The Smart City Opportunity for Utilities

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WHAT IS A "SMART CITY"?

As municipalities seek to grow and invest in infrastructure, there is pressure to modernize and incorporate new technologies, integrate sustainable resources and methods in order to increase the city's attractiveness and productivity, and improve citizen satisfaction (and prospects for elected officials' re-elections). Recently, there has been much discussion of smart cities. In this paper, we provide a brief introduction to smart cities and a framework to help visualize potential components and identify a simple, step-wise path to successful support by energy utilities of their communities' efforts to pursue "smart city" initiatives.

Smart City Defined

In many ways, the smart city is today what the smart grid was a few years ago—a term that is broadly used but without a consistent definition.

Like the smart grid, defining what exactly makes a city "smart" is inherently challenging. "Smart" is open to interpretation. "Smart city" priorities are driven by the unique interests, challenges, and capabilities of a particular municipality. The menu of potential projects, applications, and technologies may be broad and diverse.

Further, many smart city projects are still in the early (pilot) phases, and few of the newest technologies have been fully rolled out or implemented at commercial scales. Finally, smart city is an evolving concept and a moving target. It is difficult to state with certainty today what the smart city of tomorrow, with all of its promises and possibilities, may look like.

Here is ScottMadden's working definition:

A "smart city" is one that employs a network of digital sensors, information controls, Internet-of-things technology, and automation to create a system that improves quality of living by reducing costs, creating new and better services, improving sustainability, and helping the city grow and compete for businesses, institutions, and residents.

Common Themes

Despite the variation in what a smart city is, we observe some objectives:

- Sustainability – Energy production and usage, water, waste
- Economic growth and viability – Investment, innovation, jobs
- Well-being/quality of life – Transportation, convenience, social engagement
- Infrastructure reinvention and enablement – Greenfield and retrofits and upgrades

- Ecosystem of projects – Partnerships and overlapping/reinforcing objectives and initiatives

Smart cities provide a fruitful ground for solutions that combine the design and implementation of intelligent assets with key principles of the "circular economy." These solutions are driven both by businesses and entrepreneurs—forming synergistic ecosystems of services that increase asset and resource productivity—and policymakers, who are in the position to make large-scale infrastructure investments, design regulation, and use sensor-generated data to create incentives for more effective resource use.

– World Economic Forum

While many models identify a comprehensive suite of capabilities, core to smart city infrastructure are the sectors, objectives, and technologies outlined in Figure 1.

Figure 1: Smart City Core Infrastructure Components

Sector	Energy	Transportation	Water and Waste	Buildings
Objectives	▪ Efficiency ▪ Low cost ▪ Low pollution ▪ Low CO2 emissions ▪ Synergies with water and transport ▪ Resilience	▪ Time savings ▪ Low cost ▪ Efficient resource utilization ▪ Universal access ▪ Low emissions	▪ Integrated system: water, flood control, agriculture, and sanitation ▪ Resilience	▪ Affordability ▪ Healthy environments ▪ Resilience ▪ Comfort ▪ Efficiency
Technologies	▪ Distributed renewables ▪ Cogeneration ▪ District heating and cooling ▪ Efficient lighting ▪ Smart grids ▪ Microgrids and virtual power plants ▪ Demand response ▪ Energy efficiency ▪ Energy storage	▪ Multi-modal integration via technology ▪ On-demand digitally enabled transport ▪ Electric vehicle infrastructure ▪ Traffic and congestion management ▪ Autonomous vehicles ▪ Parking management ▪ Technology-enabled transportation pricing	▪ Smart water meters ▪ Sensor networks ▪ District and building water re-use ▪ Digital water distribution control and leak detection	▪ Energy efficient and adaptive construction designs, technologies, and standards ▪ Sensors, actuators for real-time space management ▪ Energy management systems ▪ Smart equipment and appliances ▪ Advanced HVAC ▪ Building retrofits

In addition to these sectors, communications, healthcare, and education are also frequently referenced in smart city conceptual frameworks.

There are many technologies that can be considered elements of a potential smart city plan, energy—given its technological maturity, pervasive application, and existing infrastructure—is often a good point of focus for city planners. Energy utilities possess a physical network with a ubiquitous footprint underpinned by a data control network. Most smart city visions call for one or both of these network capabilities. It may be less efficient for the city to build a data network from scratch than to piggyback on the utility data network already in place. Especially since those networks are being funded by utility customer-citizens and in many cases are being digitally upgraded as utilities build out advanced metering infrastructure.

