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Smart Cities for Sustainability

A Sector-By-Sector Tech Review

USDN Resource Guide



Acknowledgments

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ABOUT NUTTER CONSULTING

Based in San Francisco, CA, Nutter Consulting helps cities, nonprofits, foundations and businesses leverage innovation strategies and smart cities tools to meet their sustainability goals. Led by Melanie Nutter, former Director of the San Francisco Department of the Environment and former Deputy Director for Speaker of the House Nancy Pelosi, Nutter Consulting specializes in advancing carbon emission reduction and climate adaptation efforts through program development, strategic planning, public policy development, communications, media strategy and coalition building. Learn more at nutterconsulting.net.

ABOUT THE INSTITUTE FOR SUSTAINABLE COMMUNITIES

Since its founding in 1991 by former Vermont Governor Madeleine Kunin, ISC has led over 100 transformative, community-driven projects in 30 countries. ISC specializes in developing and delivering highly successful training and technical assistance programs that improve the effectiveness of communities, their leaders, and the institutions that support them. Learn more at iscvt.org.

ABOUT THE URBAN SUSTAINABILITY DIRECTORS NETWORK

The Urban Sustainability Directors Network (USDN) is a peer-to-peer network of local government professionals from over 145 cities across the United States and Canada dedicated to creating a healthier environment, economic prosperity, and increased social equity. This dynamic network enables sustainability directors and staff to share best practices and accelerate the application of good ideas across North America. Learn more at usdn.org,

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Aerial view of a city skyline at sunset, with the sun low on the horizon, casting a warm glow over the buildings and water. The title 'Introduction' is centered over the image in a large, white, sans-serif font.

Introduction

Photo credit: Brian Koprowski, <https://www.flickr.com/photos/chewbackski/13059800693>

The smart cities movement has been described as “an agenda of promise,” one in which the use of big data and new technology will provide real-time information for more efficient, nimble, sustainable, equitable and integrated cities. Today, smart buildings, energy, transportation and infrastructure are just beginning to take root in US cities, mostly through a series of ad hoc, pilot projects. While these projects are touted as having multiple impacts, one common benefit is increased sustainability – more energy-efficient buildings, more renewable power integration, more adaptive infrastructure and increased public transportation alternatives.

In 2014, USDN funded an initial investigation into the role of smart cities to determine how data and information communications technology (ICT) can drive urban sustainability. Through the grant, 11 cities participated in the first-ever Smart Cities Summit held by, and for, city Sustainability, IT, and Innovation staff to exchange best practices and identify challenges in this field. Informed by a literature scan and a convening discussion, our working definition of smart cities for urban sustainability practitioners was created: **Smart cities solutions use advanced information and communication technologies to collect, communicate, and analyze data to improve the design and operations of a city’s core systems and programs, as well as citizen engagement, for greater efficiency and effectiveness, thus improving the city’s sustainability, resilience, bottom line and quality of life.** We also identified seven key trends – challenges and promising practices – bridging sustainability and smart cities goals.

Building on the creation of the *Getting Smart About Smart Cities Resource Guide* and the *Collective Voice of Cities*, which were developed for the Urban Sustainability Directors Network’s 2014 Innovation Fund Smart Cities project, we have developed *Smart Cities for Sustainability: A Sector-by-Sector Tech Review*. This toolkit and framework is intended specifically for use by sustainability directors to delve more deeply into specific smart city approaches, technologies, and uses of data to advance their local sustainability goals.

Through extensive desktop research, a survey of 11 participating USDN cities as well as targeted case study interviews, Nutter Consulting and the Institute for Sustainable Communities have created a practical toolkit and framework to help guide cities as they move toward integrating new technologies and public private partnerships into their ongoing sustainability and resilience efforts.

The goal of this framework and toolkit is to offer sustainability directors a comprehensive framework of smart city technologies in key sectors that have large impacts on common sustainability goals – such as carbon emissions reduction, as well as actionable case studies to assist in implementation.

The Advancing Smart and Sustainable Cities Project Working Group is comprised of the following cities:

PARTICIPATING CITIES

- Boulder, CO
- Burlington, VT
- Charlotte, NC
- Chicago, IL
- Columbia, MO
- Houston, TX
- Los Angeles, CA
- Miami, FL
- Montreal, Quebec
- Palo Alto, CA
- Salt Lake City, UT
- San Antonio, TX
- San Jose, CA
- Surrey, BC
- Washington, DC
- Vancouver, BC

ADVISORY CITIES

- San Francisco, CA
- Boston, MA
- Raleigh, NC

Why a Framework?

Since the individual technologies as well as the companies themselves are constantly and quickly evolving, sustainability directors are seeking a consistent and technology-focused outline of existing sustainability sectors mapped with points of technological intervention within those sectors. Throughout the framework, we address opportunities for technology and data interventions within waste, energy & buildings, transportation, and behavior change sectors and explore opportunities for advancing sustainability goals using new technology and data.

ISC and Nutter Consulting reviewed a broad cross-section of smart city frameworks. Some of these frameworks focus on municipal ICT infrastructure – the backbone of a smart city. Others highlight the political, financial and social elements of a smart city. Any comprehensive framework will feature all of these components and will include framework elements on strategy, culture, governance and partnerships, technology, and data.

Although broad smart city frameworks are helpful in understanding the big picture and underscore the importance of collaboration and partnerships, we narrowed the framework of this guide to feature the following priorities:

- The **sustainability objective** purpose in each sector (waste, transportation, energy and buildings and citizen engagement).
- The **current lifecycle** of the systems within each of these local level sectors.
- The points of **technological or data interventions** in each system.
- The **opportunities** for city officials to enable those interventions.

Why a Toolkit?

The toolkit sections of this guide are intended to provide a survey of the relevant technologies in each sector and demonstrate how cities are using smart city approaches to inform and inspire others to take action. In the toolkit, you'll find:

- A sampling of technologies that exist today in each sector.
- A high-level, at-a-glance, review of those technologies and where to find out more about each one.
- In-depth case studies highlighting more developed or promising projects and technologies in each sector.

The Definition of a Smart City

The 2014 *Getting Smart About Smart Cities Resource Guide* outlines our understanding of how the smart city space has been evolving. Until recently, a smart city referred to an idealized, technologically-driven, largely automated city that was developed from the top-down in conjunction with large data and technology companies. Our previous guide referred this type of approach as Smart Cities 1.0. Examples of this type of smart city include the [City of Rio Command Center](#) and [Masdar City](#).

As the smart cities market has continued to evolve, cities are supporting what we call Smart Cities 2.0 strategies that put people first and stresses technology as a tool to use predominantly in service of citizens.

The Potential of Smart and Sustainable Cities

Similar to policy mandates, financial incentives or outreach programs in cities, the use of big data & Information and Communication Technologies (ICT) are increasingly important tools that sustainability directors can use to achieve sustainability goals – from gaining real-time information about energy and transportation systems that help target greenhouse gas (GHG) reduction activities, to fostering wide-scale culture change through crowdsourcing apps. But cities are still only just scratching the surface on the potential of smart cities to reduce GHG emissions. In 2008, the Climate Group and Global e-Sustainability Initiative (GeSI) *SMART2020* report looked at the value of ICT specifically as a tool to reduce GHG emissions by 2020. It found a 7.8 gigaton (Gt) opportunity, valued at \$790 billion a year.² A 2013 updated report from GeSI, *SMARTer 2020*, increased this estimate to 9.1 Gt in GHG reduced – 6.5 percent below 1990 levels – and \$1.9 trillion in financial savings.³ Smart cities market proponents are working to realize these benefits; last year the White House announced the White House Smart Cities Initiative, with over \$160 million in federal research funding.

1 <http://www.fastcoexist.com/3038818/the-smartest-cities-in-the-world-2015-methodology>

2 http://www.smart2020.org/_assets/files/02_Smart2020Report.pdf

3 http://smarter2030.gesi.org/downloads/Full_report.pdf

How to Use This Guide

1. Find the section covering the sustainability sector relevant to you.
 2. Review the framework elements to understand key technological intervention opportunities.
 3. Skim the at-a-glance technologies for real world examples and potential technological solutions.
-

“The goal of smart cities is to be transparent and to make use of the Internet of Things and ubiquitous sensors in order to make better decisions grounded in quality information.”¹

— Dr. Boyd Cohen, *Urban and Climate Strategist*

Implementing smart city technologies can achieve multiple benefits including better integrated city agencies and reporting systems, increased efficiency in city services and potential cost savings improving livability overall. However, the goal of this framework and toolkit is to deepen the understanding of the Internet of Things (IoT) and smart city technologies among urban sustainability programs in service of realizing GHG reductions, and the economic and social benefits they can bring.



The Foundation of a Smart City: ICT Infrastructure

Photo credit: Howard Ignatius, <https://www.flickr.com/photos/howardignatius/14634898052>

The Rise of ICT Infrastructure

Urban sustainability goals, plans and policies are typically organized around three sectors with large carbon emissions: the built environment, energy and mobility. The newfound pervasiveness of ICT and IoT is creating a promising platform to better integrate sustainability programs and related outcomes within these sectors.

ICT is not just a technical concern for city practitioners, but a strategic one. Today more than ever, ICT is a dominant force for social, economic and environmental transformation. Not only is the presence of robust ICT infrastructure a key economic driver for today's cities, it also functions as a sustainability enabler for all other urban sectors covered in this report.

This section is meant to provide a primer of the foundational components of a robust smart city so that sustainability directors may have a working knowledge of smart city concepts, as well as an awareness challenges, considerations and key initiatives directed at increasing access for elderly and low-income residents.

Information is an essential ingredient for urban sustainability and resiliency. But information alone is not enough. To reach sustainability goals, practitioners need new tools to enable further participation and action. A high-functioning and interconnected communications infrastructure is an enabler that redefines how we interact with our physical environment in cities. Sensor networks that support real-time big data generation and feedback are revolutionizing everything, from the responsiveness and adaptability of urban infrastructure to the way local governments engage residents in decision-making. Public transportation systems are being re-routed to better, and more equitably, meet demand, the energy grid and buildings can now talk to each other, and deliver power more efficiently and

4 http://www.smart2020.org/_assets/files/02_Smart2020Report.pdf

5 <https://ec.europa.eu/digital-agenda/en/news/smart-ict-energy-efficiency>

6 <http://www.c2es.org/publications/leading-by-example-2-how-ict-help-achieve-federal-sustainability>

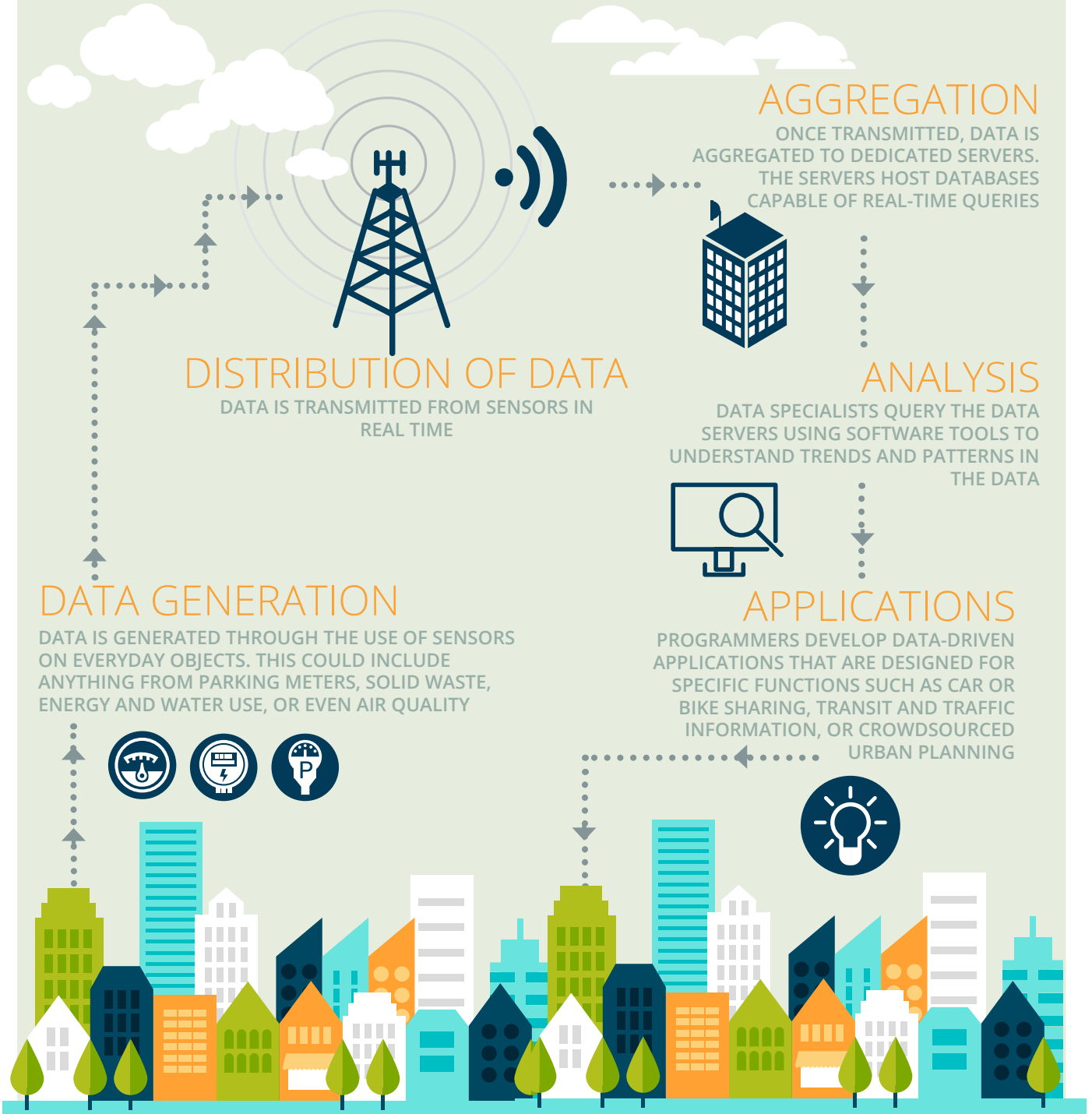
“While the sector plans to significantly step up the energy efficiency of its products and services, **ICT’s largest influence will be by enabling energy efficiencies in other sectors**, an opportunity that could deliver carbon savings five times larger than the total emissions from the entire ICT sector in 2020.”⁴ Smart metering technologies using ICT have been shown to cut energy consumption by up to 10% in annual household energy consumption, resulting in a 9-15% reduction in CO₂ emissions in the EU.⁵ ICT is also being used to lower greenhouse gas emissions by integrating renewable technologies into a smart grid, using advanced building design to create smart buildings that can track and lower energy use, expanding telework and teleconferencing to reduce travel, and enhancing logistics for road transportation that allows for a more efficient use of fleet vehicles.⁶

reliably, and waste can be collected with just-in-time systems, rather than standard collection times.

As ICT's sustainability impact grows, so too does the responsibility of the sustainability director to understand and utilize ICT infrastructure to advance urban sustainability and resilience. In addition, partnerships

with other departments are required, as the true potential of IoT can only be unlocked if cities have an underlying network architecture that takes advantage of the connected devices generating data. Key internal, citywide partnerships include digital, IT, procurement, data, PMOs among many others.

ATTRIBUTES OF A SMART CITY SOLUTION



Traditional vs. Smart Infrastructure

Traditional Urban Infrastructure	Smart Urban Infrastructure
Standardized	Demand-response
Singular Function (disconnected)	Multi-Function (connected)
Inflexible/Rigid	Adaptive
Capital intensive	Small-Scale & Networked
Local (isolated)	Local + Global (systemic)
Analog	Digital

What **smart** does differently:

- Actively measures current conditions and physical environment
- Models future scenarios
- Provides real-time feedback
- Connects people and physical infrastructure to bolster functional relationships towards sustainability, resilience and equity

Enabling ICT Technologies

ICT infrastructure includes three key components: sensors that collect and transmit data, a network through which to transmit that data, and servers to store and aggregate that data.

Sensors & Meters: Sensors are the core of smart infrastructure; they allow systems to monitor changing conditions and respond in real time. Sensors that monitor public infrastructure, such as bridges, roads and buildings, are providing an unprecedented level of performance information that is radically changing operations and maintenance procedures. Real-time monitoring reduces the cost of manual data collection and inspection and lowers the lag time between accessing data and taking action.

IoT Explosion

The deployment of small, decentralized devices has exploded alongside our reliance on the Internet. In the 1990s, one billion devices were connected to the Internet – mainly computers. During the 2000s, that figure jumped to over six billion due to the development of smartphones. According to research by Goldman Sachs, in the next five years, IoT will bring over 28 billion devices online; within the next decade, IoT will power all business. “Cities are expected to spend \$41 trillion on IoT technologies in the next 20 years. In the pursuit of smarter, more responsive city services, local governments have partnered with startups and major technology companies to begin experimenting with IoT across all dimensions of urban life.”⁷

Technological advancements and the diminishing cost of IT infrastructure have created the potential for an “Internet of Things,” a ubiquitous network of connected devices, smart sensors, and big data analytics. The United States has the opportunity to be a global leader in this field, and cities represent strong potential test beds for development and deployment of Internet of Things applications. Successfully deploying these and other new approaches often depends on new regional collaborations among a diverse array of public and private actors, including industry, academia, and various public entities. — [White House Press Release 9/14/15](#)

7 <http://www.goldmansachs.com/our-thinking/outlook/internet-of-things/iot-report.pdf>

Internet of Things: The Internet of Things (IoT) refers to the ubiquitous network of connected everyday objects such as mobile phones, streetlights, smart grid sensors, and parking meters that can generate, send and receive data. In turn, this data is used to better understand everything from energy demand, traffic patterns, and heating needs of buildings.

Broadband Connectivity: Broadband's growing capacity and ubiquity make distribution and monitoring of sensors more practical. Broadband includes several high-speed transmission technologies, such as: [Digital Subscriber Line \(DSL\)](#), [Cable Modem](#), [Fiber Optic](#), [Wireless](#), [Satellite](#), [Broadband over Powerlines \(BPL\)](#),⁸ which are not equal in prevalence, reliability, speed or bandwidth. Affordable access to increasingly higher speed broadband is now a key innovation and productivity driver critical to economic growth and competitiveness.⁹ While access to fiber has evolved slowly, it is poised for massive growth in the near future.¹⁰ For example, Google's work with Kansas City to launch [Google Fiber](#) allows their residents to access broadband that's about 100 times faster than the national average.¹¹

According to the White House, roughly forty percent of American households have either slow Internet access, or single providers (i.e. no competition in the market). To help fill the void, cities and towns around the country have developed their own locally-owned, municipal broadband networks to increase access to broadband, encourage competition, and drive local economic development.

Municipal broadband programs enable local governments to operate a broadband network like a utility from which private companies may buy access to deliver services. By doing so, governments create a competitive environment where the network owner does not determine which services consumers can receive. In October 2015, the Institute for Local Self Reliance (ILSR) documented over 450 communities on their [Community Broadband Map](#) which tracks a variety of ways in which local governments have invested in wired telecommunications networks. Case studies from ILSR¹² illustrate the economic impact of municipal broadband,¹³ and [Chattanooga, TN](#) is leveraging its broadband as a critical sustainability tool by building their own smart grid platform.

8 <https://www.fcc.gov/encyclopedia/types-broadband-connections>

9 https://www.whitehouse.gov/sites/default/files/docs/community-based_broadband_report_by_executive_office_of_the_president.pdf

10 <http://blog.m2fx.com/2015-and-key-trends-in-the-us-fiber-market>

11 <http://www.npr.org/sections/alltechconsidered/2015/03/09/390392782/in-kansas-city-superfast-internet-and-a-digital-divide>

12 Cedar Falls, Iowa: <http://www.muniwireless.com/reports/docs/cedarfalls.pdf>; Lake County, Florida: http://www.freepress.net/sites/default/files/fp-legacy/broadband_and_economic_development_aes.pdf

13 http://cfp.mit.edu/publications/CFP_Papers/Measuring_bb_econ_impact-final.pdf

ICT Infrastructure Challenges

Equitable Access and the Digital Divide

While cities are working to foster or deploy community-wide broadband networks, a sizable gap remains between those who can access the Internet and those who cannot, creating the digital divide. According to Pew Research Center, 68% of Americans own mobile devices (up from 35% in 2011) and 45% own tablet computers.¹⁴ As of July 2015, 15% of American adults ages 18 and older do not use the Internet or email.¹⁵ Pew found that Internet use remains strongly correlated with age, educational attainment and household income. One of the strongest patterns in the data on internet use is by age group: 39% of Americans ages 65 and older do not use the Internet, and these older Americans make up almost half (49%) of non-Internet users overall. Moreover, 78% of households earning \$30K and under use the Internet as compared to 97% of households earning \$150K or more.¹⁶ Understanding and addressing the digital divide is a particular concern for sustainability directors who champion equity as a core tenet of creating a sustainable and resilient city.¹⁷

As more planning and participation processes move from city hall to online, new technologies are both contributing to the problem and are intentionally designed to close the gap. Cities can reach more people through the use of the apps and engagement strategies, but without addressing the digital divide while simultaneously using robust offline engagement tactics, online engagement strategies could continue to disenfranchise elderly, low-income and minority residents, whose participation in the public process is critical.

Environmental Impact of ICT

While the technology that supports ICT is a contributor to greenhouse gas emissions and global resource consumption, it can also contribute to the solution. As more people get access to the Internet and require more data storage and faster connection speeds, more energy is needed to run the ICT networks we rely on to connect, work, and communicate. In 2012, global ICT consumed 4.7% of electricity,¹⁹ and that number is closer to 10% in 2015.²⁰ Still, the ability for ICT to reduce carbon emissions is likely to offset the expected growth in energy usage.²¹

These savings are the result of using ICT to replace other carbon-intensive activities like driving to work or a shopping mall vs. teleconferencing and

The American Council for an Energy Efficient Economy (ACEEE) reported that ICT is a significant contributor to energy efficiency: for every extra kilowatt-hour of electricity demanded by ICT, the US economy increases its overall energy savings by a factor of 10.¹⁸

“To start, cities must create a valid and comprehensive data set to assess impacts, set action priorities, and measure success.”

— *Connected and Sustainable ICT Infrastructure*

14 <http://www.pewinternet.org/2015/10/29/technology-device-ownership-2015/>

15 <http://www.pewinternet.org/2015/12/21/home-broadband-2015/>

16 <http://www.pewinternet.org/2015/09/22/digital-divides-2015/>

17 http://usdn.org/uploads/cms/documents/usdn_equity_scan_sept_2014_final.pdf

18 <http://aceee.org/sites/default/files/publications/researchreports/E081.pdf>

19 <http://ubiquity.acm.org/article.cfm?id=2755977#R6>

20 http://www.tech-pundit.com/wp-content/uploads/2013/07/Cloud_Begins_With_Coal.pdf?c761ac&c761ac

21 <http://ubiquity.acm.org/article.cfm?id=2755977#R6>

e-commerce.²² To manage ICT effectively, cities need a common framework for data and performance, and a set of solutions for urban sustainability.

Strategies for Innovations in ICT Infrastructure

As IoT continues to grow, sustainability directors and other city leaders are redefining what it means to govern in the information age. By contributing to and working with big data, cities must confront the reality that while they might collect specific data sets, that data remains public.

While IoT presents new opportunities and benefits for municipal ownership of smart infrastructure, including broadband networks, utilities, and data centers, cities cannot – nor should they – do it all. To build a useful ICT infrastructure, a culture of collaboration and common stewardship is essential.

For example, publishing datasets and creating interactive maps are certainly tasks that smart cities are undertaking, but cities are unable to make substantial progress on sustainability goals unless that data prompts action across departments and among the public. Here are some approaches cities are taking to ensure that their ICT initiatives make tangible impacts:

Cultivate data- and tech-focused in-house expertise.

- [Chief Data Officers](#) are increasingly recognized as “a rising class of officials with an often broad mandate to convert data into actionable intelligence” in both the private and public sectors.²³ Beginning with the State of Colorado’s CDO hire in 2010, New York City started the local trend and became the first to hire a CDO at the municipal level. CDOs often champion open data initiatives as well as help to improve data sharing and operability between government agencies.
- San Francisco’s innovative [Entrepreneur-In-Residence](#) program is “a voluntary, sixteen-week collaboration to bring together the private sector and City departments to explore innovative solutions to civic challenges that can lower costs, increase revenue, and enhance productivity.” By bringing private sector startups together with government agencies, San Francisco is equipped to explore new ways to use technology to make government, “more accountable, efficient and responsive,” according to San Francisco Mayor Edwin Lee.

Establish city-funded offices for tech innovation.

- In the cities of Boston and Philadelphia, the [Mayor’s Office of New Urban Mechanics](#) function as part of a network of civic innovation offices that “explore how new technology, designs and policies can strengthen the partnership between residents and government.” These city-funded offices serve as the in-house research & development

“Our SMART 2020 report found that deploying smart technologies in key areas of electricity grids, transport, logistics, buildings, and industrial motors could save 15% of global emissions in 2020, and around \$900 billion a year by 2020 in energy savings to global industry.”

— [The New Economics of Cities](#)

²² <http://aceee.org/sites/default/files/publications/researchreports/E081.pdf>

²³ <http://www.govtech.com/data/Chief-Data-Officers-Shaping-One-of-the-Newest-Positions-in-Government.html>

group for the Mayors' offices, each building partnerships between internal agencies and outside entrepreneurs to pilot projects that address sustainability needs and other the needs of residents. Knowledge is shared across the city-based innovation offices so that good practices can scale more quickly. An evolution from the traditional IT department, offices of Innovation and Technology in [Chicago](#) and [Philadelphia](#) also work on open data, mapping, the digital divide, data analytics, and civic tech, with a directive to foster innovation through technology in city government.

Create and/or participate in nonprofit collaboratives.

- The [Smart Chicago Collaborative](#) is a funding collaborative that brings together municipal, philanthropic, and corporate investments in civic innovation. Founded by the City of Chicago, the John D. and Catherine T. MacArthur Foundation, and the Chicago Community Trust as an effort to help close the digital divide, the Collaborative's mission is to improve lives in Chicago through technology. It works to increase Internet access and skills as well as to develop applications that contribute to local quality of life. As a nonprofit entity, the collaborative attracts competitive grant funding to support programs such as [Civic Works](#), designed to spur support for civic innovation.

Host and participate in civic tech competitions and challenges.

