A solutions landscape for

The Urban Infrastructure Initiative – UII

wbcsd urban

Executive summary

The World Business Council for Sustainable Development (WBCSD) Urban Infrastructure Initiative (UII) brings together 14 leading global companies to help cities identify realistic, practical and cost-effective solutions to realize their sustainability vision.

In 2012, the UII and the City of Philadelphia identified an exciting opportunity to work together, brokered by the Urban Land Institute (ULI) acting as a 'bridging organization'. This solutions landscape report presents the key outputs of this collaboration.

Under the leadership of the Honorable Mayor Michael A. Nutter, Philadelphia has become a national urban sustainability leader. Mayor Nutter has set the bold objective of making Philadelphia "the greenest city in America". To make progress towards this vision, the City has developed *Greenworks Philadelphia*, an ambitious and comprehensive urban sustainability action plan to achieve 15 measurable targets by 2015.

The UII welcomed the City's recognition of the critical role that business plays as a key solution provider and as a major stakeholder in supporting the complex transformations that are required to deliver urban sustainability.

The WBCSD and a group of seven companies (AECOM, Schneider Electric, Siemens, TNT, Toyota, UPS and UTC) active in energy, materials, technology, urban planning, mobility and logistics combined their resources to identify practical solutions. The UII team held a series of workshops and discussions with key representatives from the City administration between October 2011 and December 2012. The output from this engagement was a 'solutions landscape' focused on: integrated solutions across the challenges of urban sustainability and the specific issue of vehicle fleet management.

The UII team identified a portfolio of potential solutions to further drive efficiencies, synergies and transformational outcomes in addition to the substantial progress the City has already made. The process of developing these solutions focused on three inter-related opportunities to add value:

1. Quick wins that can be implemented in the short term and could result in measurable additional progress towards the *Greenworks Philadelphia* objectives by 2015;
2. Longer term solutions and approaches that can help lock in and scale up the successes achieved under *Greenworks Philadelphia* to achieve citywide transformation;
3. Key areas to further scale up the private sector engagement, innovation and investment in support of the City's sustainability goals.

The UII team applied the integrated solutions approach to investigate the operationalization of the EcoDistrict concept in key areas of the city.

The UII team also worked with the City's Office of Fleet Management (OFM) to identify operational and technical solutions to improve the performance, efficiency and management of the City's 6,000-plus vehicles. The solutions produced by this work focused on vehicle optimization, the use of telematics, training, and a strategy for making choices about alternative fuel technologies for different vehicle types.

This report also presents a series of infrastructure solutions for energy, energy-efficiency, water management and mobility that are relevant to the city as a whole. The subject of financing is specifically addressed, particularly new approaches to financing that can scale up the implementation of transformational solutions and encourage further innovation and investment from the private sector.

While many of the solutions presented in this report require broad-based or long-term action, there are a number of potential quick wins:

- Developing an EcoDistrict pilot as a platform to drive community engagement and sustainability transformation at a district-scale. This can further enhance the positioning of Philadelphia as a center of green technology innovation and investment for the private sector;
- Enhancing the building asset management capability of the City administration to prioritize maintenance planning and building retrofits to reach the *Greenworks* target of 30% reduction in City government energy use;
- Engaging with private and public players in the parking industry to scale up the implementation of smart parking approaches to reduce congestion and emissions and to promote investment in green stormwater infrastructure;
- Initiating a study of Roosevelt Boulevard bus rapid transit (BRT) to evaluate and rank a range of elements to optimize travel performance and walkability in the corridor;
- Investigating an integrated mobility software platform to provide travelers with real-time, personalized and localized information along the travel chain, with integrated planning, booking and payment systems for public transit, car-sharing, electric vehicles etc. This can build on substantial progress in driving modal shift and reducing vehicle miles traveled (VMT) already achieved in Philadelphia;
- Deploying fleet optimization software tools, combined with targeted use of telematics, to help the OFM improve operational efficiency and cost performance, while also reducing fuel consumption. This could be further supported by progressive deployment of alternative fuel technologies in the City's vehicle fleet;
- Organizing a funding/finance summit that provides a forum for government, government authorities, utilities, technology providers, colleges/universities, and the finance and banking communities to strategize on the future architecture of project delivery and investment to order to accelerate change.

This solutions landscape report will be of interest to many city leaders in North America who are also seeking to catalyze transformation towards a competitive, livable and sustainable future for their cities. The UII engagement with Philadelphia could serve as an example of how cities can work with business at a strategic level in a way that helps cities realize their visions, while unlocking the innovation capacity of the private sector to deliver solutions.

Introduction

City overview

Philadelphia is the largest city in the Commonwealth of Pennsylvania, the second largest on the East Coast of the United States, and the country's 5th most-populous city. It is located on the Delaware and Schuylkill rivers and is the only consolidated city-county in Pennsylvania. As of the 2010 Census, the city had a population of 1.5 million people and 680,000 jobs. Nearly 40% of the workforce is employed downtown, which places the city 3rd nationally for share of jobs in the city center.

Philadelphia is the economic and cultural center of the Delaware Valley region, home to 6 million people and the country's 5th largest metropolitan area.[1] It is prominently positioned in the northeast region, region that over the next generation is expected to grow by 26%, adding about 18 million residents.

During the 19th and 20th centuries, the city was one of the world's major industrial centers. In recent times it has shifted to an economy based on education and health, information, finance, technology, and services. Education and health activities account for the largest sector of the metro economy, and the city is one of the largest health, education and research centers in the United States. With a gross domestic product of $353 billion, Philadelphia ranks 9th among world cities and 7th in the United States.[2]

Sustainability

Under Mayor Michael A. Nutter, Philadelphia has established itself as a national urban sustainability leader. Mayor Nutter has set the objective of making Philadelphia "the greenest city in America".

Philadelphia has a number of key assets to achieve this vision. It is perceived as a desirable, vibrant place with an authentic urban form. The well-designed grid of small streets has recognized charm and function, and the city is consistently ranked as one of the most walkable cities of the United States. After decades of population loss, Philadelphia's numbers are once again on the rise. It is the economic engine of one of the largest regional economies in the world, and diverse economic sectors give the city strength across many markets, supported by excellent links with its major educational institutions.

To help realize its bold sustainability vision, the City has developed *Greenworks Philadelphia*, an ambitious and comprehensive urban sustainability action plan. *Greenworks Philadelphia* considers sustainability through five lenses – energy, environment, equity, economy and engagement. Each lens has an overarching goal, with measurable targets laid out and specific initiatives designed and described to help reach the targets by 2015 (see box 1 on page 4).

The 2013 progress report highlights that work on 95% of the 166 *Greenworks* initiatives is either complete or underway. Philadelphia has made significant progress towards its objectives, including already exceeding the target to reduce residents' driving by 10%. Municipal energy use has fallen by 7% since 2008, and alternative energy use has grown for four consecutive years to reach 14%.

The City has also taken a number of additional measures to embed sustainability within the planning agenda:

- In 2011, the Philadelphia City Planning Commission adopted *Philadelphia2035 – Citywide Vision*. This comprehensive plan provides overall policy and location guidance for future private and public investment and makes recommendations under the themes of *Thrive, Connect and Renew*. Of the nine high-level goals set by *Philadelphia2035*, seven directly relate to *Greenworks* priorities;
- The City has also adopted a new comprehensive plan and a new modernized zoning code which incorporates a number of instruments to advance sustainability in planning decision-making. In January 2013, the American Planning Association awarded the City Planning Commission the 'National Planning Award-Best Practice' for the Integrated Planning and Zoning Process.

1 US Bureau of Economic Analysis (www.bea.gov); Philadelphia Works (www.philaworks.org); (Source: www.america2050.org)

2 Ibid.

"In the United States, after decades of neglect and decline, cities are again growing, repositioning themselves as places ripe for innovation and investment. To house, move, and employ urban dwellers now and into the future, municipalities must maintain and upgrade aging infrastructure, expand economic opportunities, and improve quality of life. In recent years, many mayors have realized that sustainability is a powerful framework to address these varied responsibilities.

In order to build capacity for urban sustainability solutions and accelerate their adoption, we simply must work collaboratively. Cities need to continue to share best practices with one another while also problem solving alongside our partners in the private sector who share many of our goals. The Urban Infrastructure Initiative engagement allowed us to do just this. By bringing city staff together with representatives from WBCSD member companies to delve into specific policy and program areas, the process facilitated a two-way knowledge transfer. It proved to be a tremendous opportunity for us to share our thinking, successes and challenges in an open exchange. We came away with new ideas, benefitted from technical expertise, and gained meaningful external validation.

