



From smart meters to smart grids: Unlocking the value of AMI 2.0



Executive summary

Advanced metering infrastructure (AMI) is entering a new era—one defined not only by interval data collection, but by real-time intelligence, grid automation and data-driven decision-making. As utilities face increasing pressure from aging infrastructure, rising customer expectations and rapid expansion of distributed energy resources (DER), AMI 2.0 offers a transformative pathway to modernize operations and improve resiliency.

This paper covers the use cases by AMI meters that can be used by utilities to implement futuristic use cases to automate the utilities business processes to bring in robust security, efficiency, cost saving and reducing carbon footprint. Cognizant's point of view highlights that AMI 2.0 is not simply a metering upgrade, it is a strategic investment that enables utilities to evolve into digital, data-centric organizations. By adopting modern communications networks, scalable cloud architectures and advanced analytics frameworks, utilities can fully realize the potential of AMI data and position themselves for long-term operational excellence and regulatory compliance.

Utilities around the world are undergoing a profound transformation as they navigate shifting regulatory landscapes, aging infrastructure, increasing electrification and rising consumer expectations. Simultaneously, the rapid adoption of DER such as rooftop solar, battery storage and electric vehicles is reshaping energy flows and challenging traditional grid operating models. In this evolving environment, AMI has emerged as a foundational technology, enabling utilities to modernize operations, enhance resiliency and build a more flexible, data-driven grid.

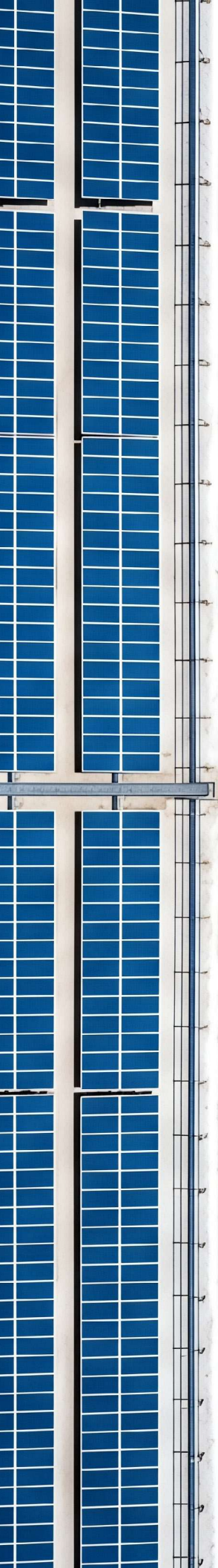
While AMI 1.0 delivered significant improvements in billing accuracy, meter reading efficiency, outage alerts and remote service operations, the next generation AMI 2.0 is designed to go far beyond meter-to-cash processes. Modern AMI systems integrate high-resolution interval data, two-way communication, edge intelligence and real-time sensing capabilities that extend visibility deep into the distribution network. These capabilities create new opportunities to automate grid operations, predict equipment failures, optimize voltage, support DER management, enhance customer programs and strengthen overall grid reliability.

At the same time, advancements in IoT, cloud computing and AI/ML analytics are accelerating utilities' ability to extract value from the massive volumes of data generated by AMI devices. By centralizing AMI, IoT, GIS, CIS, weather and operational data into a unified data lake, utilities can move from reactive operations to predictive and prescriptive decision-making, which is a key milestone on the path toward fully digital grid management. This shift enables a wide range of new capabilities, including conductor failure prediction, transformer health monitoring, vegetation hazard detection, load forecasting and dynamic DER coordination.

Introducing AMI 2.0: A new era of intelligent utility operations

Advanced metering infrastructure is evolving beyond meter reading and billing into a more intelligent, connected foundation for utility operations. As grids become more distributed and complex, utilities need real-time visibility, stronger operational control and better ways to manage outages, asset performance, power quality and distributed energy resources. AMI 2.0 addresses this shift by enabling a more predictive, resilient and future-ready grid.

