

SOLUTION BRIEF

Enhancing power utilities with 4G/5G private wireless communication

Driving digitization and efficiency in the energy sector

NOKIA



1. The future of utilities

The energy sector is facing significant challenges, including aging infrastructure, the shift from fossil fuels to renewable energy, the move from centralized to distributed generation, and the transition to smart, automated systems. Renewable energy generation by consumers and advances in battery storage are also reshaping grid operations. To address these challenges, power utilities need a reliable, secure communication network that supports decarbonization and ensures a stable energy supply.

Technologies such as industrial IoT, artificial intelligence (AI), virtual reality (VR), advanced analytics and cognitive

cybersecurity are already available to enhance operations. These tools enable real-time grid control, automation-driven distribution, predictive maintenance and improved efficiency.

The key to unlocking these advantages and mission-critical use cases lies in one essential factor: **reliable connectivity**.

To fully embrace digital transformation, your organization needs industrial-grade wireless connectivity. With a private LTE or 5G network, you can achieve real operational efficiency gains and position your organization for the adoption of advanced technologies that drive business growth.

Nokia's private wireless networks offer the secure, high-performance foundation needed for this energy transition. Built on 3GPP standards, we provide low latency, high reliability and robust security, protecting sensitive data and infrastructure from cyber threats. Designed to meet the stringent requirements of country-wide networks, our solutions go beyond what public mobile networks can offer.

For more on how Nokia is digitizing the energy landscape and securing a sustainable future, read this solution brief.

2. Power utilities use cases enabled by private LTE or 5G

Power utilities are under increasing pressure to integrate renewable energy resources, expand advanced metering infrastructure (AMI) and enhance the efficiency and security of their power grids. Below, we explore key use cases and the network requirements needed to support them:

- **Distribution automation:** This is central to grid modernization, enabling real-time management to optimize performance, balance supply and demand, and integrate renewable energy and battery storage, which are all supported by secure wireless communication.
- **Application-specific FAN convergence:** By converging application-specific field area networks (FAN), utilities can reduce costs and improve operational flexibility. Low-latency connectivity powers digitalization, automation and interconnected distributed generation and storage, helping utilities adapt to evolving energy demands.
- **Advanced Metering Infrastructure (AMI) meter connectivity:** Smart meters, crucial for grid modernization, provide real-time monitoring, network diagnostics, and secure data backhaul via private wireless networks, enhancing reliability, security and flexibility.
- **Extending network reach:** Extend your network seamlessly to reach meters deployed in new areas using Narrowband Internet of Things (NB-IoT) and LTE for Machines (LTE-M), which simplify operations. Upcoming Reduced Capacity (RedCap) features in 5G Standalone (SA) networks will further unify services, supporting high-speed IoT applications and advanced use cases, such as media transmission.
- **Field force enablement:** Mission-critical push-to-talk (MCPTT) communications enable efficient collaboration and access to essential applications, boosting safety and productivity. With Push-to-Talk, Push-to-Video, and broadband data capabilities, utilities can reduce costs and complexity while improving situational awareness through a single converged network that supports both field operations and grid management.



Additionally, technologies such as augmented reality and virtual reality (AR/VR) and artificial intelligence and machine learning (AI/ML) enable new use cases such as:

- **Training & Safety with VR/AR:** VR/AR tools enhance worker training and safety, leveraging private LTE/5G networks for immersive, low-latency experiences. These tools enable highly effective, low-latency simulations that enhance skills and ensure workers are well-prepared for real-world tasks. Video analytics can assess worker readiness, identifying potential safety gaps, and immediately alerting the operations center in the event of a 'man down' situation. As demand for these capabilities grows, small cells ensure a seamless transition to 5G, unlocking ultra-low latency performance and enhanced safety features.
- **Predictive Maintenance:** Real-time analytics-driven maintenance improves grid reliability and operational efficiency, enabling proactive issue resolution. By leveraging data from IoT

devices such as smart meters and sensors, utilities can gain valuable insights into the health of their equipment and infrastructure. When artificial intelligence (AI) and machine learning (ML) are implemented, large amounts of data can be analyzed, providing deeper insights into the network and enabling more efficient grid management.