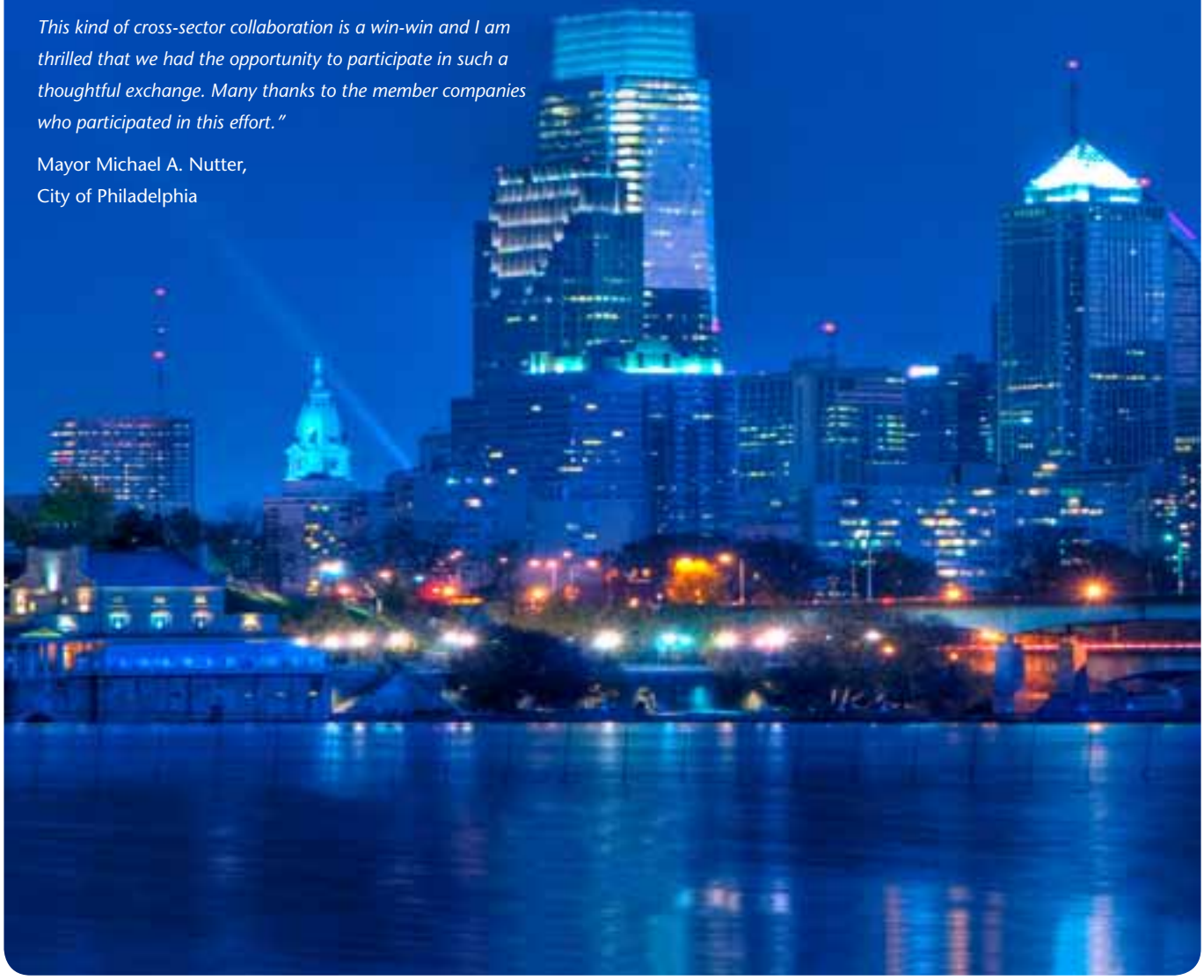
This kind of cross-sector collaboration is a win-win and I am thrilled that we had the opportunity to participate in such a thoughtful exchange. Many thanks to the member companies who participated in this effort."

Mayor Michael A. Nutter,
City of Philadelphia

"As a practitioner in a relatively young and quickly evolving field, exchange is invaluable. While I work closely with peers in other cities, there is not yet a clear infrastructure in place that brings sustainability-focused city employees together with those working on similar initiatives within the private sector. The UII presented a unique value proposition in this regard.

We have already begun to advance work around opportunities identified as part of the engagement. Beyond receiving highly valuable technical assistance and advice, the UII helped us to establish relationships with business that we can now continue to develop."

Katherine Gajewski, Director of Sustainability,
City of Philadelphia



Box 1: *Greenworks Philadelphia* targets

Target 1 Lower City Government Energy Consumption by 30 Percent.

Target 2 Reduce Citywide Building Energy Consumption by 10%.

Target 3 Retrofit 15% of Housing Stock with Insulation, Air Sealing, and Cool Roofs.

Target 4 Purchase and Generate 20% of Electricity Used in Philadelphia from Alternative Energy Sources.

Target 5 Reduce Greenhouse Gas Emissions by 20%.

Target 6 Improve Air Quality toward Attainment of Federal Standards.

Target 7 Divert 70% of Solid Waste from Landfill.

Target 8 Manage Stormwater to Meet Federal Standards.

Target 9 Provide Walkable Access to Park and Recreation Resources for All Philadelphians.

Target 10 Provide Walkable Access to Affordable, Healthy Food for All Philadelphians.

Target 11 Increase Tree Coverage Toward 30% in All Neighborhoods by 2025.

Target 12 Reduce Vehicle Miles Traveled by 10%.

Target 13 Increase the State of Good Repair in Resilient Infrastructure.

Target 14 Increase the Size of the Regional Clean Economy by 25%.

Target 15 Philadelphians Unite to Build a Sustainable Future.

Collaboration with the Urban Infrastructure Initiative

The WBCSD UII brings together 14 leading global companies from sectors including energy, buildings, materials, transport, engineering, water, equipment, and support services to help urban authorities develop realistic, practical and cost-effective sustainability action plans.

The UII is partnering with cities around the world, including Guadalajara (Mexico), Kobe (Japan),Turku (Finland), Tilburg (the Netherlands), Yixing (China), and four cities in the state of Gujarat (India). The UII is working with these cities to demonstrate the value of the early involvement of business in sustainability and infrastructure planning and to show how a multi-sector group of leading companies can assist cities in finding solutions to complex, interconnected challenges.

The collaboration with the City of Philadelphia was brokered by the Urban Land Institute (ULI), acting as a 'bridging organization'. ULI is a nonprofit research and education organization supported by its members, representing the entire spectrum of land-use and real estate development disciplines working in private enterprise and public service. A multidisciplinary real estate forum, ULI facilitates an open exchange of ideas, information, and experience among industry leaders and policy makers dedicated to creating better places.

The UII Philadelphia team – a group of seven companies (AECOM, Schneider Electric, Siemens, TNT, Toyota, UPS and UTC) and the WBCSD – held an initial meeting with the City and ULI in October 2011, which identified the opportunity to work together. An 'issues landscape' workshop held in March 2012 explored the range of sustainability issues and challenges facing the city and provided additional details on the objectives and implementation of *Greenworks Philadelphia*. This meeting identified the possibility of the UII exploring integrated solutions or the 'bundling' of initiatives to achieve efficiencies, synergies and transformational outcomes.

A further meeting in May 2012 explored one potential opportunity area in more detail – the strategic opportunity to further drive sustainability transformation through the management of the City's vehicle fleet.

The UII team worked with the City from August to December 2012 to further understand the issues at stake and to develop the solutions landscape. A series of facilitated workshops and interviews were held with City department and agency heads and key technical staff. In addition, several field reconnaissance visits to subject locations helped to deepen the understanding of local conditions and informed the recommendations.

Process

The project landscape evolved over several months through a series of discussions between the City and the UII team.

As Philadelphia already had a well-developed sustainability strategy with detailed plans, a relatively lengthy scoping phase was necessary to identify specific areas of added value. The Mayor's ambition for Philadelphia to be the greenest city in the country motivated staff to explore the potential of working with the UII and to find opportunities for valuable collaboration.

The Mayor's Office of Sustainability identified fleet management as a specific topic where business involvement could help to stimulate progress. The UII responded to this proposal and the process of identifying how to develop a more sustainable fleet built the confidence necessary to engage on the broader sustainability agenda.

The potential to do so emerged from the initial exploration of the fleet management challenge, which involved conversations with economic development, finance and other staff, as well as the Office of Fleet Management. These contacts helped to build relationships and led to the opportunity to investigate urban planning and economic development considerations – the broader context for the City's specific projects. As the work developed, the concept of integrated solutions became the overarching approach, with individual streams focusing on EcoDistricts, infrastructure and mobility, as well as fleet management.

Extensive interaction between the UII and the City was essential to achieving the project goals, and the team found City staff to be extremely open and cooperative. These interactions built a solid understanding of the challenges which could not be achieved purely by desk research and analysis of official documents and reports.

Importantly, the continuing interactions both within the UII team and with the city were crucial in building trust and common understanding between the transformation team members and between the UII and the City. Working together on specific program areas allowed the City to share its thinking and resulted in a two-way knowledge transfer.

Lessons learned include:

- Time is needed to build a shared understanding of issues, approaches and opportunities;
- The public and private sectors often use different language to describe challenges and think about solutions. Finding a shared vocabulary is important;
- The engagement was a unique opportunity for the City to share its thinking with the private sector and increase mutual understanding. It allowed for the open exploration of options and testing of potential solutions in an interactive process;
- Openness is essential on all sides to achieve valuable outcomes;
- The UII team members learned from each other as well as from the City;
- City sustainability challenges are closely interconnected and require holistic solutions.

Integrated solutions

By 2050, more than 70% of the global population will live in cities, up from 50% today. Cities already consume up to 80% of global materials and energy supplies and produce around 75% of carbon emissions.[3] Furthermore, the concentration of people, resources, and infrastructure in cities is also making societies more vulnerable to disasters and the adverse impacts of climate change.