Implementation of Smart Cities

What makes a city smart? It's not about technology IQ, but rather the careful application of the principles of purpose, planning, and process in developing and implementing initiatives that make a city smart:

- Smart cities have established strategic frameworks to identify, prioritize, and fund smart city initiatives
- Smart city initiatives are portfolios or ecosystems of projects that are deployed to achieve a shared vision and set of objectives
- Smart cities leverage technology, but they are not defined by any particular technology
- Smart solutions are tailored to the city
- Stakeholder engagement and alignment is critical, particularly given the many partnerships needed in order to deliver smart city projects
    - Municipalities – Leadership, goal setting
    - Utilities – Customer, network knowledge
    - Vendors – Technology solutions, partnerships
    - Citizens – Engagement and participation

WHAT IS THE OPPORTUNITY FOR UTILITIES?

A Phased Approach

Cities are taking one of two approaches to developing smart city initiatives based upon their risk appetite, budget, clarity of potential benefits, and stakeholder buy-in to the smart city concept:

1. Integrated, long-term planning in which a comprehensive vision for future functionality in multiple aspects of city life—transportation, energy, health, citizen/government interaction, etc.—is developed with a view to connecting all the pieces
2. An incremental approach focused on quick, affordable results from incremental system enhancements such as smart thermostat rebate programs to help achieve demand-side management program adoption or digital kiosk pilots to connect citizens to city services in new ways

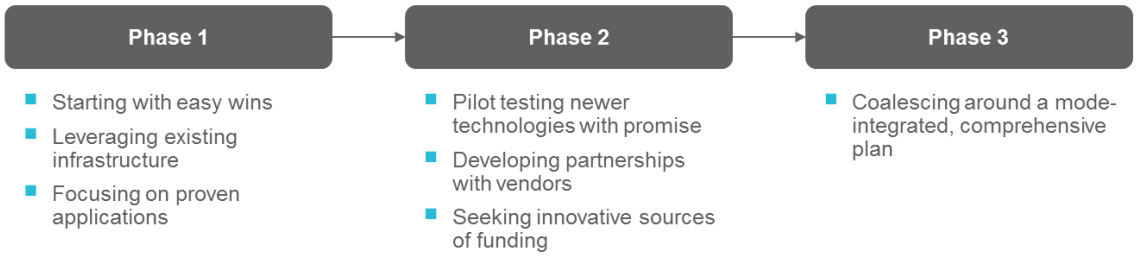
As utilities consider their roles in smart city initiatives, they should first focus on the build-out of core assets and capabilities, emphasizing their advantage as incumbent network owners and operators, to find opportunities to get more out of the utility energy network.

By focusing first on quick wins with proven technologies that leverage the existing network, utilities can engage stakeholders and establish their roles as partners and leaders in the process. And they can produce economic benefits to fund further pilots and initiatives.

As opportunities and technologies continue to evolve, utilities will then be well-positioned to continue to leverage their assets and capabilities into new areas.

- Phase 1 – Getting More out of the Utility Energy Network
- Phase 2 – Leveraging Utility Assets to Enable Non-Energy Initiatives
- Phase 3 – Leveraging Utility Capabilities to Expand into Entirely New Areas

Figure 2: Smart City Phased Approach for Utilities



	Phase 1	Phase 2	Phase 3
Objective	Getting more out of the utility energy network	Leveraging the utility assets to enable non-energy smart city initiatives	Expand into entirely new areas, leveraging capabilities
Focus	Energy optimization	Non-energy expansion	New frontiers; integration
Outcomes	Save money; prove ROI	Test ROI in new areas	Engage customers/citizens
Sample Initiatives	Street lighting; smart thermostats	Water/wastewater system automation	EVs for mass transit

Phase 1 – Getting More out of the Utility Energy Network

In this first phase, utilities should examine information and data resources provided by existing technologies and assets such as smart meters to identify opportunities to get more out of the utility energy network. Proven solutions that add automation and controllability to devices like water heaters and street lights can provide utilities with quick wins, demonstrating the ability to improve services while reducing costs and minimizing risk in early smart city initiatives.

Phase 2 – Leveraging Utility Assets to Enable Non-Energy Initiatives

In the second phase, utilities can broaden their approach to consider initiatives beyond energy-focused projects. Utilities may identify additional opportunities to leverage their information and data resources to augment other city services, and they may also consider further testing and building new capabilities on platforms implemented in the first phase. Utilities may identify other opportunities to further leverage their assets and workforces in new ways to support smart city initiatives.