- **Drone Operations:** Private networks support reliable, high-quality data transfer for drone inspections, enhancing safety and reducing costs compared to traditional methods. Traditionally, helicopters are used for inspecting large areas of power lines and grid networks. Flying helicopters requires specialized personnel, special permission and licenses. The operations are expensive and put personnel at safety risk. To combat

these issues, unmanned drones can be used for use cases such as:

- **Power line inspections:** Power utilities can inspect their power lines and transmission towers from a safer distance, leading to faster, cheaper, more comprehensive and accurate intel.
- **Wind turbine inspections:** Wind turbine drone inspections can identify blade delamination, core defects, internal component failure and other key defects.
- **Solar parks inspections:** Using drones facilitates remote maintenance of solar panels, while also increasing site security and surveillance, as well as measuring the growth of vegetation, weather degradation and planning maintenance.



The adoption of LTE/5G technology is pivotal for power utilities striving to meet the evolving demands of modern energy infrastructure. The specific network requirements vary based on each use case:

- **Reliability & Resilience:** 4G/5G networks provide the robust, low-latency communication needed for seamless grid operations and quick disruption responses.
- **Security:** 5G's advanced security features protect critical operations and infrastructure from cyber threats, ensuring grid integrity.
- **Operational Efficiency:** Consolidating network management through Nokia private wireless networks reduces complexity and costs, streamlining operations.
- **Regulatory Compliance:** 4G/5G networks support regulatory requirements by enabling accurate monitoring and reporting.
- **Sustainability:** 4G/5G facilitates the integration of renewable energy and improves energy efficiency, supporting the transition to a smart, flexible power grid.

While existing technologies like DWDM, microwave transport, IP/MPLS, and TETRA remain valuable, private wireless solutions offer enhancements, particularly in overcoming TETRA's limitations. For nationwide coverage, such as in the 450connect project, private wireless networks provide the advanced capabilities needed to meet the evolving demands of power utilities.

410/450 MHz Spectrum for Utilities in Europe

The 410/450 MHz spectrum is ideal for power utilities due to its superior coverage in rural areas and penetration through obstacles. It offers reliable communication for large-scale utility networks with cost-effective deployment. A private network operating on this spectrum ensures a robust and secure communication backbone.

The **450 MHz Alliance** is an industry association focused on the 400/450 MHz spectrum ecosystem, uniting stakeholders within this frequency band. Nokia, as a member, actively contributes to this collaborative effort.

B106 (900 MHz Spectrum) for utilities in North America

Band 106 (B106) is a crucial piece of the puzzle for expanding 5G adoption in North America, particularly in the utility industry. Operating in the 900 MHz spectrum, B106 offers a unique combination of long-range coverage, reliable penetration through obstacles and robust data capacity. This makes it ideal for supporting mission-critical applications in utilities, such as smart grid management, remote asset monitoring and emergency communications, even in challenging environments. The standardization of B106, as part of 3GPP Release 18, is paving the way for a wider ecosystem of devices and chipsets, simplifying private 5G adoption for utilities and unlocking the full potential of this transformative technology. A key player in this landscape is Nokia partner, Anterix, the largest holder of licensed spectrum in the 900 MHz band (896-901/935-940 MHz) across the contiguous United States, Alaska, Hawaii and Puerto Rico, with a focus on private wireless networks for utilities and critical infrastructure entities.



3. Choosing the right network for power utilities

Maintaining grid stability and power quality while integrating distributed energy resources is crucial for power utilities. However, achieving these benefits hinges on one key factor: **connectivity**. Unfortunately, most existing wireless networks, including their Radio Access Networks (RAN), weren't designed to support the new business-critical use cases required for smarter, more agile grids. These networks lack the latency, performance and connectivity needed for real-time grid management and optimization, which are essential as grids increasingly combine centralized generation with distributed renewables, micro-generation, and large-scale storage.

To truly harness the potential of private wireless, utilities need **industrial-grade, pervasive wireless connectivity**. A private 4G/5G network, supported by advanced mobile network technology, can deliver immediate operational efficiency and prepare your organization for the future. Nokia has been at the forefront of pioneering small cell technology for private industrial networks, enabling utilities to build a strong RAN foundation.

