARKET POTENTIAL
	IMPROVING	HIGH

Featured Story

An Indian power distributor faced costly errors from inaccurate forecasts and lacked centralized, area-wise control. LTM built an Artificial Neural Network (ANN)-based model using factors like heat index, rainfall, seasonality, and national/international holidays. This improved forecasting accuracy by 97%. Additionally, a 10% accuracy gain in load forecasting generated roughly USD 1 million in additional monthly revenue.

Key Takeaway

AI is expected to transform load generation forecasting by turning uncertainty into predictive precision. Moreover, it optimizes solar and wind forecasting, and enables scalable, efficient, and resilient clean-energy systems, critical for long-term decarbonization.

04

HORIZON 2

Power Plant Digital Twins

Overview

Digital twins use real-time IoT and AI data to create virtual models of power plants across thermal, solar, and wind assets. They mirror plant operations, predict failures, run 'what-if' simulations, and optimize performance in a risk-free environment. This reduces downtime, cuts costs, enhances grid stability, and drives proactive, data-driven power generation.

Highlights

Traditional reactive or schedule-based maintenance often leads to 'fixing what isn't broken' or failing to catch catastrophic faults. Digital twins use AI to analyze vibration, temperature, and pressure data to predict failures weeks in advance, reducing unplanned downtime by 20 – 50% and extending asset life by up to 25%. Digital twins also enable predictive maintenance, real-time monitoring, simulation-driven optimization, and renewable integration. This enables power plants to shift from reactive to proactive operations, reduce failures, cut downtime, lower costs, and manage complex grid demands efficiently.

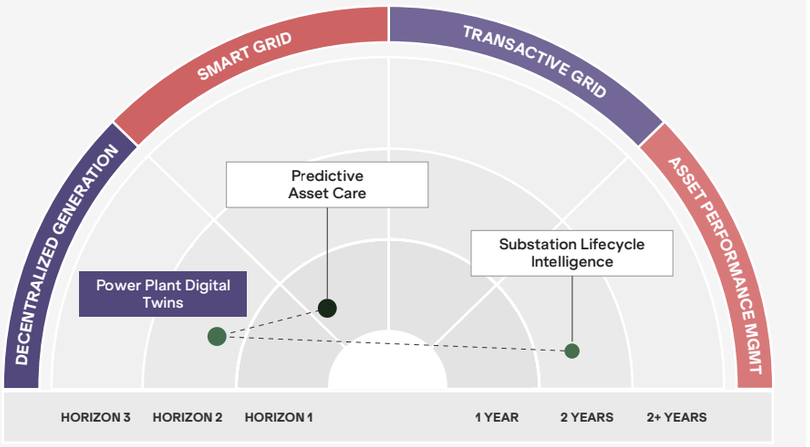
Key Technologies

Digital Twins: Real-time virtual replicas enable predictive, efficient, proactive, and optimized operations.

Internet of Thinking: Sensors capture real-time turbine and boiler data to power digital twins.

Edge Computing: Scalable infrastructure accelerates large-scale data processing for low-latency AI decisions.

Machine Learning: AI models detect anomalies and predict equipment degradation using deep learning.



HORIZON 2	ADOPTION PHASE	MARKET POTENTIAL
	IMPROVING	HIGH

Featured Story

A gas turbine plant deployed a digital twin powered by real-time sensor data to forecast equipment failures accurately. This virtual model enabled proactive maintenance decisions, preventing breakdowns before they occurred. As a result, the plant achieved a 20% reduction in unplanned downtime and significantly lowered maintenance costs, strengthening operational reliability and efficiency.

Key Takeaway

Digital twins are expected to evolve into autonomous, self-optimizing intelligence layers that transform power plants into adaptive, high-reliability systems. They could drive predictive efficiency, real-time resilience, and next-generation operational mastery.

05

HORIZON 2

Storage Dispatch Optimization

Overview

AI-integrated energy storage & dispatch optimization uses advanced ML and automation to intelligently control battery and Energy Storage System (ESS) operations, balancing charge/discharge cycles, forecasting demand/supply, and maximizing system efficiency. Its subtle differentiation lies in autonomous decisioning adapted to real-time grid conditions and market prices, enabling utilities to integrate variable renewables with minimal human oversight and enhanced economic knowledge.

Highlights

This trend addresses core utility challenges such as renewable intermittency, grid instability, and escalating peak demand by optimizing storage utilization and dispatch timing through predictive analytics and reinforcement learning. AI enhances forecasting accuracy for generation, load, and market prices, aligning storage operations with demand patterns to reduce curtailment and increase profitability. Adoption is driven by digital grid modernization, regulatory pressure for decarbonization, and utility focus on operational cost reduction. Benefits include improved grid resilience, extended battery life through intelligent state-of-health management, and enhanced participation in ancillary markets. Compliance considerations revolve around data privacy and interoperability with legacy systems, while limitations include data quality dependency and computational complexity.

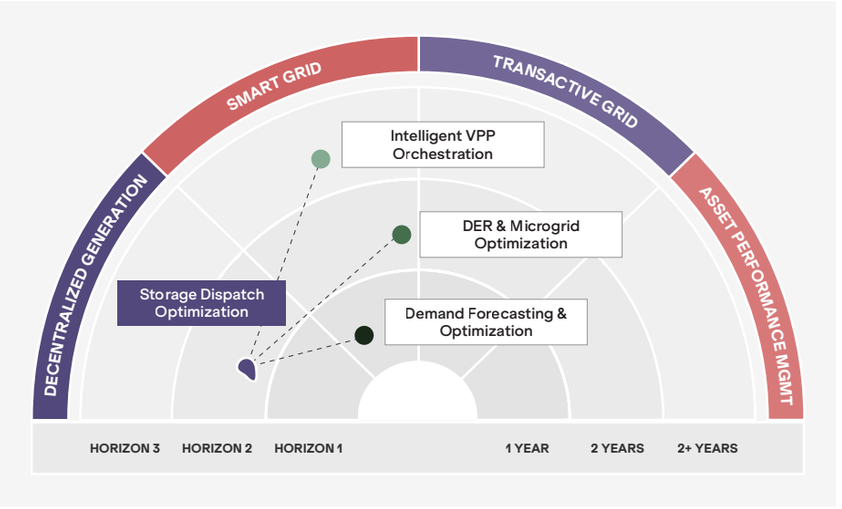
Key Technologies

Deep Learning: Predicts demand and generation patterns for optimal dispatch.

Reinforcement Learning: Learns optimal charge/discharge policies through data-driven reward feedback.

Real-Time Edge Analytics: Processes local sensor data instantly to adapt dispatch decisions.

Gen AI Predictive Models: Simulate realistic storage behavior under variable renewables for robust planning.



HORIZON 2	ADOPTION PHASE	MARKET POTENTIAL
	IMPROVING	HIGH

Featured Story

AI-enabled energy storage transformed grid operations in South Australia, where a 100MW – 400MWh system used real-time ML to optimize charge – discharge decisions based on solar variability and market signals. This improved system efficiency by ~15% and cut energy losses by ~10%. The solution also supported a record ~99.6% renewable-energy supply, showcasing how AI-driven storage unlocked resilient, flexible, future-ready grids.

Key Takeaway

AI-driven dispatch optimization is pivotal, unlocking flexible grid operations and revenue streams while ensuring investments in high-quality data infrastructure, explainable AI, and real-time edge analytics.

06

HORIZON 3

OT Cybersecurity & Compliance

Overview

AI-driven operational technology (OT) cybersecurity and compliance integrates AI into security frameworks to detect, analyze, and respond to threats across utility control systems. Its subtle differentiator is real-time, behavior-based anomaly detection tailored to utilities' Supervisory Control and Data Acquisition (SCADA) and Industrial Control Systems (ICS) environments, improving threat response and compliance with evolving standards such as NERC CIP and IEC 62443 — while reducing false positives in complex OT networks.

Highlights

This trend directly addresses utilities' growing OT attack surface, driven by grid digitization, smart substations, and DER integration, by applying AI for continuous monitoring, threat prediction, and automated response. AI models analyze massive OT telemetry to identify anomalous control commands or lateral movements that traditional rule-based systems miss, strengthening grid reliability and operational continuity. According to Gartner, by 2027, nearly 40% of power and utilities will deploy AI-driven control-room operators, reducing human error while increasing cyber-physical security vulnerabilities. Benefits include enhanced visibility across IT/OT, faster incident response, and compliance automation, while risks involve talent shortages, legacy system integration challenges, and evolving threat sophistication.

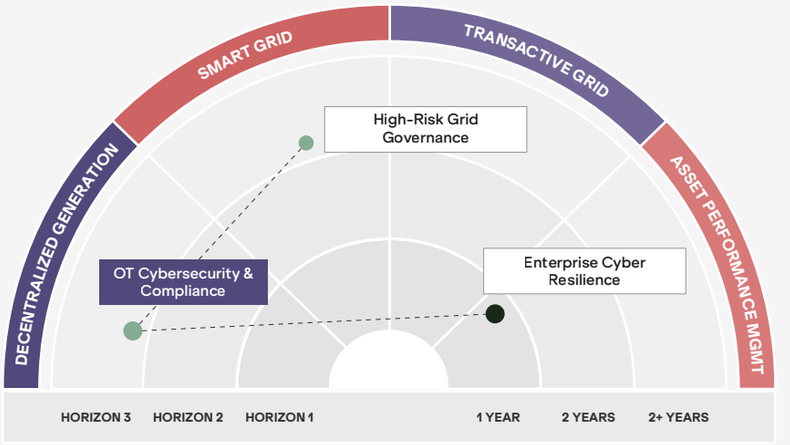
Key Technologies

Behavior-Based Anomaly Detection: Learns normal OT patterns to detect unknown cyber threats.

Machine Learning Threat Intelligence: Correlates OT events to predict and prioritize attacks.

AI-Driven Security Orchestration (SOAR): Automates incident response and compliance workflows across OT.

Deep Learning Network Traffic Analysis: Identifies malicious OT communications beyond rule-based detection.



HORIZON 3	ADOPTION PHASE	MARKET POTENTIAL
	EMERGING	HIGH

Featured Story

A leading utility provider faced critical OT blind spots, compliance pressure, and concerns over hidden cyber risks. A comprehensive, low-disruption program delivered safe asset discovery, threat hunting, architecture redesign, and system hardening aligned with IEC62443 and NIST CSF. The initiative established accurate OT visibility, reduced latent exposure, strengthened governance, and shifted the organization from reactive security to predictable resilience.

Key Takeaway

AI-enabled OT cybersecurity and compliance will be essential for utility resilience, demanding investments in AI threat analytics, workforce upskilling, and integrated IT/OT defense frameworks to counter sophisticated adversaries and regulatory burdens.