- Organizations like [Citymart](#) help communities access the wisdom of residents and entrepreneurs through Citymart Challenges. Chicago's [Chi HackNight](#) has become a weekly event for "designers, academic researchers, data journalists, activists, policy wonks, web developers and curious citizens" to learn from speakers, collaborate, and work on civic tech applications.
- Raleigh, NC annually hosts [CityCamp NC](#), where citizens, different levels of government, and businesses work together towards next generation solutions for local municipalities.
- [NYC BigApps 2015](#) asked entrants to address four issues identified in Mayor Bill de Blasio's OneNYC plan for a strong, sustainable, resilient, and equitable city: affordable housing, zero waste, connected cities, and civic engagement.
- [#Climathon](#) takes place in multiple cities including [Boston](#) and [Washington DC](#) over the course of 24 hours with one goal: "To take climate action and help [cities] find climate change solutions."²⁴

Partner with tech sector incubators.

- [BTV Ignite](#) "encourages public, private and academic institutions to develop next generation Internet applications" and is a partnership between the City of Burlington and nonprofit [US Ignite](#). Together, they are working to leverage the city's municipal gigabit infrastructure to maximize community benefit.
- [Code for America](#) builds open source technology and organizes a network of people dedicated to making government services simple, effective, and easy to use. Code for America Brigades are local volunteer groups that bring together community members with the aim of making government work better. Brigades use technology to build new tools to help with local civic issues. The Code for America's fellowship program pairs volunteer technology teams with local governments to develop digital tools to make government more accessible.
- [The Global City Teams Challenge](#) (GCTC) is a collaborative network of project teams, or action clusters, working on IoT applications within the smart city/community environment. Action clusters are typically composed of representatives from local governments, nonprofits, academic institutions and private corporations. These clusters must include representatives from at least two organizations and at least one

24 <http://www.climate-kic.org/climathon/#>

organization must be a local government. Action clusters collaborate to build, deploy and test groundbreaking IoT applications. During the first round of the GCTC, more than 60 action clusters composed of more than 200 organizations and involving 50+ cities from 10 countries presented at the culminating June 2015 event. Another event is planned for June 2016.

Get involved with or create an Innovation Lab.

- The USDN Smart Cities project team identified over 70 innovation labs in the US and internationally. Of these, 30 work with cities directly and have sustainability initiatives. For the purposes of our project, a lab has the function of accelerating the process of identifying problems that need to be solved and engaging the private sector to help. [Click here for a list of promising labs for sustainability partnerships.](#)

Create a Municipal Data Center

- In 2012, Westerville, OH opened [WēConnect](#), the nation's first municipal data center. Driven largely by the City's Chief Information Officer, Todd Jackson,²⁵ the 16,000-square-foot center can house up to 230 cages for data servers, and functions as a data utility for the community. The center not only saves the city money by eliminating monthly payments to vendors for municipal data storage that is often siloed at city agency offices, but local businesses and organizations now pay the city to house servers and connect to the city's fiber optic network. The idea came about when Westerville was making plans to expand the fiber optic network and recognized the need for local data center services. Paid for with an advance from the City, WēConnect revenues will eventually cover Westerville's cost of construction.

Address Digital Access and Inclusion

- The Mayor's Advisory Council on Closing the Digital Divide in Chicago released a [Digital Excellence Action Agenda](#) in May 2009 highlighting the problem of the digital divide. The agenda includes a number of recommendations that the city can take to "ensure universal digital access and to improve community, educational, economic and other outcomes." As part of the agenda, the [Chicago Local Initiatives Support Corporation](#) (LISC) [Smart Communities](#) digital inclusion campaign led to a 15% increase in Internet usage in five low-income neighborhoods, including installing approximately 30 HP "Touch Smart" Kiosks to provide public Internet access. Another program, [Connect Chicago](#), is a loose network of more than 250 places in the city with free Internet and computer access, digital skills training and online learning resources.

Other initiatives that are addressing the Digital Divide include:

- Washington, DC released a Digital Divide Report, offers free computer training, free public technology and Internet access, and more through [Connect.DC - Digital Inclusion Initiative](#).

"Universities and community colleges...teaming up with nearby cities that serve as "labs." Florida Tech's Civic Engagement Initiative matches community needs with student and employee interests to develop individual and collective actions designed to identify and address issues of public concern. Other educational programs include: MIT and Boston, MA; Georgia Tech and Athens, GA; University of Michigan and the Jackson, MI."

— [USDN The Civic Technology Landscape](#)

²⁵ <http://www.westerville.org/about-westerville/contact-us>

- The Mayor of Chicago is providing low-cost broadband to residents through the [Chicago Broadband Initiative](#).
- Massachusetts is addressing inequity through broadband expansion; Wi-Fi towers have been installed in low-income Boston neighborhoods providing free Internet access in public spaces through the City's [Wicked Free Wi-Fi](#) program.
- Minneapolis's [Digital Equity Program](#) is housed at The Minneapolis Foundation as a partnership between the city and wireless provider U.S. Internet, providing grants to projects that increase tech access and skills amongst non-traditional users of technology. The City's [2013 Community Technology Survey](#) indicated the neighborhoods with greatest digital divide, sparking locally-focused groups like the [TLC Phillips Hub](#) and [Northside Digital Innovation Alliance](#). Through [PCs for People](#), the City donates its used computers – 2,770 devices including 1,941 desktop computers and 650 laptops since 2009 – to households throughout Minneapolis. The city's [Fix-It Tech](#) events provide computer hardware repair, education and tech support to the public.
- In Philadelphia, the city is combining free Internet access with training and education. [KEYSPOT](#) represents a citywide coalition of community-based groups committed to bringing Internet access, training and technology to all Philadelphia communities. The KEYSPOt Network is managed by the Mayor's Commission on Literacy on behalf of the City of Philadelphia in partnership with the Office of Innovation and Technology, Philadelphia Parks and Recreation, and Drexel University. Trainings are offered at more than 50 KEYSPOts. Other cities are calling similar training locations Community Technology Centers or Digital Inclusion Centers.



SMART & SUSTAINABLE SECTOR: CIVIC ENGAGEMENT

Photo credit: Telwink, www.flickr.com

Fundamentals of ICT-Based Civic Engagement

Civic engagement fuels local democracy. As cities adopt smart technologies, new community engagement possibilities are emerging that push the boundaries of inclusive decision-making.

Today, civic engagement tools and technologies are shaped by:

1. Local governments seeking to contact, inform and engage the public.
2. Residents and civic hackers using public data to design solutions.
3. Private sector leaders, typically startups and tech entrepreneurs, developing platforms and tools for digital and virtual engagement.
4. New technologies pushing the field to adapt and evolve beyond traditional forms of engagement.

Civic engagement is not only a way for cities to reach, activate and collect feedback from residents, but more critically, it enables local residents to participate directly in decisions that affect them the most. Successful engagement is dependent on a local government's ability to remain open, adaptable and trustworthy to the public as well as residents' commitment to act. The following tools and technologies can help dissolve boundaries between local governments and their communities and empower a new generation of civic participation.

“Civic engagement means working to make a difference in the civic life of our communities and developing the combination of knowledge, skills, values and motivation to make that difference. It means promoting the quality of life in a community, through both political and non-political processes.”

— *Civic Responsibility and Higher Education*,
edited by Thomas Ehrlich, 2000

Civic Engagement for Smart Cities 2.0

Smart cities require a local government that is ready to empower local action.

Lower Engagement	Smart City 2.0 Engagement
Resident = Constituent	Resident = Co-creator
Top-down planning	Interactive/collaborative planning
Function-first	People-first
Problem-solving	Solution-generating
Service delivery	Service innovation

In lower engagement cities, the resident is first and foremost a constituent engaged primarily to approve policy decisions and through public comment or voting. In the people-first Smart City 2.0, the resident is an innovation partner with government. This represents a shift in the role of local government from delivering essential services, to open-source *service innovation*, with help from residents, businesses, nonprofits and academics.

Civic technology lies at the intersection between civic engagement and smart cities, by creating new collaboration platforms for local governments and the communities they serve. Civic tech has been in existence for over a decade, but is still an emerging field with room for growth.²⁶ Growth in civic tech spending is projected to be 14 times faster than traditional government technology spending at both state and local levels – at \$6.4 billion by the end of 2015.²⁷ Investments are already being realized, with companies like Socrata, an open government firm, recently announcing a \$30 million investment in cloud-based solutions for local governments in late 2014,²⁸ and Accela following suit with the largest civic tech investment to date – \$143 million – in cloud-based government and citizen interaction.²⁹

Engagement is not Just About Service Delivery

According to a recent report by the Knight Foundation that looked at investments across the civic tech field, technology clusters focused on civic engagement and democratic participation via public decision-making, resident feedback, and voting, are the most nascent and least funded, while the best funded apps focus on improving government service delivery. This was reflected in the USDN Civic Tech Scan, where [SeeClickFix](#) – an app that allows residents to report non-emergency issues like potholes and broken street lights to their government officials – was the most cited vendor

26 <http://techcrunch.com/2015/04/29/civic-tech-is-ready-for-investment/#.unb5b83:j9ZH>

27 <http://www.govtech.com/budget-finance/6-9-Billion-to-be-Spent-on-Civic-Tech-in-2015-Report-Says.html>

28 <https://www.socrata.com/newsroom-article/global-open-data-government-cloud-solutions-leader-raises-30-million/>

29 <http://www.accela.com/easyblog/entry/accela-closes-largest-investment-in-the-government-tech-market>

30 <http://www.saenv.com/wp-content/uploads/2015/07/1.-Civic-Tech-Final-Report.pdf>

What is Civic Tech?

The use of information technology to engage local government and community residents in behaviors that improve the quality and accountability of public services, facilitate resident-driven improvements to local quality of life, and deepen participation in decision-making and public infrastructure maintenance. In short, civic tech serves as an interface for local government and community members to virtually interact.³⁰

application by surveyed cities.³¹

Engagement for service delivery improvement alone constitutes what the Young Foundation calls *thin participation* – where “people are asked to do no more than ‘show up’ or perform some pre-defined kind of activity.” Alternatively, *thick participation* “asks people to do more than this – it requires their ideas, input and creativity.”³² A true 2.0, people-centered smart city gravitates toward the latter. “It is not the data itself that is enacting a political reality, but the conditions under which those data are being collected.”³³

The reality is, both levels of participation matter, but they have different functions. The vitality of communities is not simply how efficiently and seamlessly services are delivered, but also the degree to which *all* citizens are a part of creating those communities and services.

In their book *Public Participation for 21st Century Democracy*, Matt Leighninger & Tina Nabatchi offer six objectives of “smart” civic engagement for local governments ordered from “thin” to “thick” strategies:³⁴

1. **Disseminating Information** – emphasis on how a trusted relationship can cut through the “noise” of the crowded social media space.
2. **Gathering Input and Data** – using technologies including surveys, polls, competitions, petitions and crowdsourcing to understand what matters to residents.
3. **Discussing and Connecting** – creating inviting spaces such as online forums, competitions and deliberative dialogues.
4. **Enable Small-Scale Decision-Making** – facilitating day-to-day decisions through public meetings (online and in-person), neighborhood groups, peer-to-peer forums and sharing platforms.
5. **Enable Large-Scale Decision-Making** – facilitating opportunities for citizens to influence public policy including participatory budgeting, community coalitions, and ballot initiatives.
6. **Encouraging Public Work** – truly innovative collaborative approaches.

The Civic Engagement Spectrum

A useful framework for thinking about tech interventions in civic engagement is the [International Association for Public Participation's Spectrum of Public Participation](#).³⁵ The spectrum identifies five levels of engagement: inform, consult, involve, collaborate, empower. The *inform* stage includes technology that increases reach of, and access to, government services and tells residents what they need to know. Tech in the *consult* stage includes apps and sensors that collect real-time resident feedback and reporting. The *involve* level of participation includes technology designed to facilitate dialogue and transparency, while collaborate means technology and events that facilitate collaborative decision-making. Finally, the *empower* level of participation refers to tech that puts sustainability and innovation in the hands of the residents themselves.

The Civic Engagement Tech Guide references these levels. Each level is equally critical for robust civic engagement, and technologies are being developed to address each stage, or a combination, so a single application might invite participation at several stages. It could *inform* residents about a city's sustainability plan; *consult* residents by gathering data on their energy usage; *collaborate* with residents by deciding on sustainability targets and *empower* residents by letting them decide the best methods for achieving them. Smart civic engagement is as much about making the *informing* aspect stronger as it is about finding new and innovative ways to empower people.

31 <http://www.saenv.com/wp-content/uploads/2015/07/1.-Civic-Tech-Final-Report.pdf>

32 <http://youngfoundation.org/resilient-communities-housing/slackivism-vs-thick-and-impactful-civic-participation/>

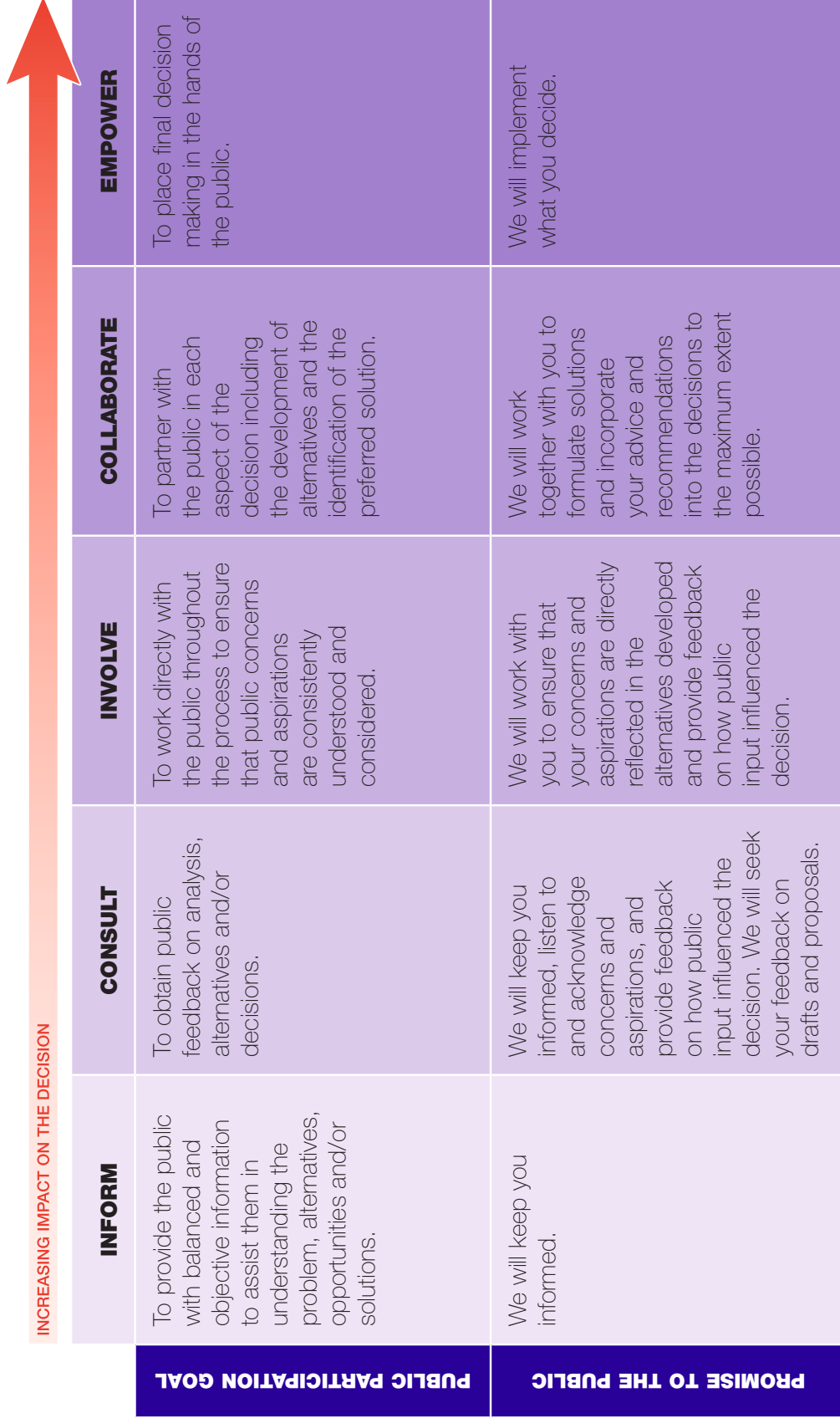
33 <http://www.theatlantic.com/technology/archive/2014/05/the-right-way-to-make-cities-smart/370900/>

34 Leighninger, Matthew, and Tina Nabatchi. *Public Participation for 21st Century Democracy*. Hoboken: John Wiley & Sons, 2015.

35 [http://www.iap2canada.ca/Resources/Documents/0702-Foundations-Spectrum-MW-rev2%20\(1\).pdf](http://www.iap2canada.ca/Resources/Documents/0702-Foundations-Spectrum-MW-rev2%20(1).pdf)

IAP2'S PUBLIC PARTICIPATION SPECTRUM

The IAP2 Federation has developed the Spectrum to help groups define the public's role in any public participation process. The IAP2 Spectrum is quickly becoming an international standard.



Civic Engagement Case Study

OpenDataPhilly

AT-A-GLANCE

Launch Date: April 2011 | **Timeline:** Ongoing

Cost: Initially pro bono from Azavea, then additional funding through William Penn Foundation and the Knight Foundation (no public information on exact amount)

Stakeholders: Azavea, City of Philadelphia, Temple University, Technical.ly Philly, Philadelphia citizens, nonprofits, private businesses, universities

Tools and Tech Used: Azavea, CKAN

Metrics: Fires, licenses and inspections, streets, parks and recreation, commerce, city commissioners, ethics, emergency management, energy and sustainability

Key Contacts: Robert Cheetham (Azavea)

City: Philadelphia, PA

Objective: OpenDataPhilly is a catalog of open data in the Philadelphia region that includes data sets from city departments, as well as several other organizations in the region. The catalog's purpose is to increase government transparency and accountability, drive and encourage innovative uses of data, and inform residents about the region's trends.

Background: The catalog initially was a pro bono project by Azavea, a private GIS firm—launching in 2011. Azavea then turned the site over to Temple University, which maintains daily operations.

Process: Azavea built the original data portal from scratch, and included data sets from several outside organizations, including universities, local companies. From the outset, their goal was to provide collaborative data sets that would benefit the residents, and provide a free data platform for the municipal government.

Tech and Tools: The first iteration of the site was built using Azavea's proprietary technology. In the second iteration, Azavea used CKAN, an open-source data portal software. CKAN is a data-management system that is able to catalog information, and makes data accessible through streamlining the publishing, sharing and searching of the data. It provides data visualization, storage, and an API that allows for customization and integration with third-party sites.

NEXT STEPS AND LESSONS LEARNED

OpenDataPhilly represents a fundamental change in the way local governments, community members, and the private sector collaborate around shared, open data. While releasing data was the obvious outcome of the project, it was only part of the overall picture. The project also created a community of stakeholders with shared values and responsibility. The project enabled journalists to catalog data; allowed new access to data for government agencies and members of the public; provided research data for both students; and fostered new business development platforms for local businesses.

The community surrounding OpenDataPhilly was incubated through public events, such as a tech week, hackathons, competitions and a public voting process to determine which data sets would be made available.

Website: <https://www.opendataphilly.org/> | [ckan: http://ckan.org/](http://ckan.org/)



SMART SECTOR: BUILDINGS + ENERGY SYSTEM

Photo credit: David Yu, www.flickr.com

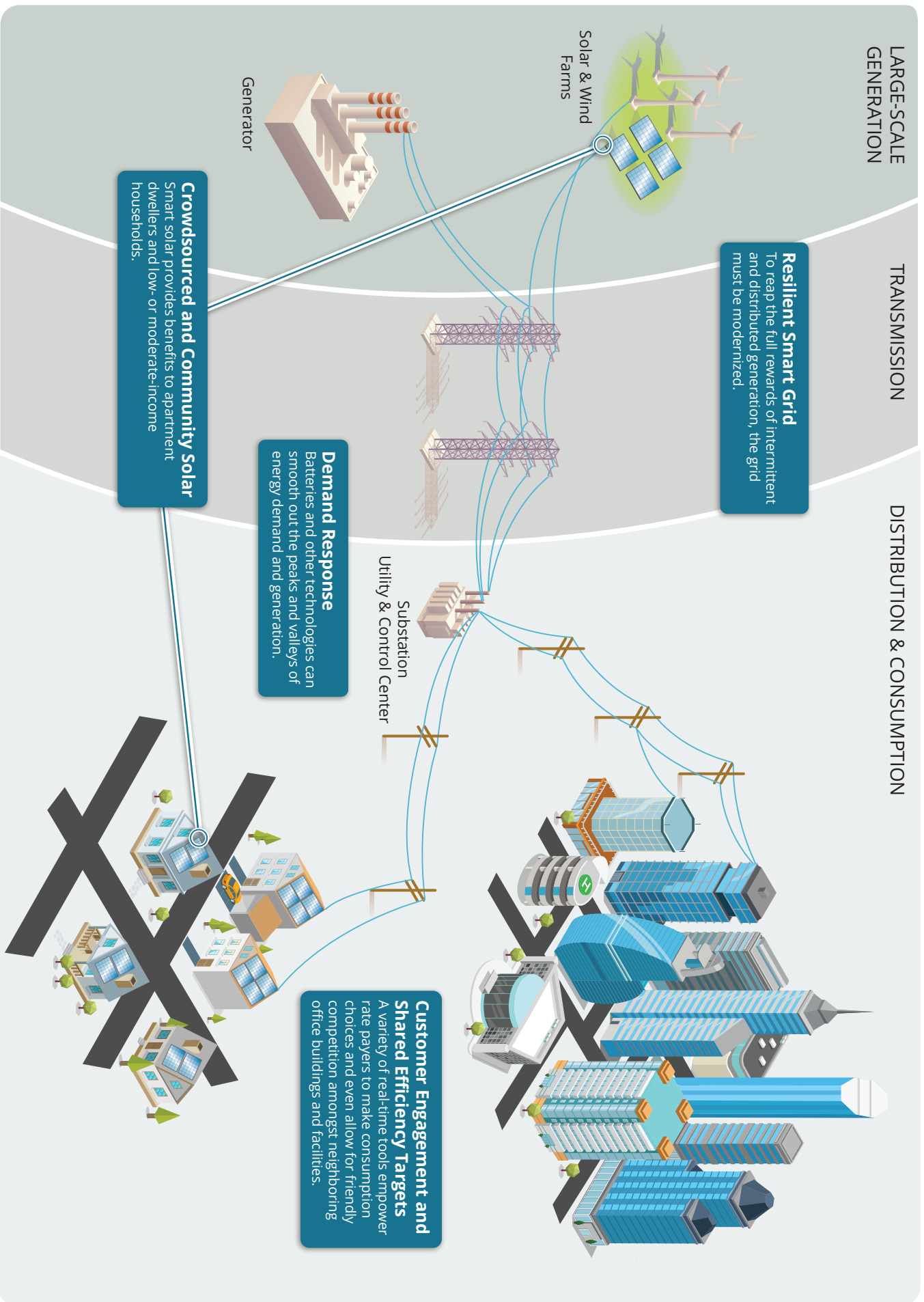
The energy and buildings sector is in the midst of an exciting transition. In the old model, centralized power plants were controlled by operators to match power generation to demand at any given moment. Power flowed in one direction, from the plant to the end user. In the new model, the spread of smart sensor technologies enabling two-way communication between power sources and end users is contributing to a flexible and more efficient system that allows greater penetration of large and small-scale renewable energy sources.

This section focuses on the following sustainability goals:

- **Integrate renewable** energy into energy grid supply.
- Create a **resilient grid** that sheds load and integrates renewables.
- Enable **net zero energy** buildings and energy end-uses.

SMART SECTOR

BUILDINGS + ENERGY GRID SYSTEMS



Fundamentals of the Buildings + Energy System

Modernizing the Grid for Renewables

The United States grid supplies energy to more than 143 million residential, commercial, and industrial customers through about 450,000 miles of high voltage transmission lines, and roughly 5.5 million miles of low voltage distribution lines.³⁶ Electricity usage accounted for 31% of US greenhouse gas emissions in 2013. This represented an increase of 11% since 1990.³⁷ With a 66% increase of renewable energy supplies from 2005 to 2015³⁸ renewable electricity represents more than 15% of installed capacity in the US, but a much larger share is required to achieve meaningful GHG reductions.³⁹ Additionally, as of October 2015, 29 states, Washington DC, and three territories have a renewable portfolio standard in place with targets as high as 50% by 2030. Even with such ambitious numbers, many cities are looking to surpass these targets. Unfortunately, our current grid structure has been largely unchanged for the last 150 years and is not designed to accept high volumes of renewable energy; a modern, smart and flexible grid is needed.

In the traditional grid model, energy is supplied by large, centralized power plants, transmitted over high-voltage power lines, reduced to lower voltage at individual substations, then distributed to residential, commercial, and industrial users through lower voltage distribution networks. In this original grid design, operators need to match electric supply to demand in real time. When demand is at peak levels, operators activate additional power generators (typically higher-polluting, less efficient power plants); when demand is low, unnecessary generators are powered down. This model works with fossil fuel plants because they provide base load power, a consistent, reliable energy supply that can be moderated for demand. Renewable energy from wind and solar, by contrast, is an intermittent energy source. Renewable sources are subject to fluctuations due to natural occurrences like wind speed and cloud cover, thus the energy they generate is more difficult to match to real-time grid demand.

Renewable energy can be supplied to the grid in two ways: through wholesale supply or distributed generation. Wholesale supply includes large-scale solar or wind farms that supply power to the grid through high-voltage transmission lines. Distributed generation (DG) includes smaller-scale renewable sources that connect to the grid through low-voltage distribution lines, typically behind the meter. Increased wholesale renewable energy supply is driven – in part – by policies such as state renewable energy portfolio standards that require minimum renewable energy supply to the grid. DG adoption is driven largely by net metering laws, which allow residential and commercial customers to sell power generated from small-scale solar or wind back to the grid. DG can also include district-scale energy generated through systems such as combined heat and power plants.

