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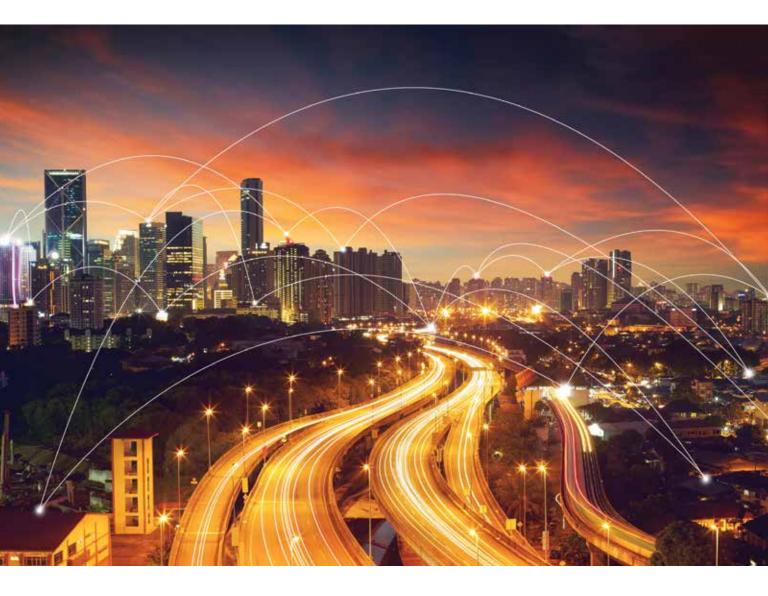ENVIRONMENTAL LEADERSHIP

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Special Report

Smart City Pioneers:
Forging Solutions to Early Challenges

INTRODUCTION

Smart City Pioneers: Forging Solutions to Early Challenges

Many share the hope that today's troubled urban centers can be transformed into tomorrow's smart cities. At a recent conference, "Smart Utilities: A Bridge to Smart Cities of the Future," co-sponsored by Suez and Wharton's Initiative for Global Environmental Leadership (IGEL), some early pioneers in this effort shared their experiences and thoughts.

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SPONSORS

The Initiative for Global Environmental Leadership (IGEL) and Suez have partnered with Knowledge@Wharton to create this special report.

Laying the Groundwork: Philadelphia Is Taking a Strategic Approach to Becoming a Smart City

WHEN SIDEWALK LABS, A SUBSIDIARY OF GOOGLE'S PARENT ALPHABET, decided to create a smart city, CEO Dan Doctoroff explained why the company was looking for a location with as few buildings and residents as possible. "There is an inverse relationship between your capacity to innovate, and the actual existence of people and buildings," he said during a talk before the San Francisco Bay Area Planning and Urban Research Association.

Existing cities come with baggage that Sidewalk Labs wants to avoid—limited budgets, traffic jams, pollution, archaic zoning regulations, neglected infrastructure and no end of political divisions. But it's the ability to address these kinds of issues that has made the concept of smart cities so attractive to so many people. The goal of smart cities is not to create showplaces for technology but, the Smart Cities Council said, to use information and communications technology—smart sensors, the Internet of Things and machine learning—to enhance "livability, workability, and sustainability" for the residents of major cities like Miami, New York and Philadelphia.

By highlighting the work underway in the City of Brotherly Love, a recent Wharton conference, "Smart Utilities: A Bridge to Smart Cities of the Future," helped clarify what it will take for Philadelphia to realize its potential as a smart city. From the beginning in 2016, the city approached the challenge strategically. Rather than tackle individual projects piecemeal, as so many cities have done, Philadelphia's Office of Innovation and Technology (OIT) decided to create a roadmap that would guide and ensure long-term coordination of its wide-ranging projects.

The first step, said Ellen Hwang, the city's program manager for innovation management, was to take stock of what was already happening. And in Philadelphia, a lot was indeed happening.