01

HORIZON 1

Predictive Asset Care

Overview

Predictive maintenance uses AI, condition data, and digital monitoring to anticipate failures in transmission-grid assets such as high-voltage transformers, circuit breakers, and lines. It enhances grid resilience by continuously analyzing sensor, weather, and operational patterns to detect anomalies early. Transmission networks benefit from AI's ability to interpret complex multi-source datasets, improving foresight for equipment stress, environmental exposure, and evolving loading conditions.

Highlights

Predictive maintenance is reshaping transmission operations by improving how utilities understand and act on asset degradation. By combining indicators such as dissolved gas trends, thermal behavior, partial discharge activity, and breaker timing with weather, vegetation exposure, grid topology and loading context, operators gain a clearer view of where outage risks are forming. This supports more accurate prioritization of field work. Key factors influencing adoption include the need for higher reliability, aging fleets, environmental stress, and cost efficiency. Challenges include varied asset vintages, uneven sensor availability, integration with Geographic Information System (GIS) and Outage Management System (OMS), and ensuring conservative, safe interpretation of predictive alerts.

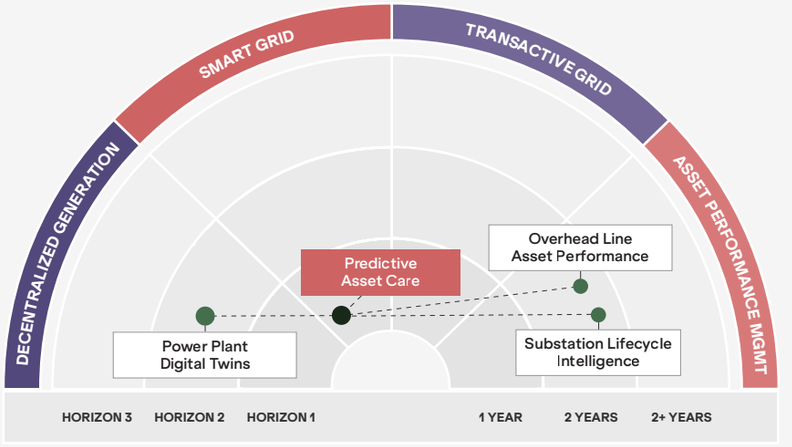
Key Technologies

Sensor Tech: Ensures AI-driven asset health through sensors.

Digital Twins: Simulation for grid-asset degradation.

Industry Cloud Platforms: Reliability data hubs integrating SCADA/AMI/GIS/weather patterns.

Edge AI: Real-time anomaly detection for transformers/ breakers.



HORIZON 1	ADOPTION PHASE	MARKET POTENTIAL
	MATURE	HIGH

Featured Story

LTM implemented a predictive maintenance and Remaining Useful Life (RUL) approach for heavy industrial equipment using autoencoder-based anomaly detection and generative AI to overcome sparse failure data. The solution ingested IIoT sensor streams, generated synthetic fault instances to strengthen model training, and delivered early warnings that prevented a catastrophic breakdown. This cross-domain case demonstrates how to address data scarcity, operationalize anomaly alerts, and estimate RUL, providing a transferable pattern for transmission-asset programs where rare failures and heterogeneous sensors are common.

Key Takeaway

Predictive maintenance delivers strong reliability benefits when condition and environmental data are combined and translated into safe, actionable plans. Early focus on transformers and breakers, supported by disciplined data quality and coordinated field execution, offers the fastest and most consistent operational gains.

02

HORIZON 1

Demand Forecasting & Optimization

Overview

Load forecasting and demand management leverage AI, advanced analytics, and highly-granular consumption data to predict electricity demand and actively shape load patterns across distribution networks. By combining smart meter data, weather signals, and DER insights, utilities improve grid planning, prevent overloads, and dynamically balance supply and demand in increasingly electrified, decentralized systems.

Highlights

Rapid electrification, electric vehicle uptake, and DER are fundamentally reshaping how demand behaves at the distribution edge. Traditional, static forecasting methods struggle with this volatility, often leading to local congestion, inefficient asset utilization, and reactive grid operations. AI-driven load forecasting transforms demand from an uncertainty into a controllable variable by combining Whigh-resolution smart meter data, weather intelligence, and behavioral patterns. When paired with demand management programs such as dynamic pricing, demand response, and DER orchestration, utilities can proactively load management in near real-time, defer infrastructure upgrades, and operate distribution networks with higher flexibility, resilience, and cost efficiency.

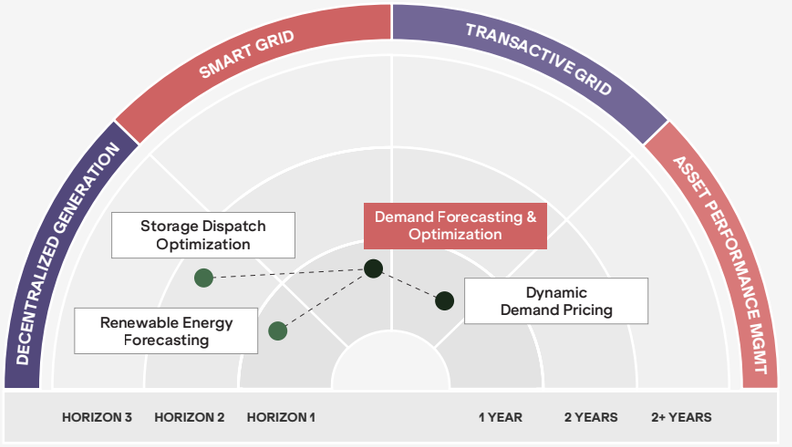
Key Technologies

Adaptive AI: Continuously recalibrates forecasts as demand behavior and grid conditions evolve.

Edge AI: Executes localized forecasting for substations or feeders to prevent overloads.

Decision Intelligence: Converts forecasts into actionable demand, shaping network balancing decisions.

Digital Twins of Distribution Networks: Simulate load scenarios to test demand response and capacity constraints.



HORIZON 1	ADOPTION PHASE	MARKET POTENTIAL
	MATURE	HIGH

Featured Story

A US-based utility needed better short-term load forecasting and demand management as renewables and DERs increased. They integrated AI-powered weather forecasting, demand-response analytics, SCADA/PCS, and planned Advanced Distribution Management System (ADMS) operations to optimize dispatch and shape the load. The program improved renewable integration and enabled targeted demand response to reduce peaks and congestion on distribution feeders.

Key Takeaway

AI-driven load forecasting and demand management is redefining how distribution utilities operate, shifting from reactive capacity planning to predictive, adaptive grid control. Today, it helps utilities anticipate peaks, optimize assets, and engage consumers, while tomorrow, it will autonomously coordinate DERs, electric vehicles, and flexible loads in real-time, enabling grids that self-balance demand, delay costly upgrades, and remain resilient in an increasingly electrified future.

03

HORIZON 1

Autonomous Restoration

Overview

Fault detection and automated restoration (FDAR) uses AI, grid analytics, and real-time sensing to rapidly identify, isolate, and restore faults across electricity distribution networks. By combining Advanced Metering Infrastructure (AMI), SCADA, and advanced outage analytics, distribution companies can reduce outage duration, improve reliability indices, and enable self-healing grids capable of responding to complex, decentralized operating conditions.

Highlights

As distribution grids evolve with a higher penetration of renewables, electric vehicles, and distributed assets, fault behavior is becoming less predictable and harder to isolate manually. Traditional protection schemes struggle with complex, bidirectional power flows and delayed fault localization. AI-enabled fault detection combines feeder sensors, AMI signals, and event analytics to interpret fault signatures in real-time. Automated restoration logic dynamically reconfigures the network by coordinating switches and reclosers, reducing dependency on human intervention. This shift enables utilities to operate distribution networks that respond autonomously to failures while maintaining stability under rapidly changing grid conditions.

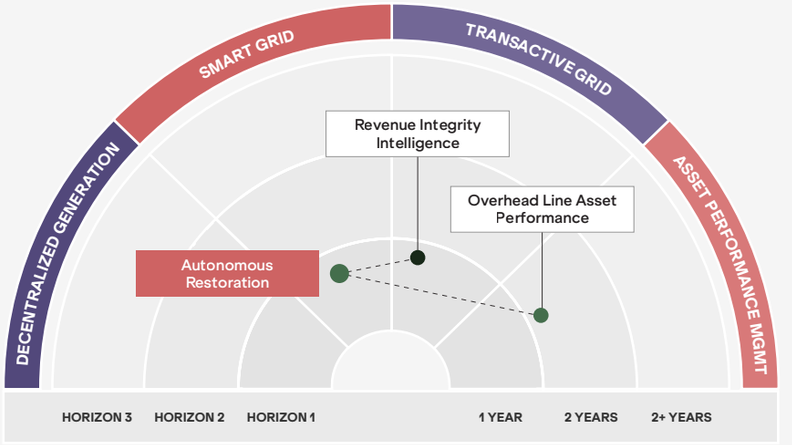
Key Technologies

Edge AI: Detects faults locally and triggers sub-second isolation/reconfiguration

Agentic AI: Plans safe switching sequences and executes coordinated restoration actions.

Adaptive AI: Learns evolving fault patterns from DER/EV bidirectional power flows.

Computer Vision: Identifies visible equipment faults to corroborate electrical fault signatures



HORIZON 1	ADOPTION PHASE	MARKET POTENTIAL
	IMPROVING	HIGH

Featured Story

To increase reliability and speed, an Australian energy corporation deployed Advanced Distribution Management System (ADMS) features including Outage Management Systems, Advanced Metering Infrastructure integration, AI-driven switching, and mobility. The rollout delivered record reliability and helped achieve maximum performance incentives through faster, targeted restorations and operational efficiency gains.

Key Takeaway

FDAR is advancing distribution grids toward self-healing operations. By combining AI-driven fault analytics with automated switching and real-time edge intelligence, utilities can respond autonomously to failures in increasingly complex networks. This capability reduces reliance on manual interventions and positions distribution operators to manage DER-rich, dynamic grids with greater resilience and control.