DG runs counter to the design of traditional grid systems, since it sends power to the grid from end users via local substations, rather than from large, central plants via high voltage transmission lines. At low levels, DG can be beneficial to distribution systems because it reduces the load at individual substations. At higher levels, DG systems reverse the flow of energy from the substation to the transmission grid, which if the proper controls are not in place, can produce harmful high voltage swings.⁴⁰

36 https://mitei.mit.edu/system/files/Electric_Grid_Full_Report.pdf, page 1

37 US EPA <http://www3.epa.gov/climatechange/ghgemissions/sources/electricity.html>

38 Energy Information Agency http://www.eia.gov/electricity/monthly/epm_table_grapher.cfm?t=epmt_1_01_a

39 <http://www.nrel.gov/docs/fy15osti/62580.pdf>

40 https://mitei.mit.edu/system/files/Electric_Grid_Full_Report.pdf, page 17

Electrification of the Transportation Sector

In addition to DG, the grid is increasingly affected by the proliferation of electric vehicles (EVs). EV sales jumped 128% from 2012 to 2014, with approximately 119,710 new vehicles on the road.⁴¹ While EV's are still less than one percent of total car sales in the US, forecasts estimate that annual sales could grow by 400% by 2024, adding 860,000 new vehicles per year.⁴²

As the EV market grows, their impact may hinder stable grid operation if charged at inopportune times, or support stable grid operation if charged off-peak and/or used as flexible energy storage.

Making the Grid Smarter

Fortunately, utilities across the country are upgrading to a smart grid system to enable more dynamic grid control. While there is no single definition or standard for a smart grid, smart grid efforts typically focus on three key goals:

1. Provide customers with more control over their energy consumption via time-of-use smart meters and appliances.
2. Improve grid reliability through automation and outage detection.
3. Integrate renewables through better energy storage and distributed generation.⁴³

While these goals are in various stages of deployment across the country, the end vision is a grid that can handle a two-way flow of power, organically reroute power in the case of grid failure, integrate intermittent energy sources and energy storage smoothly, and empower citizens to shift loads and choose their own power sources. This smart grid uses data and ICT as a platform for a wide array of strategies at the municipal and utility scale, many of which are discussed later in this section.

Making Buildings Smarter

The design and operations of buildings – both commercial and residential – is changing along with the grid. Building systems (e.g. HVAC, lighting, water, envelope and power) that were once independent, can now be fully integrated and optimized to work in tandem with grid energy supply and demand. Automated systems respond to changing conditions in the building itself – from occupant schedules to weather conditions – and interact with the grid to either supply surplus power, or reduce demand when needed. A new generation of smart buildings is using ICT to move beyond even high performance standards in three key areas:

- **Performance Benchmarking:** High-performance buildings use submeters, real-time energy tracking and diagnostics to monitor and optimize energy use. Smart buildings go a step further by joining a larger network of buildings that share performance data and energy goals.
- **Demand Management:** High performance buildings automatically respond to conditions inside the building, without the need for manual control. Through smart meters and real-time energy pricing, smart buildings also respond to energy supply in the grid to automatically shed their energy load, or store energy to supply the grid when demand is high.
- **Occupant Engagement:** High performance buildings display real-time energy use to occupants, either through kiosks or online applications. Smart buildings also volunteer energy use data to the market (or are mandated to disclose the information to the city by law) to help tenants make more informed decisions on where to locate their business or homes.

41 <http://insideeews.com/december-2014-plug-electric-vehicle-sales-report-card/>

42 Electric Vehicle Geographic Forecasts <https://www.navigantresearch.com/research/electric-vehicle-geographic-forecasts>

43 <http://www.naruc.org/policy/ferc/smartgrid101/smartgrid101-introduction.pdf>

ICT-driven changes to the design and operation of buildings are enabling a new generation of net zero energy buildings. California is arguably leading the charge for net zero, as the state's building code requires that all new residential buildings produce as much renewable energy as they consume by 2020 (new commercial buildings will be zero net energy by 2030).⁴⁴ Elsewhere, net zero energy is becoming the standard to which environmentally minded developers aspire, although many net zero energy building technologies require more development and market maturity to become cost competitive.

Opportunities for Municipalities to Influence the Buildings + Energy System

The following focuses on ways that municipalities can influence the buildings and energy system to achieve city-scale carbon emission reduction goals. Building and energy infrastructure interact to create a complex but vital system, providing the foundation for city economic activity, safety and livability. While the complexity of this system creates challenges – city managers must consider the potential system-wide effects of implementing new technologies – it also creates opportunity, providing a variety of places for cities to intervene. However, cities have different levels of control over each part of the buildings and energy system. When putting together a smart technology plan for this sector, cities should select strategies that reflect local conditions and that leverage local resources.

Some common technological and data driven interventions undertaken by cities include the following:

Municipal building demonstration projects: Many cities start internally by setting clear energy/carbon emissions reduction goals and efficiency and renewable projects for city-owned buildings. Municipal buildings make ideal demonstration sites to demonstrate new technologies and help grow the smart building market. The [Green Building Resource Center in Houston, Texas](#), for example is located where contractors from across the city visit for building permits. The center features demonstrations of the latest green building technologies, staffed by a program director who offers plan reviews for green design options.

Building and energy policies: Cities can influence the local real estate market through policy such as energy disclosure ordinances, energy efficiency stretch codes and green building standards. Organizations such as [City Energy](#) – a joint project of the Natural Resources Defense Council – to promote city policies to disclose building energy use, provide financial incentives for energy efficiency and commissioning, and to encourage leadership from major anchor institutions.

Municipal microgrids: An increasing number of cities are establishing microgrids – community-scale energy systems that generate and distribute their own electricity, heating, or cooling. Microgrids are typically designed to meet the specific energy needs of buildings within a neighborhood or district through localized low-carbon or renewable energy. They include their own renewable energy storage systems, and sophisticated demand response systems. If operated well, microgrids can also offer continued operations in the event of a conventional grid failure.

A helpful primer on microgrids was developed by the Pace Energy and Climate Center at Pace Law School, called [Community Microgrids: Smarter, Cleaner, Greener](#). It offers a how-to guide for setting up municipal microgrids, outlines regulatory actions cities can take to ease the way for microgrids, and includes helpful case studies.

⁴⁴ <http://www.cpuc.ca.gov/NR/rdonlyres/C27FC108-A1FD-4D67-AA59-7EA82011B257/0/3.pdf>

Energy and Building Case Studies

The Community Power Partnership

Boulder Colorado and Pecan Street Research Institute Partner to Understand Citizen Energy Use

City: Boulder, Colorado

Sustainability Objective: Gather real-time data on citizen energy use in order to better design city energy sector policies and incentives

BACKGROUND

When it comes to city sustainability, the city of Boulder, Colorado, has long been a pioneer. The city first developed a Climate Action Plan in 2002, and passed a Climate Action Plan tax in 2007 – the first voter-approved climate related tax in the country. Funds from the tax are used to reduce and avoid greenhouse gas emissions through city programs and incentives.

Boulder's first interaction with energy-related smart technologies was through Xcel Energy, a national investor-owned utility. In 2007, Xcel deployed a citywide smart grid project in Boulder, promising ratepayers much more visibility into their energy use and control over individual appliances in the home. Unfortunately, city residents struggled to reap the benefits of Xcel's smart grid deployment. Xcel's web portal was difficult for residents to use, and the technologies used by Xcel did not meet ratepayers' needs.

Hoping to build city programs and incentives to complement Xcel's project and improve residents' experiences with smart technologies, Boulder sought data on ratepayer energy use. The city partnered with the Pecan Street Research Institute to collect the data in real time. The result is a fuller picture of residential and commercial customer energy use, helping Boulder to refine its energy efficiency incentives for citizens.

PROCESS

The project began in 2014 when the city was approached by the Pecan Street Research Institute, which had secured a \$25,000 grant from the U.S. Department of Energy (DOE) to help cover the cost of the project. After getting the city council's approval to use \$30,000 of Climate Action Plan Tax funds to help finance the project, city environmental managers reached out to community members to identify residents and businesses that wanted to participate. Community interest was strong, and the city easily signed up 48 homes and 14 businesses to share ongoing energy use data with the city in the study. While the city on-boarded participants and gathered demographic data on each business/residence (e.g. size of home, number of occupants), Pecan Street handled the installation of the project's smart meters and built a web portal for participants to view their energy use consumption patterns.

TECH AND TOOLS

The main technology utilized by this project is the eGauge Meter, a combination smart meter, data logger and web server. The data is delivered

AT-A-GLANCE

Boulder's Energy Monitoring Program

Launch Date: December, 2014

Timeline: Pecan Street is committed to collecting data for two years, as a part of its overall DOE study

Cost: \$55,000 for eGauge meter purchase and installation

Stakeholders: City of Boulder, Pecan Street Research Institute

Tools and Tech used: eGauge Meters

Key Contacts: Kara Mertz, Environmental Action Project Manager, Boulder, CO

securely to Pecan Street over the Internet, which scrubs it of personally identifiable information it before delivering it to the City of Boulder for privacy. Citizens can access their own data through Pecan Street's web interface.

While energy use data is now accessible to participants in the study, Boulder has seen that after initial excitement and interest in the project, most residents do not continue to access their data over time, and do not take action based on the data. This may be partially because data analysis capabilities of the web portal are lacking and residents and businesses typically require expert assistance to walk through the data and identify potential efficiency improvements. Boulder is using this result to strengthen its EnergySmart program, in which the city pays for an energy advisor to assist property owners with identifying, bidding out, and implementing energy efficiency improvements.

NEXT STEPS AND LESSONS LEARNED

Boulder is currently searching for a third-party partner to use data collected in the study to answer a variety of program design questions, such the likelihood that a property owner with a residential solar system will complete an efficiency upgrade as well, or when electric vehicle owners actually charge their cars.

When asked for advice for other cities interested in replicating this study, Environmental Action Project Manager Kara Mertz had three suggestions:

1. Start with a small project to work out any issues in data collection, before ramping up the study to get to statistically relevant sample sizes.
2. To ensure that the project produces useful information, engage participants early and periodically over time to assess citizen needs around managing their energy use.
3. Cities should ensure that the energy use data they receive from partners is in a format that is useful and manageable. Boulder has struggled to perform in-house data analysis needed to inform energy program design.

DOCUMENTS AND LINKS

Boulder Community Power Partnership

<https://bouldercolorado.gov/lead/community-power>

Boulder's Climate Action Plan Tax

https://www-static.bouldercolorado.gov/docs/City_of_Boulder-_Climate_Action_Plan_Handout_2015-1-201508261630.pdf

Pecan Street Research Institute

<http://www.pecanstreet.org>

eGauge Systems

<https://www.egauge.net>

BuildSmart DC

Optimizing the Energy Use of Municipal Buildings Through Open Data

City: Washington, DC

Sustainability Objective: Reduce energy use and cost in municipal buildings, setting an example for the private sector

BACKGROUND

Facing rising energy costs and searching for more sustainable sources of electricity, the District of Columbia has developed a broad approach to achieving energy sustainability. From becoming the first city in the country to sign a long-term wind power purchase agreement, to deploying 10 MW of solar on municipal rooftops, to exploring the possibility of integrating energy storage into municipal systems, DC is leaving no stone unturned.

A major component of DC's energy strategy is using smart grid technology to manage and reduce energy use in municipal buildings. The City's Department of General Services (DGS) conceived the BuildSmart DC program in early 2013, as a means to benchmark city building performance and assess opportunities for energy efficiency projects and retro-commissioning. Through a partnership with Pepco, the area's investor owned utility, DGS publishes smart meter 15-minute interval data for municipal building energy use through the program's website. Through program-enabled improvements to building performance, the City has reduced its energy cost by 3% annually across its building portfolio.

PROCESS

When faced with the charge to reduce energy costs in city buildings, DGS's first step was to gather as much data as possible on how buildings were currently operated. This soon led to a partnership with Pepco, in order to take advantage of the energy use data stemming from Pepco's recent smart meter deployment across the District service territory (funded by the Recovery Act).

Initially, Pepco set up a simple secure file transfer protocol (SFTP) to provide municipal building energy use data to the city. This data was then parsed and analyzed on basic software developed by the city's technical team before being fed to the BuildSmart DC website. While this worked for the first few months of the project, Schneider Electric was quickly brought in to develop a first-of-its-kind application program interface (API) to transfer data directly from Pepco's internal database for the city to publish in a way that meets the U.S. Department of Energy's Green Button standard.

AT-A-GLANCE

BuildSmart DC

Launch Date: March, 2013

Timeline: 3-4 months of preparatory work before website launch, six months to steady state/ data covering 80% of city load

Cost: ~\$100,000 (not including meters, which were covered by a recovery act grant to Pepco)

Stakeholders: City of Washington, DC, Pepco (utility), Schneider Electric (meter data management systems vendor)

Tools and Tech used: Smart Meters, Meter Data Management Systems

Metrics: ~3% annual reduction in city electricity cost

Key Contacts: Department of General Services

DGS also collaborated with Pepco to improve data quality. For example, some smart meters had been installed in areas with inconsistent mesh coverage, sometimes resulting in days of lost or delayed data. Pepco ended up moving and/or replacing many meters, and installing additional signal relays where appropriate to ensure that data was collected in an accurate and timely manner.

With this data in hand, DGS has been working to educate building facility managers and service providers on how buildings can be operated more efficiently in order to reduce energy use and cost.

TECH AND TOOLS

The foundational technology used in this project are residential, commercial and industrial smart meters sourced by Silver Spring Networks, which is the vendor Pepco used for its 2009 smart grid deployment. Building on these sensors, Pepco and the District relied on Schneider and IBM to build meter data management systems with the capability of sharing high-quality interval data from the utility's system to the District's. Since the BuildSmart DC program is focused on municipal buildings only, privacy concerns were low, although data is transferred securely to maintain quality and accuracy.

Once enough energy-use data had been gathered to cover 80% of the District's building load, DGS engaged the company FirstFuel to audit the data and identify opportunities for improvement. FirstFuel's data audits were supplemented in some cases by in-person building audits as well. The audit recommendations enabled the District to work with facility managers to retool existing building management systems, replace outdated equipment, and reorient service contracts with external building management vendors to optimize building performance. The public energy data was also used to set up friendly efficiency competitions between buildings, and gives facility managers timely feedback on performance compared to the portfolio benchmark.

NEXT STEPS AND LESSONS LEARNED

The BuildSmart DC program will continue adding data analysis capabilities to the website, so that building managers can have even better and more actionable information. Along those lines, DGS is in the process of adding an open-standard monitoring and verification system to the Buildsmart DC program to help normalize energy use data to weather patterns and improve the accuracy of measured savings. DGS will also begin to extend the program services to private sector building owners in the District in the coming year.

Cities wishing to follow the District's example should consider investing in a technical team (in-house technical or consultants) capable of working with vendors and utilities to set up appropriate meter data management systems and analysis algorithms. The technical team within the Sustainability and Energy Division at DGS enabled the District to self-advocate when dealing with Pepco and Schneider Electric, accelerating the program's launch and increasing its impact.

DGS's effort to better understand its building load and energy needs through BuildSmart DC has had a variety of benefits. It has become a method of driving behavior change in building occupants. It is also the main tool to manage contractors around building performance and led to a culture of continuous commissioning. On a grander scale, the data from BuildSmart DC provides the critical framework necessary for the District to make smart power purchase decisions, continue integrating renewables onto the grid, and explore the possibility of participating in demand response markets.



SMART SECTOR: TRANSPORTATION

Photo credit: Chris Smith, www.flickr.com

Most cities face common strategic transportation challenges like congestion, increasing emissions, insufficient transport infrastructure, affordability constraints and growing urban populations. These challenges are exacerbated by a historic lack of infrastructure investment in the US. Transportation consumes 70% of all US petroleum, produces 27% of all US GHG emissions and represents 1.8 gigatons of CO2 equivalent.⁴⁵ More than 93% of our current transportation needs are dependent on petroleum and 87% of our trips to work are still made by cars with single occupants.⁴⁶ According to the [Annual Urban Mobility Scorecard](#), Americans burn nearly \$2 billion in gasoline while idling and spend an average of 38 hours per year in traffic.⁴⁷ In order to address climate change, a transformational shift in our transportation sector is needed.

This section focuses on the following sustainability goals:

- Enable **shared mobility** for decreased vehicle miles traveled (VMT).
- Adopt a **complete street policy** that addresses all users' needs.
- Plan for smart **energy management**.

⁴⁵ http://cta.ornl.gov/vtmarketreport/pdf/2014_vtmarketreport_full_doc.pdf

⁴⁶ <http://nhts.ornl.gov/2009/pub/stt.pdf>

⁴⁷ <http://mobility.tamu.edu/ums/>

SMART SECTOR: TRANSPORTATION

Efficient Last Mile Delivery
Intelligent cargo groups items more efficiently to reduce trips, thus reducing emissions and congestion due to "last mile" deliveries.

Smart Streetlights
Modern streetlights reduce energy use and also sense traffic, pollution and weather.

Parking
Parking guidance and information (PGI) systems reduce idling and circling, and make enforcement easier.

Smarter Couriers
Apps pay pedestrians and cyclists to quickly move items through the city.

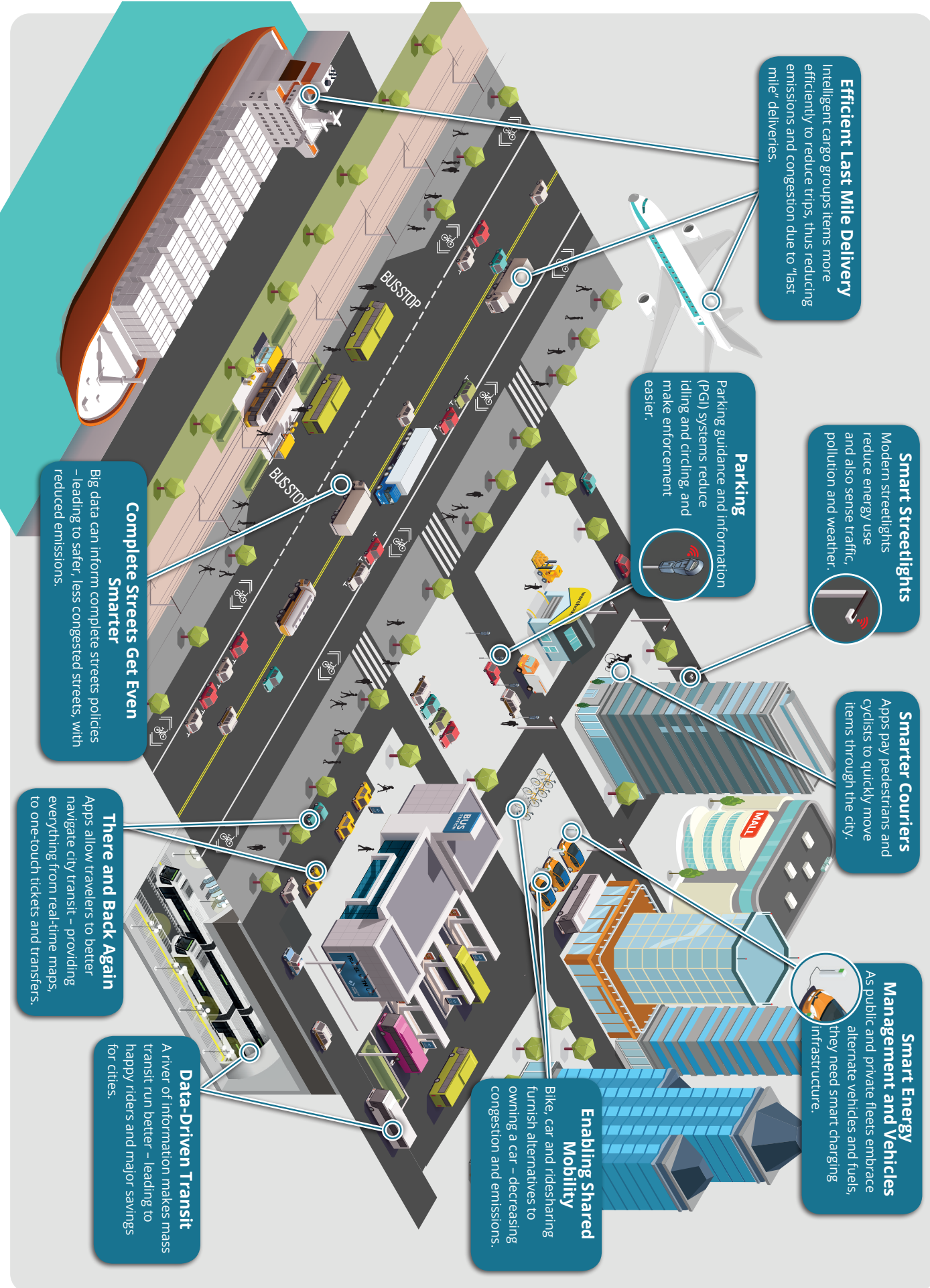
Smart Energy Management and Vehicles
As public and private fleets embrace alternate vehicles and fuels, they need smart charging infrastructure.

Enabling Shared Mobility
Bike, car and ridesharing furnish alternatives to owning a car - decreasing congestion and emissions.

Data-Driven Transit
A river of information makes mass transit run better - leading to happy riders and major savings for cities.

There and Back Again
Apps allow travelers to better navigate city transit - providing everything from real-time maps, to one-touch tickets and transfers.

Complete Streets Get Even Smarter
Big data can inform complete streets policies - leading to safer, less congested streets, with reduced emissions.



Fundamentals of the Transportation Sector

Technology in the Transportation Sector

- Technological approaches to congestion may be as effective as doubling or tripling of city roads.⁴⁸
- Five technologies: in-vehicle feedback, vehicle-to-vehicle communications, carsharing, telecommuting and transit ridership apps could save almost 13 billion gallons of fuel by 2030.⁴⁹
- Transport network companies (TNCs) can strongly encourage the public to sell or postpone the purchase of a vehicle. In one study, 25% of carsharing members sold a vehicle and 25% postponed a vehicle purchase due to carsharing across the study population. In this study, each carsharing vehicle replaced between 9–13 vehicles. Carsharing participants reduced VMT and GHG emissions by up to 43%.⁵⁰

Transportation challenges cannot be addressed in isolation from the many other issues cities face. Instead, cities are building transit friendly “livable” communities, incentivizing alternative energy options and reacting to federal, state and regional transit decisions. In doing so, American cities are shifting away from car-reliance toward multi-modal transportation systems that balance the needs of drivers alongside those of bus and train riders, pedestrians, cyclists, and taxi users.⁵¹ For example, in Denver, city leaders heard from both residents and business leaders that a comprehensive bicycle network is a top priority to attract and retain young workers and the businesses that employ them. As a result, [Denver’s Downtown Area Plan](#) outlines a specific strategy to build protected bike lanes to promote mobility and economic development.⁵²

ICT and the IoT are playing a role in this transformation. Imagine a city where sensors indicate potholes; where predictive analytics stop accidents before they occur; where congestion is prevented with smart signaling and rerouting; where mobility options from shared vehicles to electric bikes are seamlessly connected and paid for with a swipe of the phone; and where electric vehicles play a critical role in the grid’s demand response by storing energy for peak demand times. This vision of a responsive, intermodal system that uses real-time data calls for a more active ICT role. An ICT powered system can merge all aspects of the transportation network including infrastructure, vehicles and the user to improve quality of life as well as sustainability outcomes.

According to the US Department of Transportation (DOT), all transportation that helps make a city smart/connected is “connected transportation” – transportation where vehicles, travelers, and infrastructure communicate with each other through various data streams.⁵³ Concepts being vetted by DOT and local governments include driverless cars, mobile wireless charging and real-time dynamic pricing. For example, in September 2015, DOT announced awards of up to \$42 million in its first wave of [Connected Vehicle Pilots](#), including midtown Manhattan, Tampa and Wyoming. In December 2015, DOT as well as Microsoft co-founder and philanthropist Paul Allen offered \$50 million to midsize cities, including Seattle, in a Smart City Competition to promote next-generation transportation systems.

Shared Mobility Opportunities and Challenges

As data collection and analysis becomes less expensive and more widespread, public transportation departments like the ones in [Spokane, WA](#) and Portland, OR have instituted projects to provide real-time tracking of their public bus systems that can help riders reduce wait times. Spokane, like other municipalities, is going beyond real-time tracking by using ICT to drive [ridership](#) via software applications that link fuel consumption, driver behavior, and road incidents. TriMet of Portland lists over [50 applications](#) to help residents

48 <http://www.ericsson.com/res/docs/2014/ict-and-the-future-of-transport.pdf>

49 <http://aceee.org/research-report/t1401>

50 https://www.cambridgema.gov/~media/Files/CDD/Transportation/PTDM/PTDM_Impact_on%20Vehicles.ashx

51 <http://www.citylab.com/design/2014/10/3-big-challenges-for-planning-multi-modal-cities/381254/>

52 https://www.transportation.gov/sites/dot.gov/files/docs/Draft_Beyond_Traffic_Framework.pdf

53 ibid

move more efficiently across their system, most of which were built by the private sector using open source data.

As the field of shared mobility develops, many questions still need to be answered:

- How does a city integrate TNCs (i.e. ridesourcing, ridesharing and/or carsharing programs)?
- How can TNCs reduce VMTs, encourage more frequent shared rides, make cities safer and decrease GHGs while being equitable?
- If TNCs diminish transit income and bifurcate modes of travel based on wealth, how will public transportation survive in the 21st century?
- How can ICT better meet the first and last mile dilemma for those taking transit?
- How do companies provide adequate coverage for bikes and cars during rush hour?
- Can cities force private companies to share a common and consistent platform to increase transparency and efficiency?
- How do underserved and disadvantaged populations benefit if TNCs costs more or provide less frequent services?

The nonprofit, [TransportationCamp](#), has hosted gatherings of transportation professionals, technologists, and others interested in the intersection of urban transportation and technology across the U.S. to ask and help answer these and other related mobility dilemmas.

Cities can hinge market access on a provider's consistency and transparency. For example, in January of 2015, Massachusetts filed rules and regulations formally recognizing Uber, Lyft and other rideshare operations as official modes of transportation in the state. Shortly after, Uber pledged to give government officials its transportation data to review. By providing the City of Boston with anonymized information about its car-hailing service, the City hopes to find ways to help ease traffic congestion to ensure smart city planning. As taxi services are forced to deregulate, cities can enforce a higher level of regulation on the TNCs to better serve residents.

The entry and consolidation of the mobility space by original equipment manufacturers (OEMs) can also transform cities. The German multinational Daimler Auto Group, which owns Mercedes-Benz and others, now owns multiple ICT companies: Car2Go, the world's largest carsharing service; RideScout which helps users get around cities faster and smarter; and Global Sherpa, a developer of secure, mobile payment platform for transit systems. Other automotive powerhouses that have opened Silicon Valley offices include Ford, Toyota, Honda, Hyundai, Volkswagen, BMW, Mercedes-Benz, Nissan and automotive suppliers Continental, Delphi and Denso. California's aggressive environmental regulation and generous electric car subsidies have nurtured companies such as Tesla and its emerging rival Faraday Future. The future of mobility has shifted from Detroit to technology developers worldwide.