In concert with residents, business associations, institutions and other city agencies, the City Planning Commission had developed a comprehensive blueprint, Philadelphia 2035, to guide public and private investment in the city's physical development. A collaboration of governmental agencies and community and advocacy groups had developed a three-year Vision Zero action plan to eliminate traffic fatalities. The water department was deploying advanced metering infrastructure; the Office of Sustainability was working on an automated building management system; Philadelphia-based Comcast was rolling out its smart-city networking service, machineQ; and entrepreneurial students from Wharton were jumping into the smart city space. By assessing all this activity, OIT hoped to minimize redundancy and identify promising collaborative opportunities.

> The goal of smart cities is ... to use information and communications technology—smart sensors, the Internet of Things and machine learning—to enhance "livability, workability, and sustainability."
>
> —Smart Cities Council

As in any big city, siloed departments were a potential stumbling block. So during the first year, said Hwang, "We've been making sure first and foremost that our colleagues in the city are on board with what we're doing. We're still building and strengthening those relationships across city departments, and we are establishing an internal working group to make sure that city government projects are going to be better coordinated moving forward."

FOCUS ON INCLUSION

Greater Philadelphia is home to more than 20 Fortune 500 companies and several of the nation's leading universities. It is also the poorest major city in America, according to the latest Census data. Such socio-economic diversity is common in big cities, of course. What is far less common is Philadelphia's commitment to developing a roadmap that reflects the interests of everyone with a stake in the city's future.

"We didn't want to specify Philadelphia's vision as a government and then impose that on our larger community," said Hwang. "We have been very intentional in wanting to bring different folks along as we've been conceiving and thinking about this, including those who normally aren't at the table."

During his opening remarks at the Wharton conference, co-sponsored by the school's Initiative for Global Environmental Leadership (IGEL) and Suez, Charles Brennan, the city's former chief information officer, explained that Philadelphia is a city of neighborhoods, each of which has its own view of what a smart city means. Poorer neighborhoods, said Brennan, ask for surveillance cameras to help reduce crime, while wealthier areas are eager for better parking. To ensure that smart technology addresses everyone's concerns, OIT chose to take an inclusive path. Rather than risk exacerbating inequality and division within the city, Philadelphia decided to solicit input from all stakeholders.

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>
> —Ellen Hwang, Program Manager for Innovation Management, City of Philadelphia

One of only five urban centers to win a Smart Cities Council Readiness Challenge grant in 2017, the city used the additional resources to launch an inclusive workshop. A statement announcing the event invited broad participation. "Whatever your background, if you have an innovative idea on new uses for city assets, we want to hear from you," the city's chief administrative officer wrote.

The day-long event, which took place shortly after the IGEL-Suez conference, attracted about 160 people, including city leaders, businesses, civic organizations and other groups. The goal was two-fold. To ensure a productive discussion among all the diverse stakeholders, OIT wanted to foster a common understanding of what a smart city is all about. According to Hwang, "We also wanted to get folks who don't normally collaborate in the same room, learning and sharing together, planning and thinking about what a smart city in Philly would look like."

To facilitate these conversations, OIT focused discussions on the real issues people in and out of city government are grappling with on a daily basis. Public health, public safety, the opioid crisis and affordable housing were among the topics being discussed, as were government efficiencies, internal business processes and access to services in city government.

Experts added valuable perspectives. Emily Schapira, vice chair and executive director of the Philadelphia Energy Authority, was invited to present an overview of the Philadelphia Energy Campaign – the city's $1 billion, 10-year effort to reduce poverty, create jobs and fight climate change. As she explained during the IGEL-Suez conference, the program has an important role to play in enhancing livability, workability, and sustainability in Philadelphia. Among other things, while working in municipal buildings, schools, low-and middle income housing and small businesses, the Energy Campaign can acquire data that will help the Health Department identify asthma triggers and possible areas of lead paint contamination.

NEXT STEPS

The initial workshop was just the beginning of a more in-depth conversation now underway among all those involved in the smart city effort. "There is much more work to be done to uncover and understand the nuances of each neighborhood," said Hwang. But the conversations have started.

Both technologists and neighborhood development groups are talking now, for instance, about how smart technology and Big Data can help meet the needs of neighborhoods where basic literacy and internet access are pressing problems. While Philadelphia has long been a leader in digital inclusion (the city has a network of more than 50 community-based public computer-access centers located across the city), bridging the digital divide is high on the list of smart city goals.

