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Modernizing Utility Operations Beyond the Grid

Contents

Modernizing Utility Operations Beyond the Grid 03

Smart Meter Rollouts Are Accelerating: But the Environment Has Changed 03

Connectivity Becomes the Critical Constraint 04

Why Two-Way Communication Changes Smart Meter Operations 05

Extending Command-and-Control to Rural and Off-Grid Deployments with Satellite NTN 06

Designing Smart Meter Connectivity for Decades, Not Deployment Cycles 07

Unlocking the Next Phase of Smart Meter Innovation 08

What Smart Meter OEMs Should Evaluate Next 09

Extending Safety Beyond Infrastructure: Satellite Handheld GPS Messengers for Lone and Remote Workers 10

Building Resilient Systems Beyond the Network Edge 11

Utilities and municipalities are under growing pressure to modernize infrastructure while maintaining reliability, security, and long-term cost control. Smart metering has become a foundational element of this transition, enabling more accurate billing, remote operations, and improved demand management. At the same time, utility providers are expanding IoT deployments to support everything from environmental monitoring to infrastructure health, often across vast, rural, or hard-to-reach areas where traditional connectivity falls short.

As these systems scale, connectivity becomes more than a data transport layer; it becomes a command-and-control center. Two-way communications are increasingly essential, allowing operators not only to collect data but to issue commands, confirm actions, and respond in near real time. This capability is essentially critical in remote deployments, where meters, sensors, and field assets may operate far beyond the reach of terrestrial networks.

Equally important is the human element behind these systems. Utility and municipal workers are frequently deployed alone in isolated environments to install, inspect, or maintain critical infrastructure. Ensuring their safety requires reliable communication that works wherever operations take place. Satellite-enabled IoT and handheld communication devices play a vital role in bridging these gaps, supporting both automated systems and the people responsible for keeping them running.

Satellite-based IoT connectivity supports modern smart metering deployments, enables resilient smart city applications, and enhances safety for lone and remote workers to deliver a unified approach to visibility, control, and resilience across today's distributed utility environments.

Smart Meter Rollouts Are Accelerating: But the Environment Has Changed

Utilities around the world are moving decisively toward large-scale smart meter deployments[1]. What began as regional pilots and phased upgrades is now evolving into long-term infrastructure programs designed to modernize grid operations, improve efficiency, and support more responsive energy management. These deployments are no longer experimental. They are foundational investments expected to operate reliably for decades.

At the same time, the operating environment for smart meters has changed significantly. Utilities are deploying devices across increasingly diverse and challenging locations, from rural distribution lines and remote substations to agricultural regions, mountainous terrain, and other hard-to-reach areas. Many of these locations were never designed with modern communications infrastructure in mind, yet they play a critical role in grid performance and reliability.

Smart meters are also being asked to do more. Beyond periodic usage reporting, utilities now expect greater visibility into system health, remote configuration capabilities, and the ability to interact with devices in near real time. These expanded requirements place new demands on the underlying connectivity, particularly in environments where network availability is inconsistent or difficult to maintain.

Importantly, smart meter programs are designed with long lifecycles in mind. Devices are expected to remain in service for ten, fifteen, or even twenty years. Connectivity decisions made at deployment must therefore account not only for current coverage needs, but also for future regulatory requirements, evolving security standards, and changes in operational expectations over time. Retrofitting or replacing connectivity solutions at scale is costly, disruptive, and often impractical once meters are in the field.

This combination of accelerated rollout timelines, increasingly remote installation environments, expanded device functionality, and long-term operational horizons is reshaping how utilities and smart meter OEMs evaluate connectivity. Coverage alone is no longer sufficient. The ability to deliver reliable, secure, and manageable communication over the full life of a deployment has become a central design consideration.

As utilities look beyond urban and suburban grids and toward comprehensive, nationwide modernization, connectivity must be able to reach wherever the grid extends — not just where terrestrial networks are strongest. This shift is driving renewed focus on solutions that can support smart meter deployments in rural, off-grid, and infrastructure-limited environments without introducing additional complexity or operational risk.