Sustainability directors can better enable cities to promote diverse transportation modes—including walking, bicycling and transit—that are safe, lower-cost, sustainable and reduce VMT with ICT. In light of how quickly technologies are developing, sustainability directors need to regularly ask if ICT will ultimately reduce VMT, serve all populations equally and make streets safer, healthier and more efficient.

Transportation Case Studies

Ventra App

Smart Payment Options for Mass Transit

City: Chicago, Illinois

Sustainability Objective: Using smart technologies to improve access, reliability, efficiency and mobility options for citizens

BACKGROUND

Ventra is operated by Cubic Transportation Systems. In November 2011, the Chicago Transit Board (CTA) approved a \$454 million, 12-year contract for an open standards fare system, making it the largest automated fare collection contract ever placed in North America. The contract was structured such that CTA was able to implement the system with no upfront costs. Cubic had previously won a CTA contract to manage the old fare system, which included the Chicago Card. “The Ventra system is not only advanced next-generation technology, but it is based on a new public-private partnership model that can be replicated for other transportation payment system implementations,” said Matt Cole, executive vice president and deputy, strategy and business development, for Cubic Transportation Systems. “With this partnership model, public agencies can future-proof their system to help ensure it delivers on their promise of providing efficient and convenient public transportation to their customers.”

MOVING FROM THE VENTRA CARD TO THE VENTRA APP

Mobile ticketing is becoming a popular new method for transit fare collection. Riders benefit from the convenience of buying tickets from their mobile device and accessing transit information such as real-time arrival information. Transit agencies benefit from a lower cost of collection relative to other ticket sales channels, as well as the rich data sets that mobile devices provide. Mobile payments using smartphones can serve as a bridge towards comprehensive electronic fare collection in the future, or as one of several sales channels in the context of an open payments fare collection system.

The Ventra App allows customers to pay for rides on all three transit systems—CTA, Metra and Pace—from their mobile devices, integrating the way people across Chicago take transit each day. Developed jointly by CTA, Metra and Pace, and funded by the Regional Transportation Authority (RTA)'s Innovation, Coordination, and Enhancement (ICE) program, the app provides riders with a “one-stop shopping” experience for transit riders.

PROCESS

Like dozens of other cities, Chicago envisioned one card that would access all transit options. In October 2014, the Chicago Transit Authority

AT-A-GLANCE

Ventra App

Launch Date: Contract approved October 2014 and App released November 2015

Cost: \$2.5 million split among CTA, Metra and PACE

Stakeholders: CTA/Metra/Pace, Cubic Transportation Systems, GlobalSherpa, Smart Chicago

(CTA) Board of Directors approved GlobeSherpa's development of a new mobile app for all Chicago area transit riders.

GlobeSherpa, a mobile app developer, created the app with Ventra's creator, Cubic Transportation Systems Inc., and the three transit agencies. Ventra App allows CTA riders to use stored fares on their Ventra cards to buy Metra commuter rail tickets; works as a train-and-bus tracker; and even helps plan trips. CTA riders can use their smartphone to pay for rides, add value to their Ventra accounts, and store fares or passes.

The transit agencies determined the first version of the Ventra App was ready for public launch in November 2015, after several months of testing by more than 700 individuals who ride CTA, Metra and Pace. Among the testers were dozens of the Smart Chicago Collaborative's Civic User Testing Group, a program that maintains a pool of Chicago residents to road-test apps under development, as well as customers with disabilities to make sure the app is accessible.

TECHNOLOGY

GlobeSherpa has helped the authority carve out efficiencies and reduce the cost of fare collection relative to other expensive sales channels like ticket vending machines and the fare box itself. By reducing cash-based transactions and lowering the overall maintenance costs of infrastructure, mobile payments can be a huge cost saving technology. As of 2015, GlobeSherpa is now owned by RideScout that in turn is owned by Moovel, a division of German automaker Daimler.

Unrelated to the Ventra App, CTA is also exploring the use of Bluetooth-enabled sensors called "beacons" in 40 locations near 11 high-traffic rail stations. The beacons are powered by San Diego-based Gimbal. This technology could identify if a rider is standing on the platform for the Brown and Green lines or on the Blue Line subway platform and provide specific train tracking information based on the rider's location directly to the rider's phone. The technology also may sense at which bus stop riders are waiting on a busy street served by multiple bus lines and provide tailored bus tracking information.

NEXT STEPS

Later phases planned for 2016 will provide additional account management features (e.g. card ordering, replacing a lost/stolen card) and a door-to-door trip planner with service information for CTA, Metra and Pace that allows customers to navigate the region using all three transit systems. Also in a later phase, the app will allow customers to download a virtual Ventra card onto their near field communication-compatible mobile devices, which will allow them to access their Ventra transit accounts to pay for rides on CTA trains and CTA and Pace buses directly from the Ventra App by touching the phone or device to a Ventra reader.

In the future, the CTA, Metra and Pace also intend to explore offering advertising on the app, which could include customized promotional content that customers would voluntarily select to receive – similar to other apps. Any in-app advertising or promotional functionality would only be launched with the approval of CTA, Metra and Pace consistent with agency policies including advertising guidelines.

While the Ventra card had hidden fees, the app should correct those issues. Of course, Chicago's disadvantaged communities do not all hold smartphones and a portion of those that do are unbanked, leaving an equity gap yet to be addressed.

CONTACTS

- Don Orseno, Metra Executive Director/CEO
- David Faust, CTA Senior Project Manager
- Tony Coppoletta, Manager of External Electronic Communication of the Chicago Transit Authority
- Nat Parker, GlobeSherpa Chief Executive Officer

DOCUMENTS AND LINKS

Smart Card Alliance: Alliance of all cities that have adopted this technology

<http://www.smartcardalliance.org/smart-cards-applications-transportation/#smart-cards-and-transit>

Ventra Card: <https://www.ventrachicago.com/>

GlobeSherpa: Mobile Solutions for Transit Fare Collection Best Practices for Creating a Secure and User Friendly Approach to Mobile Ticketing: http://www.globesherpa.com/wp-content/uploads/GS_TransitSherpa_WhitePaper_MobileTicketing_3.15.13.pdf

car2go

Integrating Transit Networked Companies into Smart Mobility Planning

City: Seattle, WA

Sustainability Objective: Reduce Vehicle Miles Traveled (VMT) and car ownership while improving the air and quality of life for Seattle residents.

BACKGROUND

Seattle has the fourth-worst traffic in the country.⁵⁴ Since 2010, the city has added 26,000 jobs downtown, but thanks to increases in transit ridership, walking, and biking, the number of cars on the roads has remained essentially flat. Mayor Ed Murray, elected in 2011, worked to regulate ride-hailing services without driving them out of the city completely, and installed a protected bike lane downtown. In a multi-tiered plan called *Move Seattle*, Seattle will manage congestion and increased populations without adding vehicles.

Under this plan, Seattle allowed car2go, a car-sharing service intended for short, one-directional, spontaneous trips, with parking available in most of the city’s on-street parking stalls, to join other sharing options like Uber, Lyft and ZipCar.

The fact that the Austin-based company car2go is a subsidiary of Daimler North America signals a significant sea change, where auto manufacturers are now embracing the latest disruptive technologies **to their own industry**. About 63,000 people have enrolled in car2go in Seattle and taken some 2 million trips during two years through the close-in Seattle neighborhoods – the highest use in the U.S.

car2go complements existing transit systems. Some trips, like those between outlying or less-dense areas, are difficult to serve with transit. Cities like Seattle are growing, and city governments are working to figure out how to reorient their streets to move people around more efficiently; car2go helps them do that by ensuring residents have on-demand access to a car, thus enabling them to either forgo owning a

AT-A-GLANCE

Car2Go

Launch Date: December, 2012

Number of shared (petite) vehicles: 750 with 63,000 users

Coverage: 83 square miles

Stakeholders: City of Seattle, Car2Go

Pricing: Car2Go has a per-minute pricing plus taxes and fees

⁵⁴ <http://www.thefiscaltimes.com/Articles/2014/06/06/10-US-Cities-Worst-Traffic>

car completely, or to reduce use of a personal vehicle within the city limits.

While an overall success, car2go is dependent upon a natural equilibrium that provides free (but not guaranteed) parking at any legal street space that is timed for more than two hours without peak-hour restrictions. When that equilibrium is lost, drivers start to get tickets. In a single year, car2go drivers had racked up more than 2,000 parking tickets.⁵⁵

PROCESS

Move Seattle includes a complete streets focus, maintenance and upgrades – it does not include new accommodations for cars. Instead, it is a plan to more efficiently move people around the city by bus, transit, bike, and on foot.

Here are just a few of the initiatives contained in the plan:

- Seven to 10 multimodal corridor projects, travel corridors that incorporate designated space for bikes, buses, and other mass transit.
- Seven new bus rapid transit corridors that will bring riders in and out of the city in designated lanes, separate from car traffic.
- Easy access to buses that arrive at least every 10 minutes, throughout the day, for three-quarters of city residents.
- A build-out of half of the city's perpetually underfunded bicycle master plan, including 50 miles of protected bike lanes.
- One hundred blocks of new sidewalks, new crossings at 225 intersections, and safe walking and biking routes to all of the city's schools.
- Reducing traffic deaths to zero by, among other things, dropping speed limits on residential streets of 20 mph, and 30 mph on arterial streets.

"This is not ideological," said Hannah McIntosh, the Seattle Department of Transportation strategic advisor who spearheaded the planning process. "It's purely geometry. It's purely pragmatism. There is simply no more space on our roads."

NEXT STEPS

Mayor Murray also supported Proposition 1, the Move Seattle levy, that passed in November, 2015. Seattle will now spend a record \$930 million over nine years on streets, transit, pedestrian and bicycling routes. The Move Seattle plan will actually cost over \$3 billion to implement.

According to the CEO of car2go, Nick Cole, more cities could adopt 100% EV fleets. In San Diego, the car2go program is 100% electric because it had a federal grant and a partnership to install charging stations. In general, if there are enough public charging stations that they can access, car2go will put in EVs. Surveys show that while 3% to 4% of car2go clients gave up personal cars, the majority are driving the same amount of miles overall.⁵⁶

CONTACTS

- Scott Kubly, Seattle's Director of Transportation
- Mike O'Brien, Seattle City Council's Chair of Sustainability & Transportation
- Nick Cole, CEO of Car2Go
- Hannah McIntosh, SDOT strategic advisor

55 <http://www.king5.com/story/news/local/seattle/2015/10/08/car2go-drivers-parking-tickets/73619618/>

56 <http://www.seattletimes.com/seattle-news/transportation/car2go-expands-to-cover-all-of-seattle/>



SMART SECTOR: WASTE

Photo credit: Gord McKenna, www.flickr.com

The United States generates more waste than any other nation at about 220 million tons of municipal solid waste each year or 4.4 pounds per person per day.⁵⁷ Approximately 55% of this waste ends up in one of the over 3,500 landfills, which is the second-largest source of human-related methane emissions in the United States, accounting for approximately 22% of these emissions in 2008.⁵⁸

Thus far, the municipal waste sector has experienced only moderate attention from ICT innovators, but experts in the field believe that waste will be tracked in a manner similar to water and energy in the near future. Most technology companies have focused on the collection and processing phases of waste management. New uses of sensors in both public and private receptacles as well as the use of RFID tags have provided real-time data to waste haulers to help them better plan pick-up routes. While it is clear that ICT has had a new, but discernible impact on the waste collection process, it is less clear if and how ICT can help reduce waste at the consumption stage.

In this section, we will explore international approaches to integrate ICT throughout all phases of the waste system or has promise to positively impact recycling and composting rates toward achieving zero waste goals.

⁵⁷ <https://center.sustainability.duke.edu/resources/green-facts-consumers/how-much-do-we-waste-daily>

⁵⁸ <http://www3.epa.gov/epawaste/nonhaz/municipal/>

SMART CITIES: WASTE

Consumer Choice

Achieving zero waste hinges on changing consumer purchasing habits. While the issue of changing residents' consumption is tricky to tackle, ICT has big potential when it comes to reducing waste where it starts: at point of purchase.

Changing the Way We Buy

Apps monitor consumption patterns, and educate consumers on their GHG impacts.



Smart Homes and Offices

Tracking and auditing waste creation through sensors in bins.



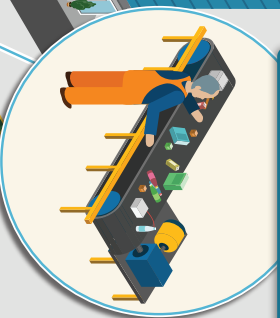
Saving Time and Energy

Sensors are streamlining curbside pickup locations and route via ICT.



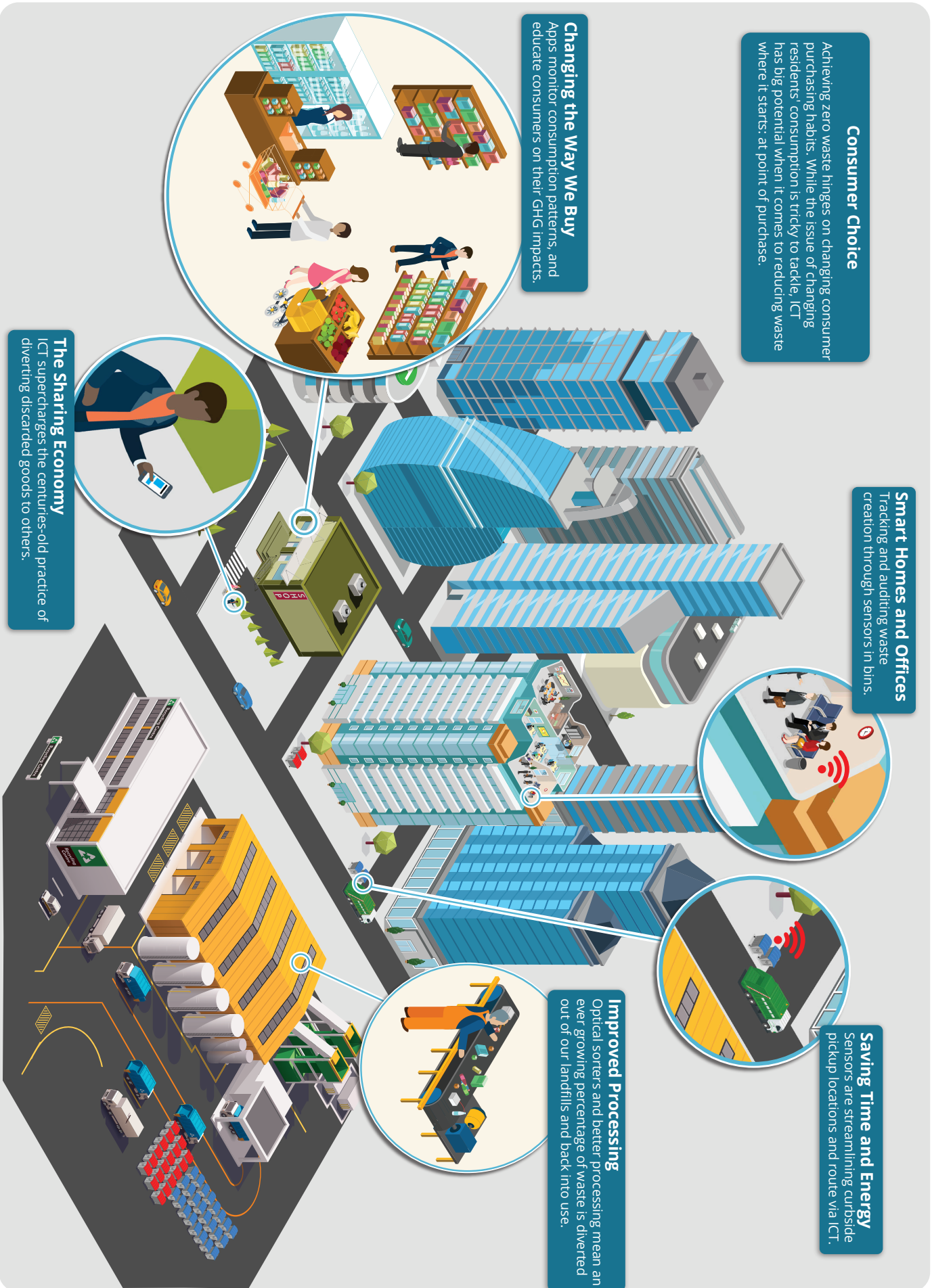
Improved Processing

Optical sorters and better processing mean an ever-growing percentage of waste is diverted out of our landfills and back into use.



The Sharing Economy

ICT supercharges the centuries-old practice of diverting discarded goods to others.



Fundamentals of the Waste Sector

Consumer Choice and Consumption: As those in the waste field know intimately, achieving zero waste begins at the point of consumption. The issue of consumption has been notoriously tricky for local governments to tackle and is often addressed through light touch outreach and education campaigns. To date, the potential for ICT to impact public consumption patterns is largely unrealized. Apps that track or monitor consumption patterns have only just begun to emerge and have the ability to drive consumer purchases for the better. For cities, counties and other entities reporting on GHG emissions, ICT that impacts public consumption could finally give an easier way to track GHG emission reductions from waste minimization.

The Sharing Economy: The sharing economy movement has inspired innovators to create new applications and sharing platforms for unwanted items to help divert them from the landfill. While Goodwill Industries and the Salvation Army have been repurposing discarded clothes, books and furniture for over a century, companies such as Yerdle are bringing the sharing economy online. There are many roles municipalities can play to help facilitate sharing economy platforms. Municipalities could help fund or kickstart innovations, conduct outreach to educate residents about specific platforms or, in some cases, contract or partner with existing technology firms to provide services within their jurisdiction.

Smart Bins at Home or in the Office: Short of visually determining what is in a home or office bin, there has been no other way to provide information about what we are throwing away. Unlike building energy or water use, mixed waste, recycling and composting are a much more complex system to monitor. The main metrics for tracking waste have been weight and/or volume through waste audits. But while more innovations are emerging that will track whether the waste is clean or dirty, there are few technologies that digitally discern what exactly is thrown away.

Part of the challenge is the complex mix of materials in our waste bins as well as the decentralized nature of where things are thrown away. The ability to track at this level would show municipalities the types of materials being consumed and thrown away at a granular level and allow waste reduction programs to run more specific outreach campaigns that target certain materials more easily. Municipalities could essentially conduct waste audits with the click of a button if the appropriate technology is created.

At the curb/loading dock/street/park/bus stop: The final stage before processing, whether at the curbside, the street, the bus stop or the office building loading dock, has received the most attention from technology companies. A few companies have focused on ways to outfit public space bins or private office containers with sensors and trackers that attempt to make collection and processing more efficient. Both Bigbelly and Enevo make use of RFID tags to provide real-time data to waste haulers and help them better plan pickup routes. Data from their bin sensors is emailed to the route servicer and/or communicated to a database, which can be queried and filtered by the user for information to see when bins are getting full or if bins can be eliminated or should be added. The information makes collection routes more efficient and helps pickup vehicles expend less energy – reducing their carbon footprint and saving operational costs.

En route to facility: In recent years, contracted waste management companies have been investing, or have been required to invest through their municipal contracts, in route-optimization software. The components of the system include GPS, vehicle location data, onboard computers, and software programs, which help study a company's operations and drivers' habits to streamline operations. As the software evolves, more haulers are adopting the technology. Companies such as Republic Services and Recology have implemented optimization software and Waste Management developed their own, which has helped reduce route hours and miles driven, reduce fuel costs and provide multiple route planning options.

Processing: A material recovery facility (MRF) is a specialized plant that receives, separates and prepares recyclable materials for sale to end-user manufacturers. Generally MRFs are classified as clean (only recycling) or dirty (all mixed waste). MRFs use hand sorters and automated sorted methods, such as disk screens, air classifiers, drum separators, eddy currents and optical sorting to receive, separate and prepare recyclable materials for recycling, landfill or compost. MRF technology is constantly evolving, but perhaps one of the most novel technologies is optical sorting. Optical sorters can now distinguish not only color differences based on visible light, but also different materials, like plastic resins based on other optical characteristics to sort materials. Recently, there has been the development and launch of several wet MRFs, which combines dirty MRF technology with water to density separate and clean output streams.

In 2014 the [San Francisco Department of the Environment](#) launched a program to combat the 39 million pounds of textiles sent to landfill by San Franciscans every year. In addition to a set of bins throughout the city, SFE also partnered with the design firm Frog and nonprofit Goodwill Industries to launch a set of smart “[goBINS](#)” in strategic locations. The goBIN replaces heavy security doors with a friendlier slot, and wireless-connection. Donors can use a QR code on the bin to access a tax donation form, and a sensor inside signals to Goodwill when it is time for pickup. Bins are managed through a partnership with I:CO, a company that specializes in sorting and repurposing used textiles. After mapping out existing bins, they have been able to plot out where more are needed. The goal is to outfit all high-rise apartments in the city by 2019.

In 2012 InnoCentive, Inc., EMC Corporation, and Environmental Defense Fund (EDF) led an [Eco-Challenge](#) aimed at finding solutions for tracking shipments of used electronic components and subsystems and ensuring that they are disposed of responsibly. According to Greenpeace, 20-50 million tons of electronic products are discarded each year. Whether the materials end up in landfills, are destroyed by incinerators or get recycled, the potential health, environmental and data security impact of e-waste has made proper disposal an ongoing concern for both environmental groups and industry. The ability to track products to their final destination and ensure safe, legal and transparent disposal is critical for measuring the true destination of e-waste as it passes through each level of the disposal process.

Participants were asked to develop a scalable process or device that would allow organizations that produce electronic devices to follow the flow of discarded items – such as computers, office electronic equipment, entertainment devices, mobile phones and television sets – from the location of their use through the waste stream to final disposal.

Of the 800 participants and 60 solutions submitted, three were selected, including: the use of a unique 12-digit code printed directly onto each subsystem component using passive radio-frequency identification (RFID) ink, the use of an electronic identification bee (e-Bee) that combines electronic identification codes printed on components with an online crowdsourcing platform that together yield a holistic picture of where electronic components end up, and a tracking system that leverages a sheet of labels printed with unique, encrypted codes for each major component in the system. Similar to those used in the fresh food industry, the labels would stay with subsystem components as they move through the disposal process.

Waste Sector Challenges & Promising Practices

Construction and Demolition: Construction and Demolition (C&D) debris is part of the solid waste stream that results from land clearing and excavation, and the construction, demolition, remodeling and repair of structures, roads and utilities. Nationwide, C&D debris accounts for 25% to 45% of the total solid waste stream (by weight), with the balance consisting of regular municipal and commercial trash. Many cities have ordinances that require a certain percentage (sometimes all) C&D debris material to be removed from a project for recycling or reuse. As a part of these ordinances, many municipalities track the tonnage and volume generated by construction and demolition projects and educate contractors on proper disposal. To ease the tracking process, more municipalities are starting to use online tracking methods that also integrate with existing civic platforms. For example, the County of San Mateo and the City of Cleveland both use Accela's Civic Platform to track documentation, assign workflow and improve transparency for C&D recycling. Each project has a record created and a user name assigned to the project, as the property moves through the process, asbestos survey, demolition and construction recycling is tracked in one record. San Mateo also leverages Accela for other items such as planning, permitting and inspections.

Litter: It is estimated that 275 million metric tons of plastic waste entered the ocean from 192 coastal countries in 2010. China and Indonesia are reportedly the largest contributors, with a third of plastic, from bottles to bags, ending up in the ocean. In Hong Kong, marketing firm Ogilvy & Mather, in collaboration with the Hong Kong CleanUp Initiative, launched a citywide campaign called the Face of Litter on April 24 for Global Earth Day. The campaign uses new DNA technology to reveal the offender's actual face and shames them at bus stops and on social media. Littering in Hong Kong also results in a \$1,500 fine.

Another campaign, Litterati, uses social media to create a digital landfill. Using the hashtag #litterati, users take photos of piece of litter, post it on Instagram and throw the trash away or recycle it. The Litterati Instagram account has more than 16,200 followers and the #litterati hashtag has more than 80,000 posts from users throughout the world, picking up about 1,000 pictures of salvaged trash each week.

Extended Producer Responsibility (EPR): The California Product Stewardship Council notes that an estimated 10%–33% of prescribed medicines are not consumed. "With a lack of safe and secure disposal options, consumers traditionally have had the option of trashing, flushing or storing these medicines in the home," they state. "Numerous studies have documented the widespread consequences of improperly stored and disposed medicines, including the impacts on water quality and public health."

A number of counties have developed local solutions for EPR, which requires pharmaceutical manufacturers and others in the product chain to design, manage and fund take-back programs to securely collect unwanted medicines and sometimes their packaging from the public and ensure the collected materials are properly managed.

On June 24, 2012, Alameda County adopted the Safe Drug Disposal Ordinance and became the first place in the nation to require pharmaceutical companies to fund the collection and disposal of unused medications from the public. Other counties in the United States that followed suit were King County, Washington, City and County of San Francisco and San Mateo County.

Anaerobic digestion: Anaerobic digestion is a series of biological processes in which microorganisms break down biodegradable material in the absence of oxygen. One of the end products is biogas, which is combusted to generate electricity and heat, or can be processed into renewable natural gas and transportation fuels. Currently, according to the American Biogas Council, there are approximately 191 digesters on farms, and around 1,500 operating in wastewater treatment facilities around the country. With the invention of food

de-packaging units that separate plastics and non-organic material from food waste before sending the waste into the digester, larger chain grocery stores are considering these machines for their distribution centers.

In 2002, California's East Bay Municipal Utility District (EBMUD), which serves Oakland and Berkeley, became the first sewage treatment plant in the U.S. to digest food waste with wastewater and produce biogas. And in 2012, the utility district became the first to generate, on-site, more energy than it needs through anaerobic co-digestion. In the last fiscal year, the facility produced about six megawatts of power and made about \$1 million by selling surplus electricity to the Port of Oakland via the grid operated by Pacific Gas and Electric.

Recycling food waste may be relatively new in the U.S., but it is common in other countries, particularly in Europe. In Germany, residential food waste is mainly composted, with more than a quarter of it bio-digested first, according to the German Biogas Association. Most industrial and commercial food waste is broken down in biodigesters. Europe has roughly 14,000 municipally operated biogas digesters, nearly 9,000 in Germany alone.

The cost of building an anaerobic digestion system ranges widely, depending on the size of the plant, the feedstock, types of end-products produced, and other variables. Last year, the Lewiston-Auburn Water Pollution Control Authority in Maine installed a \$14 million anaerobic digestion system. DC Water in Washington, D.C., is spending an estimated \$470 million on a new anaerobic digestion system modeled on Norwegian technology.⁵⁹ D.C. Water expects to recoup \$16 million a year in operational costs and \$10 million on its electricity bill, while the Lewiston-Auburn system is expected to save the plant \$600,000 a year through reduced energy costs and lower volumes of solids to dispose of.