This white paper outlines the evolution of metering from legacy systems to AMI 2.0 and examines the broader technology, data and operational foundations needed to unlock its value. It covers the role of AMI 2.0 in enabling near real-time grid visibility, supporting advanced analytics, improving outage management, strengthening power quality monitoring and helping utilities manage growing DER complexity. It also looks at how AMI 2.0 connects with broader grid modernization efforts and enterprise platforms to enable more proactive, coordinated and intelligent utility operations.



Evolution of metering technology till AMI 2.0

Metering technology has undergone a significant transformation over the years, evolving from basic manual readings to the advanced, data-driven smart meters we use today.

01 The early days: Manual mechanical meters



In the early days, utilities were using mechanical meters, which required technicians to visit each location and manually record usage for billing. Because these readings were taken only monthly or sometimes quarterly, the data was limited and often led to gaps or inaccuracies in customer bills. This manual process was also labor intensive and expensive for utilities, requiring significant time, workforce and logistical effort to collect meter readings across the service territory.

02 First advancement: Automated meter reading



The first major step toward smart metering was the introduction of automated meter reading (AMR), which allowed utilities to remotely collect usage data using radio frequency signals or drive by systems. This significantly improved efficiency and reduced human error. However, it still did not provide the real time insights needed to fully manage utility operations.

03 AMI 1.0: The revolution of real-time data and connectivity



The next major advancement in metering technology was the introduction of advanced metering infrastructure (AMI). Smart meters within AMI systems can collect and transmit data in real time or at frequent intervals, providing utilities and customers with a continuous stream of actionable information. With two way communication capabilities, AMI enables accurate and timely billing, enhances leak and fault detection, supports energy and water conservation efforts, and significantly improves overall utility management.

04 AMI 2.0: Integrating smart meters for smart cities

As cities become increasingly interconnected, smart meters will play a foundational role in enabling the next generation of smart city infrastructure. By integrating smart meters with IoT devices, renewable energy systems and advanced data analytics platforms, utilities gain far more detailed visibility into consumption patterns. This deeper insight empowers consumers to better manage their usage, while enabling utilities to optimize resource distribution, enhance operational efficiency and reduce environmental impact.

AMI standards

In smart grid technology, establishing clear regulations and standards is essential to ensure seamless communication and effective use of exchanged data. These AMI standards are critical because devices from different manufacturers must operate together without compatibility issues. To achieve this, various standards and protocols define how information is exchanged across the smart grid ecosystem. Several major standards organizations such as IEEE (Institute of Electrical and Electronics Engineers), IEC (International Electrotechnical Commission) and ANSI (American National Standards Institute) play a key role in developing and maintaining these guidelines.

Organization of standard	Description	Standard	Standards applicable in smart grid AMI
IEC (International Electrotechnical Commission)	IEC is the leading global standard body that publishes standards for electrical, electronics and related technologies in the electric power industry.	IEC 62056	These standards define the data models (IEC 62056-6-1 and IEC 62056-6-2) and application layer (IEC 62056-5-3) for secure data exchange in smart metering. This provides the foundational communication protocol for the smart meters themselves.
		IEC 61850	Substation automation, distributed generation, SCADA communication, distribution automation, etc.
		IEC 61968	Distribution management and AMI back-office interfaces.
		IEC TC 13 and 57	Metering and communication for metering in AMI.
		IEC 62052	This standard specifies the general requirements, tests and accuracy performance requirements for AC smart meters, ensuring reliable measurement data
		IEC TR 63097:2017	Defines various smart energy use cases that the other standards are designed to support.
IEEE (Institute of Electrical and Electronics Engineers)	This body develops standards in all areas of electrical, electronics and related technologies. It develops standards in the areas of communication and interoperability.	IEEE 802.3	Ethernet
		IEEE 802.11	Wi-Fi
		IEEE 802.15.1	Bluetooth
		IEEE 802.15.4	Zigbee
		IEEE 802.16	WiMAX

