Developing mission-critical grid communications
With a growing combination of micro-generation by renewables and conservation measures by households and industry, today’s power utilities are confronting lower demand for their energy with traditional revenues flat or declining. As these trends only deepen, utilities have to decide if they will remain as transmission or distribution operators (TSO/DSO), or add to their portfolio by entering into the renewables market. They can also leverage their assets and right of ways to offer new smart city services, such as smart poles to provide LED lighting, electric car plug-ins, small cell wireless communications and closed-circuit television (CCTV).

Those who choose to continue as TSOs/DSOs will need to focus on optimizing costs and extending their communications deeper into the grid to control and automate distribution for greater efficiencies. Analytics will play a key role, using artificial intelligence and machine learning to identify efficiencies and drive automated control. Those who enter into renewables will also need to extend communications further into the smart grid for control and automation of micro-generation, storage and demand-side response (DSR). Similarly, those who choose to offer new smart services will need to extend their communications network to support these services. All of these approaches will require a mission-critical network paired with multi-cloud, analytics, and machine-learning capabilities. Such a high-performance network should be capable not only of supporting multiple communications sub-systems, but should make possible applications such as predictive maintenance, workforce optimization and safety, asset optimization, and smart-grid billing systems for an improved customer experience.

**Nokia and power utilities**

Nokia is a global leader innovating the technologies at the heart of our connected world. We understand that smart, dynamic networks will be the foundation for the digital transformation of society, including our energy sector. The Nokia Bell Labs Future X architecture is a connected, digital platform that supports and fosters new applications and services for greater productivity and innovation, richer experiences and enhanced quality of life.

As a leader in mission-critical communications, we believe that building this dynamic, connected platform is the best starting point for achieving smarter, more flexible utility grids and expanding the services offered by utilities. It is the architecture needed for tomorrow’s agile, mission-critical grid communications. We are committed to helping utilities build this smart foundation and, in this way, realize their goals for taking their businesses to the next level.
Renewable energy sources, such as wind and solar, not only reduce the carbon footprint, they can dramatically change electricity costs for households and industries, especially when spurred by government subsidies designed to shift the energy mix. Along with energy conservation, renewables can significantly reduce grid-distributed electricity. Renewables also generate surplus power during peak hours of sunshine or wind, which then flows back into the grid. This poses a number of technical and business challenges for the transmission and distribution of electricity.

Foremost, TSOs/DSOs in many markets are seeing demand and prices for electricity plateau and even drop. Accommodating distributed micro-generation that is not under direct utility control requires a smarter, more agile grid. Power system management and information and communications technologies are required to orchestrate the interplay between renewables, storage and other elements of the energy system, such as demand-side response DSR.

One good piece of news is that the investment in information and communications technologies also has the potential to lower grid operating costs, including power theft. Historically, the lack of predictability and load control made it necessary to over-produce electricity to be able to cover spikes in demand. Along with the loss of power from long-haul transmission, the old grid was very inefficient. DSR and other smart grid technologies, mixed with environmental sensing (predicting wind and solar levels), and cognitive analytics and machine learning, have the potential to lower operating costs through intelligent management.

Some TSOs and DSOs have gone beyond upgrading their grids and are entering the renewables market themselves. Initially, they invested in large-scale renewable installations such as wind and solar farms, and geothermal and biofuel plants. These large-scale generation sources tended to fit more naturally into the traditional grid design. However, driven by government policies and economic incentives in many markets,

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### Challenges and opportunities for utilities

- **6.7%** Increase in renewable generation compared to 2015
- **1160 TWh** Increase in electricity generation from renewables since 2012
- **31%** Increase in solar power generation compared to 2015
- **$US19bn** Amount of public investment in renewables in 2016

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Source: IRENA, Worldwide renewable energy highlights, 8 July 2018. IRENA’s renewable energy statistics can be downloaded from resourceirena.irena.org
Foremost, transmission and distribution operators in many markets are seeing demand and prices for electricity plateau and even drop. Accommodating distributed micro-generation that is not under direct utility control requires a smarter, more agile grid.