Automated Vacuum Technology or Pneumatic Refuse Collection: Automated vacuum collection (AVAC), transports waste at high speed through underground tubes to a collection station where it is compacted and sealed in containers. The process begins with the deposit of trash into intake hatches, called portholes, which may be specialized for waste, recycling, or compost. The waste is then pulled through an underground pipeline by air pressure created by large industrial fans, in response to porthole sensors that indicate when the trash needs to be emptied and help ensure that only one kind of waste material is travelling through the pipe at a time. The pipelines converge on a central processing facility that uses automated software to direct the waste to the proper container, from there to be trucked to its final location, such as a landfill or composting plant.

There are thousands of these systems in countries all over the world including China, South East Asia, Korea, the Middle East, the U.S. and Europe. Several major companies provide this technology including the MetroTaifun Automatic Waste Collection System and the Envac system. In Vuores, Finland, their largest AVAC serves 13,000 residents and processes 4.1 million lbs/year of residential waste, 1.4 million lbs/year of office waste and provides 400 collection points. The world's largest AWCS is now being built in Mecca, Saudi Arabia where during the Ramadan and Hajj, 158,916 cubic feet (1.3 million lbs), of waste is generated each day, which puts a heavy demand on those responsible for collecting the waste and litter. There are many benefits to this system including increased air quality and the health, limiting the usage of garbage trucks and decreased costs for maintenance and employees. One of the major difficulties is that these systems do require that existing roadways are dug up throughout the city to install pipelines.

59 <http://www.triplepundit.com/2015/10/long-full-of-crap-dc-will-now-churn-some-of-it-into-energy/>

Waste Sector Case Studies

Enevo Waste Sensors

City: Tufts University and City of Birmingham

Sustainability Objective: Use wireless sensors to measure and forecast how full waste containers are and then save money and energy by generating smart collection plans using the most efficient schedules and routes.

BACKGROUND

Tufts University: Tufts Save That Stuff, and Enevo Inc. agreed to test the Enevo ONE, an intelligent fill-level sensor solution, at five locations on the Tufts campus. The two-month testing pilot ran through the end of May, 2014.

Birmingham, UK: The Birmingham City Council partnered with Enevo to deploy Enevo ONE sensors in the Jewelry Quarter of Birmingham after seeing recycling rates in 2014 drop from 40 to 30 percent. In August 2015 the council placed the ten bins around the city center as a trial. The partnership is still in the preliminary phase, but the city council already plans to install more sensors in other shopping centers after seeing initial success.

In both cases Tufts and the City of Birmingham were testing whether the sensor could positively impact waste collection operations by reducing pickups, thereby reducing collection costs. Both organizations were also testing how data collection could give greater insight into collection operations for improved decision-making.

PROCESS

Tufts sought initial buy-in for the pilot program from key stakeholders, such as the university's facilities manager, waste reduction manager, waste hauler and also partnered with Campus's Save That Stuff program to help run the pilot. The initial pilot program was carried out to determine the cost savings Tufts could expect and whether those savings would justify deployment throughout the campus. The ONE sensors changed the baseline pickup in the following ways:

Location	Baseline Schedule	Enevo enabled schedule
66 Colby Street	1 time per week	< 1 time per week, now on call, approx 1 every 2 weeks
Curtis Hall	2 times per week	1 time per week
Dame School	2 times per week	1 time per week
Hill Hall	4 times per week	2 times per week
Posner Hall	2 times per week	2 times per week
Totals	11 collections per week	6.5 collections per week

At-a-Glance

Tufts

Launch Date: April, 2014

Timeline: One month pilot and one year roll-out

Stakeholders: Save That Stuff, Tufts University, Enevo

Tools and Tech used: Waste Sensors, Data analysis to generate schedules, smart bins

Metrics: Cost of sensors, collection reduction, cost savings, cleaner streets

Key Contacts: Adam Mitchell – Save That Stuff, Dawn Quirk, Waste Reduction Manager, Tufts University, Enevo – Andy Crofts

At-a-Glance

City of Birmingham, UK

Launch Date: September 2015

Timeline: One month pilot

Stakeholders: Enevo, Wybone, Birmingham City Council

Tools and Tech used: Waste Sensors, Data analysis to generate schedules, smart bins

Metrics: Cost of sensors, collection reduction, cost savings, cleaner streets

Key Contacts: Birmingham City Council (Recycling), Wybone, Laura Dean, Enevo, Andy Crofts

The monthly cost savings were close to 45% – six times the cost of the Enevo service. Tufts has expanded the Enevo program throughout the campus and continue to use the program data to increase efficiency and make better-informed decisions.

In Birmingham, data from the pilot showed that bin size needed to be increased from 90 liters to 145 liters in the Jewellery Quarter. Using this information, bin manufacturer Wybone created smart collection bins using Enevo's smart sensors specifically for the city of Birmingham. Birmingham was able to reduce the collection frequency from daily to once every 2.8 days on average (a 64% reduction in the need for collections) by increasing the size of the bins and utilizing Enevo ONE data to optimize pickup routes.

TECH AND TOOLS

Enevo sensors are smart wireless sensors that measure how full waste containers are, and how quickly they are filling up. Sensor data is used to automatically generate schedules and optimize routes, which take into account an extensive set of parameters (future fill-level projections, truck availability, traffic information, road restrictions etc.). Customers also have access to all of this data via a web portal, which allows them to route trucks themselves.

NEXT STEPS AND LESSONS LEARNED

Tufts University had an issue with the geolocation data generated by Enevo. When requested, Enevo was able to change from a coordinate-based system to street addresses, which made it easier for Tufts to route collection trucks and personnel. Tufts plans to roll this program out to the majority of their campus in fiscal year 2015/2016.

The Birmingham pilot ended in the fall of 2015, and project is still being analyzed for future steps, though initial cost savings and efficiency gains look promising.

DOCUMENTS AND LINKS

Tufts University & Save That Stuff

<http://www.enevo.com/wp/wp-content/uploads/2014/09/Enevo-Case-Study-Tufts-University-Save-That-Stuff.pdf>

Enevo website

www.enevo.com

UK Birmingham: Mail News

<http://www.birminghammail.co.uk/news/midlands-news/mapped-new-recycling-bins-birmingham-10163128>

Enevo News

<http://www.enevo.com/news/enevo-wybone-announce-product-partnership/>

Bigbelly Philadelphia

City: Philadelphia, Street Department

Sustainability Objective: Reduce trash collection by compacting waste, making trash collection more efficient, preventing litter and stormwater pollution and freeing up Streets Department employees' time for other activities.

BACKGROUND

The City of Philadelphia's Streets Department initiated the Bigbelly program in an effort to reduce the amount of litter, more efficiently manage litter in commercial corridors/business districts and offer a public recycling option.

Bigbellies are smart solar-powered trash (and recycling) cans with the objective of reducing trash collection by compacting waste, alerting the customer when bins are full to make trash collection more efficient and prevent litter and stormwater pollution.

PROCESS

In 2008, the City began its Bigbelly program with the installation of 470 units in the center city. By converting from wire baskets to Bigbellies, collections were reduced from an average of 17 per week using three crew shifts to about three per week using one crew shift. This not only reduced the amount of trash on the street, but also freed up time for Streets Department workers to tackle other issues.

The program began steadily growing. In 2009 and 2010, with funding from both the state and the City's Commerce Department, 220 more Bigbelly units, 100 of them with side-by-side recycling bins, were added. Bigbellies were placed beyond on the street corners of city center's surrounding neighborhoods.

A third deployment of Bigbellies was initiated by the Sanitation Division funded through the USDOE Energy Development Block Grant to the City as a part of its American Reinvestment and Recovery Act grant. Today there are about 900 standalone units and 400 others paired with single-stream recycling bins. Recently the Bigbellies were also used for mural projects, environmental messages and even advertising by environmental companies.

Bigbelly Bin Stats:

- Operates for a week on the energy it takes to make a pot of coffee.
- Operates for a year on the energy it takes to drive a trash truck one mile.
- Holds up to five times the volume of ordinary trash receptacles – about 150 gallons before compaction.
- Compacts trash with 1,200 pounds of force.

At-a-Glance

Bigbelly Waste Bins

Launch Date: July 1, 2009

Timeline: 2009-2013

Stakeholders: Philadelphia Streets Department, Bigbelly Company
Tools and Tech used: solar-power, smart sensors, data collection, dispatching system

Metrics: Trash collections reduced, cost savings on fuel, operational and truck costs, amount of trash diverted

Key Contacts: Philadelphia Streets Department, Bigbelly Company and Mayor Nutter

- Results in less collections potentially reducing greenhouse gases and other pollutants by 80%.
- Needs only 20% the number of trash truck pickups.

TECH AND TOOLS

Bigbelly trash bins use solar power to automatically compact trash once it reaches a certain level. Additionally, a sensor in the Bigbelly tells Philadelphia sanitation when it is full or needs repair.

Data collected about when cans are emptied, which bins are filling up first and where and how often the cans are used, helps Philadelphia efficiently route trucks around the city. Philadelphia also has access to a web-based communications and monitoring system and receives email notifications about the bins.

NEXT STEPS AND LESSONS LEARNED

The program has been considered a success and the city continues to deploy more Bigbelly units. These bins have saved the city \$1 million annually on collection costs and also reduced litter and stormwater pollution, which has not been quantified in the cost savings.

Despite the overall success of the initiative, many of the oldest Bigbellies are beginning to show their age. So much so, that people do not want to touch handles and instead open them with their elbows. The City of Philadelphia also reported that there were training costs for their mechanics and sanitation crew associated with Bigbelly installation that they had not considered in their evaluation of installing Bigbellies.

Privacy issues were brought up during deployment, but because information is not gathered on individuals, but only on the status of trash cans, these concerns were addressed.

Next steps:

- Have a training program built into deployment for city workers.
- Include more maintenance and cleaning costs in contract with Bigbelly.
- Figure out a way to make them openable without handles or clean handles more often (model with a foot pedal is now available).
- Mural projects are a way to make the cans look more attractive, and can be paid for through advertising. These projects also have the added benefit of reducing graffiti.

DOCUMENTS AND LINKS

Philadelphia Streets Department

<http://www.philadelphiastreet.com/sanitation/the-bigbelly-program/>

Philly Mag

<http://www.phillymag.com/citifed/2015/08/04/big-belly-trash-cans/>

Huffington Post

http://www.huffingtonpost.com/2015/09/16/smart-cities-green-infrastructure_n_6977504.html

Syracuse News

http://www.syracuse.com/news/index.ssf/2013/07/philadelphia_streets_department_responds_to_criticism_of_4000_big_belly_trash_ca.html

NBC Philadelphia

<http://www.nbcphiladelphia.com/news/green/Solar-Trash-Cans-Save-Philadelphia-Millions-200626771.html>

SECTION II: SECTOR TECHNOLOGY GUIDES

Information Communications Technology Tech Guide

Smarter Open Data

Open data initiatives can help governments, businesses, organizations and citizens use digital data more effectively to drive sustainability goals. Ideally, open data initiatives involve taking publically available data and transforming it into more usable and understandable formats. For city practitioners, the challenge is to connect government data sets to those who will use them for sustainability-oriented innovation, without pushing out large quantities of unused data.

This section offers an overview of key open data technology, including platforms and portals, dataset aggregators, and data mapping and visualization.

OPEN DATA PLATFORMS & PORTALS

- **Provider: GitHub** – Agencies use GitHub to engage developers and collaborate with the public on open source, open data and open government efforts including code, data sets, and policy. Philadelphia has used GitHub to streamline its RFP process and San Francisco has posted its municipal code to GitHub for hackers to use and improve.⁶¹
- **Provider: Socrata** – Socrata’s cloud-based software allows government organizations to put their data online.
- **Provider: OGPL** – The Open Government Platform (OGPL) is a product developed by the governments of India, Canada, and the United States to promote transparency and greater citizen engagement by making more government data, documents, tools, and processes publicly available through a freely available, open source platform.

“Data is the infrastructure of our time and age; as we expect other elements of the country’s infrastructure - roads, railways, water pipes, electricity lines - to follow effective practices, the same should apply to Data.”⁶⁰

— Giuseppe Sollazzo, Senior Systems Analyst, St. George’s University of London

“Open data means the city is open to civic tech. It’s the signal the tech community looks for. Put it out there with good content, and see what happens. Long term maintenance is part of building a programmatic approach.”

– *The Civic Technology Landscape: A Field Analysis and Urban Sustainability Directors Network Recommendation* (USDN 2015)

60 <https://data.gov.uk/blog/four-challenges-future-open-data>

61 Sutherland, USDN Civic Tech Report

- **Provider:** [ArcGIS Open Data](#) – ArcGIS Open Data is an Esri hosted and managed software solution that is included with ArcGIS Online.

OPEN DATA POLICY GUIDANCE

- **Provider:** [Sunlight Foundation](#) – The Sunlight Foundation is a national, nonpartisan, nonprofit organization that uses the tools of civic tech, open data, policy analysis, and journalism to make government and politics more accountable and transparent.
- **Tool:** [Open Data Handbook](#) – Guides, case studies and resources for government and civil society on the what, why and how of open data.

OPEN DATA AGGREGATORS

The open data movement has vastly increased the amount of data available, but many existing platforms and technologies are designed mainly to view and access individual data sets one at a time. This restriction often only perpetuates city silos; in today's cities, everything is connected to everything else. Open data aggregators are designed to integrate separate datasets. As an [article on gcn.com](#) points out, before data aggregation platforms existed, someone who wanted to test a correlation between crime and outside temperature would have to acquire data from two different sources – the National Oceanic and Atmospheric Association and the local police department. Open data aggregators streamline this process by connecting these types of data to provide a more holistic view of a city.

- **Provider:** [Data.gov](#) – Data.gov is the federal government's open data platform. Starting in August 2012, cities with their own open data initiatives including Chicago, Seattle, New York and San Francisco began sharing their data sets on Data.gov to enhance collaborate on issues of mutual concern.⁶²
- **Provider:** [Plenar.io](#) – Plenar.io is a centralized hub for open datasets from around the world to search and download. Plenar.io lets users to study regions over specified time periods using all relevant data, regardless of original source, and represent the data as a single time series.
- **Provider:** [Knoema](#) – Knoema delivers curated datasets from around the world used to facilitate engagement.
- **Provider:** [Factual](#) – Factual focuses on data about where places are and how to better understand people based on their geographic behavior. Factual provides APIs, mobile drivers, and on-premise implementations.
- Examples:
 - [Smart city platform aggregates, maps open data](#)
 - Smart Chicago: [Plenar.io, the next stage in open data](#)
 - UChicago: [From Spreadsheets to Solutions](#)
 - Harvard: [Changing How We Use Open Data](#)

OPEN DATA VISUALIZATION

- **Provider:** [Azavea](#) – Azavea specializes in the creation of geographic web and mobile software, as well as geospatial analysis services to enhance decision-making.
- **Provider:** [ArcGIS Online](#) – ArcGIS Online allows users to discover, use, make, and share maps in the cloud.
- **Provider:** [DriveDecisions](#) – DriveDecisions combines open data and visualization to improve decision-making.⁶³

62 <http://www.govtech.com/e-government/4-Big-Cities-Launch-Shared-Data-Platform.html>

63 <http://www.govtech.com/data/Open-Data-Visualization-Tool-Challenges-Traditional-GIS.html>

- **Provider:** [TableauPublic](#) – Offers free data visualization software.
- **Provider:** [Mapbox](#) – Open-source mapping and open data platform with visualization tools in the cloud or via private infrastructure.
- Other Examples: [Tucson](#); [San Francisco](#); [Kansas City](#); [New York City](#)
- Resources:
 - [Open Government Initiative](#)
 - [Code For America Open Data Playbook](#)
 - [I Hate Open Data Portals](#)
 - [DATA CRUNCHED: how the country's first community open data catalog got done](#)
 - [The Philadelphia Experiment](#)

Network Providers

MODULAR SENSOR NETWORKS

- **Project:** [Array of Things](#) (Chicago)
- **Provider:** [Libelium](#) – Together with IBM, Libelium has released an Internet of Things Starter Kit in which a real-time operating system is integrated in Libelium Wasp mote nodes to support more than 60 different “plug and play” sensors, allowing developers to easily build any application on top.
- **Provider:** [Urbiotica](#) – Designs and develops sensor networks that capture real-time data on what is happening in the city in areas of mobility (parking and traffic), waste management and environmental quality monitoring.

INTERNET OF THINGS NETWORKS

- **Provider:** [SigFox](#) – Provides low energy, narrow bandwidth global cellular connectivity for the Internet of Things, fully dedicated to low-throughput communications, allowing for connectivity of IoT devices in more rural and less connected areas.⁶⁴
- **Provider:** [Silver Springs Network](#) – An open, standards-based networking platform, software and services used by major utilities and cities worldwide to support multiple smart grid and smart city applications.
- **Provider:** [PlanIT UOS](#) – The PlanIT Urban Operating System™ helps customers converge infrastructure with sensors, devices and people across developments and cities. The PlanIT UOS enables systems such as energy, water, waste management, transportation, telecommunication and healthcare security to communicate intelligently with each other, as well as sensors and devices.

Data Crowdsourcing

- **Application:** [LocalData](#) – LocalData is a cloud-based mapping platform that helps cities and communities make data-driven decisions by capturing and visualizing street-level information in real time.
- **Application:** [OpenStreetMap](#) – OpenStreetMap is built by a community of mappers that contribute and maintain data about roads, trails, cafés, railway stations, and other public spaces. Contributors use aerial imagery, GPS devices, and low-tech field maps to verify that OSM is accurate and up to date.
- **Application:** [Streetwyze](#) – Streetwyze uses local knowledge to map key assets in neighborhoods.

64 <http://www.techradar.com/news/world-of-tech/a-closer-look-at-sigfox-supercharging-the-smart-city-and-beyond-1301470>

Data Analytics

Data-driven analytics is the systematic use of information to find patterns of interest. For cities, this means looking at the detailed data which city agencies collect – citizen complaints, licenses and permits, transactions, violations, social networks, etc. – and identifying opportunities for increased efficiency and sustainability breakthroughs. Prior to the advent of Big Data, citywide IT departments focused on troubleshooting internal tech needs. Now, the roles within the IT department are shifting to become strategists working on an enterprise level.

Analytical applications can be categorized into three functions: *descriptive*: tech that summarizes what happens based on data you have (i.e. what is); *predictive*: tech that predicts data you don't have (i.e. what could happen); and *prescriptive*: tech that goes beyond descriptive and predictive models by recommending one or more courses of action, and showing the likely outcome of each decision (i.e. what should happen).⁶⁵

- **Provider:** [CityPulse](#) – Real-time IoT stream processing and large-scale data analytics for smart city applications
- **Provider:** [MIT City Science, Urban Analysis and Modeling](#) – Urban Analysis and Modeling focuses on data-driven analyses of economic activity, urban perception, human behavior, mobility patterns, and resource consumption to inform the city design process. Parametric urban design tools and computer simulations are designed to enable the creation of rapid prototyping tools for the placement of mobility nodes, street typologies, and resource allocation.
- **Provider:** [Government Analytics Program](#) – The mission of the Government Analytics Program is to strengthen government's use of data, measures, and goals, to make it a permanent feature of management practices, and to accelerate the sharing of ideas and best practices among governments and government departments.
- **Provider:** [Chicago Data Visualization Group](#) – A group of data visualization enthusiasts interested in networking, learning, professional development, and competing in visualization contests.
- **Program:** [Mayor's Office of Data Analytics in New York City](#) is a dedicated city office for civic intelligence, which allow both cities to aggregate and analyze data from across agencies and citizen-led initiatives.
- **Application:** [City Analytics Dashboard, Digital Front Door Initiative](#) – The City Analytics Dashboard lets city governments display live traffic on their websites from a Google Analytics account. Originally designed for the city of Oakland, CA.
- **Project:** [SmartData Platform](#) (Chicago) – Funded with a \$1 million grant from Bloomberg Philanthropies, Chicago's SmartData project will build an open-source, predictive analytics platform – aggregating and

"In the past, individual agencies have been limited in their ability to conduct large-scale analytics by mandate, scope, and organizational structure. City agencies across the country, which already have a prescribed list of duties to fulfill to keep the city running smoothly, often do not share data with one another, nor are they equipped to analyze it. In an era of shrinking budgets, however, many cities, including New York, have made new efforts to solve this problem by creating teams existing specifically for the purpose of data investigation that can cross agency boundaries, with promising results."

– [Expanding the Use of Data Analytics in City Governments](#)

⁶⁵ <http://www.informationweek.com/big-data/big-data-analytics/big-data-analytics-descriptive-vs-predictive-vs-prescriptive/d/d-id/1113279>

analyzing information to help leaders make smarter, faster decisions and prevent problems before they develop.⁶⁶ SmartData will give leaders a tool to search for relevant data and detect relationships, analyzing millions of lines of data in real-time.⁶⁷

- **Project: [PhillyStat](#)** – PhillyStat was created in 2008 by administration officials to bring transparency to government performance in the delivery of services for their residents. It exists to increase organizational effectiveness and to bring alignment in plans, processes, decisions, people, actions and results that bring improved value to residents.

Civic Engagement Tech Guide

The Civic Engagement Tech Guide uses the IAP2 Spectrum of Public Participation as a framework to explore engagement technology and tools through three key sustainability domains: Sustainable Behavior and Culture Change, Land Use & Urban Planning, and Civic Science & Reporting. The guide then covers key tactical technologies that can be employed to strengthen participatory democracy and healthy civic engagement in sustainability initiatives and across other municipal mandates, such as voter participation and fair election processes, budgeting, community networking, and decision-making. Sustainability officials (as well as other local leaders) can use these tactical technologies to enhance civic engagement in sustainability objectives.

SUSTAINABLE BEHAVIOR & CULTURE CHANGE

Sustainability Goal: To empower individual and collective awareness of and action towards impacting sustainability.

Tech focused on sustainable behavior & culture change can *INFORM* and *CONSULT* the public on sustainability plans, goals and results; *INVOLVE* the public in sustainability decisions; *COLLABORATE* with the civic and private sectors to meet sustainability goals; and *EMPOWER* the public to drive change.

ONLINE SUSTAINABILITY PLANS & PLATFORMS

Online sustainability plans and platforms are web-based applications and websites that detail a city's objectives and tactics and invite feedback and creative problem-solving from the public.

Relevance to urban sustainability directors: INFORM & CONSULT the public on sustainability plans and goals

- **Project: [Sustainable City pLAN](#)** – Built by [Nation Builder](#), Los Angeles's Sustainable City pLAN sets targets and details actions in 14 categories to improve city's environment, economy and equity in anticipation of 500,000 more Angelinos by 2035, and achieve progress by 2017 on issues like water conservation, clean energy, waste, green jobs, transportation, and air quality. Residents can learn about and engage with the plan online.
- **Project: [#OneNYC](#)** – This plan lays out four major visions for New York City in an interactive user-friendly website that invites feedback via an online form. By using a hashtag as part of the plan name, the city is hoping to spark (and track) social media engagement. The city partnered with a local social impact design agency, [Hyperakt](#), to create the site.

⁶⁶ <http://datasmart.ash.harvard.edu/news/article/chicago-mayors-challenge-367>

⁶⁷ http://www.govtech.com/data/Chicago-Pioneers-Open-Source-Analytics-Platform.html?utm_source=related&utm_medium=direct&utm_campaign=Chicago-Pioneers-Open-Source-Analytics-Platform

Sustainability Performance Dashboards

Putting a sustainability plan online becomes even more powerful when tangible results can be measured and studied. Online performance trackers help cities communicate their results while encouraging enhanced civic engagement to reach those results.

Relevance to urban sustainability directors: INFORM & INVOLVE the public on sustainability impacts and results

- **Project:** [Sustainable City pLAN Dashboard](#) – The City of LA released a dashboard of sustainability metrics and results related to the nearest-term goals identified in its Sustainable City pLAN. The dashboard allows visitors to see where the city is in relation to its goals, including helpful icons that indicate which measures are on track.
- **Project:** [Marin Sustainability Tracker](#) – In March of 2015, a partnership of 16 jurisdictions in Marin County, California called the [Marin Climate and Energy Partnership](#) launched the [Marin Sustainability Tracker](#) – a web-based interactive sustainability tracker illustrating progress being made by local government, residents and businesses toward reducing emissions and increasing sustainable practices. The partners include 11 cities, three public utilities, a transportation authority and the county itself.
- **Project:** [Fair City](#) – The City of Budapest, Hungary uses a smart city and community platform and mobile app to communicate and engage with its citizens. The platform allows citizens to view progress on the city's projects and reports and indexes, such as sustainability and health, and even engages in collaboration and opinion sharing.

Sustainability Games

Gamification is the craft of applying the fun and excitement of games to serious activities, using game concepts and behaviors to engage users and change behavior. Now applied to many industries, gamification is making headway as an effective tool for sustainability. Cities can create campaigns and use gaming apps to encourage behavior change and measure progress towards sustainability goals.

Relevance to urban sustainability directors: EMPOWER the public on sustainability impacts and results

- **Application:** [Vermontivate](#) – Vermontivate! is a nationally award-winning climate and sustainability game designed to bring fun and creativity to the serious work of tackling climate change. While the game is running, players can win coupons that are redeemable in stores as well as cash rewards to be used towards sustainability projects identified during the course of the game.
- **Application:** [JouleBug](#) – Joulebug allows user to learn about sustainable resource use and to change their everyday habits.
- **Project:** [Rethink/](#) – As part of its goal to become carbon neutral by 2050, the city of Austin, TX, worked with JouleBug to design its own app that provides simple sustainability actions for residents. Each action is translated into the impact it can have to save money, energy, time, and resources. Embedded videos and URLs share localized tips, including City of Austin resources or programs that can help. Rethink/ is a product of the Austin Green Business Leaders Program via the Sustainability Office.⁶⁸
- **Application:** [GreenStarNYC](#) – GreenStarNYC helps New Yorkers and its small businesses become more sustainable by providing a marketplace and tool for them to promote their businesses and green initiatives to customers and visitors of NYC while finding resources and buying groups to save on their own green investments.