Organization of standard	Description	Standard	Standards applicable in smart grid AMI
ANSI (American National Standards Institute)	ANSI has developed relevant standards for interoperability of AMI systems.	ANSI C12.19	Metering tables internal to the meter.
		ANSI C12.22	Communications for metering tables.
		ANSI C12.1-2024	This is the current edition of the American National Standard that specifies acceptable performance criteria for new types of AC watthour meters, demand meters, demand registers, pulse devices and auxiliary devices. It also describes acceptable in-service performance levels for meters and devices used in revenue metering.
IETF (Internet Engineering Task Force)	IETF publishes internet standards, dissemination of request for comment (RFC) documents for finalization of standards.	RFC 791	Internet protocol (IP)
		RFC 793	Transmission control protocol (TCP)
		RFC 1945	Hypertext transfer protocol (HTTP)
		RFC 2571	Simple network management protocol (SNMP)
		RFC 3820	Internet X.509 public key infrastructure (PKI) for security
NIST (National Institute of Standards and Technology)	This standard body produces publications that provide guidelines toward secured interoperability.	NERC CIP 002-009	Bulk power standards with regards to critical cyber asset identification, security management controls, personnel and training, electronic security perimeters, physical security of critical cyber assets, systems security management, incident reporting and response, planning and recovery plans for critical cyber assets.
		CIP-015-1	Approved in 2025, this standard requires monitoring traffic within electronic security perimeters to detect anomalous activity that has bypassed perimeter defenses.
W3C (World Wide Web Consortium)	This body standardizes interoperable technologies such as specifications, guidelines, software and tools for the world-wide web.	HTML	Web page design
		XML	Structure documents and other object models
		SOAP	Web services for application-to-application communication for transmitting data.

Source: [Advanced metering infrastructure - SyC Smart Energy](#) and [CIP-015-1](#)

Here is a list of detailed information that can be supplied via AMI systems:

Data from electric meters:

Category	Data elements
Energy usage	<ul style="list-style-type: none">• Cumulative kWh usage• Daily kWh usage• Time of use (TOU) kWh readings
Demand data	<ul style="list-style-type: none">• Peak kW demand• Last interval demand• TOU peak kW readings
NIST (National Institute of Standards and Technology)	<ul style="list-style-type: none">• Load profile• Voltage• Voltage profile
W3C (World Wide Web Consortium)	<ul style="list-style-type: none">• Voltage sag/swell logs• Voltage event flags
Phase and outages	<ul style="list-style-type: none">• Phase information• Outage counts• Outage logs
Security	<ul style="list-style-type: none">• Tamper notifications
Power characteristics	<ul style="list-style-type: none">• Power factor
Meter status	<ul style="list-style-type: none">• Events• Alarms

Compared to electric meters, AMI enabled water and gas meters have fewer advanced use cases, primarily focusing on consumption measurement, leak detection and basic meter or battery related alerts. Historically, gas meters did not include even remote disconnect capabilities, but modern versions now feature remote shut off valves that can be activated during emergencies such as leaks, floods or earthquakes. Many next generation gas meters (2025) also use ultrasonic technology to improve measurement accuracy and eliminate mechanical components that degrade over time.

Most innovation and investment in AMI advancements continue to center on electric meters, as electricity cannot be stored at scale, making accurate real time measurement and generation consumption balancing far more critical.

Data from water meters:

Here are the most common data elements captured by AMI-enabled water meters:

Category	Data elements
Consumption data	<ul style="list-style-type: none">• Hourly or daily usage readings• Peak demand trends• Total cumulative consumption
Flow and pressure	<ul style="list-style-type: none">• Real time flow rates• Network pressure measurements• Detection of abnormal or continuous flow patterns (for example, leaks)
Event and alarm data	<ul style="list-style-type: none">• Leak detection alerts• Backflow incidents• Tamper notifications (for example, cover removal and magnetic interference)• Dry or empty pipe alerts
Operational data	<ul style="list-style-type: none">• Battery health status• Communication signal strength• Time synchronization data for accurate logging
Customer service enhancements	<ul style="list-style-type: none">• Detailed usage profiles for billing transparency• Remote disconnect/reconnect (where supported)• Alerts for unusual consumption spikes