Another key issue is workforce development. Smart city projects need the hands-on experience of long-time workers, but they also need the fresh thinking of younger staff. To be successful, city departments have to find ways

to meet this dual demand. David Stanton, president of Suez in North America's utility operations and federal services division, discussed at the conference how his group confronted the challenge of integrating experienced workers who are often resistant to change—what he called "the crusty layer"—with younger staff who have a much more intuitive grasp of smart technology. Suez launched a "hug a millennial" program. "We had to find someone with the millennial spirit, and we had to make that person part of the leadership team," he said, adding, "It was shockingly effective."

In Philadelphia, OIT and the talent development unit of the city's Commerce Department have been working intensively to ensure that city departments are aware of the trends and ready for the changes that are coming up. Many departments are already seeding their teams with tech-savvy staff who are eager to think differently about long-standing problems. The Water Department, in particular, has hired people (Hwang calls them "civic hackers") to rework outdated technology and improve the quality and efficiency of the city's green storm water infrastructure.

Once all the conversations have taken place and all the groundwork has been laid, Philadelphia will set about turning the ideas and information that have been generated into a strategic plan. With the help of $200,000

from the Knight Foundation, the city has contracted with the consulting firm PwC to assist in the process, which is scheduled for completion in the second quarter of 2018.

> **"We had to find someone with the millennial spirit, and we had to make that person part of the leadership team. ... It was shockingly effective."**
>
> —David Stanton, President, Utility Operations and Federal Services Division, Suez North America

If all goes as planned, by that point Philadelphia will have created a thriving Smart City ecosystem of interconnected groups representing city departments, major utilities and corporations, entrepreneurial start-ups, university researchers and students, community groups and others, all focused on a shared vision of what Philadelphia can become as a smart city.

"We're excited about our approach to the strategic planning process," said Hwang. "We know it's a heavy lift and it's a long-term process, but in addition we also see a lot of promise and opportunity for our city." ◆

Collect, Crunch, Collaborate: Fresh Approaches to Smart Cities' Core Functions

YOUNG WHARTON ENTREPRENEURS AT THE IGEL-SUEZ CONFERENCE ON SMART CITIES expressed frustration in dealing with utilities. According to Claire Tram, Wharton class of 2018, "Entrepreneurs are giddy to get into this market, but utilities are a daunting problem." Tram understands that state-regulated utilities, responsible for critical services, are risk-averse for good reasons, but she also knows investors are impatient for returns. "When you're trying to manage investors who want to see growth in 18 months," she explained, "it's hard to work with such slow-moving companies."

Utilities may move more cautiously than entrepreneurs like Tram would like, but in many ways they are taking the lead when it comes to smart cities. When Debra McCarty, another speaker at the conference, began her career with the Philadelphia Water Department (PWD) in 1982, water meters all around the city were read each month by people employed for that purpose. Or not. Sometimes, the meter readers didn't get inside the house. "Sometimes, they did what we called 'curb reads,'" says McCarty, who is now commissioner of PWD. Such guesswork inevitably led to some inaccurate data.

> Utilities may move more cautiously than entrepreneurs would like, but in many ways they are taking the lead when it comes to smart cities.

Then, in 1997, the city took a first early step towards smart technology. PWD installed 480,000 new water meters that automatically sent readings to the utility on a regular basis. "It was a significant capital investment by the department," McCarty told conference attendees. But thanks to the new Automatic Meter Reading (AMR) system, the department no longer had to send employees out to every building, curb reads all but disappeared, accuracy improved and customers were pleased.

Now that the 20-year AMR contract has ended, PWD is taking its smart technology to a new level, creating an interactive meter-reading system known as Advanced Metering Infrastructure (AMI). The new system, which makes use of existing smart meters, offers both customers and PWD a new level of real-time information. Customers can opt in to receive messages alerting them to abnormally high water usage, often caused by a leak, well before their monthly bill has climbed. They can also use detailed data about their usage to lower their water bills and reduce their environmental footprint.