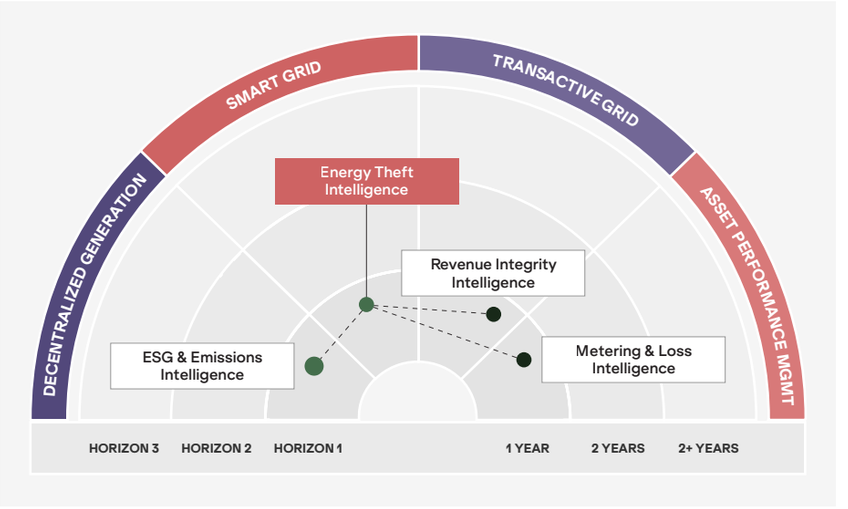
04

HORIZON 1

Energy Theft Intelligence

Overview

Energy theft and losses undermine grid stability and drain billions from distribution utilities. AI-driven analytics, smart meter data, and real-time anomaly detection enable distributors to identify fraudulent consumption with higher accuracy, reduce revenue leakage, and strengthen grid reliability, turning loss prevention into a strategic capability for modern, intelligent distribution networks



HORIZON 1	ADOPTION PHASE	MARKET POTENTIAL
	IMPROVING	MEDIUM

Highlights

Electricity distributors are battling rising non-technical losses as theft techniques are becoming more sophisticated and harder to detect through manual audits. AI-powered systems now analyze smart meter data, load curves, and feeder-level anomalies to uncover patterns that would otherwise remain invisible. ML distinguishes genuine faults from fraudulent activity, reducing false positives and enabling targeted field inspections. Beyond revenue protection, this intelligence improves grid stability, prevents dangerous illegal connections, and supports regulatory mandates for transparency. With theft costing billions annually, AI-driven loss prevention is becoming essential for modern, resilient distribution networks.

Key Technologies

Machine Learning: Analyzes consumption patterns to distinguish faults from theft with higher accuracy.

Edge AI: Enables instant anomaly detection and alerts at the feeder or transformer level without relying solely on cloud connectivity.

Sensor Technology: Supports real-time monitoring of meter health, feeder loads, and tamper events across distributed networks.

Digital Twins: Simulate expected load behavior and identify deviations caused by unauthorized consumption.

Featured Story

A US-based distribution utility facing rising nontechnical losses and frequent meter tampering adopted AI-driven predictive maintenance analytics to analyze smart meter and feeder-level data. The system detected irregular consumption patterns in real-time, reduced false theft alerts, and guided targeted field inspections, cutting investigative costs and improving grid efficiency while significantly strengthening theft detection accuracy.

Key Takeaway

AI-driven theft detection is becoming essential for modern distribution utilities. By combining smart meter intelligence, predictive analytics, and real-time anomaly detection, utilities can significantly reduce energy losses, prevent unsafe illegal connections, and strengthen grid reliability. These capabilities turn loss prevention from a reactive challenge into a strategic, data-powered advantage.

05

HORIZON 2

Grid Capacity Optimization

Overview

AI-driven Dynamic Line Rating (DLR) and real-time grid optimization use environmental, conductor, and operational data combined with ML to continuously calculate the true capacity of transmission assets. Its subtle differentiator is adaptive optimization, unlike static limits, it predicts conductor limits under varying weather and load conditions, unlocking latent capacity for renewable integration and reducing congestion. Adoption accelerates as grids digitize and demand flexible, data-centric operations.

Highlights

The trend directly tackles grid constraints from rising renewables, electrification, and aging infrastructure by replacing static line ratings with real-time ampacity derived from AI-augmented analytics. Utilities can safely increase throughput when conditions allow, deferring costly upgrades and integrating more wind/solar into the grid. DLR adoption drives digital grid modernization, regulatory encouragement for better capacity utilization, and urgency to optimize existing assets without expanding the footprint. AI and ML significantly enhance DLR forecasts by calibrating weather data with local sensor history, achieving 97 – 98% confidence for up to four-hour horizons, while allowing Transmission System Operators (TSOs) to tune confidence levels based on operational risk policies. Integration with EMS/SCADA systems enables automated dispatch adjustments and operational decisioning. Challenges include accurate forecasting, data latency, and conservative safety margins.

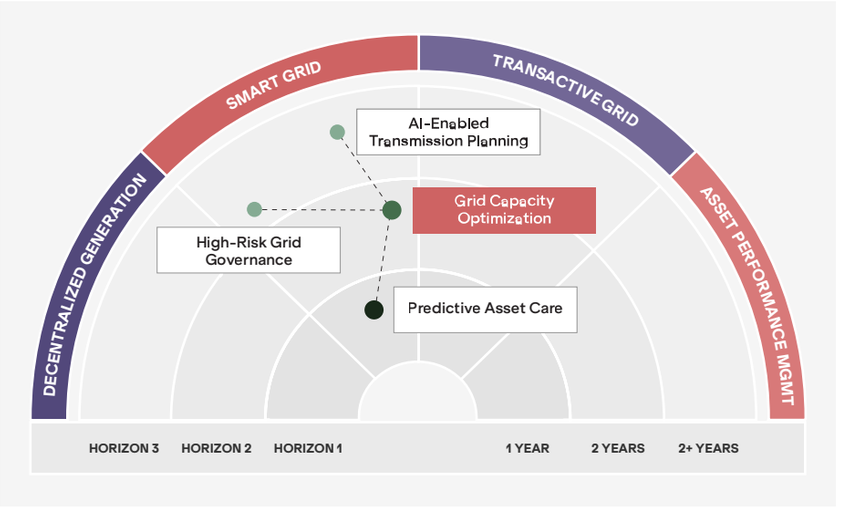
Key Technologies

AI Forecasting Models: Predict weather and conductor behavior for dynamic ampacity.

Real-Time Data Fusion AI: Combines sensor and weather data for precise ratings.

Digital Twin Analytics: Virtual grid model for proactive line optimization.

ML Congestion Prediction: Forecasts grid bottlenecks for real-time relief.



HORIZON 2	ADOPTION PHASE	MARKET POTENTIAL
	IMPROVING	HIGH

Featured Story

A US-based electric generation and transmission company deployed a DLR system on a 230 kV transmission corridor, integrating AI-augmented analytics to increase usable capacity and minimize congestion without new infrastructure. Following installation, the solution reported significant transmission capacity gains and operational savings, allowing better utilization of existing assets while supporting ongoing transmission expansion projects.

Key Takeaway

AI driven DLR is the fastest way to unlock hidden transmission headroom through risk tuned ampacity and automated EMS/SCADA dispatch. Demand aware optimization reduces congestion and curtailment while accelerating renewable integration without costly grid build out.

06

HORIZON 2

Autonomous Asset Inspection

Overview

Autonomous aerial asset inspection refers to using automated drones, remote flight operations, and AI-driven analytics to capture condition data for high voltage transmission assets. Utilities are deploying these systems to inspect towers, conductors, insulators, transformers, and substation equipment with increased frequency and reduced physical exposure. Beyond Visual Line of Sight (BVLOS)-enabled platforms, cloud-based processing, and AI-assisted defect detection enhance consistency and support condition monitoring in complex transmission environments, including substations and long overhead corridors.

Highlights

This trend addresses reliability challenges by increasing inspection frequency and reducing dependence on manual climbing, helicopter patrols, and weather-limited access. It strengthens Operations & Maintenance (O&M) planning by standardizing data capture across towers, conductors, and substation equipment. Drivers include BVLOS-enabled platforms, the need for higher quality thermal and visual data, and the shift toward condition-based maintenance. Utilities benefit through faster data availability and reduced exposure to hazardous environments. Challenges include GPS instability, electromagnetic interference near energized equipment, regulatory constraints, data management complexity, and the need for training large datasets for AI detection models.

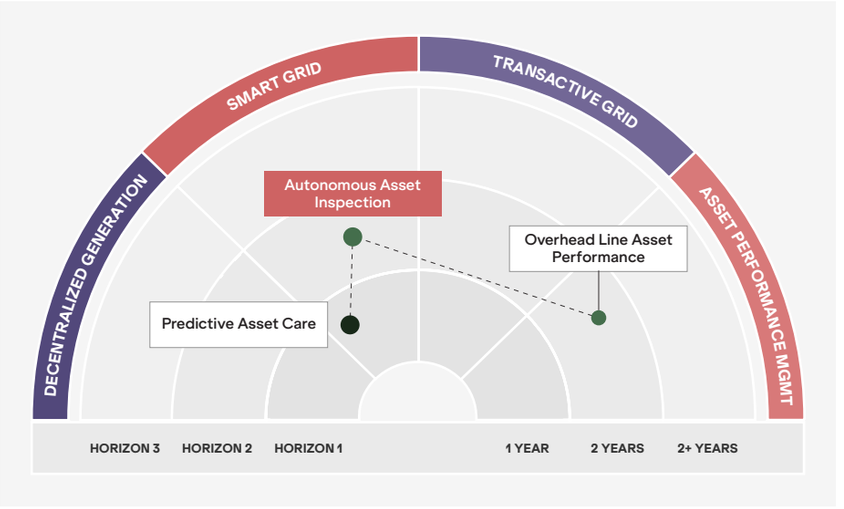
Key Technologies

Sensor Tech: BVLOS autonomous drones for remote transmission asset inspection.

Computer Vision: Thermal, and Red, Green, Blue (RGB) imaging for substation condition surveys.

Digital Twins: Light Detection and Ranging (LiDAR) and photogrammetry for tower and conductor modelling.

Machine Learning: Analytics for defect detection and asset health insights.



HORIZON 2	ADOPTION PHASE	MARKET POTENTIAL
	IMPROVING	HIGH

Featured Story

A British multinational electricity and gas utility company adopted centralized autonomous inspections, where drones operate BVLOS near live transmission infrastructure to capture high resolution data for maintenance planning. This transition followed a four-year innovation program and enables remote oversight while reducing reliance on climbing and helicopter patrols. The system supports condition assessments for towers and conductors across the transmission network in England and Wales.

Key Takeaway

Transmission utilities should prioritize BVLOS readiness, structured data capture programs, and AI model training grounded in diverse thermal and visual datasets. Near term gains arise from automating routine tower and substation inspections, improving data consistency, and accelerating asset health assessments.

07

HORIZON 2

DER & Microgrid Optimization

Overview

Distributed Energy Resource (DER) integration involves coordinating decentralized power sources like solar, wind, and batteries into localized microgrids that operate independently or with the main grid. A subtle differentiator in 2026 is the transition from manual backup to AI-driven autonomous load-balancing, enabling remote industrial sites to maintain power resilience without human intervention.