Utilities are now experimenting with centrally managed distributed energy resources (DERs), which can be virtually managed as if they were a single power source. Powered by micro-generation and without the same transmission losses, DERs can also integrate with distributed storage technologies (including electric vehicles (EVs) and house batteries) and targeted management and cooperation schemes (e.g., neighbors exchanging or selling power to each other when on vacation or installing solar near businesses that use most of their power in the middle of the day). Again, information and communications technologies are critical to integrating DERs into the existing grid.

DSOs also have the opportunity, when regulators allow it, to leverage their investment in advanced information and communications technologies to offer telecom and smart city services. This extension of their business leverages other assets, such as rights of way and distribution networks, to offer new broadband services typically in underserved areas. Installing street furniture, such as smart poles, they can also offer new services such as street-side EV charging, LED lighting and city-wide CCTV — all powered by the same mission-critical communications technologies needed to manage the smart grid. These same communications can also support the data and grid control for new transaction services that enable neighbors to sell excess power to each other when on vacation.

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1. Source: U.S. Government data compiled by Bloomberg
2. Source: Sierra Club
The Future X architecture for power utilities

The Nokia Bell Labs Future X architecture for power utilities provides an intelligent, dynamic communications and cloud-based platform as the foundation for smart grids. This smart platform will interconnect all of the individual systems, processes and activities, and provide integrated analytics, machine learning and digital support for innovative new applications and services.

At the deepest level of the Future X architecture lies dedicated universal broadband connectivity, both wireless and wired, making every kind of communication and information exchange possible. Built with a dynamic mesh fabric around a mission-critical IP/MPLS and optical core, it uses LTE today (and 5G tomorrow), as well as multiple other fixed and wireless access types, to connect to everything from customer smart meters to mobile workers using push-to-talk communications, all securely and with the highest reliability.

Cloud technology is essential to the Future X architecture, ensuring the flexibility, scalability and universal availability of both data and intelligence. Placed throughout the
Communications network fabric, local and distributed edge clouds ensure the ultra-low latencies required for response times in automated wide area protection systems, for instance. Cloud-native, software-defined communications networks dynamically allocate capacity when and wherever it’s needed, ensuring quality of service for deterministic systems such as teleprotection.

Built into the Future X architecture are data processing capabilities and analytics, including machine learning and artificial intelligence systems. These can be leveraged to play a critical role in improving distributed generation management, identifying and even predicting outages and better managing and maintaining assets. The platform includes analytics, sensor and device management, digital operations and machine learning; together they provide a digital value platform that can be leveraged by many smart grid applications.

We believe that the Nokia Bell Labs Future X architecture will help power utilities to make their grids smarter, more reliable and responsive to shifting power generation and consumption. It will also help to make their operations more efficient, lowering costs and improving asset utilization. Finally, for some utilities, it will also offer a broadband communications platform for new services and a transition to new business models.

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Use cases for power utilities:

Field-area networks (FANs)
The Nokia FAN solution for power utilities provides reliable, secure, ubiquitous and cost-effective smart grid communications for distribution automation, substation automation, distributed generation and advanced metering infrastructure. It also provides the required communications foundation for a utility to deploy their IoT strategy. Nokia offers the flexibility to choose from a broad range of technologies, including LTE, DSL and FTTx to effectively address a utility’s range of applications. Nokia has the experience to integrate the technology that best meets the utility’s business drivers, and can ensure that the FAN interoperates seamlessly with WANs, LANs and neighborhood area networks (NANs). For example, the services and management capabilities of IP/MPLS used in the WAN can be extended over a private LTE network to critical sites to ensure the required performance while simplifying operations.

Wide-area networks (WANs)
The ongoing migration to smart grid technologies will enable power utilities worldwide to operate their electric systems more efficiently. Substation automation, distribution automation and a variety of new applications will revolutionize the way utilities manage and deliver electricity to customers. To truly enable the full potential of smart grids, a smarter communications infrastructure is needed to route the increasing amounts of monitoring, control and status information effectively, efficiently and on time. A converged, mission-critical WAN built on IP/MPLS, packet microwave and packet optical networking technologies provides the flexibility, security, and scalability to support smart grid communication, as well as application-aware traffic management to ensure high quality of service (QoS) for critical grid applications. IP/MPLS also supports teleprotection applications using label-switched paths to ensure that all packets associated with teleprotection follow the same path and predetermined delay targets are always met.