However, cities are also central to the necessary transformation to an inclusive green economy and to sustainable development. Cities will increasingly generate the majority of economic output, and are the primary centers of technological and social innovation. They provide the platform for much more efficient economies and societies. Compact cities with mixed-use urban form are more resource-efficient than any other human settlement pattern for a given level of economic output.

Integrated planning and urban design are fundamental to fostering thriving communities and dynamic urban economies that are resource and energy efficient. Operationalizing these plans will require new infrastructure services that simultaneously provide energy-efficient buildings, access to efficient, low-impact mobility, as well as affordable and reliable low-carbon energy, water and wastewater services. These services can be made more responsive, efficient and resilient through the use of technology that will also increasingly capture the efficiencies and synergies of integration of these infrastructure systems.

These transformations will be expedited through engagement with all sectors of the business community, providing locally appropriate solutions to a city's challenges and underpinning the broader transition to a green urban economy.

The opportunities for Philadelphia

These opportunities are particularly relevant to Philadelphia. As in many urban areas across North America, the city is experiencing a comprehensive resurgence of urban life, driven by changing demographics – people who prefer city-living, mass transit, parks, quality schools, and walkable urbanism – and further fostered by policies to encourage compact redevelopment and vibrant communities.

The City of Philadelphia is making sustainability the engine of this urban transformation and working toward the bold ambition of becoming the greenest city in America. This ambition is being turned into a reality through the flagship *Greenworks Philadelphia* sustainability plan, the *Philadelphia2035* plan, and the new zoning code.

This has created a highly promising platform to encourage and scale integrated approaches and drive sustainability transformation both district-wide and citywide. Integrated thinking is already clearly evident in the City's leading programs in sustainable urban planning, energy-efficiency, mobility and green infrastructure.

The City is also seeking to catalyze the dynamic linkage with the building of the local green economy, for example through support to the Navy Yard Clean Energy Campus and the National Energy Efficient Buildings (EEB) Hub. Through the Philadelphia Industrial Development Corporation (PIDC), the city is positioned as a center for the development and deployment of clean technologies, with sustainability programs providing an additional platform for the coordination of investment and innovation.

Furthermore, the City has already begun a planning process to address the cross-cutting challenge of climate change adaptation and resilience. The City aims to publish a climate adaptation plan in 2014, with progress in key areas made by 2015. Hurricane Sandy made landfall in the area October 2012 during the course of the UII collaboration, bringing to the forefront already important concerns about climate change, adaptation and resilience for US cities and transforming the discourse on both public and private investment risks. The lessons from Hurricane Sandy will require a fundamental and integrated rethinking of planning, land-use, and the design and operation of critical infrastructure.

3 United National Environment Programme (UNEP) (2012) *Sustainable, Resource-Efficient Cities – Making it Happen!* Available online at: www.unep.org/urban_environment/PDFs/SustainableResourceEfficientCities.pdf

Figure 1: Philadelphia initiatives and plans to drive urban sustainability.

What is the role of business?

Business plays an essential role in the transformations required to achieve urban sustainability. The key infrastructure, technology and financing solutions that will support the sustainable visions and strategies of cities are predominantly developed, designed and implemented by business. Businesses acting collectively can bring wide-ranging expertise from different sectors to help cities understand complex cross-sector challenges. They can support the development of integrated approaches and holistic solutions needed to drive sustainable urban development in practice.

In addition, business can bring a number of key attributes to assist public officials and citizens with making more-informed decisions. These include:

- Knowledge of the opportunities, benefits, limitations and risks of new technologies that are often central to integrated approaches;
- Understanding the new finance and delivery models to scale private investment and to enable the implementation of complex, multifaceted projects and programs;
- Awareness of best practices from the private sector and solutions that have worked in other locations.

The UII was developed specifically to provide a platform to mobilize the capabilities of a multi-sector group of leading businesses to help cities identify new and complementary solutions to accelerate progress towards their sustainability goals.

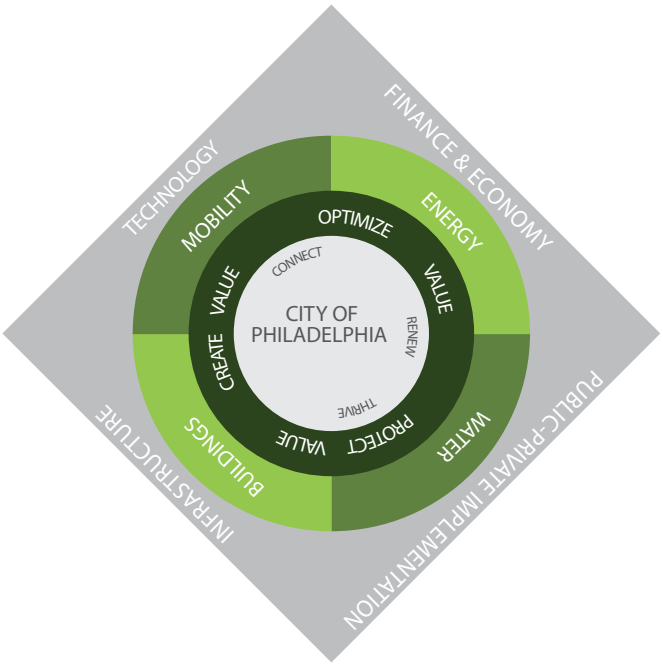
UII Philadelphia team approach

Building on Philadelphia's substantial portfolio of existing initiatives and programs, the UII team sought to identify opportunities to use integrated approaches to drive efficiencies, synergies and transformational outcomes toward the City's sustainability goals. The process of scanning for and developing these solutions focused on three inter-related opportunities to add value:

1. Quick wins that can be implemented in the short term and could result in measurable additional progress towards the *Greenworks Philadelphia* objectives by 2015;
2. Longer term solutions and approaches that can help lock in and scale up the successes achieved under *Greenworks Philadelphia* to achieve citywide transformation;
3. Key areas to further scale up private sector engagement, innovation and investment in support of the City's sustainability goals.

To help structure the analysis, the UII team used the conceptual model presented in figure 2. The analysis focused on four primary urban domains: buildings, energy, water and mobility; enabled by technology, finance and economy, infrastructure, and public-private implementation. Working together these parts generate outcomes that connect, renew and thrive – the key themes of *Philadelphia2035*.

Figure 2: Integrated analysis framework



Source: AECOM

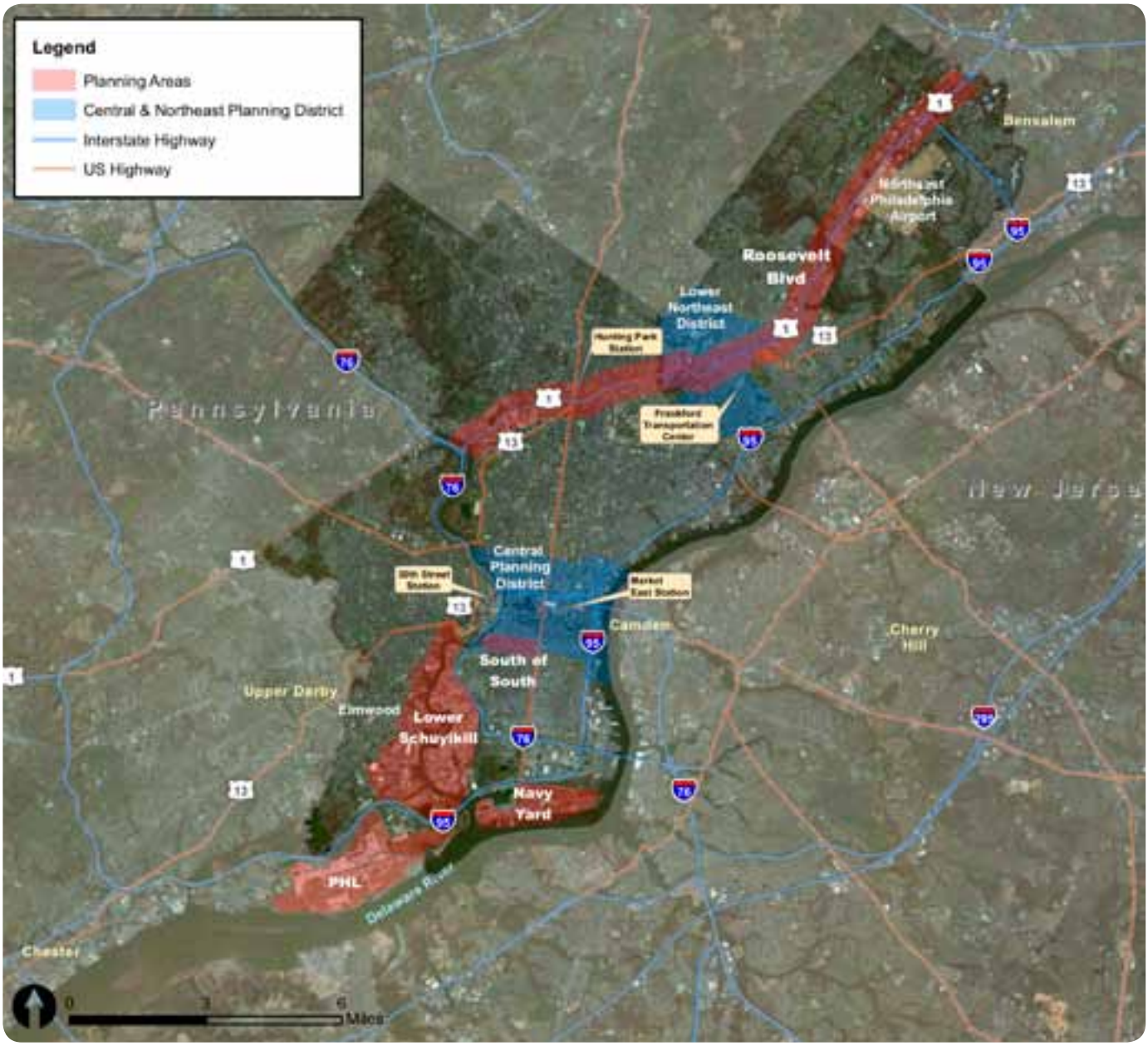
This integrated approach seeks to transcend operational silos and bundle solutions in a way that allows the market drivers of technology innovations and collaborative decision-making to flourish.