Highlights

The utilities industry leverages microgrids to address rising energy costs, grid congestion, and reliability challenges across remote communities, critical infrastructure, and urban edge networks. By integrating hybrid renewable systems such as solar, wind, and battery storage, utilities reduce carbon emissions while improving resilience against fuel price volatility and grid disruptions. The global microgrid market is expected to grow as decarbonization mandates and grid modernization initiatives accelerate. Key benefits include lower operating costs through optimized energy management and reduced transmission losses. However, adoption faces challenges such as high upfront capital investment for storage, complex interconnection and regulatory requirements, and increasing cyber security risks associated with distributed and digitally connected energy assets.

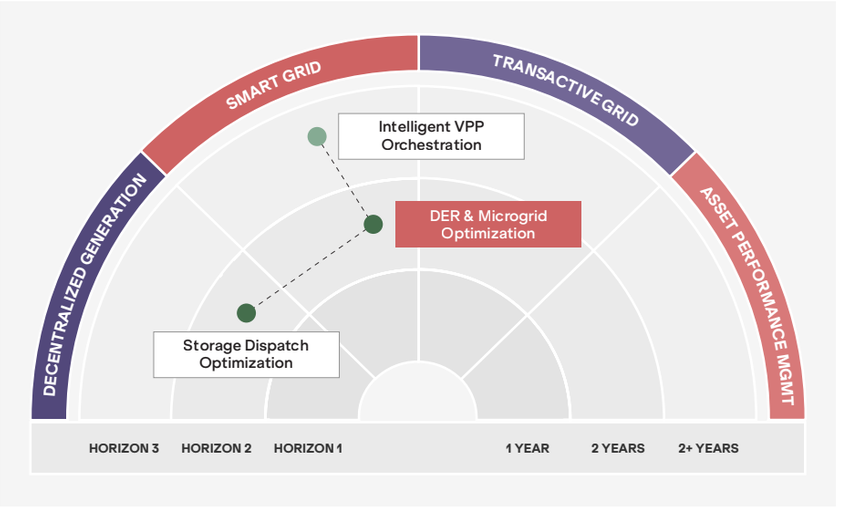
Key Technologies

Distributed Ledger Technology (DLT): Secures transparent energy transactions, enabling multiparty microgrid and VPP coordination.

Sensor Technology: Provides real-time grid visibility, improving stability and microgrid optimization.

Agentic AI: Autonomous agents coordinate DERs, balancing supply and demand and optimizing grid operations.

Edge AI: Local low latency intelligence enables faster control for grid operations



HORIZON 2	ADOPTION PHASE	MARKET POTENTIAL
	IMPROVING	HIGH

Featured Story

The Larsen and Toubro (L&T) group has implemented decentralized energy solutions globally. This includes a microgrid for an energy and power generation company in India, which enhances energy access and reliability. L&T also developed the 700 MW Ar Rass Solar PV IPP (Independent Power Producer) in Saudi Arabia and a hybrid energy management system for a clean energy producer in California.

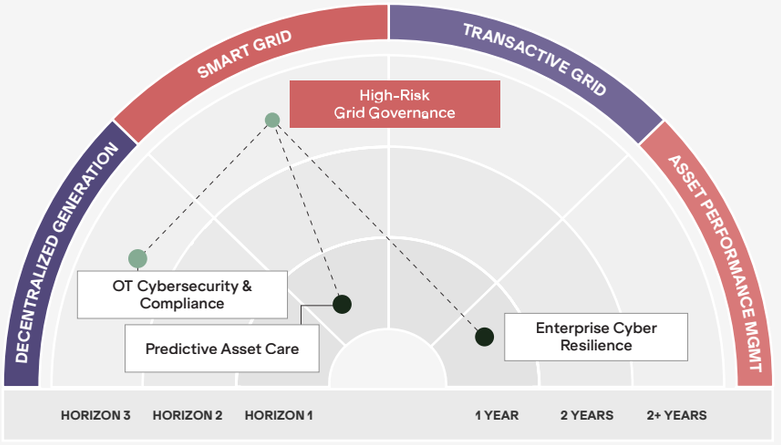
Key Takeaway

DER integration will emerge as a strategic imperative for utilities to meet decarbonization targets, improve grid resilience, and manage rising demand from electrification. The market will increasingly shift towards Energy-as-a-Service (EaaS) model, enabling utilities to deploy and scale microgrids, storage, and renewable assets without bearing high upfront capital investments.

08 HORIZON 3
High-Risk Grid Governance

Overview

AI governance and explainability ensures safe, auditable use of AI in high-risk transmission control (EMS/SCADA, protection, stability tools). Utilities need model risk management, transparency, continuous monitoring, and cybersecure operations so that operators and regulators can trust AI decisions that affect system stability, restoration, and markets, aligning the practice with evolving sector guidance and policy expectations.



HORIZON 3	ADOPTION PHASE	MARKET POTENTIAL
	EMERGING	MEDIUM

Highlights

AI is increasingly used in transmission operations to support forecasting, stability analysis, and grid control decisions. Considering these systems directly affect grid reliability and safety, utilities must ensure AI behaves predictably and responsibly. Governance and explainability help operators understand why AI recommends a control action, verifies and aligns with grid rules, and intervenes when needed. Clear accountability, human oversight, and auditability are becoming essential as AI moves closer to real-time and high-impact grid operations, especially under regulatory and cybersecurity scrutiny.

Key Technologies

Explainable AI (XAI): Ensures operators and engineers can understand operational, safety, & risk mitigation recommendations.

AI TRiSM: Defines rules for safe, ethical, and compliant use of AI systems.

Decision Intelligence: Combines AI outputs with grid rules to recommend safe actions.

Agentic AI: Coordinates multi-step checks, escalations, and human approvals before execution.

Featured Story

At the National Renewable Energy Laboratory, a team from the Department of Energy introduced eGridGPT, an AI agent for decision support, that acts as a virtual assistant in a transmission control room. By weaving in strict grid procedures, digital twins, human approvals, and transparent logs, they earned operator trust and set a new standard for safe, explainable AI in power system operations.

Key Takeaway

In transmission networks, AI must be trustworthy before it can be powerful. Strong governance and clear explainability ensure operators understand why AI makes recommendations and stays in control of critical actions. With proper oversight, security, and transparency, AI can safely support today's grid operations and gradually enable more autonomy without risking reliability or trust.

09

HORIZON 3
Intelligent VPP Orchestration

Overview

Virtual power plant (VPP) orchestration is a cloud-based system that links decentralized energy sources such as industrial solar, wind, and batteries into a single, coordinated network. The primary evolution in 2026 is bidirectional market participation, allowing assets to switch from being passive consumers to active traders that sell surplus energy and grid-balancing services back to the wholesale market for profit.

Highlights

VPP orchestration enables utilities to manage rising energy demand, renewable variability, and grid congestion while maintaining cost efficiency and reliability. By aggregating distributed energy resources such as rooftop solar, batteries, EVs, and flexible loads, utilities can transform customer-side assets and community microgrids into dispatchable, grid-responsive resources. This enables energy arbitrage by absorbing low-cost renewable generation during off-peak periods and exporting stored power during peak demand, reducing system costs by up to 20%. However, adoption remains constrained by fragmented regulatory frameworks, interoperability challenges between legacy grid infrastructure and cloud-based VPP platforms, and escalating cybersecurity risks as distributed assets gain real-time grid and market connectivity.

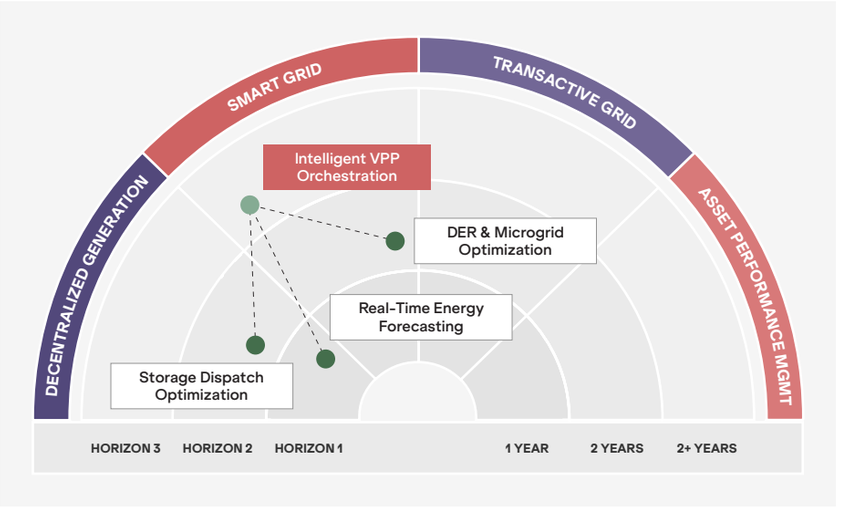
Key Technologies

Super Platforms: Unify diverse energy assets into integrated marketplaces, enabling dynamic participation models.

Connected Enterprise: Links distributed systems, enabling coordinated energy orchestration across virtual power networks.

Decision Intelligence: AI-enhanced decision models improve distributed energy trading and market responsiveness.

Decentralized AI: Federated intelligence enables secure collaborative optimization across diverse energy assets.



HORIZON 3	ADOPTION PHASE	MARKET POTENTIAL
	EMERGING	HIGH

Featured Story

LTM's VPP project modernized a major US utility's grid, using AWS Step Functions, Lambda, and Snowflake for efficient data orchestration, validation, and workflow automation, cutting costs by over USD 3.2 million annually. By integrating DERs and enabling real-time monitoring, the VPP enhanced grid stability, reduced reliance on manual processes, and improved operational efficiency, paving the way for increased renewable integration and significant savings.

Key Takeaway

VPP orchestration transforms Distributed Energy Resources (DER) into dispatchable assets such as EVs and batteries that utilities can control on demand. This allows utilities to slash capital expenditures by deferring costly infrastructure upgrades while unlocking new revenue through flexibility markets.

10

HORIZON 3

AI-Enabled Transmission Planning

Overview

Gen AI for transmission planning refers to the use of advanced AI models that synthesize data, generate scenarios, and support decision-making for high-voltage grid expansion, asset modeling, and operational studies. It enhances model fidelity, accelerates planning workflows, and improves situational awareness by integrating heterogeneous datasets. Research from National Renewable Energy Laboratory (NREL) shows that Gen AI can support mapping between operational and planning models and aid grid operators in interpreting complex system data.