Data from gas meters:

Category	Data elements
Consumption data	<ul style="list-style-type: none">• Hourly or daily interval usage (time differentiated records)• Cumulative register reads• Remote move in/move out readings
Event and status data	<ul style="list-style-type: none">• Tamper alerts (for example, cover removal and magnetic interference)• Leak detection alerts (continuous flow anomalies)• Battery health indicators and low battery warnings• Communication status (signal strength and connectivity issues)
Operational and diagnostic data	<ul style="list-style-type: none">• Firmware version and meter configuration• Valve status (open/closed for meters with remote shutoff)• Temperature/pressure compensation values for corrected volume readings• Diagnostic flags or error codes for hardware/software issues

With high-end AMI systems, nearly all of this information is available in real time and on-demand, allowing for improved operations and customer management.

Challenges utilities face today

Utilities are operating in an environment shaped by multiple pressures at once. The major forces transforming the industry include shifting regulatory landscapes, aging infrastructure, increasing electrification and rising consumer expectations. At the same time, the rapid adoption of distributed energy resources such as rooftop solar, battery storage and electric vehicles is reshaping energy flows and challenging traditional grid operating models. Together, these changes are making utility operations more dynamic, complex and difficult to manage with conventional approaches.

Earlier metering models are no longer sufficient for this new reality. Manual mechanical meters required labor-intensive, infrequent readings that created gaps and inaccuracies. While AMR improved efficiency, it still lacked the real-time insight needed to fully manage utility operations. Even AMI 1.0, though effective for billing

accuracy, outage alerts and remote service operations, has been used for relatively limited, easier-to-measure use cases. This leaves utilities short of the deeper visibility and intelligence needed to respond to modern grid conditions.

Another challenge is the scale and complexity of data needed to support next-generation utility use cases. Advanced capabilities such as outage restoration prediction, fault isolation, conductor failure prediction, transformer health monitoring, DER coordination and power quality management require live data processing across multiple systems. Utilities will need infrastructure, integration and possibly cloud readiness to bring together data from AMI, IoT devices, MDMS, field crews, weather, CIS and GIS. In that sense, the challenge is not only operational, but also technological. Utilities must be prepared to process and act on large volumes of connected, real-time data.

Use cases from AMI 1.0 to AMI 2.0

1. Billing without truck roll
2. Remote service switch operations
3. Theft detection
4. TOU rates
5. Security
6. Improved customer service
7. Time to restore
Utilities want to predict and keep customers up to date on the unplanned outages and provide an accurate ETA for the restoration.
8. Public safety power shutoff (PSPS)
Utilities proactively shut off power for public safety by predicting possible fire or other emergency scenarios due to weather, downed power lines, vegetation incursion, etc.
9. Identifying, isolating and restoring fault location
Fault can happen due to equipment failures, downed power lines, vegetation incursion, etc. The use case is to automatically detect faults, isolate the damaged section and reroute power to keep most customers online during outages, significantly reducing downtime from hours to minutes by using smart reclosers and automated switching devices for faster and more reliable grid management.
10. Energized downed conductor
11. Cable/conductor failure prediction
Use cases 10 and 11 are on the same line as that of identifying fault location. Using voltage and current data, and complex algorithms, system can predict cable/conductor failure.
12. Vegetation management
Vegetation management is the crucial process of controlling trees and plants near power lines, pipelines and other infrastructure to prevent outages, fires and hazards, ensuring reliable service, public safety and grid resilience. Using GIS mapping, aerial patrols (drones) and proximity sensors to automate the detection part in the vegetation management
13. Predicting transformer failure
It involves monitoring physical signs (humming, leaks, hot spots) and AI/ML to correlate data (temperature, load, gas levels, environment) for early warnings, enabling proactive maintenance before catastrophic failure.