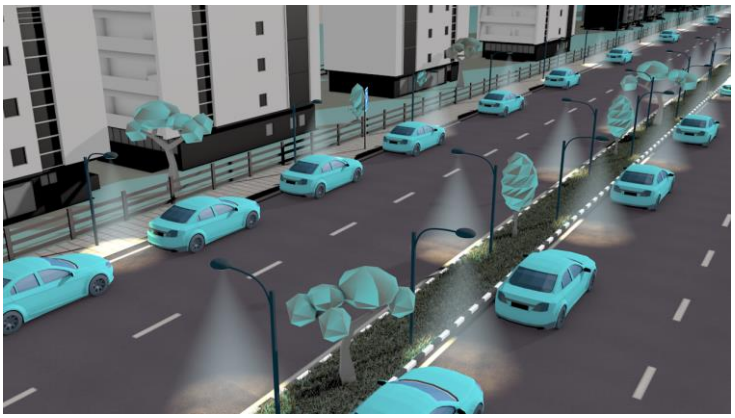
Phase 3 – Leveraging Utility Capabilities to Expand into Entirely New Areas

In the final phase, as utility, municipal, and regulatory goals and objectives for smart city initiatives continue to evolve and align, utilities may consider further expanding into entirely new areas such as transportation and customer/ citizen engagement. As new innovations and technologies are identified, utilities should have strategy and a plan for identifying, piloting, and testing new concepts. As technologies advance beyond the "science experiment stage" and successful pilots, however, utilities may choose to venture farther afield, building new partnerships and expanding beyond the existing assets and the traditional energy network.

This three-phase approach allows the utility to get more value out of its network, and offer more and better choices to customers and allows the city, and the people who live there, to get more value out smart city initiatives at less cost.

The First Killer App: Smart Street Lighting

For utilities looking for a "phase one" entry point into the world of smart cities, they need look no further than one of the initial components of their network—street lights. Street lighting projects are a popular entry point into the smart city conversation because of their enormous potential to deliver a strong (and fast) return on investment.



- Street lights represent a substantial portion of city energy budgets, up to 40% by some estimates
- Smart street lights, according to those who sell them, can save 50% to 70% of this cost by dimming when activity is low (please see discussion below). This can be big money. And it can be used to reduce city expense and to fund future initiatives while offering the utility a chance to increase asset base at the expense of energy costs
- Networked LED lights can provide not only energy savings but information about outages or other anomalies in the energy network
- Lights can be remotely dimmed to reduce energy usage, and they can also be managed by smart devices that adjust lighting in response to traffic patterns and help identify roadway hazards
- Networked lighting systems are also seen as a viable "platform" on which to build future sensing, data gathering, and communications capabilities
- For example, networked lights can be connected, communicating with video cameras, parking sensors, environmental sensors, weather sensors, etc. through the same network infrastructure

CONCLUSION

The combination of continuing urbanization and the increase in embedded intelligence in assets of all kinds will continue to push cities to consider smart city pilots and programs.

There remain open questions as the smart city concept faces realities of implementation:

- How will cities address privacy and security concerns?
- What will be workable funding mechanisms—municipal borrowing, public-private partnerships, integration with federal programs? Something else?
- How can cities create alignment and collaboration among private and public stakeholders and secure the support of their citizenry?
- What is the expected return on these investments, how will it be measured, and will hoped-for cost reductions be achieved?

Still, smart city investments are accelerating at a rapid pace, with a constant flow of U.S. cities and cities around the globe announcing smart city plans and initiatives, particularly over the last year. While the uncertainty of technology, innovation, and political support is not likely to decline, utilities need to forge a path forward, providing their organizations with clear direction, while maintaining balance and flexibility to react to unforeseen developments and opportunities in the future.

ABOUT SCOTTMADDEN'S ENERGY PRACTICE

We know energy from the ground up. Since 1983, we have been energy consultants. We have served more than 400 clients, including 20 of the top 20 energy utilities. We have performed more than 3,000 projects across every energy utility business unit and every function. We have helped our clients develop strategies, improve operations, reorganize companies, and implement initiatives. Our broad and deep energy utility expertise is not theoretical—it is experience based.

ABOUT THE AUTHORS

Stuart Pearman (spearman@scottmadden.com) is a partner in ScottMadden's Raleigh office and leads the firm's energy practice. Chris Vlahoplus (chrisv@scottmadden.com) is a partner in the Raleigh office and leads the firm's clean tech & sustainability practice. Greg Litra (glitra@scottmadden.com) is a partner and energy, clean tech, and sustainability research leader in the Raleigh office. Quentin Watkins (quentinwatkins@scottmadden.com) is a manager in the Atlanta office.