Highlights

Transmission planners face fragmented models, increasing renewable variability, and long study cycles. Gen AI strengthens planning by synthesizing missing network data, enabling rapid scenario generation, and improving alignment between real-time operational models and offline planning cases. Gen AI also improves transmission network model accuracy and reduces reliance on manual updates. These capabilities help planners manage uncertainty, evaluate interconnection requests faster, and prepare for extreme conditions. Limitations include the need for high-quality grid models, rigorous validation, physics-informed constraints, and adherence to cybersecurity and reliability standards.

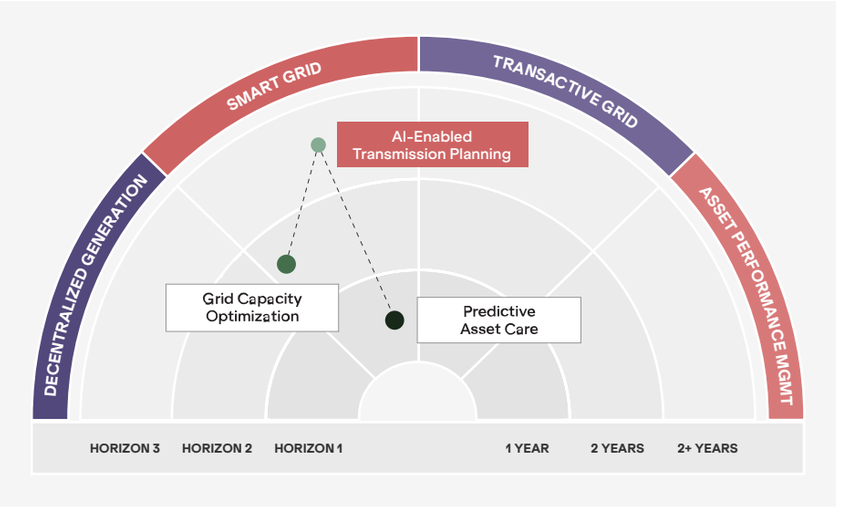
Key Technologies

Generative AI: Reconciliation for planning-operations alignment.

Digital Twins: Simulations to validate AI-generated transmission scenarios.

Computer Vision: Topology and equipment mapping for planning.

Synthetic Data Generation: Automated network model completion for data gaps in transmission.



HORIZON 3	ADOPTION PHASE	MARKET POTENTIAL
	EMERGING	MEDIUM

Featured Story

The National Laboratory of the US Department of Energy demonstrated that Gen AI can map equipment and topology between the Energy Management System's (EMS) operational and planning models within minutes rather than weeks. By reconciling mismatched transmission line, transformer, and bus data, the converted planning case closely matched EMS' state-estimation results, enabling higher-fidelity planning studies and improving the accuracy of contingency and long-term reliability analyses.

Key Takeaway

Transmission planners should prioritize high-quality network models and operational data to enable physics-aligned Gen AI applications. Early gains emerge from model reconciliation, scenario generation, and automated data completion, supported by digital twins that validate the impact before integrating outputs into planning workflows.

01

HORIZON 1

Cognitive CX

Overview

AI-driven contact centers with omnichannel engagement unify voice, chat, email, SMS, and social into a single, context-rich experience, while AI automates intent recognition, routing, self-service, and agent assistance for faster, personalized resolutions. Agents get predictive insights and next-best actions, while customers switch channels without repeating themselves, boosting efficiency, consistency, and satisfaction.

Highlights

AI enhances workforce productivity by providing agents with real-time insights, predictive recommendations, and automated summaries, allowing them to resolve complex queries faster. Utilities can offer proactive service through AI-powered forecasting, personalized notifications, and self-service capabilities, improving satisfaction while lowering operational costs. Omnichannel platforms further enable real-time digital sensing and personalized communication, strengthening engagement and trust. Overall, utilities gain efficiency, reduced support load, improved CX, and higher retention through consistent, AI-optimized customer experiences across all touchpoints.

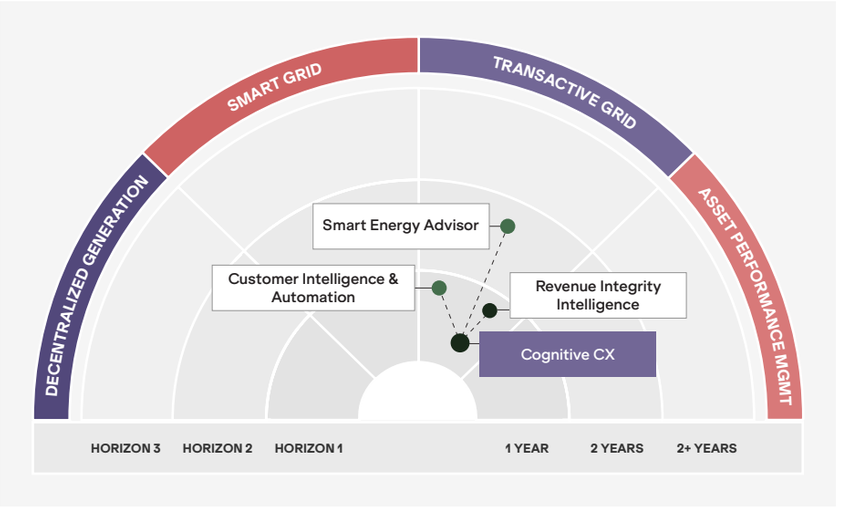
Key Technologies

Robotic Process Automation: AI-driven automation speeds billing, payments, account updates, documents, and workflows.

Generative AI: LLMs enable natural customer interactions, resolving queries across channels contextually and consistently.

Conversational AI: AI assistants deliver 24/7 omnichannel support, resolving user inquiries and guiding complex tasks.

Predictive Analytics: Utilities leverage predictive insights to anticipate churn and personalize engagement.



HORIZON 1	ADOPTION PHASE	MARKET POTENTIAL
	MATURE	HIGH

Featured Story

LTM transformed the customer operations of a 135-year-old US utility with 900,000 customers across northern and central California by deploying a 360° persona-driven experience platform. The solution introduced microservices, automated workflows, real-time service updates, and AI-enabled asset management to streamline outages and service interactions. This resulted in significantly faster dispatch, improved platform adoption, enhanced operational efficiency, and reduced service interruption durations, elevating overall customer satisfaction.

Key Takeaway

AI-driven omnichannel contact centers enable utilities to deliver faster, proactive, and personalized service by unifying channels, automating interactions, and empowering agents. They reduce time, improve self-service, and strengthen resilience.

02

HORIZON 1

Customer Intelligence & Automation

Overview

Autonomous CX refers to the use of Gen AI to manage entire customer journeys without human intervention. The focus has evolved from simple chat tools to autonomous virtual agents that possess emotional intelligence. These agents use AI to independently execute complex transactions, such as adjusting energy contracts or rerouting fuel shipments, rather than just providing scripted answers.

Highlights

Electric, gas, and water utilities are increasingly adopting AI-powered customer service agents to overcome slow, manual support processes and rising service demand. These agents deliver instant, 24/7 assistance for billing inquiries, outage updates, consumption insights, and service requests, effectively handling high interaction volumes during peak demand periods, price changes, or weather driven disruptions. Adoption is driven by digital-first utility engagement and rising expectations for real-time support. Beyond automation, AI proactively predicts issues like bill shocks or outages, improving customer satisfaction and lowering service costs. Key risks include AI hallucinations causing inaccurate tariff or outage information, and strict data-privacy requirements demanding strong governance.

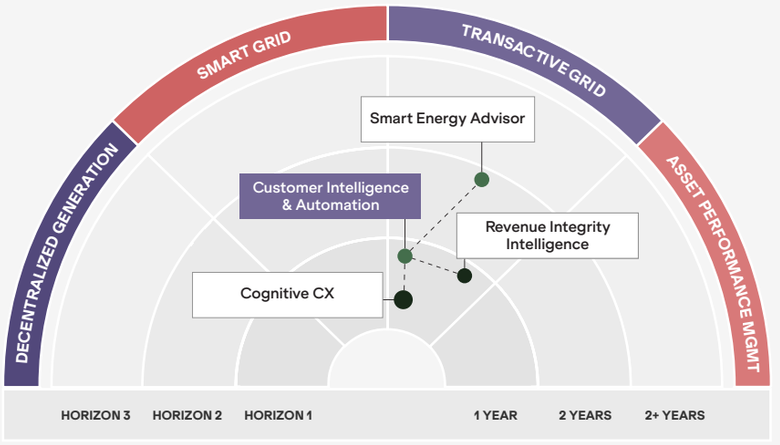
Key Technologies

Conversational Systems: Enable natural human-machine dialogues, delivering instant autonomous support across customer channels.

Unified Communications Platform: Combines channels seamlessly to support consistent, automated engagement and intelligent customer interactions.

Conversational Systems: AI-powered natural language interactions that drive autonomous, intelligent customer engagement experiences.

Generative AI: Creates adaptive virtual agents that deliver personalized, context-aware responses across channels.



HORIZON 1	ADOPTION PHASE	MARKET POTENTIAL
	IMPROVING	MEDIUM

Featured Story

LTM launched BlueVerse™, a dedicated business unit and comprehensive AI ecosystem designed to accelerate enterprises from AI concept to value. BlueVerse™ brings together modular AI components to enhance operations, boost productivity, and deliver transformative customer experiences. Its marketplace features 300+ industry and function specific agents, supported by seamless interoperability, an expanding connector ecosystem, and enterprise grade responsible AI governance for trust and scalability.

Key Takeaway

Future ready utilities must adopt AI agentic workflows to enable predictive, sentiment-driven engagement. Autonomous agents can manage tariffs, flexibility programs, and market interactions, transforming customer service from a reactive function into a proactive value and revenue driver.

03

HORIZON 1

Revenue Integrity Intelligence

Overview

Billing optimization streamlines utility billing through data analysis and AI-driven automation to improve accuracy, reduce manual errors, lower operational costs, and accelerate payment cycles. Fraud detection identifies energy theft, false invoicing, identity-based scams, and digital payment fraud using analytics and AI to spot anomalies, prevent revenue loss, and enhance security across utility systems.

Highlights

Utilities can modernize revenue operations by embracing data-driven billing optimization. Advanced analytics and automation streamline invoicing, reduce errors, accelerate payment cycles, and improve customer satisfaction, ultimately strengthening cash flow and operational efficiency. AI further enhances billing accuracy by automating meter data extraction, identifying anomalies early, and preventing costly disputes. On the fraud detection front, utilities can leverage ML to uncover energy theft, false invoicing, meter tampering, and unauthorized account creation, issues that significantly erode revenue. With digital payments rising, utilities must combat sophisticated scams such as spoofed payment requests, synthetic identities, and account takeovers through continuous monitoring and stronger authentication. Together, these capabilities unlock substantial revenue protection, transparency, and customer trust.