The UII analysis and recommendations are synthesized in this report, organized by the following sections:

- **Place-based approaches** focused on driving district-scale sustainability in Philadelphia, providing a platform for broad-based stakeholder engagement and the integrated deployment of sustainable infrastructure and mobility solutions;
- **Infrastructure solutions** to enhance the sustainability performance of core urban infrastructure – buildings, energy, water management and streets – with specific consideration of how these approaches can be moved forward in Philadelphia;
- **Mobility solutions** to enhance public and private mobility and connectivity within Philadelphia with a focus on the opportunities for technology to enhance the performance of existing infrastructure and systems;
- **Financing** – identifying effective public-private mechanisms and greater collaboration between and among the public and private sectors;
- **Fleet management** – applying private sector practices to support improvements in the performance and efficiency of City vehicle fleet management.

For each solution, the key considerations are identified along with next steps and quick wins, i.e. impactful actions that could be implemented by 2015. The relevant *Greenworks* objectives to which the solution will contribute are also identified.

Figure 3: UII study focus areas



Source: AECOM

Place-based approaches

Overview

Place matters. The UII team employed a cross-cutting, place-based strategy designed to improve the impact and effectiveness of investments. The UII team examined the assets, attributes, resources, and location profile, and considered how government, business, industry, nonprofits and other stakeholders can work together in these areas.

Figure 3 indicates the location of three focus areas that are quite diverse in their form and land-use yet have the advantage of being close to each other. The UII team considered the potential to create EcoDistricts in the Lower Schuylkill and Navy Yard complex, as well as the applicability of the Aerotropolis model to Philadelphia International Airport (PHL).

Additionally, the team investigated the central downtown core, with an array of potential community revitalizations in the form of transit oriented development (TOD), parking reform, complete streets, stormwater management, energy-efficient buildings, and sustainable mobility. The team also considered the 30th Street Station area anchored by the historic Amtrak station building and the Market East area near the Southern Pennsylvania Transportation Authority (SEPTA) station. The scale and attributes of the South-of-South neighborhood make it a preferred location for an array of integrated measures aimed at parking reform, complete streets with green infrastructure, and walkability improvements.

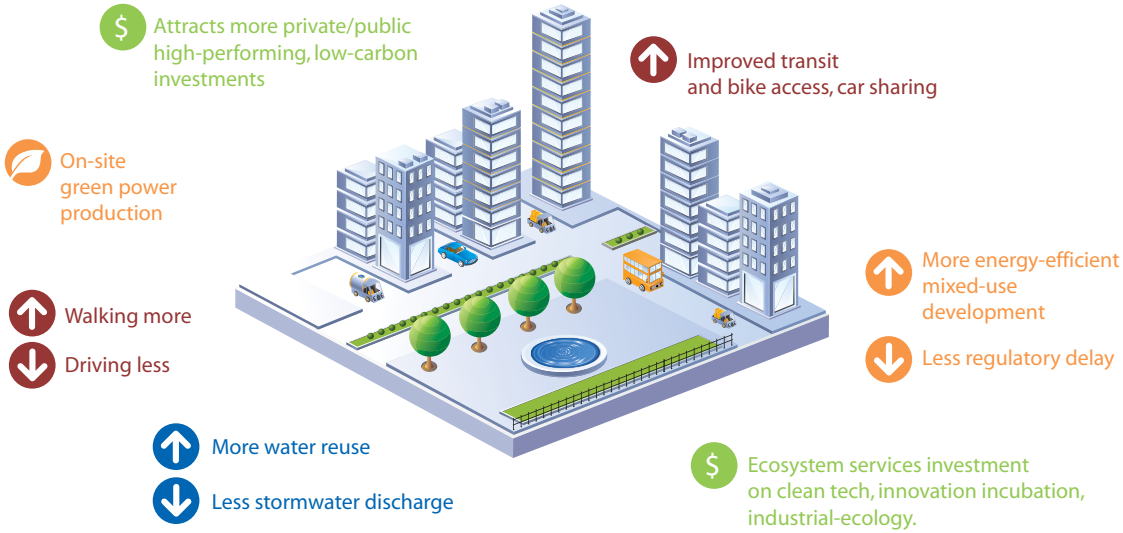
EcoDistrict

An EcoDistrict is a neighborhood or district with a broad commitment to accelerating neighborhood-scale sustainability (see figure 4). It is a comprehensive, place-based strategy to accelerate low-carbon and sustainable development activities at the neighborhood scale by integrating water, energy, buildings, and mobility initiatives with community programs, utility providers, businesses, community leaders, and individual action. EcoDistricts commit to achieving ambitious sustainability performance goals, guiding district investments and community action, and tracking the results over time. This approach is based on the potential for performance-based management to improve competitive advantage, communities and quality of life.

Detailed investigation and eventual piloting of the EcoDistrict concept should be of interest to the City for a number of reasons including:

- ***Greenworks* objectives.** The EcoDistrict model presents an integrated platform to advance most or all of the *Greenworks* targets at a district-scale;
- **Engagement with business.** The EcoDistrict model presents an excellent platform to scale up business engagement in urban business innovation and delivery capacity. EcoDistricts promote opportunities to deploy and demonstrate new green and smart infrastructure technologies. The EcoDistrict model often requires the development of district-scale utility schemes, which are likely to require public-private financing models in the US context.[4]

Figure 4: EcoDistrict



Source: AECOM

Box 2: North America EcoDistricts – best practice examples

- **SW EcoDistrict, Washington, DC**
- **Brooklyn Living City Block, New York, NY**
- **Capitol Hill EcoDistrict, Seattle, WA**
- **Lloyd and SoMa EcoDistricts, Portland, OR**
- **Central Corridor, San Francisco, CA**
- **Edmonton Airport, CN**
- **FortZED – the Fort Collins Zero Energy District, CO**

Potential locations

There are several areas across the city currently slated for renewal, redevelopment, and investment. The potential exists to pilot an EcoDistrict model in these areas incorporating district-wide heating and cooling, water and waste management, multimodal mobility, streetscape and public realm improvements, and public-private partnerships.

To help advance City thinking in this area, the UII team investigated two areas that could represent prime opportunities to deploy a pilot program – **the Lower Schuylkill district** and **the Navy Yard**.

The UII focused on these areas because business could play a leading role in supporting the establishment of an EcoDistrict in these locations, and both are prospective locations for active clean-technology cluster development.