Cyber-security
Cyber-attacks have the potential to severely impact power grids. Multi-layered protection is vital for securing the smart grid from end to end. Utilities must comply with regional security regulations, such as NERC CIP in North America, as well as standards and guidelines defined by organizations including NIST, IEC, and ISO. The Nokia Smart Grid Communications solution is designed and tested to meet these standards. Our award-winning security technology is paired with services from Nokia’s certified security professionals to keep electrical grids secure.

Scene analytics
Nokia SpaceTime scene analytics solution transforms video surveillance and opens the door to new CCTV applications with technologies that detect unusual or unexpected activities as they happen. It can help you manage safety, security and operational continuity in a proactive and automated way. Scene analytics lets you use computer vision and machine learning algorithms to process thousands of streams from video cameras and IoT sensors in real time. If the solution detects an anomaly, it sends an instant alert with insights and footage that help you prioritize and address the problem. By deploying scene analytics, you can: reduce video streaming, storage and monitoring costs, swiftly identify and mitigate any safety, security and operational risks and proactively protect workers and the public from dangerous or life-threatening situations.
Brazilian power distributor Elektro, part of the Neoenergia/Iberdrola group, is deploying a private LTE network for automation to increase the reliability and efficiency of the electrical grid in the City of Atibaia and surrounding areas in the state of Sao Paulo. This will provide critical connectivity for grid equipment, smart meters, substations and distributed energy generation sources throughout the service area, enabling grid automation through real-time exchange of information between these devices and Elektro’s Operations Center in Campinas. Their objectives are to quickly identify events on the electrical grid for rapid restoration in case of failure and to avoid outages, even before they occur, helping ensure high-quality service for Elektro’s customers.

The LTE network is deployed in the 3.5 GHz frequency band, the first such installation in South America. The project reinforces Nokia’s strong track record of providing mission-critical networks to power utilities. The private LTE deployment will provide the large-scale connectivity, extensive coverage and high-bandwidth service needed by Elektro to extend the reach of its network into their distribution grid, making it much smarter.

This solution will also provide an evolution path to 5G technology in the future, which will offer an array of additional capabilities to keep pace with the fast-evolving utility market.

Customer case story:

Private LTE network strengthens power grid reliability and efficiency

“Neoenergia is committed to sustainable development and the full digitalization of its networks. The project in Atibaia is a pioneering effort here in Brazil, and will deliver increased power efficiency to bring both increased quality and cost savings to our customers. As important, this deployment will enable the introduction of distributed power resources in the future, such as photovoltaic generation and electric vehicles, while providing the required communications for our transformation to new business models.”

Mario Ruiz-Tagle, President of Neoenergia
As a leader in power utility communications, we believe that the Nokia Bell Labs Future X architecture is the best starting point for achieving advanced smart grid communications. Nokia is well placed to support power utilities with over 30 years’ experience in mission critical utility communications networks and the most complete portfolio of products and services to support your communication needs.

Complementing our portfolio of utility solutions, Bell Labs Consulting will help you plan for the future and understand the business case benefits of new technologies using a structured methodology for establishing quantifiable outcomes for your power grid operations. Nokia professional services can help you leverage your technology platforms for transformation and growth. Our 30 years of experience with critical utility communications and helping more than 120 utilities modernize their operational communications will help accelerate your transformation while optimizing its risk.

networks.nokia.com/industries/power-utilities

Solutions for mission-critical grid communications
About Nokia
We create technology that helps the world act together.

As a trusted partner for critical networks, we are committed to innovation and technology leadership across mobile, fixed and cloud networks. We create value with intellectual property and long-term research, led by the award-winning Nokia Bell Labs.

Adhering to the highest standards of integrity and security, we help build the capabilities needed for a more productive, sustainable and inclusive world.

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