With private wireless networks, utilities can meet today's needs while ensuring a seamless evolution to further

generations of connectivity. A dedicated private wireless network built for industrial applications offers:

- **Intrinsic security** to ensure compliant and reliable connections
- **Mission-critical reliability** for continuous operations
- **Deep, wide coverage** to connect everyone and everything
- **Predictable performance** for automation and real-time asset coordination
- **High capacity** to manage the rapid growth of devices, sensors, and data
- **Greater operational control and flexibility** to enhance safety and respond quickly to business changes
- **Effortless mobility** based on trusted 3GPP mobile standards

This robust infrastructure, anchored by an efficient mobile network, will support the critical operational connectivity required for your utility's future success.

Mission critical communications networks

Private LTE/5G networks are essential in driving digital transformation and enabling new use cases for power utilities. Their effectiveness is amplified when integrated into Nokia's comprehensive mission-critical communication networks. This best-of-breed portfolio includes optical transport, IP routing, data center networks, 5G core, advanced security, automation solutions and analytics powered by artificial intelligence. Together, these technologies create a secure, and future-ready ecosystem that supports effective connectivity, operational efficiency and next-generation applications.



4. Nokia private wireless connectivity portfolio for utilities

AirScale Radio Access Network portfolio

Central to Nokia's offering is the AirScale Radio Access Network (RAN) portfolio, which spans all network sizes from small campus or industrial sites to mid-size regional networks and nationwide deployments:

- **AirScale BTS portfolio**, designed for high capacity and performance, which includes:
 - Macro Remote Radio Head (RRH) FDD/TDD for **wider coverage**
 - Massive Antenna Array (MAA), Micro Remote Radio Head (mRRH), Airscale Micro Remote (Radio) (ASMR), Airscale Indoor Radio (ASiR) for **small coverage**

Additionally, our **Kolibri all-in-one (AiO) solution** combines baseband, radio and integrated antenna for both indoor and outdoor applications

These products are all managed by Nokia MantaRay Network Management (NM).





Nokia also offers our enterprise 5G core solutions:

- **Nokia Modular Private Wireless (MPW):** Designed for industries needing highly customizable private networks, such as manufacturing, logistics and mining. It provides a flexible architecture that supports both fully owned private networks and seamless carrier network integration, offering versatility in operations and maintenance.
- **Nokia Core Enterprise Solutions (NCES):** Geared toward power utilities and critical infrastructure sectors that require large-scale, resilient networks. With a focus on reducing Total Cost of Ownership (TCO), NCES provides future-proof, carrier-grade solutions that ensure regulatory compliance, with options for fully owned networks, Mobile Virtual Network Operator (MVNO), or network slicing.

Nokia's 4G/LTE and 5G performance is built on a unified software platform for all Radio Access Technologies (RAT), offering the most comprehensive enterprise feature set. As a pioneer in private LTE for industrial use, Nokia leads the market in small cell technology, providing power utilities with cutting-edge communication solutions.

Nokia's anyRAN approach includes third-party core solutions from partners like Cisco and HP/Athonet, ensuring flexibility and broad compatibility. This versatile RAN portfolio is tailored for industrial use, maximizing spectrum utilization to meet the diverse needs of power utilities. By leveraging these technologies, Nokia is driving the digital transformation of the energy sector, offering secure, reliable and sustainable communication solutions globally.

5. Successful commercial deployments

450connect, Germany

Nokia's work on the 450connect project in Germany, showcases how private networks meet the demanding needs of power utilities. Nokia provides nationwide LTE and LTE-M coverage for critical voice and M2M services, ensuring robust and reliable communication.

Key features include 72-hour power backup at base stations, a dedicated backbone ring for security, georedundant LTE cores, and Mission Critical Push-to-Talk (MCPTT) across two locations. Redundant microwave links and prioritized radio services further enhance network reliability and resilience.

Nokia's solution includes geo-redundant LTE cores, a robust RAN network, Wavence microwave backhaul, power backup, and management solutions, with comprehensive support services. Nokia also offers 20 years of lifecycle management for this critical network, ensuring long-term reliability.

The Nokia LTE450 technology is ideally suited for wide-area coverage and essential services like voice, M2M, and IoT applications for critical infrastructure.