APPENDIX A – SMART CITY CASE STUDIES: LESSONS FROM ABROAD

IssyGrid Initiative – Moulineaux, France

The IssyGrid project in Issy-les-Moulineaux, a suburb south of Paris, combines solar panels on rooftops with power storage in recycled Renault car batteries and a local power grid that manages electricity produced and consumed in the neighborhood. IssyGrid—which includes 1,000 apartments and five office buildings with a total space of more than 200,000 square meters—will test the integration of new power, grid, and monitoring technologies with a view to rolling these out commercially.

Per an April 2016 IssyGrid press conference, the grid infrastructure is now complete, and the first energy-related data, which have been published in real time, will now be broadly accessible. The residents, students, users, companies, and public facilities covered by this system are now in a position to interact in order to help optimize energy use via a sizeable smart grid with cutting-edge infrastructure. Less than four years after its launch, IssyGrid has now assembled all the components of an urban smart grid in the Seine Ouest and Fort d'Issy Business District in Issy-les-Moulineaux.

The grid includes:

- Approximately 1,000 homes connected via smart meters, including 861 in Fort d'Issy with 2,200 residents
- Four smart grid-ready office buildings in the Seine Ouest Business District with 120,000 m^2 in total office space and more than 5,000 employees who contribute to the smart grid
- The Paris Law School (Ecole de Formation du Barreau de Paris: EFB) with 8,500 m^2 in building space and 1,700 students
- A portion of the urban street lighting

IssyGrid infrastructure consists of:

- Three solar power generation facilities, one of which is connected to IssyGrid via the network
- A latest-generation electric power distribution substation which can be managed remotely, and enables consumption, generation, and storage to be optimized
- Two energy storage systems: recycled batteries from Renault electric vehicles installed in the power distribution system, which enable 33 kWh of electricity to be stored, together with storage batteries capable of storing 60 kWh that have been installed in the EFB's basement
- A solar power forecasting system
- Fourteen interconnected information systems
- An energy monitoring dashboard that will be capable of supplying data in an open architecture

This system enables consumption peaks to be smoothed and ensures the general balance of the grid is maintained, while reducing the district's carbon footprint. The residents in connected homes can see their average electricity consumption throughout the day and the level of available solar power generation on an hourly basis, six hours in advance, giving them the option to shift their electricity consumption.

IssyGrid's scope is still being expanded, with more planned new connected buildings and facilities. Ultimately, IssyGrid will cover 2,000 homes (housing 5,000 residents) and 160,000 m^2 of offices (10,000

employees). The IssyGrid application scope may gradually be extended to other sites in the city, or even to other energy grids in the Seine Ouest and Fort d'Issy District in the future.

Amsterdam Smart City (ASC) Initiative – Amsterdam, The Netherlands

- The ASC initiative features more than 150 projects currently underway across six themes:
  - Infrastructure and technology
  - Energy, water, and waste
  - Mobility
  - Circular city
  - Governance and education
  - Citizens and living
- Broad range of engaged stakeholders include public organizations, private companies, knowledge partners, and individual citizens
- Amsterdam is deploying various energy and smart grid projects, including City-zen, which includes:
  - Energy efficient retrofitting of 700 to 900 dwellings
  - Connecting 10,000 dwellings to its intelligent electricity network. The grid operator can operate the medium-voltage grid remotely, permitting end-user transactions (such as sale of distributed solar energy) and ability to sell energy from battery storage into the market. It also enables virtual power plant capabilities
  - District heating and cooling with sustainable resources such as daylight collectors, sewer system heat, and cooling from surface water
- Smart City Entrepreneurial Lab at Amsterdam University of Applied Sciences founded in 2015 to analyze projects and collect lessons learned