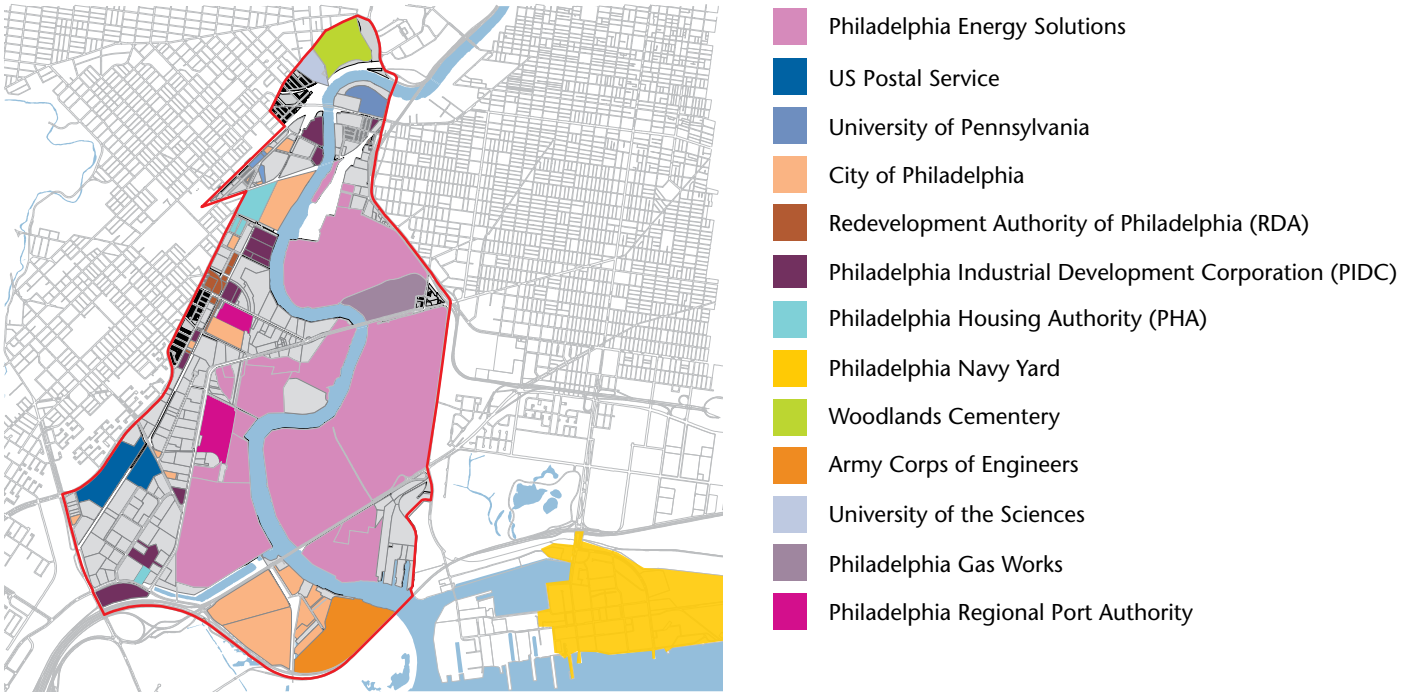
The nearly 4,000-acre **Lower Schuylkill district** (figure 5) is close to the Central District, University, Navy Yard, and airport. Historically the district was an industrial corridor along the east and west banks of the Lower Schuylkill River. The area is well-situated at the riverfront with excellent transport connections.

There is an existing public-private collaboration around the Lower Schuylkill Master Plan, which establishes a basis for incorporating redevelopment and sustainability within an EcoDistrict model. This collaboration involves the Philadelphia Industrial Development Corporation (PIDC), the Philadelphia City Planning Commission, and the City of Philadelphia, in association with local businesses and residents.

The UII team sees that the Lower Schuylkill district could be suitable for a clean technology incubation space, industrial ecology, and integrated economic renewal programs. There is a swath of underused and City-owned property abutting the riverfront between streetcar and heavy rail lines. The redevelopment of this district also provides an opportunity to enhance the city's green footprint by significantly expanding the Schuylkill River Trail, enhancing public access to green and recreational amenities, integrating progressive stormwater and flood management systems, and identifying potential wetlands mitigation sites.

4 Portland Sustainability Institute *Financing an EcoDistrict* (2011)

Figure 5: Lower Schuylkill District and the Navy Yard



Source: Philadelphia Industrial Development Corporation and Penn Praxis

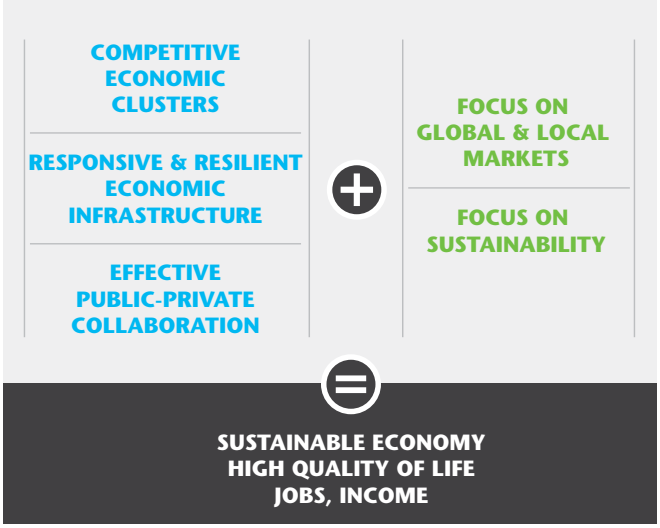
The **Navy Yard** is another obvious location for an EcoDistrict project. It is currently home to more than 130 companies and 10,000 employees in the industrial, manufacturing, and research and development sectors. The updated master plan for the area involves the development of 1,000 rental units in the near future. From a sustainability perspective the Navy Yard has a number of existing attributes that could anchor the establishment of an EcoDistrict:

- Integration of sustainability into the area's master plan, with a vision that includes environmentally friendly workplaces, notable architecture, industrial development, great public spaces, waterfront amenities and improved mass transit;
- Home of the National Energy Efficient Buildings (EEB) Hub and a growing collection of LEED-certified buildings;
- Home to the Center for Distributed Power consortium and the site of the largest urban solar power generation facility in the US;
- Scope for up to $3 billion in private investment at full build out.

Clean-technology cluster development

These potential EcoDistrict developments could be additional catalysts for clean economic and technology solutions and in scaling up emerging local clean-technology clusters. Clustering is an industrial formation model (figure 6) based on co-location/proximity. It is a process that enables the participants to exploit synergies and the complementarities between their product outputs. Benefits to the district area could include knowledge transfer, sharing infrastructure and utilities, job creation, preservation of connectivity along the value-chain, and community renewal.

Figure 6: Clean-technology clusters: core components



Source: AECOM

The UII team believes that clean-technology clusters could define Philadelphia's low-carbon future, with tremendous opportunity to drive economic growth. According to Ernst & Young's second annual global survey of cleantech adoption (2008-2009), three-quarters of major global corporations plan to increase clean-tech budgets from 2012 to 2014. The clean energy market, in particular, is projected to grow dramatically in the next decade. Environmentally friendly technology is a vital part of business enterprise and a rapidly growing market driven by huge global demand.

Energy-efficient solutions and technologies offer a three-fold advantage to Philadelphia. They benefit businesses and boost their own success through low energy costs and higher productivity. They benefit future generations by helping to preserve and improve their environment. And lastly, they benefit business economic development by helping companies tap attractive markets, generate family-wage jobs and contribute to the local fiscal balance sheet.

Issues/considerations

- The EcoDistrict can be focused within a single location or multiple sites that are functionally and operationally unified. The EcoDistrict model integrates multiple redevelopment and technology solutions toward sustainable objectives.
- Local involvement of the community and business underpins successful execution.

Next steps & quick wins

- Formulate goals and objectives for an EcoDistrict model in Philadelphia.
- Integrate consideration of the EcoDistrict model with ongoing master planning, revitalization and economic development activities; explore opportunities with PIDC, relevant City departments and community stakeholders.
- Prepare feasibility assessment for locating an EcoDistrict pilot.
- Interface with technology companies and explore opportunities for demonstration/pilot projects.
- Prepare a business plan that describes project delivery.

Greenworks Philadelphia objectives

- Target 1 : Lower City Governement Energy Consumption by 30%.
- Target 2: Reduce Citywide Building Energy Consumption by 10%.
- Target 4: Purchase and Generate 20% of Electricity Used in Philadelphia from Alternate Energy Sources.
- Target 5: Reduce Greenhouse Gas Emissions by 20%.
- Target 6: Improve Air Quality toward Attainment of Federal Standards.
- Target 7: Divert 70% of Solid Waste From Landfill.
- Target 8: Manage Stormwater to Meet Federal Standards.
- Target 13: Increase the State of Good Repair in Resilient Infrastructure.
- Target 14: Increase the Size of the Regional Clean Economy by 25%.
- Target 15: Philadelphians United to Build a Sustainable Future.

Aerotropolis

The UII team also explored another placed-based approach specifically focused on Philadelphia International Airport (PHL). PHL is one of the largest economic engines in Pennsylvania. The Commonwealth's Aviation Bureau reported that the total economic impact of direct spending and the multiplier effect of that spending made by PHL was already $14 billion in 2011.

The 'Aerotropolis concept' links the connectivity and economic dynamism of PHL with planned urbanization to create high-value, attractive and sustainable environments. This approach was specifically proposed for Philadelphia by John Kasarda, the creator of the Aerotropolis concept, who met with leaders, stakeholders and airlines as part of the most recent PHL master planning process. Mayor Nutter and his commissioners of transportation and utilities are supportive of this approach, and the Deputy Mayor for Transportation and Utilities is currently planning to advance the development of the concept further.

The Aerotropolis concept requires the development of a unified strategic land-use and mobility plan and a viable yet flexible real estate vision. It is aimed at the potential economic development opportunities linked to the international connectivity of the airport as well as the localized benefits associated with the development of the airport as a component of the local community/city. This vision must create an adaptive framework for the translation of sustainable systems into a vibrant commercial and industrial hub. This will help realize the latent value of the airport land, create ongoing income streams and support the development of non-aviation land assets.