BETTER SERVICE

The department benefits, too. The AMI system alerts the utility to suspected meter tampering and possible contamination resulting from reverse flow. Better information means PWD can more often help customers resolve problems over the phone without the inconvenience of a repair call. And it can use hard data, rather than customer guess work, to right-size pipes that need to be replaced or installed.

While these innovations can help reduce customers' bills, they can also lead to revenue recovery for the utility, said David Stanton, president of Suez in North America's utility operations and federal services division. According to Stanton, data provided by the largest AMI network in North America—Suez works with 18 separate utilities—has shown that well-run companies are sending out inaccurate bills 6% to 8% of the time. "And it's always wrong in the wrong direction," he said. "We have not yet found one instance where we were over-billing, but we have been significantly under-billing a lot of people."

It takes a combination of human and machine intelligence to capitalize on the data pouring in from smart systems like AMI. "These systems are automated, but they're not autonomous," said University of Pennsylvania Environmental Sustainability Director Dan Garofalo. "So we need to have people in position who know what they are looking at and can interpret it very quickly." According to Garofalo, the university spent the past 10 years installing smart sensors in buildings across its 302-acre campus, while also developing the computer systems to store and access the resulting data. Only now is Penn ready to start figuring out how to take full advantage of the input, he said.

One important step is presenting the data visually, so trained staff can put it to use almost immediately. The goal is two-fold: to save the university money in the near term by catching problems early on, and to improve the accuracy of budgeting long-term by using the quickly accumulating wealth of historical data to accurately anticipate the university's future utility costs.

"But what we're really focused on is being able to use predictive modeling to identify peaks," said Garofalo. Predicting energy usage for a campus full of buildings is a complex undertaking. A wide variety of data must be collected from numerous sources, including weather stations (which provide readings of outdoor temperature, humidity, wind speed and solar radiation, among other data points); metered consumption of electricity, chilled water and steam for every building; and occupancy rates at every hour of the day for all types of rooms (dorm rooms, offices, labs).

MACHINE INTELLIGENCE

It takes machine intelligence to make sense of this much diverse data and predict future energy peaks. But first, incomplete, incorrect, inaccurate or irrelevant data have to be identified and cleaned up. Computer scientists then have to harmonize the myriad data formats and use the resulting datasets to train machine learning systems, which continually refine their predictions as new data comes in.

The payoff is a substantial reduction in energy costs through "peak shaving," a way of reducing energy costs by buying power during off-peak hours, when it is markedly less expensive, and storing it for use when demand is highest. Garofalo said the university has numerous ways to store energy on campus. When it comes to cooling, ice tanks are key. Alerted to future cooling demand peaks by predictive modeling, the university can over-cool when usage is low, then turn off its energy-hungry chillers and use the stored cold water when demand peaks.

Smart cities can save money by taking advantage of existing projects and technology. Steve Davis, who worked

as GE's Digital Business Transformation Leader for 10 years, urged smart city pioneers to carefully evaluate what kinds of data they need most and what they are already collecting. "You might not have to invest a lot in acquiring new data," he said. "Just start getting the data you have connected, so you can get it to people who can analyze and draw insights from it."

Smart cities can save money by taking advantage of existing projects and technology.

GE Power, Water & Process Technologies (recently acquired by Suez) already had automated sensors monitoring water quality in industrial cooling towers, Davis explained. The data they generated was crucial to optimizing the towers' performance. "But you still had to be at the site to catch the data at the time the system had an issue," he said. "Otherwise all that data just sat in the box."

Once GE connected the water-monitoring sensors, however, people quickly identified fundamental changes that reduced costs. The data made it painfully clear, for instance, that energy-hungry pumps and fans were operating at the same level all the time, regardless of demand. "We learned to turn the system down at night," said Davis. "Run only when you need to run."

GE also used the networked data to make its service calls more responsive to customer needs. Instead of routinely showing up on Fridays, service representatives began showing up when the data showed there was an actual problem. Sometimes, thanks to predictive modeling, they could even show up before a problem had surfaced. GE was able to avoid unnecessary service calls and improve customer service at the same time, without having to install any new sensors.