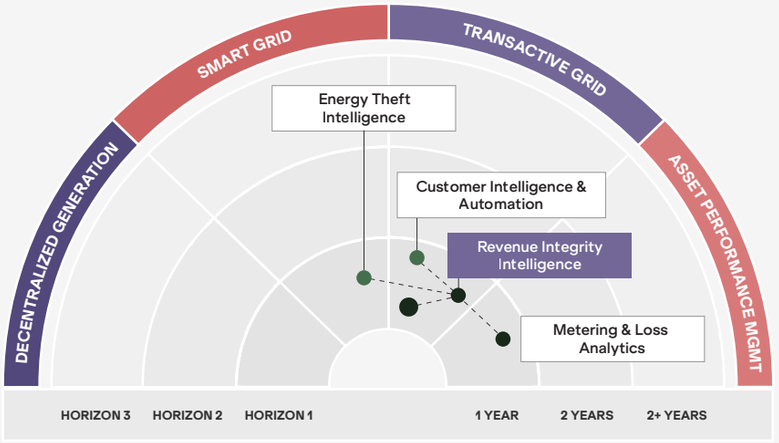
Key Technologies

Robotic Process Automation: Automates the billing process, exception handling, data validation, and payment posting.

Machine Learning: Identifies billing errors, missing data, and improves the overall accuracy.

Digital Twins: Build a virtual billing model that simulate performance to proactively resolve inefficiencies.

Blockchain: A decentralized ledger ensures transparent immutable records, reducing reconciliation conflicts and enhancing trust.



HORIZON 1	ADOPTION PHASE	MARKET POTENTIAL
	MATURE	MEDIUM

Featured Story

A leading energy provider in the US deployed an AI-powered fraud detection platform that analyzes consumption patterns to flag billing fraud, meter tampering, and energy diversion. The system helped recover substantial revenue and prevent ongoing losses. By proactively combating fraud, the utility strengthened operational resilience and boosted customer trust, with consumers appreciating the transparent, data-driven safeguards protecting their bills.

Key Takeaway

Utilities strengthen revenue and resilience by modernizing billing with intelligent automation, improving accuracy, accelerating collections, and eliminating manual errors. AI-driven fraud detection protects by identifying energy theft, billing and payment fraud, and identity scams.

04

HORIZON 1

Dynamic Demand Pricing

Overview

Demand forecasting and dynamic pricing enable utilities to predict electricity demand and adjust prices in real-time to balance supply, enhance grid reliability, optimize renewable integration, and reduce operational risks. Demand forecasting guides planning and prevents blackouts, while dynamic pricing shifts consumer usage, easing grid stress and improving efficiency in flexible, modern energy systems.

Highlights

Demand forecasting helps strengthen grid reliability and optimize infrastructure investments by anticipating peak loads and stress. It also enables better renewable integration by balancing intermittent wind and solar generation with demand. AI-enhanced forecasting provides utilities the opportunity to leverage real-time, multidimensional data for greater accuracy, improving operational efficiency, reducing risks, and enabling predictive planning. On the other hand, dynamic pricing enables a shift in consumer behavior, encouraging load flexibility, reducing peak-time strain, and improving overall system efficiency. It also strengthens consumer engagement by aligning pricing with affordability and ensuring access to flexible, low carbon energy services, which are the key factors in accelerating sustainable energy adoption.

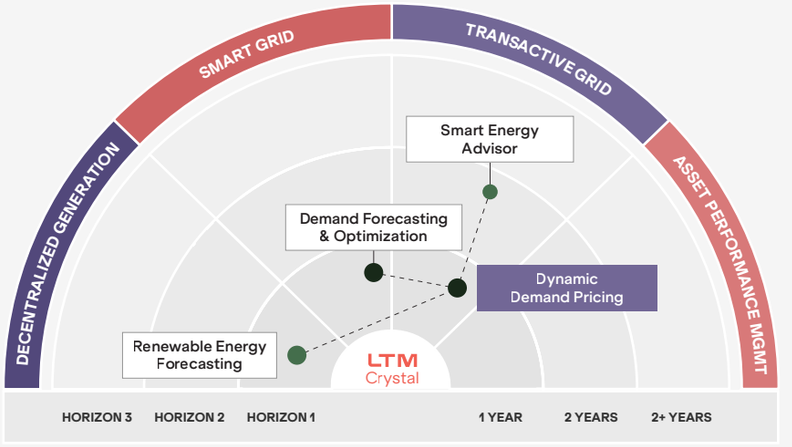
Key Technologies

Machine Learning: Identifies nuanced consumption patterns, improving short-and long-term forecasting accuracy.

Agentic AI: Simulates future scenarios and autonomously updates forecasts amid volatile demand.

Cloud: Dynamic pricing uses real-time data and cloud scalability, enabling timely tariff adjustments.

IoT: Smart meters capture usage and grid data, enabling accurate demand forecasts and pricing.



HORIZON 1	ADOPTION PHASE	MARKET POTENTIAL
	MATURE	HIGH

Featured Story

A Canada-based public utility company uses AI-based short-term load forecasting models that combine weather data, historical consumption, and real-time grid signals. These models improve demand prediction accuracy, support grid balancing, and enable time-based pricing and demand-response decisions. The approach helps utilities proactively manage peaks, optimize generation, and improve operational resilience during volatile demand periods.

Key Takeaway

Demand forecasting and dynamic pricing anticipate demand, preventing blackouts and strengthening grid stability. AI insights enable timely decisions and efficiency, while dynamic pricing engages consumers to shift usage, reduce peaks, and support a sustainable energy ecosystem.

05 HORIZON 2

Smart Energy Advisor

Overview

Energy advisor bots for prosumers are AI-powered virtual assistants that help households and small businesses generate their own renewable energy to make smarter, cheaper energy decisions. By analyzing real-time data from meters, solar systems, batteries, EVs, and appliances, they offer tailored advice, automate actions like battery and demand-response scheduling, and simplify complex energy choices through easy, 24/7 conversational guidance.

Highlights

Energy advisor bots for prosumers transform homes or small businesses into intelligent, self-optimizing energy hubs. By combining AI-driven forecasting, device-level automation, and real-time grid awareness, these bots empower prosumers to maximize solar self-consumption, intelligently schedule batteries and EV charging, and participate seamlessly in demand-response and local energy markets. As the machine economy accelerates with smart grids, automation, and data-driven decisioning reshaping the sector, these bots act as always-on digital energy stewards, turning complex signals into simple, cost-saving actions. They reduce waste, increase resilience, automate routine optimization, and enable prosumers to actively contribute to system-wide decarbonization, strengthening the grid while lowering their own energy costs.

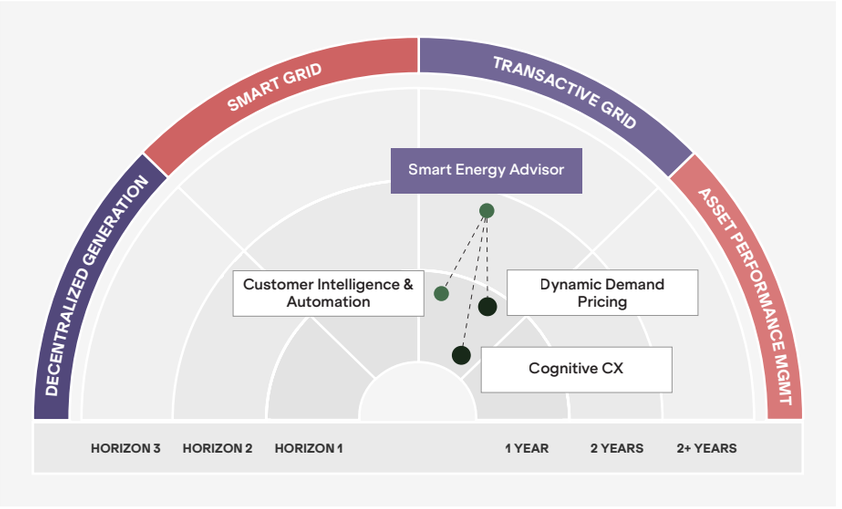
Key Technologies

Machine Learning: Provides real-time forecasts, enabling prosumers to manage renewable energy.

Smart Sensors: Enable continuous monitoring of solar, EV chargers, and home storage.

Big Data and Advanced Analytics: Support renewable integration forecasting and consumption analytics for prosumer planning.

Blockchain: Enables secure, peer-to-peer energy trading, empowering prosumers while increasing transparency.



HORIZON 2	ADOPTION PHASE	MARKET POTENTIAL
	IMPROVING	MEDIUM

Featured Story

A modern Finnish distribution center used AI to optimize prosumer energy decisions. With a large solar array, battery storage, and heat-recovery systems, AI analyzed real-time data to decide when to store, sell, or consume energy. This reduced costs, enhanced efficiency, supported grid stability, and demonstrated how AI empowers prosumers in renewable-powered microgrids.

Key Takeaway

Energy advisor bots for prosumers elevate everyday homes into autonomous energy nodes, predicting, optimizing, and orchestrating solar, storage, and EVs with precision. By uniting AI forecasting, automation, and real-time grid awareness, they simplify decisions, boost renewable self-consumption, and open access to emerging energy markets. With true closed-loop control and transparent execution, they seamlessly align prosumer actions with broader grid decarbonization.

01

HORIZON 1

Enterprise Cyber Resilience

Overview

Enterprise cybersecurity hygiene strengthens organizational resilience by securing endpoints, applications, and cloud environments against evolving threats. It standardizes patching, credential governance, network segmentation, and asset baselining, while using AI to detect anomalies across users, workloads, and devices. Continuous monitoring, least-privilege controls, and secure access practices reduce outage risks, protect critical operations, and ensure compliance with constantly shifting regulations.

Highlights

AI-enabled enterprise cybersecurity hygiene is shifting from basic protection to a proactive, intelligence-driven practice. Organizations face challenges from legacy systems, inconsistent telemetry, and complex cloud–SaaS–vendor environments that widen the attack surface. Modern hygiene emphasizes continuous asset visibility, zero-trust access, configuration integrity, and secure remote operations. Strengthening hygiene through segmentation, credential governance, continuous monitoring, and AI-driven anomaly detection improves threat detection and reduces business risk. AI unifies security across endpoints, applications, cloud, and networks, shortens investigation time, and safeguards critical operations, ultimately enhancing organizational resilience and regulatory readiness.