14. Identify high voltage incident (EV/ Inverter)
Using AMI's voltage data, high voltage incidents can be detected. Based on the high voltage incident, EV/inverter charging can be turned on/off or reduced to low voltage charging.
15. Distribution asset management
16. Power quality
Power quality refers to the consistency and stability of electrical power, ensuring voltage, frequency and waveform remain within ideal limits for reliable equipment operation, with common issues including voltage sags, swells, harmonics and transients that can cause malfunctions or damage, requiring solutions such as filters, stabilizers and proper grounding to maintain efficiency and protect sensitive electronics.
17. Optimize load flow and voltage control
Voltage optimization is the process of systematically lowering incoming electrical voltage to the optimal level for equipment, reducing energy waste, lowering power demand and saving costs, especially for devices such as motors, lighting and heaters that consume excess power at higher-than-needed voltages.
18. Identify overloaded circuit
Utilities identify overloaded grids using smart meters, sensors and engineering software such as ADMS that analyzes real-time data for voltage issues, high current or heat, often visualized with heat maps showing stressed lines/transformers, while customer reports (flickering lights, tripped breakers) serve as early warnings, prompting system adjustments such as load shedding or deploying new capacity voltage disaggregation.
19. Distributed operations (ADMS)
Advanced distribution management system (ADMS) for electric grids, a software platform for utilities to manage, control and optimize power distribution, integrating renewables and improving reliability.
 - DMS/ADMS support
 - VVO and CVR support
 - Volt/VAR optimization (VVO) enhances control and optimization capabilities, leveraging real-time data and advanced algorithms to improve system efficiency and reliability. VVO is an approach to optimizing voltage and reactive power in the distribution network. Conservation voltage reduction (CVR) is an energy-saving strategy that fine-tunes voltage, while ADMS is the software platform that enables CVR by integrating grid data and controlling devices for smarter, more efficient grid operations, reducing costs and improving reliability.
20. DERMS
Distributed energy resource management systems (DERMS) is a crucial software platform that helps electric utilities monitor, control and optimize various smaller energy sources such as rooftop solar, batteries, EVs connected to the grid, ensuring stability, integrating renewables and managing demand for a more efficient, flexible energy future.
21. DER/EV/solar monitoring
Using DERMS and AMI data, you can monitor DER/EV and solar monitoring. Having data will enable control, and optimize energy sources such as rooftop solar, batteries and EVs connected to the grid.
22. Customer load control/engagements
Customer load control, or demand response, is when utilities temporarily adjust customer electricity use (such as cycling ACs or water heaters) during peak times to balance the grid, often using smart devices, to prevent outages, lower costs and integrate renewables, with customers often getting incentives or control options. It moves beyond old direct control to flexible, tech-driven programs using smart thermostats, EV chargers and batteries.
23. Virtual power plant and vehicle to grid
A virtual power plant (VPP) is a coordinated network of small, distributed energy resources (batteries, electric cars) that, when aggregated and managed together, can deliver reliability and economic value to the grid comparable to a traditional power plant. With unpredicted EV and solar penetration, more utilities are implementing this use case more aggressively.

Our point of view: From smart metering to AI-driven, real-time intelligence

Cognizant is a key player in consulting and system integration (SI), and in the energy and utilities sector. We're working with multiple utilities in many areas of smart grid implementation, operations and consultation, covering more than 55 million smart meters.