The UII team supports actions to complement the economic development potential of the Aerotropolis with the opportunity to drive district-scale sustainability. The Aerotropolis concept could include these elements:

- **Greenhouse gas emissions reduction and energy-efficiency.** Opportunities for community energy systems, on-site renewable energy production, transit oriented development (TOD) and energy conservation goals. This could also include participation in the global Airport Carbon Accreditation program[5] along with *Airports Going Green*.[6]
- **Sustainable infrastructure.** Investment in infrastructure in a manner that considers material reduction, utility coordination, green stormwater infrastructure, site lighting, local and recycled materials, low-toxic materials and materials reuse.
- **Transportation and connectivity.** Promotion of access to the site via public transit, air, and rail to maximize efficient movement of goods and people and promote economic activity between PHL and downtown, the Navy Yard, and Lower Schuylkill.
- **On-site mobility.** Automated people movers (APMs) are one of the key components supporting the expansion of the airport, connecting the proposed ground transportation facility with the terminal complexes and also providing a connection between the anticipated terminals. The APM connections can offer a more direct and seamless ride and relieve congestion on airport roads by controlling the number of private automobiles and buses. This will assist in mitigating the increase in vehicle miles traveled and help improve air quality.

Issues/considerations

- The PHL multi-billion dollar modernization program has the opportunity to integrate several sustainability measures, and incorporate an economic development program based on the formation of a dynamic Aerotropolis.

Next steps & quick wins

- Formulate a vision statement for the PHL Aerotropolis.
- Engage the real estate community, property owners, and business in shaping a framework for Aerotropolis.
- Conduct an airport sustainability audit and test applicability of best practices drawn from global and national examples. For example, the Chicago area airports are practice leaders in sustainability guidelines, reporting, and implementation (see www.airportsgoinggreen.org).
- Prepare PHL Sustainability Manual with measurement and reporting; require performance in contracts.
- Examine smart parking and advanced optimized parking with green design in building facilities.
- Examine renewable energy sources on-site.
- Review energy needs and test viability of micro-grid, islanding, and other alternate energy generation installations.
- Examine ways that PHL green strategy and APM can function as a stepping stone to broader phasing of Aerotropolis.

5 http://www.airportcarbonaccreditation.org
6 http://www.airportsgoinggreen.org

Transit oriented development

Specific elements of urban design – such as transit, biking, walking, mixed-use development, density, and multi-functioning open spaces – are increasingly being used to promote low-carbon cities. Transit oriented development (TOD) is a pivotal integration strategy to drive these outcomes. In general, TOD involves the following components:

- Development around transit that is dense and compact, at least relative to its surroundings;
- A rich mix of land-uses – including housing, work and other destinations – creating a lively place, reducing travel requirements and balancing peak transit flows;
- A great public realm, including sidewalks, plazas, bike paths, and buildings that address the street at ground level.

TOD is already a key planning and redevelopment strategy being employed in Philadelphia. The UII team recommends that the majority of the integrated solutions described in this document be further supported by the wide-spread application of the TOD approach. For example, when implemented within a TOD, an EcoDistrict can enhance the sustainability objectives and leverage efficiencies achieved in resource exchanges between buildings and places created by urban landscapes.

As part of the UII study, the team inspected new TOD areas in the city. Both the existing 30th Street TOD and emerging new station area TOD at Market East will invigorate each area and offer new opportunities to provide benefits and amenities to residents and visitors.

In addition, the 30th Street Station offers several opportunities to collaboratively formulate a unified but modular master plan vision with the consortium of Drexel University, Brandywine Realty and Amtrak, in coordination with the City's efforts for the area. This could include assessing the potential for development of air rights above the rail yards and surrounding neighborhoods.

Box 3: Aerotropolis concept

Source: AECOM

Infrastructure

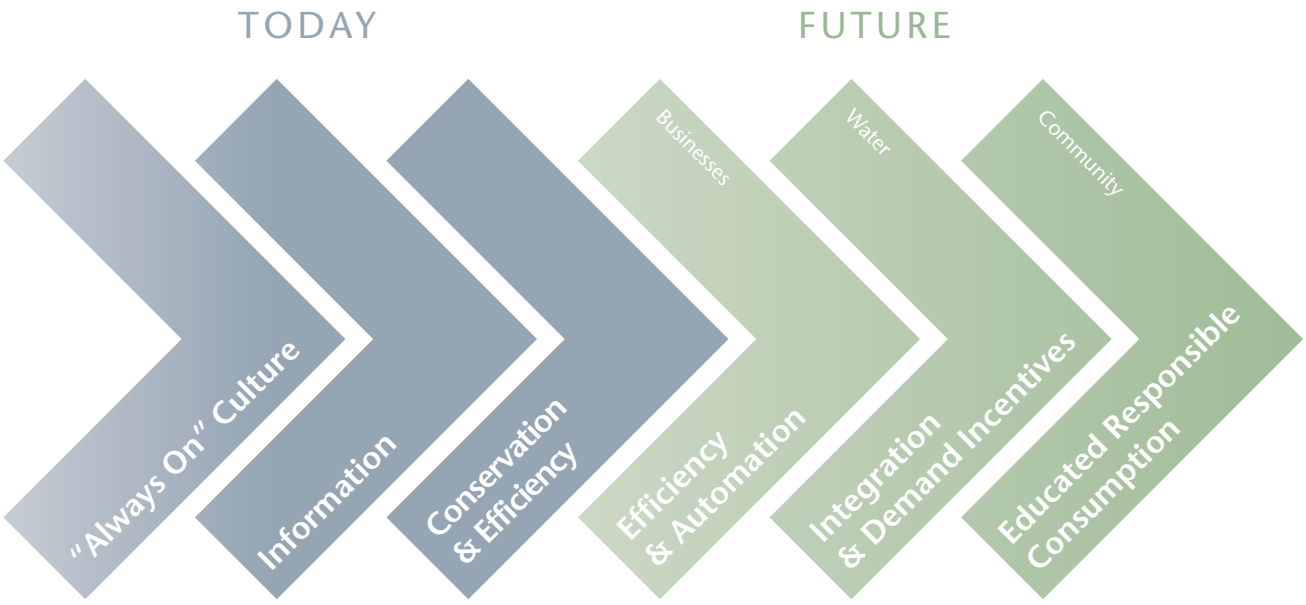
The infrastructure elements that are required in an EcoDistrict are also applicable to other areas of the city where improvements can be made, including energy, water and wastewater, and making the city's streets more accessible to all transport modes. The interconnections can be seen between energy, water and wastewater, and the holistic complete streets approach.

Smart grids

A smart grid is an electrical grid that uses information and communications technology to gather and act on information (particularly the behaviors of suppliers and consumers) to improve the efficiency, reliability, economics, and sustainability of the production and distribution of electricity. Smart grids are not just about infrastructure modernization. They can bring awareness, education and responsibility to resource use, transforming communities and driving innovative new approaches to energy delivery (see figure 7).

The future design of cities is changing to interconnected collections of districts with sustainable and resilient local energy delivery infrastructure. The use of smart grids in this context will make maximum use of renewable and distributed resources (e.g. solar photovoltaic, small wind installations, small engines, combustion turbines and fuel cells). It can also support great stability and reliability, enabling the grid to gracefully degrade in managed predictable layers of demand priority. Reliability is a pertinent concern for Philadelphia. Most grid failures begin at the distribution level of electricity service, where they are most fragile and at risk from physical disruptions.

Figure 7: Community transformation through smart grids



Information, automation, integration, and education as a framework

Source: Leverage Service @ Siemens

The average outage duration in the city is one hour and is climbing (in the metropolitan regions of Canada and Europe it is less than 10 minutes and improving).

The smart grid concept can help Philadelphia achieve its *Greenworks* targets and establish an evolvable legacy for the community. The first stage of this is to create a design guideline and examples for the City, potentially within the context of an EcoDistrict development. For example, the Navy Yard's existing energy system embodies much of what can be used as a model for demand response management; participation in the local wholesale electricity market (PJM, a regional transmission organization); local operation; and integration of renewable energy resources.

Most current Department of Energy (DOE) American Recovery & Reinvestment Act (ARRA) projects have supported elements of this model. PECO DOE project being implemented locally specifically addresses metering, two-way energy consumption, information exchange, and automation of the grid under its current form. The PJM market already allows the bidding of demand resources into forward markets. The basics are therefore in place to establish a smart grid model at the district level in Philadelphia.

Elsewhere in North America, utilities in conjunction with their city, state, and community leaders have chosen to demonstrate the advantages of a collaborative district-scale model. One example is the Kansas City Power and Light "Green Impact Zone" DOE demonstration project, which aims to establish a more sustainable and revitalized district in urban Kansas City.

We propose identification and focus on selected high-value and high-visibility areas as examples around which a design guide can be developed as a model for sustainable EcoDistricts. The suggested areas in this report – the Navy Yard, Lower Schuylkill and the Aerotropolis – could provide these examples. The design guide would outline a plan for which a budget could be determined and a staged implementation schedule prepared for consideration by the City. It would embody a vision, characterize district 'types', and verify the viability of implementation with a transformation plan for districts of differing specific needs. This would include (at a minimum):

- Local renewable and distributed generation capacity;
- Local demand response capacity;
- Aggregated district consumption metering and resolution with utility metering;
- PJM market participation coordination and settlement;
- Local monitoring and, potentially, operational control of the district;
- Layered levels of demand reliability priorities for graceful degradation of supply and utility relief under extreme conditions (resilience);
- Integration with local utility operations.

The UII team recommends establishing design discussions with the local utilities and district stakeholders on definition and design.