It can take some detective work to identify valuable existing resources. "There are so many networks being built," said Ellen Hwang, Philadelphia's program manager for innovation management. "We need to understand what already exists and think about how we are going to leverage the networks we already have." When new networks are needed, it's equally important to coordinate the work, which often involves digging up city streets. With cross-department planning, the disruption such work entails—and the expense—can be drastically reduced, said Hwang.

Infrastructure, too, can be shared. Patrick Cairo, emeritus member of IGEL's advisory board, noted that as networks are being built to meet the needs of utility customers and

companies, "They can also serve as a backbone for other services." McCarty suggested, for instance, that other utilities and city departments could piggyback on the infrastructure PWD is building to gather data from water meters across the city, just as cell phone base stations piggyback on everything from high rises to newsstand kiosks.

"We want to turn the garbage truck into a roving data center."

— Michael Allegretti, Senior Vice President for Policy and Strategy Initiatives, Rubicon Global

To take advantage of coordinated efforts like this, city departments that tend to work in isolation have to start communicating with each other. Rubicon Global is a technology company focused on improving the efficiency and sustainability of commercial waste. About a year ago, the company began to adapt its smart technology for use in cities. According to Michael Allegretti, Rubicon's senior vice president for policy and strategy initiatives, one of the company's goals was to use its technology to serve the needs of both sanitation and sustainability departments, "which are historically siloed and working towards totally different policy goals."

Rubicon began its new municipal initiative in three cities, Atlanta, Santa Fe, N.M., and Columbus, Ohio. Equipped with Rubicon technology, garbage trucks in these three areas now collect and share data with both sanitation and sustainability departments in the cities. Sensors in the trucks gather data that helps improve the efficiency of trash collection (when is trash being picked up, how well are different routes and trucks performing), while other data (what's in the waste, how does that vary from neighborhood to neighborhood, what are recycling contamination rates) increases the amount of waste being diverted from landfills.

Rubicon envisions ways its technology can bring together other siloed departments as well. "We want to turn the garbage truck into a roving data center," said Allegretti. "Garbage trucks are going up and down every street in every city in the world at least once a week. That's a huge untapped potential for governments." As they collect garbage, the truck can also collect information on everything from downed power lines to abandoned cars, from air quality to noise levels. And this data can be updated on a weekly basis.

"My definition of a smart city is an interconnected one," said Allegretti. "If we get all the departments playing off the same sheet of music, it would be a big step. And garbage trucks, of all things, can be the thing that collects all that information, brings it back to one place and distributes it to all the different departments so they can act on it." ✦

Smart Money: New Funding Mechanisms Are Being Developed for Smart Initiatives

IN ITS ANNUAL INDUSTRY SURVEY, "2017 STRATEGIC DIRECTIONS: SMART CITY/SMART UTILITY REPORT," the consulting company Black and Veatch found both overwhelming enthusiasm for the concept of smart cities and wide-spread uncertainty about how to pay for implementation. Those surveyed included a cross-section of utility, municipal, commercial and community stakeholders. Ninety-four percent viewed the smart city movement as transformational and likely to have long-term positive effects on cities worldwide. Yet three-quarters of respondents said they lacked the financial resources to undertake their own initiatives.

Traditionally, cities have paid for large infrastructure projects either with city funds raised through taxes or with capital acquired in the municipal bond market. Neither approach holds much promise for smart city financing. There is little appetite for tax increases in general and only 5% of the municipalities in the Smart City survey were willing to use property taxes to fund smart initiatives. That suggests that city leaders and residents do not fully appreciate the financial benefits of such efforts. Whatever the reason, tax-based funding of smart city projects is unlikely any time soon.

Municipal bonds face different obstacles. One is the staggering amount of debt states and cities are already carrying. Another is the unconventional nature of smart city projects. According to a 2017 report by Deloitte, "Funding and Financing Smart Cities," projects based on inter-connectivity lack the traditional single-sector focus municipal debt financing favors. According to the report, "This inherent flexibility presents both opportunities and challenges for cities from a funding/financing perspective."