APPENDIX B – EXAMPLE CITY INITIATIVES: A USEFUL DATABASE

Technology	Project Description	Energy-Related?	Cities and Links
Solar DG + Storage	Residential solar PV + behind-the-meter storage	Yes	Denver (link)
Smart Street Lights	Networked LED lights and sensors – A recently completed pilot project delivered smart street lighting, sensors, and a pubic gigabit Wi-Fi network to a three-block area, which reduced lighting energy costs by 50%	Yes	Washington D.C. (link)
Smart Water Systems	Water and wastewater infrastructure automation	No	Philadelphia (link)
DSM/Smart Thermostats	DSM program expansion via subsidies for smart thermostats	Yes	San Antonio/ CPS Energy (link)
Smart Transportation	Partnership with Waze app for data sharing with city traffic engineers	No	Boston (link)
Smart Transportation	"SmartSantander project" measures traffic, parking, noise, temperature, etc. to direct city services more efficiently	No	Santander, Spain (link)
Smart Transportation	"Green Park Baton Rouge" program provides EV charging stations	Yes	Baton Rouge (link)
Smart Transportation	Development of the first electric bus rapid transit in the United States	Yes	Indianapolis (link)
Communications/Energy Demand	"16 Tech" is a comprehensive hub that will pioneer citywide digital infrastructure	Yes	Indianapolis (link)
Smart Buildings	Implementing a citywide building automation system to monitor and control mechanical and electrical systems such as HVAC and lighting. Several city buildings will also be renovated for improved energy efficiency, and the results will be monitored through an online building analytics dashboard	Yes	Orlando (link)
Smart Street Lights	Using smart lighting technology as a tool to help fight crime, assist in emergencies, and better serve their citizens	Yes	Chattanooga, Fresno, Peoria, Pittsburg (link)
Smart Street Lights	Adding smart controls to street lights to enhance functionality and increase savings	Yes	Los Angeles, Philadelphia, Montgomery (link)
Smart Transportation/Citizen Engagement	Field testing smart transit shelters that include free Wi-Fi, digital displays that track and update bus arrival times, and intelligent lighting	Yes	Chicago (link)
Waste/Recycling	Using technology solutions to reduce illegal dumping – soliciting citizen reporting and motion-activated cameras	No	San Jose, Dallas (link)
Smart Building/Energy Demand	Accelerated Conservation and Efficiency program (ACE) streamlines funding for energy capital projects that are independently identified, managed, and implemented by partner city agencies. ACE encourages agency staff to identify key energy-saving projects based on their understanding of building needs	Yes	New York (link)

Technology	Project Description	Energy-Related?	Cities and Links
Citizen Engagement	Complaint collection and resolution via mobile app and social media	No	Buenos Aires (link)
Citizen Engagement	New York City Wiki survey to solicit ideas in support of PlaNYC 2030 (citywide sustainability plan)	No	New York (link)
Smart Street Lights	World's first pilot of GE's intelligent LED solution for cities, including roadway hazard identification functionality and other sensing and data-gathering capabilities	Yes	San Diego (link)
Water/Wastewater	Wireless meter-reading system that provides citizens with hourly readings to identify potential issues	No	Cary, NC (link)
Water/Wastewater	Reducing lost revenue from zero-read meters and achieving operational cost savings with AMI/smart meters, automated workforce management, and integration with enterprise asset management system	No	Albuquerque (link)
Energy Demand/DSM	"Envision Charlotte" public-private partnership between heads of business, building owners and managers, utilities chiefs, city planning professionals, and more to achieve 20% energy reduction by 2016	Yes	Charlotte, NC (link)
Communications	Implementation support for "Smart Energy Now" (part of "Envision Charlotte" initiative), including wireless network transport to cloud, kiosks, and monitors (Verizon)	No	Charlotte, NC (link)
Communications	High-performance wireless broadband network for the city of Venice, Italy. The Wi-Fi solution comprises a network of fixed and mobile nodes that can handle more than 200 gigabytes of data and 40,000 subscribers a day (ABB's "Tropos" Solution)	No	Venice, Italy (link)
Infrastructure	Expansion of Dubai's international airport, to become the busiest in the world (by passengers and cargo), including capacity to handle 100 Airbus A380s at once	No	Dubai, UAE (link)
Infrastructure	$40 billion project aimed at achieving "aerotropolis" (airport integrated with city center) and "ubiquitous city" (concept of integrating many different data sources in a single mobile platform, including every device, component, and service)	No	Songdo, South Korea (link)
Energy Supply, Energy Demand, Communications	World's first zero-carbon, zero-waste city	Yes	Masdar City, UAE (link)
Communications	The city of Chicago is working with the Argonne National Laboratory and the University of Chicago to deploy the Array of Things—a citywide network of 500 lamppost-mounted sensors that monitor air quality, among other conditions; and it is analyzing its non-emergency complaint-call data to identify environmental	No	Chicago (link)

Technology	Project Description	Energy-Related?	Cities and Links
	issues, such as pest infestations connected to the incidence of asthma		
Citizen Engagement/Data Analytics	The New York Fire Department started using data mining and predictive analytics to determine which of New York City's one million buildings are most likely to erupt in a major fire. They now examine 7,500 factors across 17 city-agency data streams and use artificial intelligence to track trends citywide	No	New York (link)
Community Solar	Exelon City Solar, the largest urban solar plant in the United States, opened in 2010 and spread across a 41-acre brownfield site that had been vacant for more than three decades. The plant now produces 10 MWs of power, cutting 14,000 tons of greenhouse gas emissions annually and creating several hundred local jobs	Yes	Chicago (link)