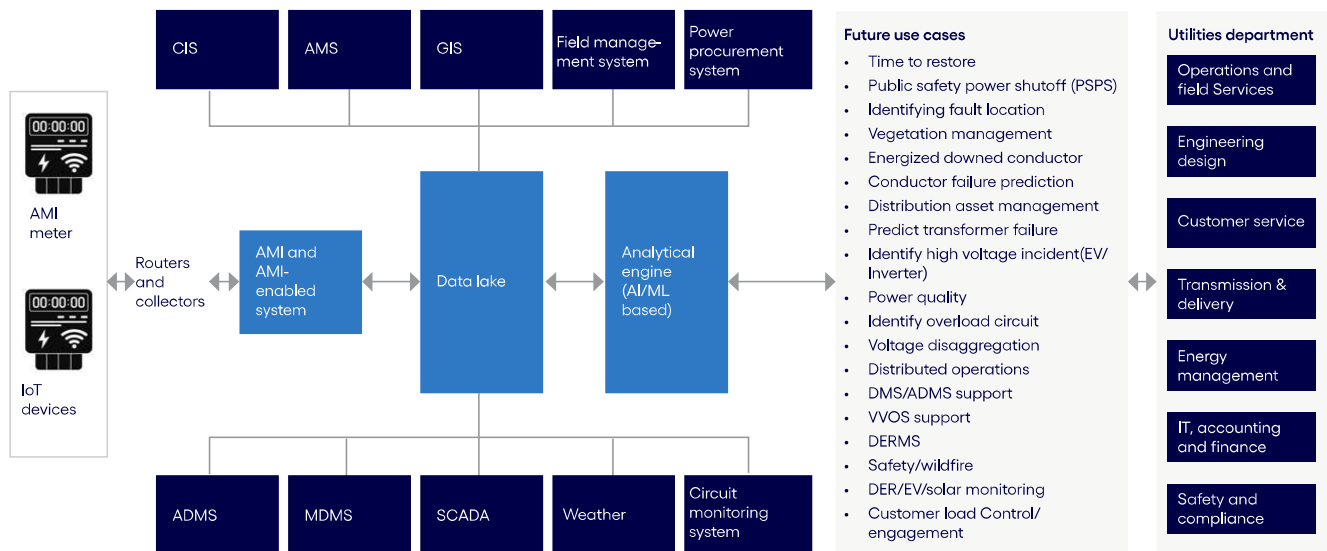
Based on our experience, we believe that most utilities that implemented smart meters have focused on billing and remote service switch, theft detection, TOU rates, outage notification, etc. These use cases (mentioned below) were "low-hanging fruit", easy to measure and showcase benefit to customers and utility commission.

The next level use cases (use case from 7 to 23) need tons of data processing live, possibly using AI to achieve complex prediction and projections. We believe utilities will start envisioning and implementing all the use cases mentioned below at some point of time in future, and start putting together infrastructure and integration needed for data collection and processing in data lake. This may be cloud-based infrastructure and hence utilities may have to prepare cloud migration readiness as well. The live data from different systems such as AMI, IoT devices, MDMS, AMI event, AMS, field crew, weather, CIS and GIS will be put into one place. On top of this, data AI/ML will be applied to derive actionable data points.

A high-level diagram is presented below for easy understanding.