ESB, Republic of Ireland

Nokia's private wireless network plays a crucial role in decarbonizing the electricity system and supporting the integration of renewable energy into the grid. The solution improves fault resolution speed, reduces outage durations, and enhances control and visibility of the electrical network.

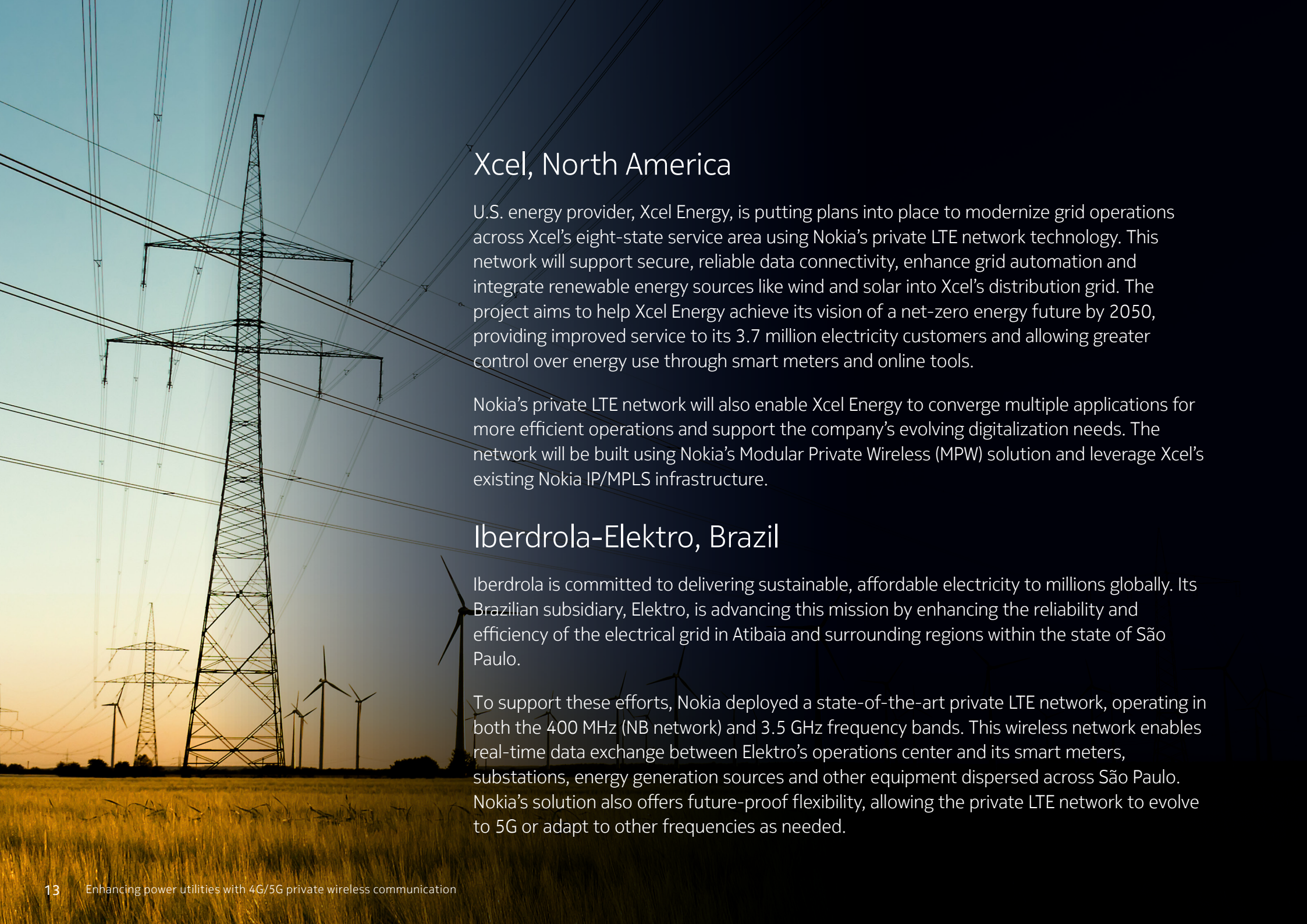
The deployment, covering 90 sites, includes a Private LTE core and RAN network in partnership with Sigma Wireless, operating in ESB's licensed spectrum (410-414 MHz and 420-424 MHz) and compliant with 3GPP Band 87. Designed with Release 16 3GPP standards, the solution meets ESB's specific operational needs.