Connectivity Becomes the Critical Constraint

As smart meter deployments scale, connectivity is increasingly the factor that determines success or failure. While urban and suburban environments often benefit from dense cellular coverage, large portions of utility infrastructure extend far beyond those boundaries. Rural distribution networks, isolated substations, agricultural regions, and hard-to-access terrain introduce persistent connectivity gaps that traditional networks struggle to address consistently.

In many of these environments, cellular coverage is intermittent, unavailable, or economically impractical to extend. Even where coverage exists on paper, signal reliability can vary due to terrain, vegetation, distance from towers, or network congestion. For smart meters expected to operate autonomously for years at a time, unreliable connectivity introduces operational risk that utilities cannot afford.

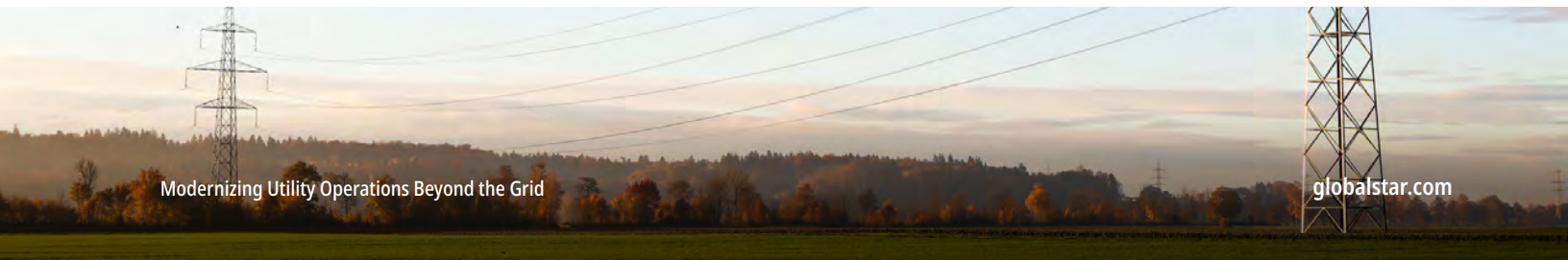
Connectivity limitations directly impact how meters are used. In constrained environments, utilities are often forced to reduce reporting frequency, limit remote interactions, or rely on one-way communication models to preserve power and minimize data transmission failures. These tradeoffs restrict visibility, delay response times, and reduce the overall value of smart meter investments.

At the same time, regulatory and security expectations are increasing. Utilities are facing greater scrutiny around device integrity, data protection, and long-term resilience. Frameworks such as the Radio Equipment Directive (RED) are reshaping requirements around how connected devices authenticate, communicate, and maintain trust over their operational lifetime. Connectivity is no longer just about moving data; it is part of a broader security and compliance posture that must hold up over decades.

This is where flexible Non-Terrestrial Network (NTN) connectivity begins to change the equation. Satellite-based IoT connectivity is inherently designed for wide-area coverage, independent from local infrastructure, and with predictable performance in remote environments. When integrated thoughtfully, NTN solutions extend connectivity to locations that would otherwise require complex network planning, additional hardware, or costly site visits.

Crucially, modern satellite IoT architectures support low-power, efficient communication models that align well with smart meter use cases. Rather than forcing utilities to choose between visibility and battery life, NTN connectivity enables consistent, reliable communication without imposing additional hardware complexity at deployment.

For smart meter OEMs, this shift opens a meaningful opportunity. Connectivity solutions that can operate across rural, off-grid, and infrastructure-poor environments — while supporting evolving security expectations and long device lifecycles — allow OEMs to offer meters that are deployment-ready anywhere utilities operate. As utilities expand modernization efforts beyond population centers, connectivity that adapts to the grid, rather than the other way around, becomes a strategic differentiator.



Why Two-Way Communication Changes Smart Meter Operations

For many smart meter deployments, connectivity has historically been treated as a one-way function: transmit usage data, receive it centrally, and analyze it later. While this approach delivers basic visibility, it limits how utilities can actively manage distributed infrastructure in real time. As grids become more dynamic and regulatory pressure increases, that model is no longer sufficient.

Two-way IoT connectivity introduces a fundamentally different operational paradigm. Instead of meters acting as passive data sources, they become active endpoints that utilities can examine, update, and control remotely. This shift enables a command-and-control model that improves responsiveness, resilience, and long-term efficiency across the network.