⁶⁸ <http://community.joulebug.com/resources/case-studies/gbl-challenge/>

- **Provider:** [WeSpire](#) – WeSpire is an employee engagement platform that employs gamification to launch programs that inspire people to take action.
- **Application:** [One Small Act](#) – One Small Act suggests hundreds of ways to green personal lives. Users can join a team for collective action, take on projects, and share their accomplishments.
- **Provider:** [Persuasive Games](#) – Designs video games for persuasion, instruction, and activism.
- **Platform:** [CrowdGauge](#) – An open-source framework for creating educational online games. It first asks users to rank a set of priorities, then demonstrates how a series of actions and policies might impact those priorities. The third part of the sequence gives users a limited number of coins, asking them to put that money towards the actions they support most.

Sharing Economy

The sharing economy, also known as collaborative consumption, refers to peer-to-peer-based sharing of access to goods and services. It can take a variety of forms, but most commonly utilizes [information technology](#) to enable sharing and reuse of excess capacity in goods and services.

Relevance to urban sustainability directors: Empowers the public to reduce unnecessary consumption

- **Application:** [Acts of Sharing](#) – Acts of Sharing is a platform to facilitate and enhance the peer-to-peer sharing experience.
- **Application:** [Peerby](#) – Peerby enables local residents to loan and to borrow goods.
- **Application:** [TaskRabbit](#) – TaskRabbit connects users with safe and reliable help for household errands and skilled tasks.
- **Project:** [Time Banks](#) – Time Banks are locally organized and operated exchanges through which neighbors can give and receive goods and services to build supportive networks and strong communities. By utilizing an increment of time as currency or credit, typically one hour, community members can contribute their talents and skills in exchange for the ones they need.

LAND USE & SUSTAINABLE DEVELOPMENT

Sustainability Goal: To empower collective stewardship of and interaction with our physical environment.

Land use & urban planning tech can *INFORM* and *CONSULT* the public on sustainable land use; *INVOLVE* the public in planning decisions; *COLLABORATE* with the civic and private sectors innovate urban land use; and *EMPOWER* the public to steward and improve their physical environment.

COMMUNITY VISUALIZATION

Relevance to urban sustainability directors: CONSULT and EMPOWER the public to envision sustainable communities and built environments

- **Application:** [Click That Hood](#) – Click That Hood challenges players to quickly identify various neighborhoods of a city. The game began with a clickable map of just one city, but now includes a growing list of 86 different locations across 11 countries, through an open source community.
- **Application:** [Streetmix](#) – Streetmix is an interactive street section builder that helps community members mockup the streets they'd like to live on and offer these mockups as future plans for city officials and planners.

- **Platform:** [Blockee](#) lets users envision a better community by looking up their block, adding “Civic Bling” including crosswalks and recycling receptacles, and sharing their work with neighbors through block parties.
- **Application:** [Community PlanIt](#) – Community PlanIt is a game that provides residents the ability to participate in local planning decisions.

Enterprise Planning Tools

Enterprise planning tools are online software designed to help urban planners and local officials shape communities by engaging the public and leveraging open data sets.

Relevance to urban sustainability directors: INFORM and COLLABORATE with the public on built environment projects

- **Tool:** [mySidewalk](#) – Once known as MindMixer, mySidewalk is an enterprise planning tool that contains hundreds of preloaded demographic/socioeconomic data sets for use with geo-referenced data, analysis tools, and stakeholder engagement.
- **Tool:** [CommunityViz](#) – CommunityViz helps urban planners promote informed, collaborative decision-making about the future of cities and regions.
- **Tool:** [MetroQuest](#) – MetroQuest is public involvement software that can accommodate from 2,000 to over 10,000 participants.
- **Tool:** [Mapbox](#) – Mapbox is software designed integrate location data into any mobile or online application.
- **Platform:** [Urbanomics Mobility Project](#) – The Urbanomics Mobility Project is a data analysis platform designed to help urban planners and commercial developers better understand the relationship between how people travel and what they buy to inform growth strategies.
- **Application:** [WALKscope Denver](#) – WALKscope is a mobile tool developed by WalkDenver and PlaceMatters for collecting data related to sidewalks, intersections, and pedestrian counts in the Denver metro area. WALKscope is designed to create an inventory of pedestrian infrastructure, identify gaps, and build the case for improvements.
- **Application:** [MetroPulse](#) – This app, developed for the Chicago Metropolitan Agency for Planning, allows users to search, visualize and analyze more than 200 socioeconomic indicators about communities in the Chicago Metropolitan Area.
- **Application:** [Dwellr](#) – This Census Bureau app is designed for residents to view neighborhood level statistics to inform home location choices.
- **Application:** [Housing Discrimination Complaint Application](#) – This HUD app allows people to learn about fair housing and submit complaints.
- **Application:** [Chicago Buildings](#) – The Vacant and Abandoned Building Finder is a tool for helping people and organizations find buildings in Chicago that are not in use and potentially hazardous to the neighborhood around them.
- **Application:** [Vacant Lot Finder](#) – The City of Buffalo developed this app to identify and track its over 6,000 vacant lots that are in need of storm water management and inspection.
- **Provider:** [City Form Lab](#) – The City Form Lab at the Harvard Graduate School of Design focuses on urban design, planning and real estate research. The Lab develops new software tools for researching city form; uses cutting-edge spatial analysis and statistics to investigate how the physical pattern of urban

infrastructure affects the social, environmental and economic quality of urban environments; and develops creative design and policy solutions for contemporary urban challenges.

- **Application:** [Textizen](#) – Textizen’s web platform sends, receives, and analyzes text messages, enabling cities to reach the public through their smartphone and tablets. Boston plans on using Textizen to facilitate public feedback for its citywide master planning process.⁶⁹
- **Project:** [Palo Alto Development Services](#) used [Textizen](#) to make sure that residents and neighbors could chime in about local construction projects, using a prompt on signs at construction sites that allowed passersby to learn more about and offer feedback on the project. The prompts at construction sites ask: “Curious about what’s happening here?” Texting in to the number provided sets off a brief survey, first offering project information and the contact for the project manager, then asking whether the site is tidy, as well as whether the construction is affecting people’s commutes or businesses. Respondents can also sign up to receive ongoing project updates by text message.
- **Project:** [Text It Forward](#) is just one public engagement effort of [One Region Forward](#), a broad-based, [collaborative effort](#) to promote more sustainable forms of development in Erie and Niagara counties – the Buffalo Niagara Region – in land use, transportation, housing, energy and climate, access to food, and more, including the creation of a regional plan for sustainable development. Text It Forward sends a brief survey via text to broaden the conversation.⁷⁰

Crowdsourcing Stewardship

Connecting with and caring for natural spaces is an important sustainability goal. These applications highlight urban green spaces and ensure that public spaces and natural resources are being found, used, and stewarded.

Relevance to urban sustainability directors: EMPOWER residents to take responsibility for shared resources.

- **Application:** [Adopt-a-Drain](#) – Volunteers in Oakland, CA and [Boston, MA](#) can sign up to keep storm water drains clear and report any problems.
- **Application:** [Downtown DC](#) – The Business Improvement District’s Safety/Hospitality and Maintenance (SAM) employees use handheld devices to log issues they spot into an application created by the BID’s public space management department. This application combines data on conditions – such as broken pavers and graffiti – with GIS mapping, to create a real-time data mapping system, which has helped increase the number of resolved issues in Downtown DC.
- **Application:** [OpenTreeMap](#) – OpenTreeMap is a collaborative platform for crowdsourced tree inventory, ecosystem services calculations, urban forestry analysis, and community engagement.
- **Application:** [CityGardens](#) – With over 400 gardens in the city of Paris, this smartphone app provides information for the public who use green spaces and parks.
- **Application:** [SF Park Finder](#) – SF Park Finder is an interactive mapping tool for the public to locate parks.
- **Application:** [To the Trails](#) – To the Trails is a responsive web application that helps citizens find information on any trail regardless of jurisdiction or the device they use.
- **Project:** [Asheville Tree Map](#) – An online crowd-sourced tool that allows residents to identify, map and monitor trees in the city and provide easily searchable info on the city’s tree stock. Customized by the city’s [Information Technology Services](#) and the [Tree Commission](#) from open source software, the online map is designed to increase knowledge of trees in the area, and highlight their benefits to the community.

69 <https://www.bisnow.com/boston/news/deal-sheet/this-weeks-boston-deal-sheet-51004>

70 <http://www.oneregionforward.org/about/>

CIVIC SCIENCE

Sustainability Goal: To enhance the quality of sustainability and environmental science by empowering public participation.

Relevance to Sustainability Directors: Civic science tech can *INFORM* and *CONSULT* the public with real-time environmental data; *INVOLVE* the public in creating data; *COLLABORATE* with the civic and private sectors to innovate data; and *EMPOWER* the public to create and report their own data.

As the impacts of climate change intensify, so too does the likelihood of disastrous climate events. Mobile applications can help alert residents about emergencies as well as crowd source vital real-time information.

- **Application:** [Prepared.ly](#) – Prepared.ly offers a simple interface for emergency preparedness with checklists and facts in order to help residents protect themselves against natural disasters.
- **Application:** [Clean Air Maui](#) – This app allows members of the community to use their smart phones to report incidents of excessive cane smoke, ash, and fugitive dust to the state Department of Health’s Clean Air Branch (CAB), the Mayor’s Office, and the Environmental Protection Agency.
- **Application:** [SurviveSD](#) – This app, created as part of the San Diego apps challenge, provides emergency preparedness information including a flashlight function, list of emergency supplies, police scanner feeds, and links to local response services.
- **Application:** [AlertID](#) – AlertID uses proven technology to help citizens and federal, state, and local authorities share information about crime, terrorism, natural disasters, missing children and severe weather, among many others, that can threaten the safety of families and neighborhoods.
- **Program:** [Public Lab](#) – Public Lab is a community where anyone can learn how to investigate environmental concerns. Using inexpensive DIY techniques, it seeks to change how people see the world in environmental, social, and political terms.
- **Program:** [MIT extrAct](#) – extrAct, a suite of Internet-based databasing, mapping and communications technologies for use by communities impacted by natural gas development.

“Using such devices as balloons, modified consumer cameras, and free-source software, the end results of a grassroots approach can include better images of oil spills, more epidemiological data on endocrine-disrupting chemicals, and more thorough monitoring of well water.”

— [Validating civic perspective, grassroots resources for environmental science](#)

Tactical Technologies for Civic Engagement

This section describes categories of technology and approaches used for several civic engagement tactics, built from Matt Leighninger’s [Ten Tactics for Engaging the Public](#). While these technologies are not specific to sustainability initiatives, the tools can be applied to engage the public in meeting sustainability goals and to spark ideas for collaboration across multiple government departments and functions.

INFORM CITIZENS

For use when updating and informing citizens on important events or open data:

- **Application:** [CityGram](#) – Citygram is a notifications platform for residents that can cover a range of issues, from foreclosures in a given neighborhood to building permits along commuting routes.
- **Application:** [CityConnect](#) – CityConnect helps city staff update citizens with an agency-branded application that gives access city-related information.
- **Application:** [Civic Insight](#) – Civic Insight makes official information about buildings and construction projects available to the public. It also customizes visualizations that show how a city is changing over time.
- **Application:** [Honolulu Answers](#) – Honolulu Answers allows residents to search for answers about city services as if they were typing questions into a search engine.
- **Platform:** [Wikispaces](#) – Wikispaces is a free wiki host providing community wiki spaces, visual page editing, and discussion areas. Active since 2005.
- **Platform:** [Ning](#) – Built from the ground up for social networking, Ning's scalable, hosted platform provides tools and expertise needed to publish and connect communities.

SURVEY CITIZENS & GATHER FEEDBACK

For use when gathering streamlined opinions and feedback:

- **Application:** [Textizen](#) – Textizen's web platform sends, receives, and analyzes text messages, enabling cities to reach the public through their smartphone and tablets.
- **Application:** [CityZen](#) – CityZen helps organizations collect, understand and leverage online audience data.
- **Application:** [CityVoice](#) – CityVoice is a place-based call-in system to collect community feedback on geographic entities (like vacant properties) using the simple, accessible medium of the telephone.
- **Application:** [SurveyMonkey](#) – SurveyMonkey is an online survey tool.
- **Application:** [SurveyConsole](#) – SurveyConsole is web-based software for creating and distributing surveys.
- **Application:** [SurveyGizmo](#) – SurveyGizmo is online survey tool.
- **Application:** [Google Forms](#) – Google Forms create custom forms for surveys and questionnaires.
- **Platform:** [Quicktopic](#) – Quicktopic is designed for group discussions and provides free message boards.

REPORT PROBLEMS

For use when gathering ideas and information from citizens on a given issue:

- **Application:** [SeeClickFix](#) – SeeClickFix encourages residents to become active citizens in taking care of and improving their city by reporting non-emergency issue in their neighborhood.
- **Application:** [FixMyStreet](#) – FixMyStreet is an online reporting tool for public infrastructure issues.
- **Application:** [Open 311](#) – Open311 provides open channels of communication for issues that concern public space and public services.
- **Platform:** [Spot Reporters](#), initially developed for local governments, provides ways to empower citizens and let them connect with the city through online technology they use daily.
- **Application:** [Street Bump](#) is a crowd-sourcing project that helps residents report problems with public streets.

- **Provider:** [Connected Bits](#) develops mobile reporting applications including Spot Reporters, Spot Workforce, and Street Bump and has worked directly with 12 US cities to help with 311 service-related mobile applications.

MAP INFORMATION

For use when educating and informing citizens, or gathering citizen-generated data, about a geography-specific issue.

- **Application:** [OpenStreetMap](#) – An openly licensed map of the world being created by volunteers using local knowledge.
- **Platform:** [OpenLayers](#) – An open source javascript library to display and render maps from multiple sources on web pages.
- **Application:** [WikiMapia](#) – An online editable map - used to describe any place on Earth.
- **Application:** [worldKit](#) – An easy to use and flexible mapping application for the web.

AGGREGATE & ANALYZE SOCIAL MEDIA OPINIONS

For use when gathering residents' opinions in real-time.

- **Application:** [CitizenScope](#) – A platform for local social media conversations.
- **Application:** [Sysomos](#) – A social media tool that helps monitor, analyze, gather insights, and ultimately make the decisions that allow for the creation of better products and services for customers.
- **Application:** [Topsy](#) – A tool to search and analyze the Social Web with a simple social media search engine, easy-to-understand analytics, and social trends lists.
- **Application:** [Hootsuite](#) – A tool to manage social networks, schedule messages, engage audiences, and measure ROI.
- **Application:** [Tagboard](#) – Tagboard uses hashtags to search for and collect public social media posted to networks like Twitter and Facebook. Tools allow the selection of specific posts to feature on websites, in broadcast TV, and on large displays.

FACILITATE LARGE-SCALE DELIBERATION

For use to encourage citizens to take shared ownership of an issue and participate in addressing it, and to address public concern in high-profile situations:

- **Provider:** [Ascentum](#) – Ascentum provides public participation, stakeholder and community relations and employee engagement.
- **Application:** [Dialogue](#) – A policy dialogue and crowdsourcing software designed for government.
- **Platform:** [Zilino](#) – A web-based solution for hosting deliberative online forums and other types of well structured, well facilitated participatory processes.
- **Event:** [IBM's Collaboration Jam](#) – Large-scale online brainstorming sessions

DISCUSSION & IDEA GENERATION

For use when ideas and information from the public is needed for a specific issue or for healthy ongoing engagement.

- **Platform:** [EngagementHQ](#) (formerly Bang the Table) – online community engagement platform designed to help organizations and government connect with the public.

- **Platform:** [Neighborland](#) – Software that empowers civic leaders to collaborate with residents in an accessible, participatory, and enjoyable way by providing real-world design tools and a powerfully simple platform to engage people on the web.
- **Platform:** [CivicEvolution](#) – Civic Evolution uses web, mobile, and face-to-face activities and applications to help people come together around their shared concerns in meaningful ways.
- **Platform:** [QigoChat](#) – Online conversation and collaboration that enables brainstorming and collaboration in small and large groups.
- **Platform:** [ConsiderIt](#) – ConsiderIt is a platform that seamlessly combines the virtues of personal reflection and public deliberation. ConsiderIt is a product of the [Engage](#) project, an interdisciplinary research collaboration at the University of Washington.
- **Platform:** [CitySourced](#) – CitySourced is an enterprise civic engagement software platform for cities, counties, government agencies, schools and utilities. CitySourced has created dozens of city-specific civic engagement mobile apps.
- **Platform:** [All Our Ideas](#) – A platform that enables groups to collect and prioritize ideas in a transparent, democratic, and bottom-up way
- **Platform:** [Open Town Hall](#) – Peak Democracy's Open Town Hall is a cloud-based online civic engagement platform that augments and diversifies public participation in ways that also enable government leaders to increase public trust in their governance.
- **Platform:** [Our Say](#) – Connects the power of social media with the impact of real decisions.
- **Platform:** [Spigit](#) – Innovation management software to crowdsource business and product innovation.
- **Platform:** [IdeaScale](#) – IdeaScale is an innovation management platform that uses crowdsourcing to help find and develop new ideas.
- **Platform:** [Community Remarks](#) – A tool for citizens to talk about what works and doesn't in their neighborhood.
- **Platform:** [Codigital](#) – An engaging way for large groups to generate, prioritize and refine ideas.
- **Platform:** [GovDelivery](#) – A digital communications platform exclusively for government, serving over 1000 public sector organizations around the world.
- **Provider:** [mySociety](#) – Based in the UK, mySociety invents and popularizes digital tools that enable citizens to access institutions and decision-makers.
- **Platform:** [Citizen Space](#) – Hassle-free consultation software for government consultation and citizen engagement.
- **Platform:** [Common Ground for Action](#) – Facilitates small groups that are able to learn more about the tensions in an issue, examine options for dealing with the problem, weigh tradeoffs, and find common ground with visuals that let users see the evolving shape of their conversation.

OPEN BUDGETING & CREATIVE FINANCING

For use to inform and engage citizens in budgeting and procurement processes.

- **Provider:** [Socrata](#) – The City of Boston uses a Socrata-supported website as its [Open Budget application](#) that provides the public with a user-friendly, interactive platform to explore and better understand where city dollars are being allocated.
- **Provider:** OpenGov – The City of Los Angeles uses OpenGov to host its [website](#) that shows details on city spending.

- **Project:** [Open Budget: Oakland](#) – Created by OpenOakland, Open Budget: Oakland publishes visualizations that allow the public to explore the adopted budget.
- **Provider:** [Participatory Budgeting Project](#) – The Participatory Budgeting Project (PBP) is a nonprofit organization that empowers people to decide together how to spend public money, primarily in the US and Canada.
- **Application:** [Budget Simulator](#) – Budget Simulator inspires insightful responses from citizens.
- **Application:** [Budget Allocator](#) – A participatory budgeting tool available for project or enterprise budgeting processes for directly involving community members in making decisions about the allocation of public money.
- **Application:** [Citizen Budget](#) – A powerful online tool to involve residents in decision-making processes and to demonstrate a municipality's commitment to citizen engagement.
- **Application:** [Balancing Act](#) – A way for residents to learn about public budgets and the choices their elected officials face in the budgeting process. It allows participants to try allocating funds – expressing their priorities and preferences – but also requires them to balance spending and revenue.

VOTING & ELECTIONS

For use when reminding voters about upcoming elections and increasing voter turnout.

- **Provider:** [ThinkVoting](#) – ThinkVoting provides tools that will empower voters and candidates alike, and make it much easier for anyone to become more politically engaged.
- **Application:** [The Voting App](#) – The Voting App consolidates scattered and fragmented information into a single place, and gives every voter the Who, What, When, Where, Why and How for every election.
- **Application:** [TurboVote](#) – TurboVote is a voting app that makes voting easy by keeping track of local and national elections, helping people get registered or update their voter registration, providing forms and absentee ballots, and sending text and email reminders to help make sure users don't miss elections.
- **Application:** [Voterheads](#) – Sends free notifications when decision makers meet on important issues - at city, county and school board levels.
- **Platform:** [Change.org](#) – A global platform that allows people everywhere to start campaigns, mobilize supporters, and work with decision makers to drive solutions.
- **Application:** [Brigade](#) – Allows voters to express what they think about important issues, and see where friends and others stand.
- **Application:** [Google Civic Information API](#) – The Google Civic Information API lets developers build applications that display civic information to their users. For any U.S. residential address, users can look up who represents that address at each elected level of government. During supported elections, users can also look up polling places, early vote location, candidate data, and other election official information.
- **Platform:** [NationBuilder](#) – NationBuilder supports campaigns with action websites, fundraising functions, email blasting, scannable worksheets, mobile canvassing applications, and voter data.

COMMUNITY ORGANIZING

For use by the community to communicate with each other, advocate for their needs, and work together on local projects.

- **Platform:** [Causes](#) – Causes helps people discover, support, and organize campaigns around the issues that impact them and their community.

- **Platform:** [Our Common Place](#) – OurCommonPlace is a community web platform designed for community residents to share and connect with each other.
- **Platform:** [Front Porch Forum](#) – Front Porch Forum is a free community-building service in Vermont through which neighbors can create and read posts online and delivered via email in a daily digest. Each neighborhood's forum is only open to the people who live there.
- **Platform:** [NextDoor](#) – The private social network for your neighborhood.
- **Platform:** [EveryBlock](#) – EveryBlock is a way to follow what's happening in your neighborhood-level activities.
- **Platform:** [Meetup](#) – Meetup enables the creation of local interest groups and organization of events for those groups.
- **Platform:** [Neighborly](#) is a crowdfunding platform that lets neighbors invest in their community through public projects like parks, education, and other civic infrastructure.
- **Platform:** [Citizinvestor](#) is a crowdfunding and civic engagement platform for government projects that is completely free for government to use.
- **Platform:** [Ioby](#) is a crowdfunding platform for neighborhood projects.
- **Platform:** [Oregon's Kitchen Table](#) is a space to empower Oregonians from every corner of the state to contribute feedback, ideas, and resources to decision-makers, public projects and initiatives. After users sign up, they are contacted periodically by email with opportunities to share their opinion on Oregon's latest public policy issues, participate in a public project, or invest in the community.
- **Platform:** [Mosaic](#) connects investors with borrowers in order to finance solar loans. This makes financing solar cheaper for the consumer, and also helps them save on energy spending overall.

CIVIC ORGANIZATIONS & COLLABORATIONS

Examples of creative partnerships that generate new tech for civic engagement.

- **Provider:** [OpenOakland](#) – Makes tools that increase access to public information and help Oaklanders engage more effectively with local government and with each other.
- **Provider:** [Smart Chicago Collaborative](#) – A civic organization devoted to improving lives in Chicago through technology by increasing access to the Internet, improving skills for using the Internet, and developing meaningful products from data that measurably contribute to the quality of life of residents.
- **Provider:** [Open City](#) – Creates [apps](#) with [open data](#) to improve transparency and understanding of government.
- **Provider:** [Code for America Brigade](#) – Brigades build participatory power in their cities by holding regular civic hack nights and events, advocating for open data, and deploying apps.
- **Provider:** [Citizen Interaction Design](#) – A partnership program between local government and University of Michigan School of Information (UMSI) students to develop new information tools to revolutionize citizen engagement.
- **Provider:** [CivicCommons](#) – A civic engagement utility and consultancy using social media and social networking tools to serve community leaders, institutions, and the growing desire of citizens to be engaged and empowered on key civic decisions.
- **Provider:** [Engage](#) – Engage is an interdisciplinary research collaboration at the University of Washington, with the goal of designing, implementing, deploying, and testing innovative ways for citizens and government to communicate, with the goal of better supporting civic engagement and deliberation. The Engage project is affiliated with the [Design, Use, Build group](#) and the [Center for Communication and Civic Engagement](#).

Buildings + Energy Tech Guide

The Buildings + Energy Tech Guide is organized according to major components of a grid system: Energy generation, distribution, and energy end use.

RENEWABLE ENERGY GENERATION + STORAGE

Sustainability Goal: Integrate renewable energy into energy grid supply

This section focuses on distributed energy generation and the alternative grid systems that support it.

Solar and Wind Mapping

A solar map is an online tool that provides consumers information about solar and wind energy installation and siting potential in their community. Most solar and wind maps provide cost and incentive information for installations and help track community-wide progress toward renewable installed capacity goals. For more information, see the American Planning Association's Solar Mapping briefing.⁷¹

Relevance to urban sustainability directors: Solar and wind maps can provide critical information on installed and potential capacity for renewables that can guide deployment goals and strategies.

- **Application:** [MIT Solar System MapDwell](#) – Based on technology developed at MIT, the MapDwell Solar System™ app analyzes local weather conditions, rooftop shape, and available incentives to provide full, remote, cost-benefit analyses for potential distributed solar customers. It then connects these customers with local installers. The app has been applied in Boston, Boulder, Cambridge, New York City, San Francisco, Washington County, OR, Washington, DC, and Wellfleet, MA.
- **Application:** [Project Sunroof](#) – Project Sunroof draws on Google's existing mapping data and connects with other pricing and incentive databases to project an optimal distributed solar installation size, based on the citizen's address and current utility bill. It also analyzes the costs and benefits of leasing and loan options to help determine the best financing model for a customer's needs.
- **Project:** [City of San Diego Solar Map](#) – The City of San Diego partnered with the California Center for Sustainable energy to develop an interactive solar map, funded by grants from the U.S. Department of Energy and the California Public Utilities Commission. The map details the locations of solar installations and offers a directory of solar installers. The site also features a forum and a blog detailing programs and incentives.

Crowdsourced and Community Solar Investments.

While the solar market is growing rapidly, soft costs associated with on-site installation are slowing the rate of adoption in residential and small-commercial markets. Crowdsourced solar investments are one way to sidestep installation costs by providing direct access to the benefits of solar energy without actually installing panels on site. Using crowdsourcing platforms, several companies are developing novel investment models that aggregate individual investments to large-scale solar deployments.

Relevance to Urban Sustainability Directors: Crowdsourced and community solar investments can be a critical tool to overcome soft costs associated with on-site solar.

⁷¹ American Planning Association. Solar Mapping. <https://www.planning.org/research/solar/briefingpapers/solarmapping.htm>

- **Program: Generaytor** – Generaytor is an online community for distributed solar owners. By sharing performance data, solar owners can benchmark the performance of their systems against the similar system in the Generaytor community. With more information, the goal is to empower solar owners to optimize their solar investment and generate better returns.
- **Program: Yeloha** – Yeloha finances, owns, and installs distributed solar systems on the roofs of customers with appropriate roof space who agree to host a system. In return for hosting a system, the customer sees a reduction in their utility bill through consumption of some of the generated solar electricity. The rest of the solar electricity is purchased by a “solar partner” in the same utility territory. These solar partners are customers who are unable to install their own system, and they also see a reduction in their utility bill. Yeloha partners with utilities to take advantage of virtual net metering laws to enact the billing reductions.
- **Program: CloudSolar** – Customers purchase individual solar panels through CloudSolar, which can either be installed on their own roof or in one of CloudSolar’s distributed solar farms. Customers who have chosen to install their panels in a CloudSolar farm receive the revenue from the sale of the solar electricity generated by their panels for 25 years (the economic life of the panel), in exchange for a CloudSolar administration fee.