Issues/considerations

- Smart grid development as part of wider EcoDistrict design(s) should be performed in conjunction with the City's key stakeholders and partners. This will require a coordinated effort between the utilities, City government, state regulators, the community, and supporting vendors.
- Funding for the design stage will support the definition of functional, technical and financial options for the generalized design approach as well as the selected example areas. Funding for the EcoDistrict implementation should be considered, noting that options may exist for performance contracting that mitigates the financial burden and pays back through benefits achieved.

Next steps & quick wins

- Develop a smart grid deployment model to be used as a reference for varying forms of EcoDistricts.

Greenworks Philadelphia objectives

- Target 1: Lower City Government Energy Consumption by 30%.
- Target 2: Reduce Citywide Building Energy Consumption by 10%.
- Target 4: Purchase and Generate 20% of Electricity Used in Philadelphia from Alternate Energy Sources.
- Target 5: Reduce Greenhouse Gas Emissions by 20%.
- Target 13: Increase the State of Good Repair in Resilient Infrastructure.
- Target 14: Increase the Size of the Regional Clean Economy by 25%.

Buildings

Overview

Buildings account for more than half of citywide energy use and are the leading source of greenhouse gas emissions in Philadelphia. In response, the City has made energy-efficiency in buildings a core focus of the *Greenworks* program – through focusing both on the City's own building stock (*Greenworks* target 1) and the city as a whole (*Greenworks* target 2). Philadelphia has already made substantial progress:

- **Municipal buildings.** Significant reductions in energy use and greenhouse gas emissions have been achieved since 2009 through lighting upgrades, energy-efficiency capital investments, and energy load management. An Energy Efficiency Fund has been established to fund energy-efficiency projects for City facilities on a competitive basis, with 25 projects already supported. Databases to track municipal properties and energy use have been established. A preventive maintenance staff of 16 has been hired by the Department of Public Property. The City has commissioned its first LEED-certified building with four more under construction;
- **Citywide.** The City has encouraged green building construction and retrofits, rapidly improving in the US Environmental Protection Agency (US EPA) ranking of green buildings in large US cities.[7] It has incorporated incentives for LEED Gold or Platinum certification in the new zoning code. In 2011, the EnergyWorks revolving loan fund lent more than $12 million, leveraged more than $142 million to upgrade 660,000 square feet of space. The City has also established new energy benchmarking legislation aimed at monitoring energy and water use in large commercial buildings.

Since 2011, Philadelphia has been the home to the National Energy Efficient Buildings (EEB) Hub, a public-private consortium supported by the US DOE. Located in the Navy Yard, the Hub seeks to reduce energy consumption in Philadelphia's buildings, including private and public office buildings, retail and food stores, warehouses, hospitals, and schools. Some 270 buildings in the city have already become paragons for energy savings through the activities of the EEB Hub.

Strategy

Building on Philadelphia's existing accomplishments, the UII has sought to provide recommendations for achieving a 30% reduction in City government energy consumption by 2015.

The focus is on data collection and management to support decision-making, especially in the following areas:

- **Asset management.** The UII recommends that Philadelphia continue to populate, analyze, and expand asset databases to provide data on the cost of operations and maintenance by building. City databases could include building attributes that could eventually be used as inputs for maintenance optimization and retrofit resource allocation;
- **Maintenance and retrofits.** Sound data and optimization software tools can guide a regular maintenance and retrofit investment schedule within a building or across a portfolio of buildings. By combining improved asset management capabilities and the recruitment of a dedicated preventative maintenance team, the City could pursue a program of priority energy-efficiency improvements;

  A work order management system that tracks the condition, maintenance and cost of operations for all buildings will provide useful data to target maintenance, upgrades and replacements. Priority actions will likely focus on investing in insulation and airflow in buildings to maximize energy-efficiency and minimize waste and leakage;
- **Building automation.** Automation can be as simple as scheduling lighting and heating, ventilation and air conditioning (HVAC) services, or as complex as a building management system that optimally controls a campus of buildings and is linked to other systems, including safety, security and transportation. Building management systems reduce operating costs with building control, energy performance monitoring, visualization, and reporting.

7 The US Environmental Protection Agency's (EPA) 2012 ranking of the number of green buildings in major cities lists Philadelphia at 11th in the list of top 25 cities. The city was ranked 24th in 2009. The 174 Energy Star certified buildings in Philadelphia resulted in US$ 26.7 million in savings.

Asset management

Philadelphia has already made a substantial investment in a property assessment system. The City has additional interest in databases for asset management and utility tracking of City-owned buildings. The Mayor's Office of Sustainability has compiled all utility bills into a commercial, cloud-based database (HARA) to measure greenhouse gas emissions and carbon footprints. Steps are underway to benchmark by building types (e.g. fire stations). In the private sector, commercial buildings larger than 50,000 square feet are required to benchmark and disclose their use of energy and water annually using the EPA's Portfolio Manager.

In the face of limited resources, Philadelphia should continue to establish a baseline for the performance of buildings by continuing to populate, analyze, and expand asset databases. The City will benefit from a centralized inventory of all its fixed assets that can be expanded to analyze the cost of operations and maintenance per building. City databases could be further developed to include building attributes that can eventually be used as inputs for maintenance optimization and to retrofit resource allocation.

A centralized information and analysis system can be created by decentralized data gathering and data entry. This requires training building maintenance staff to provide information according to standardized processes and data.

Maintenance and retrofits

Philadelphia faces a large backlog of deferred maintenance of public buildings. In the past, the allocation of capital addressed equipment failures. In the future, a proactive program of preventive maintenance and supporting tools, staff, and processes will increase equipment life and energy savings. Regular maintenance can decrease building energy use by 10 to 20%.

By combining improved asset management capabilities and the recruitment of a dedicated preventative maintenance team, the City can pursue a program of priority improvements that can drive significant progress toward *Greenworks* target 1 (the City's own building stock). This will begin with a process to identify baselines in energy consumption and building conditions. This information will help to identify and prioritize retrofits according to building type and condition. Software tools that optimize resource allocation may be employed to identify retrofit projects within buildings and across a portfolio of buildings.

The energy use database can be mined in order to identify the largest consumers of energy per square foot of building area. Building maintenance can be prioritized by comparing within classes of assets.

Savings can be realized with a better understanding of the cost drivers of the operation and maintenance of major components (roofs, HVAC systems, plumbing, etc.).
A work order management system that tracks the condition, maintenance and cost of operations for all buildings has been proposed. It will provide useful data to target maintenance, upgrades and replacements.

As savings accumulate, the program can be expanded.
The City is encouraged to standardize processes for decentralized data gathering and entry, to train employees in these methods, and to develop methodologies for information analysis.

Priority actions will likely focus on investing in insulation and airflow in buildings to maximize energy-efficiency and strip waste and leakage to the bare minimum. Cumulatively, the smaller adjustments – insulation, plugging air leaks, heat-recovery, ventilation, fluorescent lighting – ultimately become significant. New buildings in the city already include some of those measures. Standards should be applied to existing buildings as well whenever buildings are updated.

Building automation

The City of Philadelphia already owns numerous buildings with automated building management systems (BMS). Properly configured, a BMS reduces operating costs with building control, energy performance monitoring, visualization, and reporting. A BMS enables optimized building control and operations to achieve and sustain energy-efficiency. More visible building performance information allows for better decisions to be made about operations and capital allocation. Typically, a BMS carries a 3-5 year payback period.

Since a BMS is most appropriate for larger buildings, energy savings can also be achieved with an understanding of energy profiles of building types and of major equipment types. This can be accomplished by sub-metering and first-order building simulation. At a minimum, HVAC services can be put on a schedule for energy savings.

The automation of buildings is the key to optimized system-level controls and energy integration with other buildings. This many take the form of demand management (load shifting and smoothing) via a smart grid, district heating and cooling systems, co-generation (heating, cooling, power), on-site renewable generation, and advanced energy storage.

Issues/considerations

- Availability of capital investment required for preventive maintenance, retrofits and automation.
- Availability of a trained skilled workforce, and availability of resources to hire, train and retain employees.
- Cooperation between city agencies, where information is shared between different organizations, avoiding duplication of data.

Next steps & quick wins

- Expand asset management information system:
  - Share information between agencies;
  - Track building attributes, condition, maintenance schedules, and operation costs;
  - Tap into internal knowledge to populate databases;
  - Roll out over extended time period in order to defray costs.
- Benchmark building energy use by type and by square footage.
- Continue preventive maintenance program, using savings to fund expansion.
- Leverage existing retrofit analysis capability to prioritize building retrofit projects.
- Increase awareness of each building's energy use among occupants.
- Automate building operation where feasible.
- Integrate automated buildings with utility information systems and with area energy systems where feasible.

Greenworks Philadelphia objectives

- Target 1: Lower City Government Energy Consumption by 30%.
- Target 2: Reduce Citywide Building Energy Consumption by 10%.
- Target 3: Retrofit 15% of Housing Stock with Insulation, Air Sealing, and Cool Roofs.
- Target 5: Reduce Greenhouse Gas Emissions by 20%.
- Target 13: Increase the State of Good Repair in Resilient Infrastructure.
- Target 14: Increase the Size of the Regional Clean Economy by 25%.