With reliable two-way communication in place, utilities can move beyond periodic data collection and toward continuous operational awareness. This capability is particularly valuable in remote and off-grid locations, where physical access is difficult and maintenance windows are limited.

Key operational advantages of two-way smart meter connectivity include:

Remote Configuration and Updates

Utilities can adjust reporting intervals, update firmware, and modify device behavior over the air without dispatching crews. This reduces operational costs and minimizes service disruptions, especially in geographically dispersed networks.

On-Demand Diagnostics and Health Monitoring

Two-way connectivity allows utilities to query meters in real time to assess device health, signal quality, and sensor performance. Issues can be identified and addressed before they escalate into outages or compliance failures.

Faster Response to Anomalies and Events

When abnormal readings, suspected tampering, or service disruptions occur, utilities can immediately request additional data or initiate corrective actions. This shortens response times and improves overall system reliability.

Support for Evolving Security Requirements

As regulatory frameworks place greater emphasis on device integrity and trusted communications, two-way connectivity enables secure authentication, key updates, and policy enforcement throughout the meter's lifecycle.

Improved Power and Resource Management

Rather than operating on fixed schedules, meters can dynamically adjust communication behavior based on operational context, conserving power while maintaining visibility when it matters most.

Importantly, these capabilities are not limited to urban environments. In rural and hard-to-reach areas, two-way connectivity eliminates the traditional tradeoff between visibility and maintainability. Utilities gain the same level of control over remote meters as they do over devices installed near population centers, without relying on inconsistent terrestrial infrastructure.

For smart meter OEMs, enabling two-way communication is no longer just a feature enhancement. It is a way to future-proof devices against changing utility requirements, evolving regulations, and longer deployment lifecycles. As utilities demand greater control, transparency, and resilience from their metering infrastructure, two-way connectivity becomes a requirement rather than an optional upgrade.

Extending Command-and-Control to Rural and Off-Grid Deployments with Satellite NTN

While smart meter rollouts are accelerating globally, many of the most critical deployment locations sit beyond the reach of reliable terrestrial networks. Rural communities, remote substations, agricultural regions, and geographically isolated infrastructure often lack consistent cellular coverage, yet they are subject to the same performance, security, and regulatory expectations as urban systems.

This is where satellite-based Non-Terrestrial Network (NTN) connectivity becomes a strategic enabler rather than a niche option.

Satellite NTN allows utilities to extend two-way command-and-control capabilities to locations that would otherwise require complex network builds, repeaters, or manual intervention. Instead of designing separate connectivity strategies for urban and remote meters, utilities can deploy a unified operational model across their entire footprint.

Key advantages of satellite NTN for smart meter command and control include:

Coverage Where Terrestrial Networks Cannot Reach

Satellite connectivity operates independently of cellular infrastructure, making it ideal for meters deployed in rural, off-grid, and hard-to-access locations. Utilities gain consistent visibility and control without waiting for network expansion or negotiating roaming agreements.

Simplified Architecture for OEMs and Utilities

NTN-enabled designs reduce the need for additional hardware layers or external gateways. This lowers integration complexity for smart meter OEMs while enabling utilities to deploy standardized devices across diverse environments.

Consistent Two-Way Performance at Scale

Satellite NTN supports reliable bidirectional messaging for configuration, diagnostics, and event-driven communication. This ensures command-and-control functions remain available regardless of geography or terrain.

Reduced Operational Dependency on Field Visits

With two-way satellite connectivity, utilities can perform remote updates, investigations, and adjustments without dispatching crews to remote sites. This significantly lowers maintenance costs and improves response times.

Resilience in Infrastructure-Poor or Disaster-Prone Areas

Satellite connectivity remains operational even when terrestrial networks are disrupted by weather events, power outages, or physical damage. This resilience is critical for maintaining grid visibility and compliance during emergencies.

Future-Ready for Regulatory and Security Evolution

As security standards evolve, satellite NTN supports secure, over-the-air updates and device authentication, helping utilities maintain compliance across long meter lifecycles.

By enabling two-way communication over satellite NTN, utilities eliminate the traditional tradeoff between coverage and control. Remote meters no longer operate as second-class endpoints with limited functionality. Instead, they become fully integrated components of a modern, responsive, and secure metering network.