Battery-Based Energy storage

Battery storage is an increasingly affordable technology that has several applications. On its own, battery storage can be used to decrease peak demand charges by charging during a low demand period (e.g. overnight), then discharging to meet a property’s electricity needs during high grid demand periods (e.g. hot afternoons). Battery storage can also help entities engage in demand-response markets, enabling properties to demand less energy from the grid but still continue to power operations during demand-response events. When combined with distributed renewable energy sources, batteries can buffer dips in generation due to intermittent wind or sunshine, helping to integrate renewables more smoothly into the grid. While there are a variety of battery chemistries available, municipalities are most likely to purchase or incent battery storage within the context of larger battery management system or microgrid.

Relevance to Urban Sustainability Directors: a basic understanding of battery-based energy storage is essential in the application of microgrids or grid stability efforts.

- **Provider: Tumalow** – Tumalow installs a battery and battery management software at no upfront cost to large energy users (e.g. hospitals and schools). The battery management software intelligently discharges the battery during times of peak demand to reduce a building’s demand for grid electricity, thereby reducing the monthly utility bill demand charge. Tumalow’s system can also help regulate intermittent distributed energy generation.
- **Provider: Stem** – The Stem System includes batteries, power monitors (installed alongside existing electricity meters to relay energy use data in real time), and PowerScope software to provide facility managers with a deeper understanding of their buildings’ energy demand trends. The system can be installed at no up-front cost, and utilized to automatically shed peak load (reducing demand charges).
- **Provider: Green Charge Networks** – The GreenStation – a combined battery and battery management system – automatically sheds peak load through intelligent battery discharge. Customers can purchase the GreenStation technology outright, or enter into a Power Efficiency Agreement (PEA) with Green Charge Networks, under which the system is installed at no cost and operated by Green Charge Networks (customers share utility bill savings with Green Charge Networks to cover the cost). The GreenStation is designed to integrate with on-site distributed solar systems, electric vehicle charging systems, and facilitate participation in utility demand response programs.

- **Provider:** [Tesla](#) – Powerwall is a home battery that charges using electricity generated from solar panels, or when utility rates are low, and provides power when rates go up. It also protects against power outages by providing a backup electricity supply. The larger version of the Powerwall, the Powerpack, is intended for business or utility use and provides 100kWh of storage.
- *Other competitors to the battery management systems outlined above include SolarCity and Coda Energy.*

ENERGY DISTRIBUTION

Sustainability Goal: Create a resilient grid that sheds load and integrates renewables.

Smart Grid Network Platforms

Smart Grid Network platforms typically consist of networking/communications and grid control hardware, in concert with grid management software, to enable remote, real-time management of the distribution grid. Smart Grid network platforms also facilitate outage detection and enable the grid to reroute power in real time, “self-healing.” The system relies on advanced metering infrastructure that collects grid activity data and performs predictive analytics to provide actionable forecasts on the balance of energy supply and demand.

- **Project:** [Chattanooga automatic outage detection](#) – With a \$111.5 million grant from Recovery Act stimulus funds, Chattanooga, Tennessee’s utility, the Electric Power Board (EPB) is installing 1,500 advanced automatic “smart” distribution switches/sensors that automatically detect power and restore power outages. In February of 2014, the city experienced a snowstorm that affected 76,000 customers. 40,000 outages were automatically restored or prevented using the switches and sensors.⁷²
- **Project:** [Aspern Project, Vienna/Siemens](#) – Vienna is developing Aspern, a 20,000 person neighborhood with advanced smart city technology. Distributed energy production, storage, and a smart low-voltage distribution grid will be integrated with building automation equipment. The €40 million project is a joint venture of the city of Vienna, local utilities Wien Energie/Wiener Netze, and Siemens. Siemens will be undertaking a five-year research plan to test out combinations of new hardware technologies as well as data analysis software to manage all the different technologies in real time. Innovation in low voltage distribution systems is a major focus.
- **Provider:** SilverSpring Networks – The [Critical Infrastructure Networking Platform](#) uses an open, standards-based IPv6 network that integrates and connects all of a city’s smart grid infrastructure, including smart meters, distribution automation, in-home devices, demand response, and electric vehicles.
- **Provider:** [Gridco Systems](#) – The [emPower Solution](#) provides an end-to-end hardware/software system for management of the distribution grid. In-line power regulators monitor power quality and help stabilize the grid in real-time. Distributed grid controllers log and analyze local data. Their grid management and analytics software platform aggregates demand and supply data at the grid level for real time management.
- **Provider:** [Landis+Gyr Gridstream Solutions](#) – Gridstream is a modular smart grid solution with multiple applications. It includes advanced metering infrastructure, communications and network management equipment to relay energy use data, meter data management system software, and data analytics software. Landis+Gyr can also manage smart grid infrastructure on behalf of customers.
- **Provider/Project:** Spirae – [DERMS](#) Spirae’s Distribution Energy Resources Management System is comprised of hardware (servers, control units, input/output modules) and software programs to manage distributed energy resources. Already deployed by [SDG&E](#) in the town of Borrego Springs, CA to manage the local microgrid, the system stabilizes the local grid through voltage control, reactive power

72 Advancing the State of Grid in Tennessee. <http://www.energy.gov/oe/articles/advancing-state-grid-tennessee>

management, demand response capability, scheduling and dispatch of generating sources, and demand forecasting, among others.

- **Provider:** [Trilliant](#) provides a flexible networking and controls software platform that is compatible with all standard smart meter brands. The platform is able to integrate multiple network technologies, including AMI mesh, broadband mesh, PLC, and cellular.

Predictive Analytics

Predictive analytics are essential to using big data in a smart grid application. Through sophisticated software, predictive analytics allows users to know when to shed or store energy, or when prices will rise or dip. When used effectively, it can help leverage energy markets and stabilize the grid system.

Relevance to Urban Sustainability Directors: Predictive analytics can be applied at the grid, building, or citywide scale. Software systems could potentially manage grid-based demand response programs that generate energy and utility bill savings.

- **Provider:** [Trove Predictive Data Science](#) – Trove’s system incorporates smart meter data with other third party data to predict loads, identify energy theft and billing errors, and select the best customers for inclusion in demand response and other energy efficiency programs. See a profile in [Tech Crunch](#).
- **Provider:** [SilverLink Sensor Network](#) – The SilverLink Sensor Network is a network-based service to analyze real-time smart grid big data. The Network provides sensor devices and analysis software.
- **Provider:** [AutoGrid Energy Data Platform](#) – AutoGrid’s energy data platform enables grid managers to predict future loads from minutes to weeks ahead, drawing on real-time smart meter data. A specific application of the energy data platform – the Autogrid Demand Response Optimization and Management System or [ADROMS](#) – enables utilities to quickly implement demand response programs and call demand response events. See article in [Greentech Media](#).
- **Provider:** [C3 Energy Analytics](#) – A platform combines smart meter data with other publically available data sets to perform a variety of smart grid related analytics, including demand response, outage detection and restoration, load forecasting, predictive maintenance, among others.

ENERGY USE IN BUILDINGS

Sustainability Goal: Net Zero Buildings and Energy End Uses

Customer Engagement

Customer engagement software is used primarily for utilities to enable better residential energy savings. The following two providers offer application program interfaces (APIs) as platforms for digital customer engagement.

Relevance to Urban Sustainability Directors: Knowledge of common API platforms is essential to influence utilities to engage customers in support of citywide energy reduction goals.

Provider: [Green Button Connect](#) – Green Button was developed by the energy industry in a consensus process and now may be adopted voluntarily by utilities. Green Button builds on policy objectives in the Obama Administration’s [Blueprint For a Secure Energy Future](#) and [Policy Framework for the 21st Century Grid: Enabling our Secure Energy Future](#). It aims to ensure that consumers have timely access to the own energy data in consumer-friendly and computer-friendly formats.

Provider: [Tendrill Developers](#) – Tendrill offers consumer engagement software and APIs to support for advanced energy services for residential customers. APIs include user management, home profiles and building energy models, and energy consumption and savings goals.

Building Portfolio Management

Owners of multiple buildings have the opportunity to benchmark buildings and target energy efficiency investments accordingly. New software companies are making this process easier by automatically reading energy meters and providing real-time performance analytics.

Relevance for Urban Sustainability Directors: Cities can use building portfolio management software in municipal buildings and promote the results to other portfolio managers in the city.

- **Software:** [First Fuel](#) – By combining data science, building science and software expertise, FirstFuel delivers energy intelligence about what is going on behind the meter – without going behind the meter. Key detailed insights at an individual building and load level across an entire portfolio – mass customization – relieves the heavy lifting of energy management for utilities and government agencies.
- **Software:** [Building OS](#) – BuildingOS is a cloud-based building management platform that integrates and aggregates portfolio-wide building and metering systems data for collaborative analysis. BuildingOS is vendor-agnostic and natively connects to 175+ building technologies. It collects data from any utility meter, submeter, or controls system to access data from a single, centralized repository.
- **Software:** [IntelliCommand](#) – IntelliCommand monitors energy, lighting, heating and cooling to ensure buildings run efficiently and alerts property managers to potential issues before they become costly problems.
- **Software:** [Retroficiency](#) provides a way for commercial customers to track energy use and how they can reduce their usage. They aim to make energy-efficient buildings scalable by utilizing data analysis to develop models and track how and where that building is using and wasting energy.
- **Toolkit:** [2030 Districts Toolkit](#) – 2030 Districts are unique private-public partnerships that bring property owners and managers together with local governments, businesses, and community stakeholders to provide a business model for urban sustainability through collaboration, leveraged financing, and shared resources. Together they benchmark, develop and implement creative strategies, best practices and verification methods for measuring progress towards a common goal. 2030 Districts offers members a number of free and discounted resources to help property owners and managers reach the maximum performance of their buildings and benefits from participating in the program; including comparative analyses, exclusive incentives, discounts and programs; and special financing programs.

Code Enforcement

Developing and enforcing codes is a basic strategy for cities to meet sustainability targets. The following tools use mapping and big data to make those codes more relevant and enforceable.

- **Application:** [Civic Insight](#) – Civic insight allows residents to track city business (e.g. code performance or building permits) for individual properties. The app also allows municipal employees to analyze trends, such as permit wait times.
- **Application:** [Codecycle](#) – Codecycle helps design and construction teams comply with complex energy standards, and makes energy code compliance easier for municipal employees.

Performance Heat Maps

Performance heat maps are web-based data sharing platforms that aggregate building performance data across a city.

Relevance to Urban Sustainability Directors: Performance heat maps can support district or city-wide energy goals or competitions, and add new value for the real estate market.

- **Project: [BuildSmart NY](#)** – Through the use of advanced data analytics, BuildSmart NY will benchmark State facilities to prioritize resources and identify best practices. Comprehensive energy analysis will identify equipment and process upgrades in the largest and most inefficient buildings, accelerating efforts to improve the efficiency of State building portfolio. BuildSmart NY will also promote best practices for building operations and maintenance to ensure efficiency improvements are sustained.
- **Project: [BuildSmart DC](#)** – The mission of BuildSmart DC is ambitious but simple: sharing energy data – both good and bad – will empower operators, occupants, and DC residents to take action towards unprecedented energy savings.
- **Project: [Glasgow Energy App](#)** – This app explores building energy use across Glasgow. You can rate how your building performs against benchmarks and discover latest efficiency technology used in Glasgow.
- **App: [Honest Buildings](#)** – Honest Buildings is an online platform to track communication with bidders, keep project teams accountable, and level bids to run a more effective bid process. Honest Buildings provides knowledge of existing vendors to gain insight into bid history, permit data, and project history through a network with data on over 35,00 vendors.
- **Project: [Environmental Dashboard](#)** – Environmental Dashboard is a communication technology that combines real-time display of water and electricity use in buildings, organizations and entire communities with photographs and ideas contributed by community members. Using electronic signs and websites, Environmental Dashboard employs compelling graphics to reconnect people with the natural world by making flows of resources visible and promoting sustainable action. It is designed and maintained by a group of researchers, software programmers, and community members based in Oberlin, Ohio.
- **App: [AutoDesk Rapid Energy Modeling \(REM\) for Existing Buildings](#)** – REM is a method for energy analysis that provides building data quickly to identify high-potential retrofit strategies prior to onsite energy audits. The software creates preliminary energy assessments based on a building's construction, geometry and local climate conditions. REM can screen building portfolios to identify retrofit candidates; predict lifecycle energy use and cost; identify energy conservation measures; and create energy reports in less than an hour.
- **App: [RentRocket](#)** – RentRocket enables renters to see and compare basic amenities as well as utility costs, accessibility to alternative modes of transit, and recycling options.

Shared Efficiency Targets

Shared efficiency targets provide a platform for greater participation in energy efficiency. The following projects use ICT applications to track energy and progress toward goals.

Relevance to Urban Sustainability Directors: The following projects can be used as models for developing and implementing shared efficiency targets.

- **Project: [Envision Charlotte](#)** – Envision Charlotte is project that shares energy goals for buildings within the uptown submarket with at least 10,000 square feet of office space. Buildings installed equipment to display near real-time aggregated energy usage information on interactive kiosks in every participating building.

- **Project:** [2030 Districts](#) – 2030 Districts are unique private-public partnerships that bring property owners and managers together with local governments, businesses, and community stakeholders to provide a business model for urban sustainability through collaboration, leveraged financing, and shared resources. Together they benchmark, develop and implement creative strategies, best practices and verification methods for measuring progress towards a common goal.
- **Company/Partner:** [BlocPower](#) – BlocPower is an online marketplace that connects impact investors to institutional networks of energy efficiency projects in churches, synagogues, nonprofits, and small businesses in underserved communities.

Demand Response

Demand response programs allow utilities to communicate to end-users when peak demand events are imminent. End users then reduce their energy use – either manually or automatically – which can reduce or avoid peak demand.

Relevance to Sustainability Directors: The following providers and technologies can help cities adopt load management programs that reduce or avoid peak demand events. The programs have significant GHG potential because they can avoid the use of standby generators that have higher emission profiles.

PEAK LOAD SHEDDING AND BUILDING AUTOMATION

- **Provider:** [Regen](#) – Regen Energy provides a wireless automated demand management and demand response controllers for electrical heating, cooling, or discretionary energy loads. Regen controllers work together like a swarm of bees, communicating and managing duty cycles of loads being controlled.
- **Project:** [Non-Wires Alternatives in Rhode Island](#) – Cost-effective energy efficiency, distributed generation, and demand response measures aimed at reducing “dirty” peak energy demand from the electricity grid.
- **Provider:** Demand Logic - Web based platform that collects/analyzes energy use data from existing building management systems to identify efficiency savings through operating changes. Installations in the UK and San Francisco.
- **Provider:** [OhmConnect](#) – OhmConnect helps customers reduce peak electricity demand and sell reductions into the energy market as additional generation. OhmConnect hooks into users’ Wi-Fi thermostats, electric cars, and smart devices to automate reductions as well. Users are also presented with a clear visualization of where their energy is coming from and where their energy is going. For each event that they participate in, they earn points, which can be cashed out at any time.

UTILITY-BASED CUSTOMER SERVICES

- **Provider:** [OPower](#) – Opower combines a cloud-based platform, big data, and behavioral science to help utilities work with customers to reduce energy consumption.
- **Application:** [Energy Tracker](#) – Energy Tracker is an app developed by Portland General Electric that provides detailed energy consumption data to business and residential customers. Data can be used to create a savings plan and connect to cash incentives for conservation.
- **Application:** [SilverSprings Networks Demand Optimizer](#) – Demand Optimizer provides near real-time visibility to measure and verify customer participation in demand response events.

DYNAMIC UTILITY RATES

- **Project:** [PowerCents DC Smart Meter Pilot](#) – A study in the Washington DC region on dynamic utility rate pricing through smart meters.

- **Project:** [Salt River Project](#) – This project tested advanced metering infrastructure that allowed time-of-use rates pricing.
- **Project:** [PG&E Smart Rate](#) – A program with PG&E that allows customers to pay a reduced rate in exchange for minimizing electricity usage up to 15 days per-year.

SMART APPLIANCES

- **Provider:** [Nest](#) – Nest offers three products that can be monitored and controlled remotely through an app – a thermostat, a smoke detector and a security camera.
- **Provider:** [NETenergy](#) – NETenergy is a thermal energy storage system that generates cooling loads during off-peak hours.
- **Platform:** [SmartThings](#) – SmartThings allows you to control smart appliances such as thermostats, motion detectors and light switches.
- **Provider:** [Enlighted](#) – Enlighted is a lighting and HVAC control system for commercial spaces. Sensors on each fixture monitor occupancy, ambient lighting, temperature, and energy usage.

Transportation Tech Guide

In an increasingly connected environment, cities have now become the focal point for a range of new, shared vehicle mobility options – key tools for a smart city mobility strategy. Some cities are further advancing their multimodal approach to transportation. By connecting different modes of transportation to create on-demand, personalized, and flexible urban transportation systems, cities can transform how its citizens move and connect with ICT.

ENABLE SHARED MOBILITY

Technologies share and optimize data and reorient the focus from cars to mobility as a service for the people, i.e. getting there by combining all types of mobility from buses to bikes with real-time demand-response. In the near future, more cars will be purchased and operated by Transportation Network Companies (carsharing, ridesourcing and ridesharing companies) then by urban residents. CEO Travis Kalanick recently stated that Uber will eventually replace all of its drivers with self-driving cars.⁷³ A Columbia University study suggested that with a fleet of 9,000 autonomous cars, Uber could replace every taxicab in New York City.⁷⁴

Relevance to Urban Sustainability Directors: Shared mobility may reduce GHGs if car ownership and overall VMTs are reduced. Cities can and should demand access to relevant data of performance and accountability of carsharing, ridesharing and ridesourcing companies that are active within the city. One current NRDC/UC Berkeley study is investigating the environmental impacts of shared mobility services. Once the sustainability metrics are better understood, greater certainty that future applications are selected based on merit and meaningful outcomes will be paramount. The following is a partial list of companies actively innovating in shared mobility:

⁷³ <http://www.theverge.com/2014/5/28/5758734/uber-will-eventually-replace-all-its-drivers-with-self-driving-cars>

⁷⁴ <http://www.businessinsider.com/how-self-driving-cars-could-solve-new-yorks-traffic-woes-2014-6>

Carsharing

Sharing the use of a private fleet or individually-owned cars

ROUND-TRIP CARSHARING

Car memberships where cars that are returned to the same spot when a driver's time is completed:

- **Provider:** [Zipcar](#) – A subsidiary of Avis Budget Group. Zipcar provides automobile reservations to its members, billable by the hour or day.
- **Provider:** [Carma and City CarShare](#) – A Bay Area nonprofit that provides convenient, affordable hourly access to shared cars in order to reduce individual car ownership and usage.
- **Provider:** [Scoot](#) – A San Francisco based electric scooters and quads shared across a network and rented by the hour.
- **Company:** [HourCar](#) – A carshare nonprofit that serves Minneapolis and Saint Paul.

ONE-WAY CARSHARING

Car memberships that allow for members to pick up in one location and drop off in another:

- **Provider:** [Car2go](#) – A subsidiary of Daimler AG providing carsharing services in European and North American cities. Users are charged by the minute, with hourly and daily rates available.
- **Provider:** A pilot by [Zipcar](#) – Beta is now in Boston. Reserve on demand for a 30-minute minimum. Drive it one-way across town or bring it back to where you started.
- **Provider:** [BlueIndy](#) – It is one of the nation's first municipally supported one-way ride-sharing services. The service is provided by the City of Indianapolis and the Bolloré Group, a French industrial and energy conglomerate which is running the service on a 15-year contract.

PEER-TO-PEER CARSHARING

Services that create a membership and tap into members' private vehicles to create the fleet. Profits are shared with car owners.

- **Provider:** [Turo](#) – RelayRides recently rebranded itself as Turo. Cars are outfitted with in-car technology. This provides access to the vehicle using a smart card, meaning the owner and borrower don't need to meet up to exchange keys. The in-car technology also has a security mechanism that disables the ignition.
- **Provider:** [FlightCar](#) – Allows travelers parking at the airport to rent their vehicles out to visitors. Every rental is insured up to \$1 million, and every renter is pre-screened. Members get free parking, a car wash, and a profit-share if their car is rented.
- **Provider:** [GetAround](#) – An online carsharing or peer-to-peer carsharing service that allows drivers to rent cars from private car owners, and owners to rent out their cars for payment. Owners set their rental prices and earn a 60% commission from their rental revenue.

RideSourcing

Ride-sourcing drivers do not share a destination with passengers; instead, the driver's motivation is fare income while the rider's motivation may be speed, comfort, safety and/or reliability. Only recently have [Uber and Lyft decided to share their data](#) for a more complete study on what thresholds may exist to attain reduced VMT and improve safety of streets.

MAINSTREAM RIDESOURCING

- **Provider:** [Uber](#) – The company develops, markets and operates a mobile app, which allows consumers with smartphones to submit a trip request which is then routed to Uber drivers who use their own cars.
- **Provider:** [Lyft](#) – The company develops, markets and operates a mobile app, which allows consumers with smartphones to submit a trip request which is then routed to Lyft drivers who use their own cars.
- **Provider:** [Sidecar](#) – The company develops, markets and operates a mobile app, which allows consumers with smartphones to submit a trip request which is then routed to Sidecar drivers who use their own cars.
- **Provider:** [Opoli](#) – Featuring drivers who are commercially licensed and fully insured to transport commercial passengers. Drivers and customers to negotiate the fare before the ride.

Taxi companies creating taxi hailing apps such as: [Arro](#), [Way2ride](#) and [FlyWheel](#) that compete by using similar tools and allow passengers to avoid surcharges often applied by ridesourcing companies during “peak” hours.

RIDESOURCING FOR SPECIFIC POPULATIONS

- **Provider:** [HopSkipDrive](#) – HopSkipDrive is a ride service for kids designed to help you take some of the stress out of your family’s busy schedule with increased safety features.
- **Provider:** [Shuddle](#) – Similar to HopSkipDrive with the added advantage of booking times as short as one hour compared to 24 hours.
- **Provider:** [Lift Hero](#) – A platform for arranging convenient, door-through-door transportation and accompaniment to medical appointments for seniors from reliable, trustworthy drivers.
- **Provider:** [SheTaxi](#) exclusively offers female drivers, for female riders.

RIDESOURCING WITH A FOCUS ON CARPOOLING

This subcategory is the most likely type of ridesourcing to reduce VMT when fully optimized.

- **Provider:** [UberPool](#) – uberPOOL matches you with another rider heading in the same direction. It adds only a few minutes, and you both save big. Trips can be 50% less than uberX.
- **Provider:** [Lyft Line](#) – A carpooling service, which allows strangers taking a similar route to share a ride.
- **Provider:** [Via](#) – Only Carpooling in NYC and Chicago with premium vehicles for flat rates.
- **Provider:** [Split](#) – Only Carpooling in DC.
- **Provider:** [Loup](#) – Loups are optimized routes with pick-up & drop-off stops similar to a bus route. But with Loup, you will get an efficient, safe, and comfortable experience that is lower cost.

RideSharing

Some hybrid models exist that span carsharing and classic carpooling, but the idea is a true decrease of VMT if public transportation is not a viable option.

Carsharing and vanpooling provide paid services that may be faster, more efficient, cleaner or somehow an improvement on available public transit options. Some similar options like [LeapTransit](#) recently failed:

Relevance to Urban Sustainability Directors: These options could be valuable choices to integrate or be promoted by Sustainability Directors as they can directly apply reduced VMT to private businesses as well as all citizens.

- **Provider:** [Carma](#) – Carma’s main goal is to make ridesharing easy and flexible. Carma has programs in Ireland, Norway, Washington D.C., San Francisco and Austin.

- **Provider:** [Ride](#) – Ride is a ridesharing service that helps you manage your daily commute to work. Whether you already have a carpool or are looking for coworkers to share costs on your daily commute, Ride helps people get connected, communicate, plan a route, manage transactions and more. Located in San Francisco.
- **Provider:** [Vride](#) – Ridesharing and vanpooling for slightly longer commutes in the Bay Area.
- **Provider:** [Zimride](#) – Zimride provides a customized private network to connect drivers and passengers heading the same way. Backed by Enterprise Rent-A-Car, Zimride complements existing car sharing, vanpooling, and car rental services as part of a total transportation solution for universities, companies and organizations.
- **Provider:** [BlaBlaCar](#) – Carpooling offered in dozens of cities worldwide.
- **Provider:** [RideWith](#) – Waze’s carpooling app.
- **Provider:** [Bridj](#) – A point-to-point bus service in Boston and DC.
- **Provider:** [Ride Chariot](#) – The company’s mobile-phone application allows passengers to ride a shuttle between home and work during commuting hours. A point-to-point bus service in San Francisco.
- **Provider:** [Padambus](#) – The startup developed a transportation service relying on shared minibus, which is available nightly in Paris.
- **Project:** The Memphis Area Rideshare Program (MAR) has partnered with private company [vRide](#) to create an interactive social network for commuters in the Memphis metropolitan region. Once commuters sign up, they can search for rides to, and from, work based on location or place of employment, in addition to creating their own vanpools or carpools.

Bikesharing

Bikesharing systems have increased rapidly since the mid-2000s, growing from 13 systems in 2004 to 855 a decade later. Of these, 54 are in the United States. Current third-generation systems are characterized by automated credit card payments, technologies such as GPS that enable bicycles tracking, and mobile applications that show the availability of bikes and available docks in real-time. In the future, fourth-generation bikeshare could include dockless systems and improved transit integration.⁷⁵ As of the end of 2015, API feeds for [General Bikeshare Feed Specification](#) (GBFS) have been created by three major bikeshare companies.

Prior research has demonstrated a wide range of benefits from bikeshare systems as well as from adapting city streets to make cycling safer and more attractive. Infrastructure upgrades such as cycle tracks bring more than twice as many riders as nearby roads without them. “Improved human health from increased physical activity far outweighs any additional mortality from crashes and exposure to car exhaust – the equivalent of more than 75 deaths avoided for every one lost, according to a [2011 study](#) based on the Barcelona bikeshare system.”