Some funding is available from public or nonprofit sources. 2017 was a good year for smart-city grants. The John S. and James L. Knight Foundation awarded six cities—Akron,

Ohio, Boston, Detroit, Miami, Philadelphia and San Jose, Calif.—$1.2 million to explore how they might use the Internet of Things to meet their needs. The Smart Cities Council awarded Readiness Challenge grants to five cities—Austin, Tex., Indianapolis, Miami, Orlando, Fla. and Philadelphia. And the U.S. Department of Transportation committed up to $40 million to the winner of its Smart City Challenge, Columbus, Ohio.

As helpful as these grants are, such direct funding is neither sufficient nor reliable enough to fund smart cities long term. Utilities represent a potentially steadier partner, said University of Pennsylvania professor Howard Neukrug, who is also director of the Water Center at Penn. "Water utilities are not wealthy, but they do have some money," he said. In fact, Commissioner Debra McCarty said that the Philadelphia Water Department (PWD) currently has more than $320 million in its annual capital budget, although Neukrug, a former commissioner of the department, said that PWD actually needs a capital budget of $600 million just to fund needed repairs and improvements, let alone innovative smart technologies.

> There are opportunities in Philadelphia and elsewhere for smart city programs to partner with water utilities and leverage their spending on infrastructure.

Still, he said there are opportunities in Philadelphia and elsewhere for smart city programs to partner with water utilities and leverage their spending on infrastructure. Smart city networks looking to lay underground cable, for instance, can take advantage of water utilities' continual investment in repairing and replacing pipes beneath city streets.

The private sector offers more robust financing options. The business community's interest in helping smart cities is not surprising. According to a 2016 research study, "Smart Cities: A Global Strategic Business Report," by Global Industry Analysts, "The global market for smart cities is projected to reach $1.2 trillion by 2020, driven by the growing world population, unscrupulous exploitation of natural resources, and the ensuing search for sustainable ways to accommodate the 7-plus billion people on the plant."

Also not surprising is how much of the support is coming from the technology sector. At the 2017 Smart City Expo World Congress in Barcelona, Cisco announced a $1 billion initiative to provide "innovative financing options for cities and urban operators to drive the adoption of smart city technology." For Cisco, accelerating the growth of smart cities is good business. The company offers basic connectivity essential to smart cities, a platform for connecting devices and sharing data across agencies, as well as third-party software cities can use to develop new smart applications.

Cisco's City Infrastructure Financing Acceleration Program (CIFAP) offers both traditional financing options, such as private equity financing for operators and loans and leases for cities, and non-traditional options. The latter represent various types of so-called public-private partnerships (P3s).

P3s have been taking off, especially as a way of financing highways, airports, public water systems and other large infrastructure projects.

Three-quarters of those surveyed view P3s as the best bet for smart city financing. Historically more popular outside the U.S. (and especially in Canada), American P3s have been taking off, especially as a way of financing highways, airports, public water systems and other large infrastructure projects. The appeal of P3s for would-be smart cities is that the city shares in the upside of these initiatives without risking much of the downside. In typical P3s, the private partners provide the upfront financing for projects that can span decades, and bear most or all of the risk that entails. They also frequently handle the long-term management of the projects. In return the private sector partners—often a consortium of investors and businesses—share in the revenue the projects generate and stand to profit from any improvements they make.

In CIFAP's case, the private sector is offering a range of P3-type financing options:

Consumption-based financing. Cities pay for technology based on usage, increasing or decreasing capacity as needed.

"As a service" financing. Cities to avoid purchasing technology altogether. Instead, they consume it as a service, much as residents consume city services.

With **concession financing**, cities gain the benefits of technology at little or no cost while getting the incremental revenue or cost savings generated.

Revenue share financing can help to tie the cost of financing to the desired outcomes of that city's smart infrastructure projects. Cities and investors then share the revenue streams or cost savings that result from these projects.

Smart city public-private partnerships face challenges. One is the need to generate revenue streams that corporate partners and investors can rely on. As former Philadelphia Chief Information Officer Charles Brennan said at the IGEL-Suez conference, there are two basic ways smart city projects can produce revenue, by selling either advertising or data.