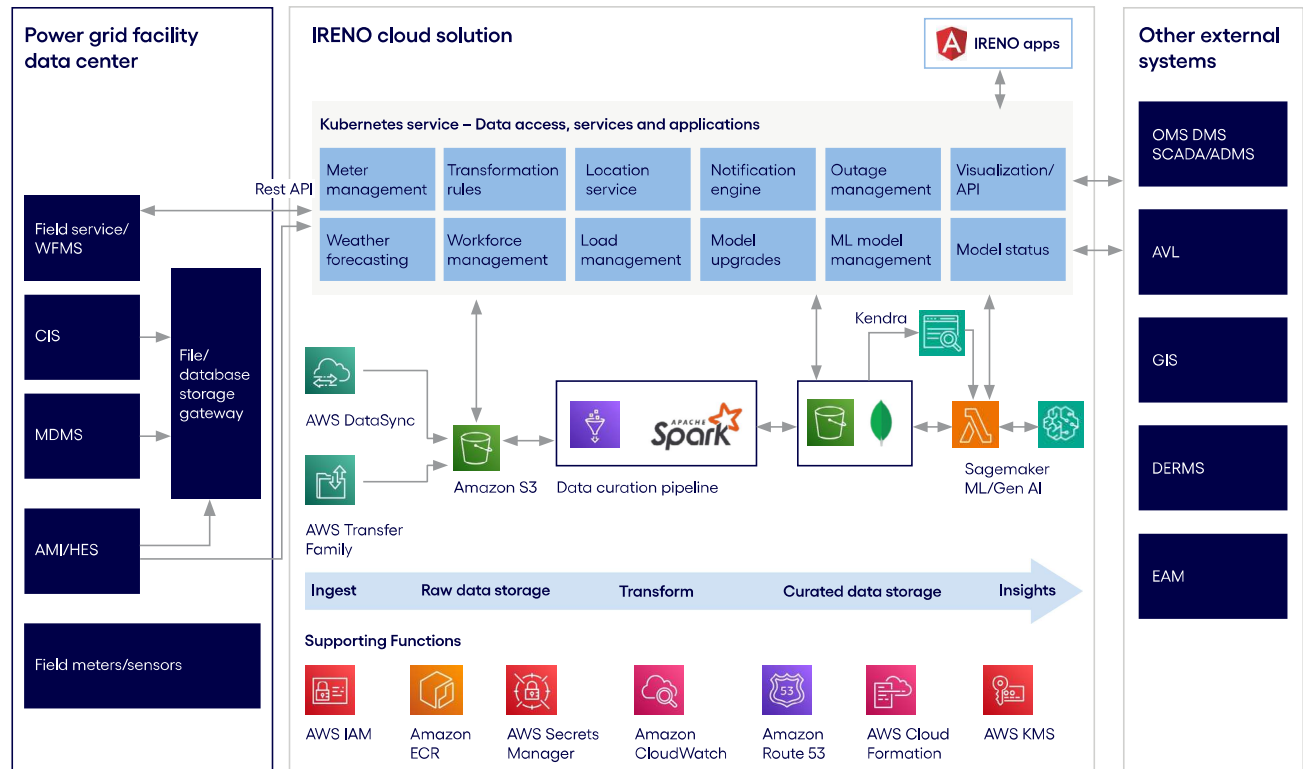
Cognizant's AMI 2.0 integration vision

Cognizant is partnering with leading product vendors to integrate IT and OT systems for advanced AMI 2.0 applications



Cognizant with a vision like what's mentioned above already developed a platform called IRENO. It integrates all the key systems and works with utilities to see the feasibility and appetite to implement the IRENO platform.

High level architecture/Data flow



IRENO (Intuitive Response Enabled Network Operations) is an Industry 4.0 platform designed to unify and integrate multiple IT and OT systems across the utility ecosystem into a centralized data platform. These systems include AMI, MDMS, CIS, GIS, IoT devices, field operations systems and external data sources such as weather. It ingests and consolidates real-time and historical data into a common data lake, creating a “single pane of glass” for operations. Leveraging advanced analytics, AI/ML models and configurable engines, IRENO transforms this integrated data into contextual insights and actionable data points, such as outage detection, billing exception identification, load analytics and storm impact predictions. These insights enable predictive, prescriptive and real-time decision-making that improves operational efficiency, reliability and response time across the grid.



Unlock the full potential of AMI 2.0 for a smarter, more resilient grid

Advanced metering infrastructure is evolving into a more intelligent and strategic enabler of utility transformation. As utilities face growing operational complexity, AMI 2.0 offers the foundation for greater visibility, faster decision-making and more advanced grid management.

To realize that value, utilities will need to look beyond traditional metering use cases and prepare for a more integrated, data-driven future. With the right digital, cloud and analytics foundation, AMI 2.0 can help utilities improve resilience, efficiency and readiness for the demands of a rapidly changing energy landscape. AMI 2.0 represents more than the next phase of metering modernization; it is a strategic foundation for the intelligent, adaptive and resilient utility of the future. Utilities that act now to build the right data, integration and analytics ecosystem will be better positioned to turn grid complexity into competitive advantage, accelerate decarbonization and elevate customer value. With deep utility domain experience and a clear transformation lens, Cognizant can help organizations shape this vision, translate it into an actionable roadmap and deliver AMI 2.0 at scale.

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