⁷⁶Even those not on bikes benefit from increased cycling, as CO2 emissions fall with every car taken off the road. The following are a list of providers:

TECHNOLOGIES

- **Provider:** [Motivate](#) (also operates CitiBike) – Motivate is focused on bicycle share management and operations. Motivate operates systems in public-private partnerships with local governments around the globe. These are fixed-location docks for all bikes with over 200 stations and annual ridership of more than two million.
- **Provider:** [SocialBicycles](#) can be locked up anywhere in their respective city, and have a pricing model that supports slightly longer trips than the Motivate system. System components are packaged into computers

⁷⁵ <http://journalistsresource.org/studies/environment/transportation/bikeshare-research-growth-user-demographics-health-societal-impacts>

⁷⁶ Ibid.

onboard every bike, rather than a networked bike rack.

- **Provider:** [Velib](#) – The Paris-based Velib has the biggest bikesharing operation in any one city outside of China with 20,000 bikes at 1800 stations around Paris.
- **Provider:** [BCycle](#) – BCycle is a public bicycle sharing company formed in partnership between Trek Bicycle Corporation, Humana, and Crispin Porter + Bogusky and is based in Waterloo, Wisconsin, United States. It has 27 local systems operating in 29 cities across the United States, as well as in Santiago, Chile.
- **Provider:** [viaCycle](#) – The company currently operates 100 bicycles in three cities: Atlanta (at Georgia Tech), Fairfax, Va., and Philadelphia. Unlike most bikeshare programs, viaCycle does not require docking stations, which makes them around one-third cheaper to set up. Instead, the bikes can be locked to any bike rack. The bikes will be GPS-enabled, meaning users can lock and unlock bicycles through a phone call, text or mobile app.
- **Application:** [Spotcycle](#) makes it easy to find a bikeshare station so you can cycle around your city. It is a bikeshare system companion app that lists the 10 stations closest to you, and can filter down to your particular needs. Bike paths are also listed so you know which routes to travel.
- **Project:** New York City has the largest bikeshare in the U.S., even though it only started in 2013. Motivate is the bikeshare operator. There are expansion plans in place, designed to double the number of bikes on the street by 2017.

BIKESOURCING

- **Provider:** [SpokeFly](#) – Like carsharing services, Turo or GetAround for bikes, SpokeFly allows owners to rent out their bicycle when they are not using it.
- **Provider:** [Spinlister](#) is a peer-to-peer bike sharing program that allows its users to rent out their own personal bikes, skis, surfboards, and snowboards through the company's apps. They recently announced plans to sell specially-built smart bikes (similar to a city bike share program) for use as franchised rentals through its mobile app. The company will sell the smart bike and allow purchasers to rent their bike for an 80% share of the revenue.

MOVING THINGS

Intelligent logistics solutions such as ITS, electronic freight and intelligent cargo are the main catalysts for innovative transport logistics and supply chain management. Intelligent logistics solutions are mainly determined by increased use of ICT – including data sharing, knowledge transfer, cooperation and collaboration.

In 2013, products ordered online generated just over one billion deliveries. According to Barclay's, by 2018, this number is expected to grow by 28.8% to 1.35 billion.⁷⁷ Because of the difficulty of reaching end users, especially in busy urban areas where deliveries to retail stores, business and restaurants present congestion and safety concerns; increased delivery services equate to higher GHG and urban pollution due to idling. Since business-to-consumer deliveries often involve one package per stop, as compared to large volumes for business-to-business deliveries, the problem is compounded on the consumer level.⁷⁸ The following are new ICT applications that may offer solutions:

⁷⁷ <https://www.home.barclays/content/dam/barclayspublic/docs/BarclaysNews/2014/September/the-last-mile-report.pdf>

⁷⁸ <https://www.mitchellsny.com/blog/2016/01/>

- **Provider:** [Uber Rush](#) – Uber Rush’s initial launch of a delivery service will be limited to three cities: Chicago, San Francisco and New York. In San Francisco, packages will be delivered via a mix of bike couriers and cars. For Chicago, it’s cars only, whereas New York deliveries will be by bicycle or on foot. For now, packages and passengers will ride separately.
- **Provider:** [Postmates](#) – Allows users pick from a menu of items in addition to letting merchants use it for their deliveries.

COMPLETE STREETS

Complete Streets is a transportation policy and design approach that requires streets to be planned, designed, operated, and maintained to enable safe, convenient and comfortable travel and access for users of all ages and abilities regardless of their mode of transportation. As sensors and wireless networking components become available for every aspect of infrastructure from streetlights to phone booths and trashcans to buses, the result is that almost any object can be utilized for a complete streets policy. For example, a network of sensors throughout a city can shift behaviors through dynamic pricing, real-time information sharing and minimizing traffic congestion. Another example is a universal payment and feedback mechanism across all modes and brands of mobility from transit to carpools and bikeshares to parking.

Connecting vehicles, infrastructure and users with smart technologies for public and private transportation is increasing exponentially. Connected technologies extend to Vehicle-to-Vehicle (V2V), Vehicle-to-Infrastructure (V2I), Vehicle-to-Device (V2X) and Vehicle-to-Grid (V2G) systems that support safety, mobility and environmental applications and use Dedicated Short Range Communications (DSRC) and Wireless Access for Vehicular Environments (WAVE) developed in the last several years.

Designers incorporate strategies such as managed lanes, toll facilities, rail transit, and commute options into a corridor, allowing capacity for moving people and freight to be more easily expanded in the future. ICT is the nervous system that allows for improved efficiencies. These providers can help a city gain access to more ubiquitous access for broadband and connect sensors and devices to make a city more efficient:

[The Intelligent Transportation Society of America \(ITS America\)](#) is the nation’s largest organization dedicated to advancing the research, development and deployment of Intelligent Transportation Systems (ITS) to improve the nation’s surface transportation system. Founded in 1991, ITS America’s membership includes more than 450 public agencies, private sector companies, and academic and research institutions. Some examples of traffic control, predicting traffic, crashes and congestion with crowdsourced issue reporting are:

- **Provider:** [KLD](#) – Helps private sector firms, utilities, governments (federal, state, local), partners and system integrators solve traffic and transportation problems.
- **Provider:** [Inrix](#) – Provides a variety of Internet services and mobile applications pertaining to road traffic and driver services. It provides historical, real-time traffic information, traffic forecasts, travel times, travel time polygons and traffic counts to businesses worldwide.
- **Provider:** [Iteris](#) – Focuses on intelligent information solutions to the traffic management market to reduce traffic congestions, improve predictions of weather and traffic conditions, and provide more accurate performance analysis.

INCREASING INTERCONNECTIVITY VIA MOBILITY

- **Provider:** [Veniam](#) – Fleet operators can turn vehicles into mobile Wi-Fi hotspots that can deliver Internet access to passengers while collecting terabytes of data for diverse applications in connected transportation, industrial logistics and smart cities.

MAKING THE CONNECTION: ICT IN PUBLIC TRANSPORTATION

Transparency and information sharing has connected citizens with their respective transit authorities and transit authorities with their citizens. There are multiple sources of data that are directly pertinent to transit planning and management. A few key sources are listed here:

- **Application:** Computer-Assisted Dispatch/Automatic Vehicle Location (CAD / AVL) - The CAD/AVL system is the heart of most Transit ITS deployments. It continuously tracks all transit vehicles in real-time, which enables efficient and effective operational control, incident management, security response, and service restoration.
- **Application:** Automatic Passenger Counting (APC) systems can be developed as stand-alone systems, or integrated into AVL systems. A standalone APC system typically records passenger boardings and alightings with time and location coordinates. The collected data then is then off-loaded or transmitted from the bus for analysis.
- **Application:** Advanced Fare Collection (AFC) where data is time-stamped, and increasingly geo-coded. The movement of individual smart cards can be tracked through the system, providing information on customer behavior, including the possibility of building complete origin-destination matrices. Researchers are also using AFC data as a method for analyzing travel times and system performance.
- **Application:** Smart Card Technologies help bridge the gap of efficiencies for payment across multiple transit options. They can also be integrated into smartphones where additional information can be shared to riders such as real-time transit information and returned to the municipality to improve usage. [NFC Smart Card Technologies](#) and other multimodal technologies that can [streamline ticketing](#) allowing, for example, all modes of travel to be placed on a single invoice.

In each case below, developer [Globe Sherpa](#) created a smart card application:

- **Project:** [Ventra](#) in Chicago – [Cubic Transportation Systems \(CTS\)](#) released the Ventra Mobile App for Chicago Transit Authority rapid transit, Metra regional/commuter rail and Pace suburban bus riders in 2015. The “one-stop” mobile app gives transit riders the ability to plan, manage and pay for their journeys for each of the region’s agencies.
- **Project:** [MuniMobile](#) in San Francisco – MuniMobile, is in its pilot phase now. Officials are testing how the app works in relation to the other payment options, how many people use it and how convenient it is for riders who would otherwise pay in cash. SFMTA is looking for ways to expand it, should the app prove successful. Muni – San Francisco’s public transportation system, includes buses and cable cars.
- **Project:** [TriMet](#) in Portland – TriMet Tickets, the first mobile ticketing app that GlobeSherpa released, reached a major milestone in the fall of 2015 as TriMet announced that riders have purchased more than five million tickets in less than two years.
- **Project:** [Société de transport de Montréal \(STM\)](#) – The STM used data analytics to increase ridership 15% over three years by streamlining its bus routes, adding new metro stations and improved service. They are now applying analytics to their marketing approach in an effort to further increase ridership.
- **Application:** [General Transit Feed Specification-realtime](#) – Many researchers and other experts have recognized that GTFS data provides a simple way to build transit network models that can be combined with Geographic Information Systems (GIS) and real-time data or other forecasting models for a variety of purposes, including analysis of performance, accessibility and equity. [Transit Time](#) is an example of how other providers are able to supplement GTFS files.

ICT-enabled transportation systems improve capacity, enhance travel experiences and make moving people and goods safer, more efficient and more secure. The local police, emergency services and other government services can use these sensor networks with smart traffic management to gain citywide visibility to help alleviate congestion and rapidly respond to incidents.

Below are a few examples of how cities are helping to manage their fleets and improve traffic flow:

- **Provider:** [Urban Engines](#) – A cloud-based solution gives unprecedented visibility into transit system performance and commuter flows to improve planning and operations decisions.
- **Provider:** [Urban Insights](#) works with transportation organizations to collect and analyze data.
- **Provider:** [INIT](#) is a supplier of integrated ITS and ticketing systems for buses and trains.
- **Provider:** [Trapeze](#) can be used for drivers, mechanics, field staff, yard personnel and dispatchers. The solution tracks any employees who can be assigned a shift. This solution is designed to automate bidding, dispatching, timekeeping, workforce management, and yard management functions.
- **Provider:** [DoubleMap](#) provides intelligent transportation solutions for municipal transit fleets, university systems, corporations, hospitals, and airports. Each product has integration within the DoubleMap ecosystem, so administrators can effectively manage their fleet from a unified location in real-time.
- **Application:** [ZenDrive](#) uses smartphone sensors to analyze driver behavior and provide insights and driver coaching.

For citizens to help understand and take advantage of public transit (three examples listed, but hundreds exist):

- **Application:** [Transit App](#) – Transit presents route choices in a grid and offers real-time schedules, along with information on nearby bike- and car-sharing services. It covers more than 100 cities.
- **Application:** [CityMapper](#) – Citymapper offers specific train exit information and covers 29 cities worldwide.
- **Application:** [Moovit](#) – Moovit gets the same official data from transit agencies that Apple and Google Maps get. But it supplements that with crowdsourcing. Volunteers improve coverage by adding information on bus routes and schedules from smaller transit agencies that don't provide mapping data. Moovit covers 800 cities worldwide.

For Private Drivers:

- **Application:** [Waze](#) is a community-based traffic and navigation app where users share real-time traffic and road info.
- **Application:** [RideScout](#) is a technology platform that aggregates transportation options and, utilizing predictive technology, helps users get around cities faster and smarter. RideScout shows users transit, taxi, ride share, car share, bike share, carpool, walking, biking, driving and parking in one view, with real-time transit departures and traffic integration.

SMART STREET ILLUMINATION

Street lighting is an essential feature of modern streets and roadways, providing illumination to ensure walkway and roadway safety. The U.S. Department of Energy estimates that there are 52.6 million roadway fixtures installed in the United States, including 26.5 million streetlights and 26.1 million highway fixtures.⁷⁹ Not only do smart streetlights save electricity and reduce GHG emissions, but their ubiquity makes them ideal to host mesh networks and sensors (this topic is also touched up on page 76 under “Demand Response”).

79 http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/nichefinalreport_january2011.pdf

- **Project:** [General Electric LEDs](#) – San Diego and Jacksonville are using GE's [Predix](#) LED solution. This uses LED street lighting installations to connect, collect and analyze data spanning from open parking spaces to overall traffic flow.
- **Provider:** [OSRAM](#), owned by Siemens, offers a standards-based street lighting management system that incorporates control networking technology. OSRAM's light management system works with a range of luminaires – from emerging technologies such as LEDs to existing technologies such as induction lighting. Relative to just using high efficiency lamps, OSRAM's street light management system can further lower energy use by up to 40 percent and reduce the cost of operating the street light infrastructure.
- **Provider:** [SilverSpring](#) is partnering with Florida Power & Light for what is believed to be the world's largest connected lighting project of nearly 500,000 networked street lights across Miami and South Florida.
- **Provider:** [Telensa](#) – Along with connected LED-based street lighting, which can be controlled and monitored from a central app, Telensa offers a number of other smart city sensors, which can piggyback on street lamps, such as pollution or weather sensors.
- **Project:** Spurred by the 2002 Winter Olympics, Utah began connecting traffic signals across the state using a fiber optic network installed in partnership with utility companies. Today, UDOT has data from over a thousand closed-circuit cameras, and can remotely control over 80 percent of the traffic lights in the state.
- **Project:** [Intelligent Renewable Optical Advisory System \(INROADS\)](#) – TRL (Transport Research Laboratory) developed intelligent road studs that incorporated LED lighting, sensors, microprocessors, and wireless communication capabilities. Powered by built-in photovoltaic cells and/or piezoelectric panels (which generate electricity when a passing vehicle drives over the marker), these smart studs could have a range of applications. For example, they could detect vehicles and pedestrians at intersections, and illuminate to warn of danger. Smart studs could illuminate the outlines of dangerous curves on rural roads for each passing vehicle, then power down between vehicles to conserve energy.
- **Project:** [Intelligent Street Lighting](#) pilot projects have been installed along three main corridors in Glasgow, in which streetlights are only turned on in response to motion. The streetlights will also monitor sound, traffic and air pollution to provide important data to city planners.

PARKING

Parking Guidance and Information (PGI) systems, or car park guidance systems, present drivers with dynamic information on parking within controlled areas. The systems combine traffic monitoring, communication, processing and variable message sign technologies to provide the service.

ICT can utilize a variety of technologies to help motorists find unoccupied parking spaces including streetlight sensors, parking space LED indicators, and Indoor Positioning Systems (IPS). In a recent study of traffic in downtown Los Angeles, people cruising for a parking spot wasted 47,000 gallons of gas and produced 730 tons of CO₂ in one year.⁸⁰

Networked sensors and parking meters that monitor parking space occupancy would not only help drivers find that space, but would also limit the cruise for parking by [improving parking enforcement](#) thus increasing the amount of spaces available and securing what is generally a city's third-largest source of revenue.⁸¹

- **Project:** [SFpark](#) – Sensors keep drivers informed of parking availability on-the-go via text and SFpark's smartphone app. When combined with demand-response pricing, SFpark results in increased parking

⁸⁰ <http://shoup.bol.ucla.edu/CruisingForParkingAccess.pdf>

⁸¹ <http://www.citylab.com/commute/2012/03/future-intelligent-parking/1573/>

availability. “SFpark showed that demand-based pricing can improve parking availability without increasing double parking, congestion or parking citations,” said SFMTA spokesperson Paul Rose.

- **Project:** [Audi](#) recently announced that it will test self-parking technology in Somerville, MA. The technology is expected reduce the space requirement of cars in the city.⁸²
- **Provider:** [Streetline](#) – A smart parking company delivering data and advanced analytics to solve parking issues. Streetline’s services makes parking easier, leading to more efficient cities and a smaller carbon footprint.

ELECTRIC VEHICLE ENERGY MANAGEMENT

Smart technologies better allow public and private fleets to embrace alternative vehicles and fuels, including infrastructure for electric vehicle charging stations. While the majority of electric car charging occurs at home, additional infrastructure is needed at the workplace and on the road. Smart charging will vary how a vehicle is charged depending on the rates and needs of the grid. These electric vehicle smart charging stations could dynamically respond to, and interact with, electricity loads and supplies – thus potentially assisting in smoothing out the demand response curve and making more room for intermittent renewable power sources (see page 25 on renewable integration).

Similarly, battery-based energy distribution can help with grid stability efforts, fleet transitions to EVs and opportunities for alternative fueling.

- **Provider:** [Plugshare](#) – A mobile and web-based app that allows users to find and review electric vehicle charging stations. Information includes number of ports, type of charging stations, a PlugScore, photos and location information.
- **Provider:** [ChargePoint](#) – ChargePoint provides a network of charging stations to businesses and individuals.
- **Provider:** [ClipperCreek](#) – Electric vehicle equipment supplier. Sells charging stations for at-home or commercial installation.
- **Provider:** [EV Solutions](#) – Electric vehicle equipment supplier. Sells charging stations for at-home or commercial installation.
- **Provider:** [Greenlots](#) – They provide charging infrastructure and network for electric vehicles. Users can manage their payments and find charging locations through the mobile app.
- **Provider:** [Green Charge Networks](#) – Uses peak demand shaving to reduce demand charges by automatically charging or discharging its batteries. The system learns the site-specific energy load demands, and customizes the charge/discharge profile to minimize demand charges.
- **Provider:** [Siemens Versicharge](#) – Provides electric vehicle charging through the VersiCharge system. It allows the user to delay charging to off-peak times after plugging in through remote control, and is compatible with all plug-in electric vehicles.
- **Provider:** [EVConnect](#) – Electric vehicle charging as a service through monthly subscriptions that includes a commercial charging station, software, and ongoing management and maintenance. They procure and install charging stations, collect payments through monthly installments (if desired), and provide support and management over the life of the contract.

82 <https://www.audiusa.com/newsroom/news/press-releases/2015/11/audi-brings-automated-parking-to-the-boston-area>

- **Project:** [The KCP&L Clean Charge Network](#) – Kansas City bet big on electric vehicles. With only about 1,000 electric and plug in vehicles in the entire Kansas City area, Kansas City Power & Light, the area investor-owned utility, installed more than 1,000 re-charging stations. That’s as many charging points as major EV hot spots such as Los Angeles, San Francisco and Seattle.
- **Project:** [The EV Project](#) – The Idaho National Laboratory deployed over 12,000 charging units in 20 metropolitan areas. The two-year study used those units to collect data from 125 million miles of driving and four million charging events.

ELECTRIC BUSES

- **Provider:** [Proterra](#) builds and markets electric buses that can serve most transit route in the US.
- **Provider:** [BYD](#) – China has several companies developing electric buses. BYD has already decided to bring its bus to the US market. It already operates a fleet of electric crossovers in US cities as part of local carsharing services, including [200 in Chicago used by Uber drivers](#).

Waste Sector Tech Guide

ICT Applications

- **Application:** [BULK](#) is an app produced by Zero Waste Home, designed to help eliminate packaging by crowdsourcing bulk food liquid refill locations. Users are able to search, add and rate bulk locations. It also encourages community building by allowing users to share and post updates and related news.

The Sharing Economy: Avoiding the Bin

- **Website:** [Yerdle](#) is an online marketplace where users can “sell” unneeded items. Unlike sites like eBay, Yerdle users do not buy or sell items using money, but instead spend and earn Yerdle Dollars, which can be used to acquire items in the marketplace. Yerdle users ship 10,000 items every month, and 200,000 since the app launched.
- **Application:** [Spoiler Alert](#) is an app that makes it easy for companies to donate or sell surplus inventory. Available in New England, Spoiler Alert connects retailers and producers to nearby nonprofits for donation or, in the case of products that are no longer edible, companies that make fertilizer and animal feed. Notifications are sent out as soon as new inventory is listed and all transactions are recorded in the app, which makes it easier for donors to prepare tax deductions. Eight organizations participated in its pilot program earlier this year donating nearly 10,000 pounds of food.
- **Application:** [Leftover Swap](#) is an app that lets diners trade or give away their excess leftovers by taking food photos and uploading them to the database. Users looking to get rid of excess food can take a food photo and post it to Leftover’s database, while browsers can arrange a pickup or delivery.
- **Application:** [Peerby](#) is an online service that helps to connect people in specific neighborhoods who want to lend or borrow various items. Launched in Amsterdam in 2012, the service is currently available in 20 European cities and has 10 pilot projects in the works in the US. Users can browse nearby items in categories like home improvement, moving or holidays. They can also request specific items and Peerby will send out push notifications to potential nearby lenders. This year the company just rolled out a new “Peerby Go” model which offers insurance and delivery options and takes a part of each commission.
- **Application:** Bulky Basics – This app, developed as part of the 2014 Apps for Amsterdam contest, provides information on days and times bulk waste is picked up, nearby recycling facilities, and rules for bulk disposal.

Engagement and Awareness

- **Application:** [GoodGuide](#) allows consumers to determine the sustainability of a product by using their smartphone to scan barcodes and check an item's environmental impact before buying it. It features over 250,000 ratings items ranging from personal care to toys.
- **Application:** [iRecycle](#) – This app provides users with 1.6 million ways to recycle over 350 materials. The app also tells users where they may recycle items.
- **Application:** [My Waste](#) is a mobile app that cities can use to help connect with residents on waste diversion programs. My Waste includes a calendar that shows the customer's trash and recycling schedule. It also includes a search tool about recyclables and non-accepted waste and a problem report tool that enables residents to communicate directly with the waste hauler.
- **Application:** [PaperKarma](#) allows users to unsubscribe from receiving junk mail simply by taking a picture of the unwanted mail.
- **Application:** The LitterGram app in the UK allows users to report and pinpoint the location of litter. The LitterGram map then allows local councils to act on the litter and alert users about when the litter is cleaned up. The app allows for a cleaner city that also drives behavior change because it has been shown that litter attracts more litter.⁸³

Curbside Pick-up and Route Optimization Technologies

- **Provider:** [Enevo](#) uses RFID tags to provide real-time data to waste haulers and help them better plan pickup routes. Data from Enevo sensors is collected in database, which can be queried and filtered by the user for information to see when bins are getting full or if bins can be eliminated or should be added.
- **Provider:** [Grid Waste](#) is a self-service matchmaking platform that connects users' waste with removal services and recyclables with recycling services across the US.
- **Provider:** [Bigbelly](#) replaces city trashcans with solar-powered trash and recycling stations. Each station is equipped with a sensor inside. When trash reaches a certain level, the bin compacts the trash creating five times more waste capacity; when it is full, it automatically alerts the appropriate city department. In the future, Bigbelly will offer more data for customers to analyze.
- **Project:** [The Robot-based Autonomous Refuse handling \(ROAR\) Project](#), headed by Volvo, is studying how to automate waste management. The project has developed ROARY, a robot which quietly grabs refuse bins and bring them to a waiting garbage truck.
- **Application:** [eMobile app](#) allows waste haulers, like Daily Disposal, to use a custom app that routes trucks and documents trash pickup more efficiently. Rather than receiving stacks of paper each morning, drivers download the day's route onto their tablets via the eMobile app. As they work, truck-mounted tablets indicate where to stop. When drivers arrive at customers' homes, they push one of three buttons on the touchscreen: "done," "not out" or "skip."
- **Provider:** [Trimble Geospatial Solutions](#) has developed technology that tracks the type of waste being dumped, such as e-waste or hazardous waste, and where the dumpsites are located. This data helps contractors who pick up the waste to dispose of it properly.

83 <http://www.littergram.co.uk/faq>

Sorting Technologies

- **Provider:** [Blue Oak Resources](#) has created advanced processing techniques for extracting gold, silver, copper, palladium and other metals out of electronic waste. Typically, e-waste is exported and processed out-of-country due to the environmental challenges it presents. BlueOak aims to establish a U.S. network of “urban mining facilities” where the process can be controlled more closely.
- **Provider:** [The HISER Project](#) works to develop and demonstrate novel cost-effective holistic solutions for a higher recovery of raw materials from Construction and Demolition (C&D) projects. They have received funding from the European Union’s Horizon 2020 research and innovation program. The HISER project will be introducing five main innovative automated sorting and recycling technologies to the market:
 - 1. New generation of sensor-based automated sorting technologies:** Fusion of two very different optical sensor systems into one single system aims to save around 35% of costs and of energy when comparing to inline separate sensor-based sorting solutions.
 - 2. Modernized electro-fragmentation technology:** The adaptation of existing technology to the selective release of materials included in the red (adhered gypsum or insulating materials) and grey fractions (adhered particles or fibers reinforcing the concrete).
 - 3. Innovative recycling technologies for gypsum plasterboards:** Development of low-cost mobile compact equipment and advanced gypsum sorting and recycling schemes – providing high purity recycled gypsum, enabling manufacturers of gypsum building products to easily accept higher amounts of recovered gypsum from waste post-consumer products. NIR and X-ray fluorescence (XRF) sensors will be integrated in such novel schemes.
 - 4. New recycling technologies for C&D waste wood and other minor emerging waste fractions:** New cost efficient sorting technological solutions for C&D wood, glass and mineral wool waste materials. It will integrate material pre-crushing, fine crushing, sorting and cleaning into one system which separates impurities and classifies the cleaned raw material into desired fractions.
 - 5. New low-cost classification technology (ADR system):** One of the main environmental challenges in the construction industry, is strong pressure to decrease the bulk transport of construction waste in urban environments. One solution is to process waste onsite prior to transport. To achieve this goal, a new low-cost classification technology, called Advanced Dry Recovery (ADR) is being developed. ADR performs purely mechanically and in the moist state, i.e. without prior drying or wet screening. This choice reduces process complexity and avoids problems with dust or sludge.

Energy recovery technologies

- **Provider:** [Enerkem](#) uses non-recyclable municipal solid waste instead of petroleum to produce low-cost liquid transportation fuels and chemicals. Their technology chemically recycles the carbon molecules contained in non-recyclable waste and converts these carbon molecules into a pure synthesis gas, which is then turned into biofuels and chemicals, using commercially-available catalysts.
- **Provider:** [Harvest Power](#) an anaerobic digestion company processes more than two million tons of organic waste per year at its facilities, producing approximately 33 million bags of soil and mulch in the process.

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