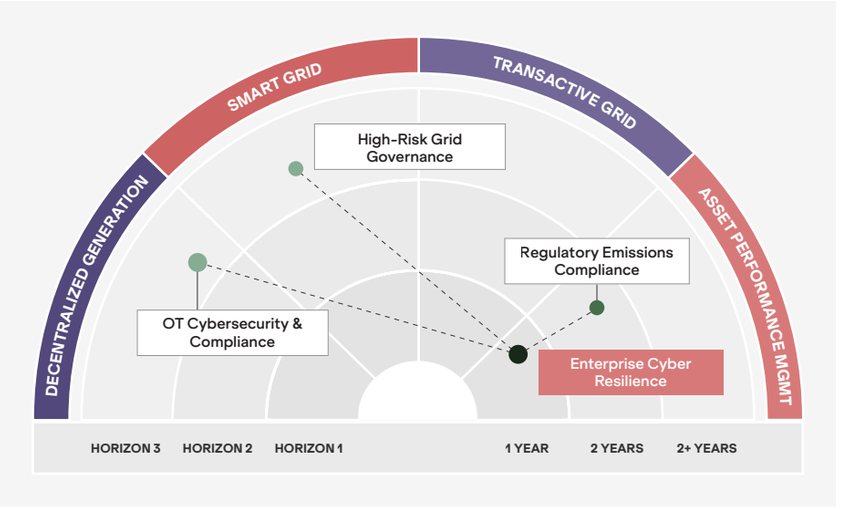
Key Technologies

ML Operational Analytics: Support unified oversight across IT/OT for better hygiene, patching, and monitoring.

Edge Computing: Monitors transmission/distribution lines and field assets vulnerable to cyber physical threats.

Analytics & GIS for Asset Management: Enables location-based asset risk visibility, isolates compromised networks, and detects anomalies.

AMI Network Health Monitoring: Monitors AMI/edge devices vulnerable to OT cyberattacks and ensures secure data flows.



HORIZON 1	ADOPTION PHASE	MARKET POTENTIAL
	MATURE	HIGH

Featured Story

A leading UK-based cybersecurity company uses automated security control validation to streamline compliance and improve accuracy. Assets are automatically identified, and critical controls such as patching, antivirus, Multi-factor Authentication (MFA), encryption, and web-proxy settings are continuously monitored. Through this ongoing validation, gaps are routinely observed across 15% of devices, with an additional 3% found to have non-functioning controls.

Key Takeaway

Enterprise cybersecurity improves when AI provides clear visibility, smart segmentation, and early anomaly detection. Strong hygiene lowers risk exposure, accelerates response, protects critical systems, and helps organizations keep pace with fast-evolving threats and regulatory demands.

02

HORIZON 1

Metering & Loss Intelligence

Overview

Metering & loss analytics use AI to turn smart meter data into actionable insights. By detecting anomalies, identifying technical and commercial losses, and enabling real-time visibility, it helps utilities reduce energy theft, improve billing accuracy, and strengthen grid reliability. This AI-driven approach supports faster decisions, better maintenance planning, and overall operational efficiency.

Highlights

Metering & loss analytics is becoming essential as utilities face a massive surge in smart meter data, expected to double from 1.7 billion to 3.4 billion devices by 2033. AI helps them make sense of this scale by sharply reducing false-positive anomalies by 63% and accelerating data processing by ~70%, turning data overload into meaningful insights. This shift overcomes legacy system bottlenecks and strengthens theft detection, billing accuracy, and predictive maintenance. With richer, sub-hour meter data improving grid visibility and planning, utilities can operate with greater reliability, efficiency, and customer trust.

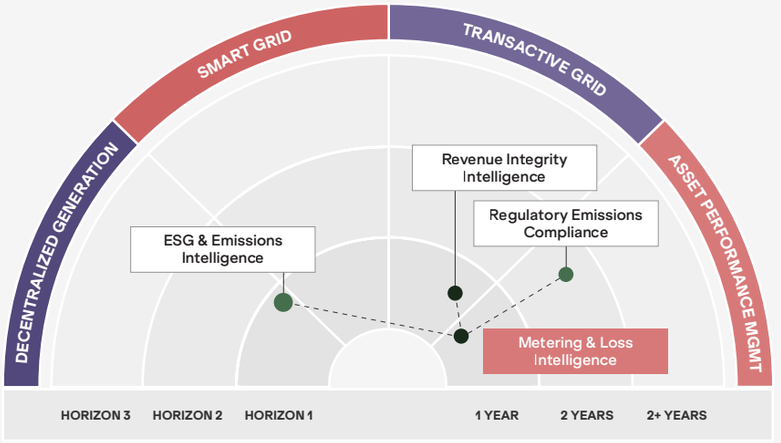
Key Technologies

IoT & Edge Devices: For real-time voltage, current, and load monitoring and granular visibility across distribution networks

Grid Analytics: Pinpoint technical losses at segment or phase levels. Moreover, identifies conductor, transformer, imbalance losses per feeder segment or electrical phase (R,Y,B) level.

Cloud Computing: Scalable infrastructure handles massive AMI data volumes, seamlessly enabling real-time analytics, dashboards, and reporting.

Real-Time Asset Performance Monitoring: Correlates abnormal losses with failing transformers, Current Transformer/Potential Transformer (CT/PT) issues, or phase imbalances.



HORIZON 1	ADOPTION PHASE	MARKET POTENTIAL
	MATURE	MEDIUM

Featured Story

A leading US-based utility tech provider revolutionized metering operations using an advanced AI-powered analytics platform. By processing sub-hour smart meter data at full resolution, the utility now detects anomalies sooner, reduces energy theft, and forecasts demand with greater accuracy. This enhanced visibility enabled smarter grid planning, lowered operational costs, and a more reliable customer experience.

Key Takeaway

Utilities see real value when meter data guides everyday decisions, helping reduce losses and respond to outages faster. AI-led metering, combined with edge intelligence, DER/V2G integration, and graph-based copilots, is gradually shifting grid operations toward smarter, more autonomous decision-making.

03

HORIZON 2

Substation Lifecycle Intelligence

Overview

Substation lifecycle management leverages AI-driven analytics, digital twins, and condition-based monitoring to oversee substations throughout their entire lifespan, from initial design to decommissioning. Utilities are becoming increasingly modern, and predictive maintenance strategies help improve system reliability, minimize operational failures, and optimize capital expenditure planning.

Highlights

There is growing focus on digitalization in new-build and retrofit substations for easier management. Retrofit programs add process-bus interfaces, and introduce AI and digital sensor systems, modernizing old infrastructure. This AI-enabled lifecycle management addresses aging assets, unreliable protection systems, and high outage risks. Digital twins improve situational awareness, predict faults, and simulate maintenance scenarios, while AI models (e.g., hybrid learning, pattern recognition) detect anomalies early. Market drivers include rising grid complexity, DER penetration, and the demand for IEC 61850-aligned remote automation. Benefits include reduced downtime, optimized maintenance, lower lifecycle costs, and modernized workforce operations.

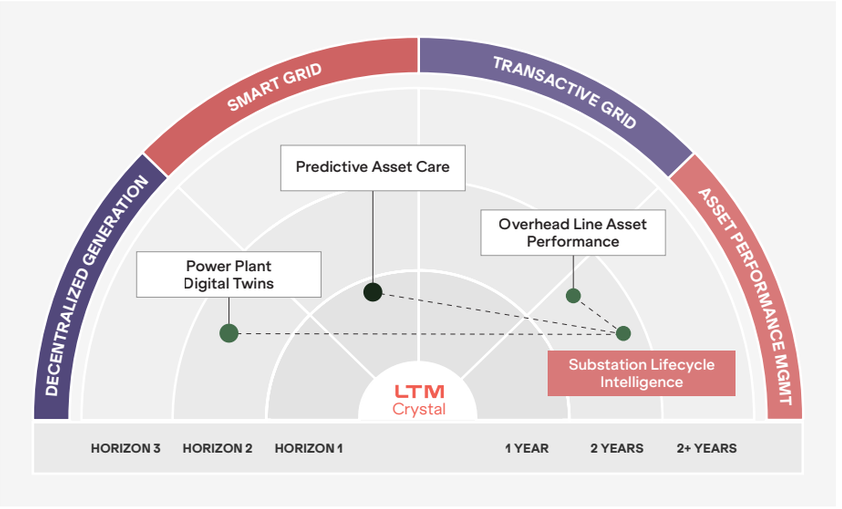
Key Technologies

Real-Time Asset Intelligence: Continuous substation asset health and performance monitoring for predictive insights.

Condition-Based Maintenance Engines: AI-driven maintenance triggered by real-time equipment condition and risk.

Digital Twins: Use real-time data to simulate performance, predict maintenance, and assess safety.

Remaining Useful Life Analytics: Advanced AI models forecast component lifespan for proactive planning.



HORIZON 2	ADOPTION PHASE	MARKET POTENTIAL
	IMPROVING	MEDIUM

Featured Story

A Swiss technology leader is developing a new method for IIoT equipment that saves digital twin data for substation automation systems and various industrial uses. This approach enhances how the data collection logic of IIoT devices linked with primary or secondary substation equipment is set up. Instead of relying on preset protocol configurations within IIoT devices, the aim is to allow configuration and reconfiguration of data collection remotely, eliminating the need for onsite technicians.

Key Takeaway

AI-first substation lifecycle management will become essential as utilities confront aging assets and grid complexity, enabling smarter interventions, predictive maintenance, and optimized planning across the asset lifecycle.

04

HORIZON 2

Overhead Line Asset Performance

Overview

Satellite sensing combined with AI analytics and Asset Performance Management (APM) can be used to monitor conductors, towers, and vegetation, supporting risk-based maintenance and regulatory compliance. The key advantage is integrated vegetation-risk and asset-health scoring at transmission/distribution scale, beyond simple inspection digitization.

Highlights

Energy grids face mounting challenges like aging infra-structure, renewable integration, rising demand, cybersecurity risks, and extreme weather, making traditional maintenance insufficient and costly. AI-powered predictive maintenance leverages IoT, ML, and digital twins for real-time monitoring, anomaly detection, and failure prediction, reducing downtime, extending equipment life, saving costs, and improving safety. Utilities are now reducing outages and wildfire risks by using drones and satellites for inspections (guided by AI) to prioritize repairs, especially as new regulations on vegetation management increase urgency. Utilities inspect transmission lines using aircraft and ground patrols to manage vegetation risks, relying on visual checks, LiDAR, and photogrammetry. Uncrewed aircraft systems (UAS) can supplement this, but currently, traditional inspections are cheaper due to UAS' line-of-sight limits.

