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The Relationship Between Smart Grids and Smart Cities

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In a smart city, energy, water, transportation, public health and safety, and other key services are managed in concert to support smooth operation of critical infrastructure while providing for a clean, economic and safe environment in which to live, work and play. Timely logistics information will be gathered and supplied to the public by all means available, but particularly through social media networks. Conservation, efficiency and safety will all be greatly enhanced.

The energy infrastructure is arguably the single most important feature in any city. If unavailable for a significant enough period of time, all other functions will eventually cease.
A smart grid alone does three things. First, it modernizes power systems through self-healing designs, automation, remote monitoring and control, and establishment of microgrids. Second, it informs and educates consumers about their energy usage, costs and alternative options, to enable them to make decisions autonomously about how and when to use electricity and fuels. Third, it provides safe, secure and reliable integration of distributed and renewable energy resources. All these add up to an energy infrastructure that is more reliable, more sustainable and more resilient. Thus, a smart grid sits at the heart of the smart city, which cannot fully exist without it.
Smart cities depend on a smart grid to ensure resilient delivery of energy to supply their many functions, present opportunities for conservation, improve efficiencies and, most importantly, enable coordination between urban officialdom, infrastructure operators, those responsible for public safety and the public. The smart city is all about how the city "organism" works together as an integrated whole and survives when put under extreme conditions. Energy, water, transportation, public health and safety, and other aspects of a smart city are managed in concert to support smooth operation of critical infrastructure while providing for a clean, economic and safe environment in which to live, work and play.

Here is one example of how cost-effective efficiency can be achieved in a smart city: Water utilities are typically one of the largest consumers of energy in a city; savings can be achieved by lessening their consumption of electricity as the electric utility nears its peak condition when energy is most expensive. By coordinating with the electric utility and shifting water pumping to non-peak hours, the water utility can reduce its energy consumption (and ultimately its bill), help the electric utility avoid problems and allow other more critical and less flexible functions (such as hospitals) to maintain uninterrupted supply. In the same sense, electric trains can be accelerated more slowly to reduce power consumption while maintaining schedules. Building owners and the public can also participate in demand response programs to the same end. Building on all combined data points and analysis of the smart grid, the smart city represents the next step in the process.

Under extreme conditions, the most critical functions of a smart city would be maintained and logistics information seamlessly coordinated with the public. The smart grid would shed load in a predictable and more manageable fashion so that critical city infrastructure and functions are maintained (among them, police, fire, hospitals), supported by microgrids. Self-healing automation would restore power rapidly to areas where alternate routes are available. Local generation would be exploited to support immediate needs. The community (industry, commercial, residential) would respond, automatically, to reduce their energy needs to lessen the burden of restoration. Transportation and traffic systems would coordinate with the energy systems to support critical transportation arteries and modes. Through it all, timely logistics information would be gathered and supplied to the public by all means available, but particularly through social media networks. Conservation, efficiency and safety will all be greatly enhanced through the availability of accurate logistical information.

Needless to say, these capabilities are not in place in their entirety anywhere in the world, as yet. But there are significant existing implementations and initiatives in progress in many cities and utilities—among them Kansas City Power and Light's Green Impact Zone Project, and Coop City in New York's Westchester County—to transform their businesses and communities to this view over the next ten years. Not surprisingly, energy infrastructure providers, developers, operators and consumers are leading this movement. The evolving technology base presents a key enabler to making the vision a reality.

In truth, much of the technology already exists to take the first steps. Significant levels of automation, communications and information technology are already being brought to bear on the electrical distribution systems of many utilities to improve reliability. There is a clear movement toward driving more intelligence into substations and field equipment to make faster decisions on fault isolation, location and restoration, feeder reconfiguration, and voltage and reactive power management. At the same time, a growing penetration of renewable generation means new needs for managing adaptive protection equipment and extending related substation designs. More than ever, implementation of equipment and protection schemes that support defined standards (such as **IEC 61850, which covers substation automation**), and principles of integrating information and operations technologies, are becoming an essential element in an effective overall design.

The result is more observability and controllability of the energy delivery network, where advanced control center visualization and analysis capabilities can be applied to better manage the growing "fleet" of intelligent agents. In addition, the integration of variable and distributed generation resources into the delivery network calls for greater means of balancing load and generation resources, where many utilities are investigating and implementing demand response programs that provide for a surgical alignment of demand management with available generation. This promotes the potential for more options and incentives for participation of the residential, commercial and industrial segments of cities and communities in energy conservation, efficiency and demand response programs. Home and building automation systems have become integral parts of this movement, which will continue to increase. Advanced metering infrastructures, meter data management systems and advanced data analytics will gather, assess and formulate essential information to refine forecasting, determine load response and improve operational decision-making. Again, integration of these capabilities will be supported through model and building automation standards such as **IEC 61970/61968** and **Open ADR2**. This all links directly back to the concept of smart grids enabling smart cities, whose other functions are also continuing to evolve. The technology base supporting a city's infrastructure, buildings, industry and consumers all continue to move toward more flexible, compatible, automated and intelligent platforms.

Smart cities, like the smart grid, will evolve slowly, but surely, over the next two decades. They will more fully harness, integrate and utilize information to be shared between departments, infrastructure operators and with citizens. Cities will partner with vendors to create integrated solutions, and the smart grid will become only a part of a greater, more responsive urban ecosystem. Ultimately, with the smart city, we are all in it together.

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