For smart meter OEMs, this approach opens new markets and deployment scenarios without increasing system complexity. For utilities, it delivers the operational confidence needed to manage distributed infrastructure reliably for decades.

Designing Smart Meter Connectivity for Decades, Not Deployment Cycles

Smart meters are not short-lived IoT endpoints. Utilities expect deployments to remain operational for 10, 15, or even 20 years, often in environments that are difficult to access, costly to service, and slow to upgrade. As a result, connectivity decisions made today have long-term consequences for operational cost, security posture, and regulatory compliance.

This reality places new pressure on smart meter OEMs to deliver solutions that are not only functional at launch, but resilient and adaptable over time.

Two-way satellite NTN connectivity plays a critical role in meeting these long-term expectations by supporting evolving operational and regulatory needs without requiring hardware replacement or major network redesigns.

Key lifecycle benefits include:

Longevity Without Connectivity Obsolescence

Satellite networks are designed for long-term service continuity, making them well-suited for infrastructure with multi-decade lifespans. Unlike terrestrial technologies that may be sunset, refarmed, or regionally inconsistent, satellite provides a stable foundation for long-lived deployments.

Security That Evolves Over the Device Lifecycle

As regulatory frameworks such as RED continue to strengthen security requirements, two-way connectivity enables remote updates, credential management, and policy enforcement. This ensures devices remain compliant long after initial installation.

Future-Proof Command-and-Control Capabilities

Over time, utilities often expand how they use meter data, adding new diagnostics, alerts, or operational workflows. Two-way satellite connectivity allows these capabilities to be introduced through software rather than new hardware.

Reduced Total Cost of Ownership Over Time

Minimizing site visits, avoiding premature device replacement, and maintaining consistent connectivity across remote regions all contribute to lower lifetime operational costs. These savings compound as deployments scale.

Confidence in Serving Rural and Hard-to-Reach Customers

Rural and off-grid installations are often the most expensive to support manually. Satellite-enabled command and control allows utilities to deliver the same service quality, reliability, and responsiveness regardless of location.

For utilities, this approach ensures that smart meter investments remain viable as regulatory expectations, security standards, and operational needs evolve. For OEMs, it provides a clear path to building differentiated, future-ready products that utilities can deploy with confidence at scale.

By pairing two-way satellite NTN connectivity with modern smart meter architectures, the industry can move beyond connectivity as a constraint and instead treat it as a long-term operational asset.

Unlocking the Next Phase of Smart Meter Innovation

As smart meter programs expand into more remote, regulated, and security-sensitive environments, connectivity is no longer a background technical decision. It is a strategic enabler that determines how effectively utilities can operate, adapt, and comply over time.

For smart meter OEMs, this shift represents a meaningful opportunity. Utilities are actively seeking solutions that reduce operational risk, extend asset lifecycles, and support secure, two-way command and control across their entire service territory, including rural and off-grid locations where traditional networks fall short.

Two-way satellite NTN connectivity offers a practical path forward. By extending reliable coverage without adding hardware complexity, enabling secure remote management, and supporting evolving regulatory requirements, it allows OEMs to deliver meters that are built for long-term utility needs rather than short-term connectivity constraints.

This approach enables:

- Broader addressable markets, including underserved rural regions
- Stronger differentiation through lifecycle resilience and security readiness
- Simpler deployments that scale globally without roaming or carrier dependencies
- Long-term utility confidence in connectivity that will not become obsolete

As utilities modernize infrastructure and regulators continue to raise expectations around security and reliability, smart meter platforms must evolve accordingly. OEMs that integrate flexible, two-way satellite connectivity into their designs are well positioned to support this next phase of deployment, while creating products that utilities can trust for decades.

The future of smart metering will be defined not just by data collection, but by secure, resilient, and adaptable communication. Two-way satellite NTN connectivity provides the foundation to make that future possible.

What Smart Meter OEMs Should Evaluate Next

As utilities rethink connectivity strategies for long-life infrastructure, smart meter OEMs face a critical design decision: how to future-proof devices without increasing cost, complexity, or deployment risk.

Connectivity choices made today will shape how meters perform, comply, and evolve over the next 10 to 20 years. That makes it essential for OEMs to evaluate not just coverage and power consumption, but also long-term flexibility, security posture, and operational control.