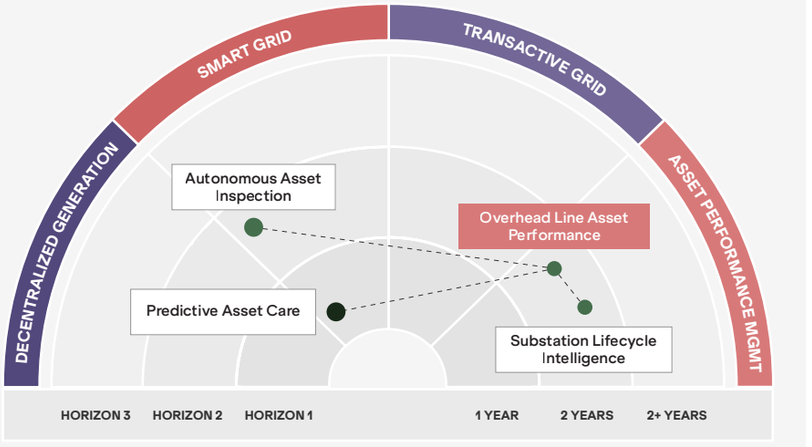
Key Technologies

Grid Analytics: To monitor grid performance, spot anomalies, and predict failures for improved reliability.

OEE Enhancement: To identify downtime causes, boost asset use, and lower maintenance costs.

Vegetation Management: Employs AI image recognition to detect vegetation threats near power lines, improving maintenance efficiency.

Weather & Emergency Prediction: To anticipate weather impacts on assets, aiding predictive maintenance and minimizing outages.



HORIZON 2	ADOPTION PHASE	MARKET POTENTIAL
	IMPROVING	MEDIUM

Featured Story

A large US electric utility worked with a top consulting company to modernize its vegetation and overhead-line monitoring using drones, cloud automation, and ML analytics. The initiative replaced error-prone, paper-based inspections with remote, AI-assisted detection of at-risk vegetation and corridor hazards, improving reliability, reducing operational costs, and enabling faster, safer maintenance decisions across thousands of circuit miles.

Key Takeaway

AI-enabled corridor management is the foundation of modern grid stewardship, shifting utilities from reactive maintenance to anticipatory risk prevention. Grid resilience in a climate-volatile world depends on AI's ability to fuse inspection, weather, and environmental data into real-time operational decisions.

05

HORIZON 2

Regulatory Emissions Compliance

Overview

Emissions & compliance monitoring uses AI to track, analyze, and predict emissions across utility operations in real-time. By integrating sensor data, regulatory thresholds, and predictive models, it helps utilities detect deviations early, automate reporting, and ensure continuous compliance. AI-driven insights also guide cleaner operations, support decarbonization goals, and prepare utilities for evolving environmental regulations.

Highlights

AI-enabled emissions & compliance monitoring gives utilities real-time visibility into CO_2, NOx, SOx, and particulate emissions by processing sensor and satellite data. It also helps overcome challenges like data latency, equipment failures, and complex regulatory demands. AI improves accuracy through analysis and predictive maintenance, helping utilities prevent compliance breaches and automate reporting. Industries are increasingly adopting AI-based emission systems for real-time monitoring & anomaly detection and automated ESG reporting aligned to global standards. This shift helps utilities improve operational efficiency and build stronger regulatory confidence. Going forward, integrated AI, predictive analytics, and Scope3 automation will define audit-ready emissions intelligence.

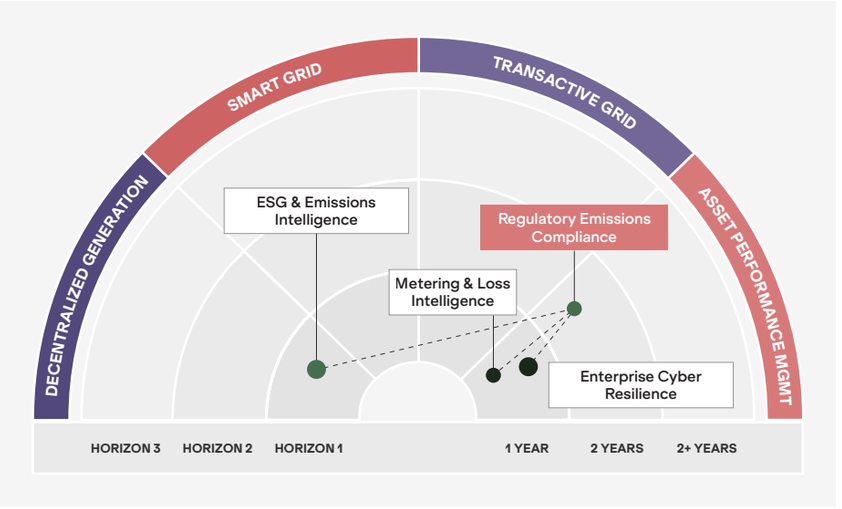
Key Technologies

Digital Twin: Simulate plant/process performance and identify low-emission operational scenarios

Blockchain: Immutable emission records for regulatory audits and transparency

Grid Analytics: Measure grid emissions, detect inefficiencies, and guide decarbonization and compliance decisions.

IoT Sensors: Detect emission anomalies, forecast risks, and ensure continuous regulatory compliance.



HORIZON 2	ADOPTION PHASE	MARKET POTENTIAL
	IMPROVING	MEDIUM

Featured Story

A leading US-based energy tech provider deployed an AI-driven emissions and compliance platform across multiple plants. By fusing sensor and satellite feeds with predictive maintenance, the utility gained real-time alerts, automated ESG-aligned reports, and ensured root-cause detection, reducing compliance breaches and inspection times. Subsequently, Scope3 data automation and regulatory intelligence will deepen audit readiness and accelerate decarbonization.

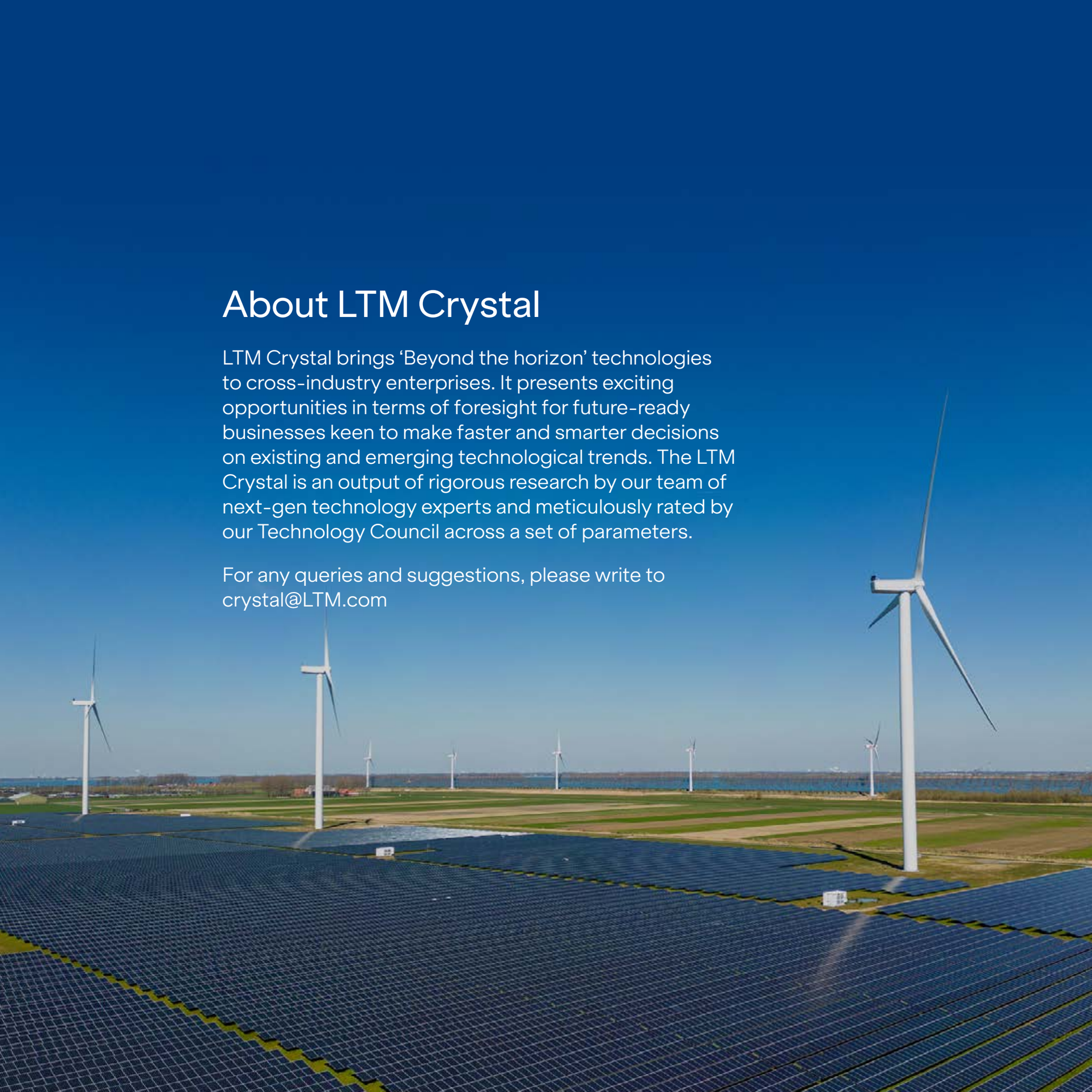
Key Takeaway

AI-driven emissions & compliance monitoring delivers real-time pollutant visibility, predictive alerts, automated ESG reporting, and stronger regulatory confidence. Going forward, Scope3 automation, grid-linked analytics, and regulatory-intelligent AI will enable fully audit-ready, decarbonized utility operations.

About LTM Crystal

LTM Crystal brings ‘Beyond the horizon’ technologies to cross-industry enterprises. It presents exciting opportunities in terms of foresight for future-ready businesses keen to make faster and smarter decisions on existing and emerging technological trends. The LTM Crystal is an output of rigorous research by our team of next-gen technology experts and meticulously rated by our Technology Council across a set of parameters.

For any queries and suggestions, please write to crystal@LTM.com



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Glossary

SAIDI	System Average Interruption Duration Index
SAIFI	System Average Interruption Frequency Index
NREL	National Renewable Energy Laboratory
IEA	International Energy Agency
EPRI	Electric Power Research Institute
LiDAR	Light Detection and Ranging
BVLOS	Beyond Visual Line of Sight
UAS	Uncrewed Aircraft Systems

PEMS	Predictive Emission Monitoring Systems
CSRD	Corporate Sustainability Reporting Directive
TCFD	Task Force on Climate related Financial Disclosures
SCADA	Supervisory Control and Data Acquisition
NERC CIP	North American Electric Reliability Corporation – Critical Infrastructure Protection
IEC 62443	Industrial Automation and Control Systems Security Standard
FDAR/ FLISR	Fault Detection and Automated Restoration/ Fault Location, Isolation, and Service Restoration

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