Given the amount of data smart cities look to collect, it's not surprising that many are interested in finding ways to profit from it. Smart streetlights can collect data about everything from street and foot traffic to pollution levels, and there are potential customers for such data. Local retailers would benefit from knowing how foot traffic varies from hour to hour and season to season, and local health clinics could better treat asthma patients if they could predict periods of increased air pollution.

But monetizing data raises the thorny issue of individual privacy. According to *The Wall Street Journal*, most cities are stripping publicly available data of personally identifiable information to provide at least some protection. Still, the paper said, it is possible to combine such data with other information "to figure out an awful lot of information about any individual."

Advertising, too, makes many in city government uncomfortable, which is presumably why only 18% of those surveyed by Black and Veatch think ad revenue is a realistic opportunity for smart city financing. Yet at least two cities, New York and Kansas City, Mo., are already reaping financial benefits from smart city advertising. In both cases, interactive information kiosks are the source of the revenue.

In partnership with Cisco and other private companies, Kansas City installed 25 smart kiosks along a 2.2-mile corridor in 2016. Located at streetcar platforms, the kiosks let passengers know when the next streetcar will be arriving, provide information about local businesses and events and offer new ways to access city services. They also feature advertising that has already made the kiosks moneymakers, according to Bob Bennett, the city's chief innovation officer.

In New York, the city formed an innovative partnership, LinkNYC, with a consortium of companies to install 7,500 digital kiosks throughout the city. Nine hundred have already been activated at no cost to taxpayers, thanks to the partnership arrangement, which specifies that companies bear the cost of the equipment, installation, ongoing maintenance and ad sales in return for a fixed share of the advertising revenue the kiosks are expected to generate.

Today, people use the kiosks to charge smartphones, access Wi-Fi and search for information about the weather and local restaurants. In the future, they may be get directions via augmented reality or use the kiosks to find and summon nearby autonomous vehicles, according to the company managing the project. In the meantime, those who stop by also see ads that are expected to generate more than $500 million in revenue over the project's first 12 years.

The other major challenge P3s face is inertia, the reluctance of some city officials to breach the metaphorical wall separating government from business. In 2012, when Mayor Rahm Emanuel first announced the Chicago Infrastructure Trust, he called it "the breakout strategy for the city," a creative way to spark business investment in infrastructure projects during a period of constrained government budgets. Three years later, a disappointed Emanuel tried to boost the performance of the venture by relaunching it as Chicago Infrastructure Trust 2.0. Yet when the city recently announced an ambitious plan to convert 85% of Chicago's outdoor lights to smart LED technology, saving the city an estimated $10 million, it said the financing would come not from private investors but from a combination of general obligation bond issues and city funds.

One challenge P3s face is inertia, the reluctance of some city officials to breach the metaphorical wall separating government from business.

It wasn't for lack of interest on the part of private investors, said Leslie Darling, executive director of the Infrastructure Trust. "Private investors were very interested. But the city was not interested in privatizing a critical public safety asset."

In the end, no single approach can resolve the financial challenges facing smart cities. It will take funding support from government and nonprofits, debt and equity financing, tax revenue, collaboration among utilities and others involved in the effort, plus a wide range of public-private partnerships and creative approaches as-yet unknown. ◆

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The Wharton-led, Penn-wide **Initiative for Global Environmental Leadership (IGEL)** promotes knowledge for business sustainability through world-class research, transformative teaching and constructive dialogue among top alumni, academic, corporate, government, and non-government organizations. IGEL is a hub for business and sustainability, connecting and leveraging academic capital at Penn to help business leaders of today and tomorrow create more sustainable industries.

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SUEZ is one of the world's leading environmental service companies. SUEZ supplies clean drinking water to 92 million people across 70 countries and 5 continents. The SUEZ mission is a Resource Revolution that helps societies shift to a sustainable relationship with the planet, where we all conserve and optimize the use of our limited natural resources.

Eric Orts
Faculty Director
Initiative for Global Environmental Leadership (IGEL)
The Wharton School, University of Pennsylvania
ortse@wharton.upenn.edu

Joanne Spigonardo
Senior Associate Director of Business Development
Initiative for Global Environmental Leadership (IGEL)
The Wharton School, University of Pennsylvania
spigonaj@wharton.upenn.edu