When assessing two-way satellite NTN connectivity for smart metering applications, OEMs should consider:

Coverage durability

Can the connectivity layer reliably support meters deployed in rural, off-grid, or hard-to-reach locations over the full asset lifecycle?

Command and control capability

Does the solution enable secure two-way communication for configuration updates, diagnostics, and response actions without on-site intervention?

Security and regulatory alignment

Is the connectivity architecture designed to support evolving requirements such as RED, trusted components, and device integrity expectations?

Integration simplicity

Can satellite connectivity be added without redesigning hardware or maintaining multiple device variants for different regions?

Scalability over time

Will the solution remain viable as deployments grow from pilots to millions of meters across diverse geographies?

For OEMs, the goal is not to replace existing connectivity models, but to extend them. Two-way satellite NTN connectivity provides a complementary layer that fills coverage gaps, strengthens security, and unlocks new deployment opportunities without disrupting existing designs.

By evaluating connectivity through a lifecycle lens rather than a deployment snapshot, smart meter OEMs can deliver platforms that utilities trust, regulators approve, and operations teams rely on long after installation.

Extending Safety Beyond Infrastructure: Satellite Handheld GPS Messengers for Lone and Remote Workers

While smart meters and connected infrastructure form the backbone of modern utility operations, people remain at the center of deployment, maintenance, and response. Utility workers, including field technicians, inspectors, and contractors are routinely dispatched to remote substations, rural metering points, pipelines, and grid assets — often working alone and far beyond reliable cellular coverage.

In these environments, satellite handheld GPS messengers provide a critical layer of protection that traditional communications cannot. Unlike smartphones or radio systems that depend on terrestrial networks, satellite handheld devices operate independently of local infrastructure, ensuring workers remain connected, wherever their jobs take them.

These devices enable workers to:

- Send and receive messages beyond cellular coverage, allowing routine check-ins and coordination with operations teams
- Enable an SOS in emergencies, automatically transmitting GPS location to emergency responders
- Share real-time location and status, improving situational awareness for supervisors and safety managers
- Maintain confidence and autonomy, particularly in high-risk or isolated working conditions

From a utility perspective, satellite handheld GPS messengers support duty-of-care obligations while reducing operational risk. They offer a simple, low-maintenance way to extend safety coverage without deploying additional network infrastructure or relying on inconsistent connectivity. Importantly, they integrate naturally into broader safety workflows, acting as a personal lifeline for workers while smart meters and sensors handle asset-level monitoring.

As utilities continue expanding operations into rural and off-grid regions, combining connected infrastructure with satellite-enabled worker safety tools creates a more resilient, human-centered operational model — one that protects both assets and the people responsible for maintaining them.

Building Resilient Systems Beyond the Network Edge

As smart metering, smart city infrastructure, and remote workforce operations continue to expand beyond urban centers, connectivity must evolve alongside them. These applications increasingly operate in environments where terrestrial networks are limited, intermittent, or nonexistent, yet expectations for reliability, security, and responsiveness continue to rise.

Smart metering depends on consistent data flow to support accurate billing, infrastructure planning, and regulatory compliance. Smart city systems require scalable visibility across distributed assets, environmental conditions, and critical services. Remote and lone workers rely on dependable communication to maintain safety, situational awareness, and access to assistance when operating far from traditional infrastructure. In each case, connectivity is not simply about transmitting data. It is about ensuring continuity, control, and confidence in operations that cannot afford blind spots.

Satellite connectivity plays a unifying role across these use cases by extending coverage to rural, off-grid, and hard-to-reach locations without adding operational complexity. One-way communication establishes visibility across widely distributed systems, while two-way capability enables command, control, and adaptive response as conditions change. Together, they support long-lived deployments designed to operate reliably for years, not just during pilot phases.

As utilities, municipalities, and infrastructure operators plan for the next generation of connected systems, the ability to combine monitoring, control, and worker safety into a cohesive connectivity strategy becomes increasingly important. Solutions that support smart assets and the people who manage them create a more resilient foundation, one that enables smarter decisions, faster response, and safer operations wherever the work takes place.

Learn more about how to enable smart infrastructure by reaching out to our team.

1. https://www.grandviewresearch.com/industry-analysis/smart-meter-market-report