The expected outcome is a smarter, more agile electricity network that supports a sustainable future by enabling renewable energy integration, decarbonization, and the electrification of heat and transport.

National Grid Distribution, UK

Nokia has provided a private 4.9G/LTE wireless network to Western Power Distribution (WPD) in the UK for SCADA testing and other mission-critical systems, including voice services. This network, part of WPD's "LTE Connecting Futures" trial, is aimed at enabling a smart grid and was tested at WPD's Test and Development Center in Taunton. The network supports secure and reliable operations across WPD's electricity distribution areas in the Midlands, South West, and Wales.

Nokia collaborated with WPD to install and test the network, including the Nokia Group Communications Talk/Video solution and industrial user equipment. The trials demonstrated the suitability of 4.9G/LTE for supporting smart grid operations, including various grid use cases and private wireless network slicing.



Xcel, North America

U.S. energy provider, Xcel Energy, is putting plans into place to modernize grid operations across Xcel's eight-state service area using Nokia's private LTE network technology. This network will support secure, reliable data connectivity, enhance grid automation and integrate renewable energy sources like wind and solar into Xcel's distribution grid. The project aims to help Xcel Energy achieve its vision of a net-zero energy future by 2050, providing improved service to its 3.7 million electricity customers and allowing greater control over energy use through smart meters and online tools.

Nokia's private LTE network will also enable Xcel Energy to converge multiple applications for more efficient operations and support the company's evolving digitalization needs. The network will be built using Nokia's Modular Private Wireless (MPW) solution and leverage Xcel's existing Nokia IP/MPLS infrastructure.

Iberdrola-Elektro, Brazil

Iberdrola is committed to delivering sustainable, affordable electricity to millions globally. Its Brazilian subsidiary, Elektro, is advancing this mission by enhancing the reliability and efficiency of the electrical grid in Atibaia and surrounding regions within the state of São Paulo.

To support these efforts, Nokia deployed a state-of-the-art private LTE network, operating in both the 400 MHz (NB network) and 3.5 GHz frequency bands. This wireless network enables real-time data exchange between Elektro's operations center and its smart meters, substations, energy generation sources and other equipment dispersed across São Paulo. Nokia's solution also offers future-proof flexibility, allowing the private LTE network to evolve to 5G or adapt to other frequencies as needed.



6. Why Nokia?

Nokia's leadership in private wireless networks is crucial in transforming the energy sector and aligning with the company's Environmental, Social and Governance (ESG) goals. The shift to smart grids, new use cases and innovative business models demands reliable, secure and sustainable communication networks—qualities Nokia's private wireless solutions deliver. As the market leader in private wireless, Nokia serves over 795 customers, including 169 power utilities worldwide. Our comprehensive suite of solutions, including small cells, cloud packet core, IP and optical transport, and common management, ensures utilities are equipped to meet future challenges.

Nokia's approach is further strengthened by a strong ecosystem of industrial partners and professional services, from end-to-end management and orchestration to design, deployment and maintenance. Innovations from Nokia Bell Labs enhance these offerings, helping power utilities transition smoothly to advanced communication networks, improving operational efficiency and sustainability.

As utilities confront the challenges of aging infrastructure, the shift to renewable energy, and the move from centralized to distributed generation, the need for innovative, reliable solutions is critical. Nokia's cutting-edge technology and extensive experience across various verticals equip power utilities to confidently navigate these changes, ensuring a stable energy supply and supporting the transition to a sustainable future.

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At Nokia, we create technology that helps the world act together.

As a B2B technology innovation leader, we are pioneering networks that sense, think and act by leveraging our work across mobile, fixed and cloud networks. In addition, we create value with intellectual property and long-term research, led by the award-winning Nokia Bell Labs.

With truly open architectures that seamlessly integrate into any ecosystem, our high-performance networks create new opportunities for monetization and scale. Service providers, enterprises and partners worldwide trust Nokia to deliver secure, reliable and sustainable networks today – and work with us to create the digital services and applications of the future.

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