Smart water networks

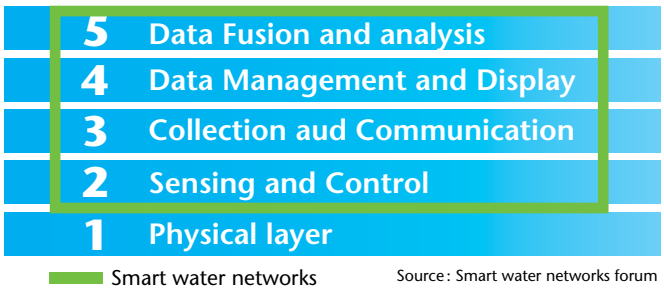
A smart water network not only provides a water utility with automated process control, but can also process data in real time, supporting enhanced management decision-making via easy-to-understand dashboards. This meaningful information can be put to work to save water, energy and labor costs, optimize compliance and security, and assure good customer service. Better integration of information facilitates better asset management, increasing the ability for planned as opposed to reactive repair, and promotes better cross-department coordination.

A smart water network requires well-implemented supervisory control and data acquisition (SCADA), power monitoring, geographic information system (GIS), and other tools that are tightly integrated. Some of these tools exist today, and others may need to be installed. Individually, each of these tools will bring value. Collectively they will help build the smart water network.

The use of the smart water network approach can make specific contributions to the *Greenworks* targets. Water and wastewater operations generally consume more than half of the total energy used by a typical municipality. Implementing a smart water network can help to reduce energy consumption by optimizing operations and removing former data silos to drive operational efficiencies. Smart water networks can also make an important contribution to improved stormwater management (*Greenworks* target 8). Leaks from a water distribution network have a negative impact on storm sewers. If freshwater is leaking out of distribution pipes, it is liable to end up draining into the storm sewer network. The utility operating with a smart water network has reliable information that can help prevent leaks and expedite location and repair when they do occur, also saving on maintenance costs and water losses.

The Philadelphia Water Department (PWD) is already considered as an outstanding example for the city and is well placed to move towards a smart water operating platform. Its *Green City Clean Waters* initiative clearly shows a utility moving in a positive, sustainable and green direction. PWD also realizes the value of data and has many systems in place to collect and use information, including GIS, hydraulic and hydrologic modeling, asset tracking and maintenance programs.

Figure 8: Key capabilities of a smart water network



Source: Smart water networks forum

Issues/considerations

- **Information**. The large amount of data produced during water network operations presents a great opportunity to make smarter decisions about current processes.
- **Integration**. By integrating existing systems, a utility can obtain much more information than if it considers its information tools as individual, isolated systems. This approach fortifies existing systems, ensures past and current information technology investments deliver the maximum return, and identifies the most critical areas for potential innovation.
- **Innovation**. A smart water network does not neglect tomorrow's requirements to achieve today's needs. A utility can consider its installed base as the starting point for planning future investments, evaluating current assets to identify gaps in both present and future information requirements.

Next steps & quick wins

- The best way for utilities to establish a smart water network that serves their specific needs is to follow a phased approach:
  - First, prioritize issues across the organization;
  - Second, look at what systems are already in place and how they can be utilized; and
  - Lastly, decide what new investments are needed to complement existing capabilities.
- By following this process logically, individual tools can be identified that will help to complete the larger smart water network solution at the lowest cost. Each of these tools will provide immediate benefits on installation, thus allowing for quick wins before the final system is fully integrated.

Greenworks Philadelphia objectives

- Target 1: Lower City Government Energy Consumption by 30%.
- Target 5: Reduce Greenhouse Gas Emissions by 20%.
- Target 8: Manage Stormwater to Meet Federal Standards.

Green stormwater infrastructure

Green City, Clean Waters is a groundbreaking plan to protect and enhance Philadelphia's waterways. It focuses on managing stormwater through innovative green stormwater infrastructure and design landscapes for homes, streets, buildings, schools, and parking lots.

Green stormwater infrastructure (GSI) uses natural systems to capture stormwater and prevent run-off. The use of systems like tree trenches, rain gardens, green roofs, rain barrels, or porous pavements catch and absorb stormwater, preventing it from flowing into sewer systems. This reduction in volume can help mitigate the amount of untreated water that makes its way to Philadelphia groundwater and rivers. The City of Philadelphia plans to retrofit nearly 10,000 impervious acres of public property to manage an inch of stormwater runoff on-site over the next 25 years at an estimated cost of $1.67 billion.

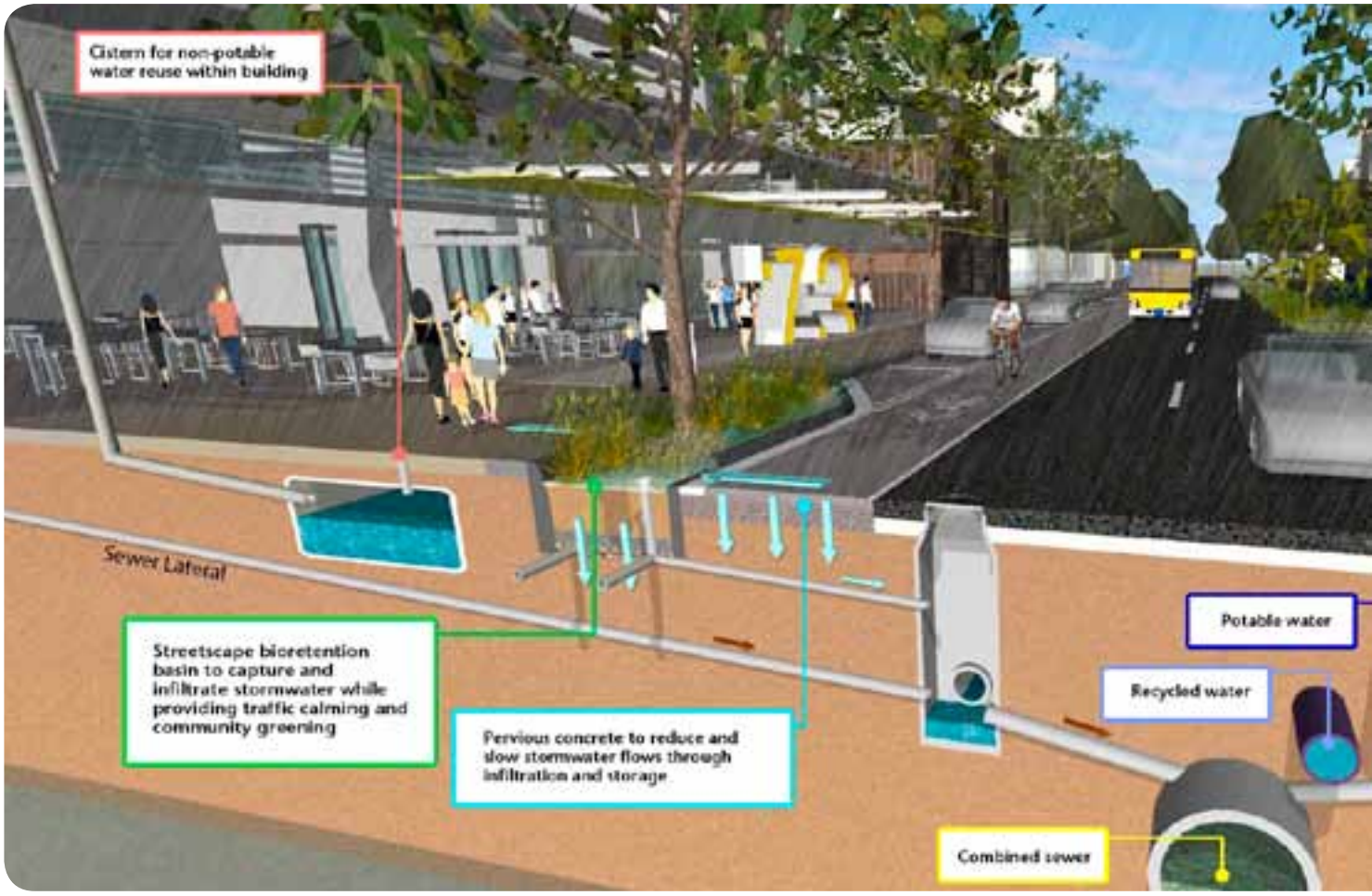
The high cost of urban retrofit has been identified as the major impediment to achieving water quality and stormwater goals. Many local government officials and the public in general see urban retrofit as a huge financial burden, questioning the affordability of water quality requirements.

The UII team examined potential opportunities to scale up the deployment of GSI, particularly through new approaches to finance. New financing strategies are emerging that will allow the City to leverage limited public funds with private funding programs. New business models enable the City to afford retrofit projects and fund long-term asset management programs.

Philadelphia has taken the lead among cities nationwide by establishing a parcel-based stormwater billing structure. In July 2010, PWD began phasing in a stormwater rate structure that applies to all land parcels, both public and private, except residential buildings of four units or fewer. It is a system based on a parcel's gross area and impervious surface area. Fees for the impervious component can be substantial, creating incentives for property owners to act.

The UII highlights the analysis in the National Resources Defence Council (NRDC) report, *Financing Stormwater Retrofits in Philadelphia and Beyond*, which presents a number of innovative financing approaches that this billing structure creates. These include off-balance-sheet project developer models, land-secured financing imitating the Property Assessed Clean Energy (PACE) model, utility-enabled

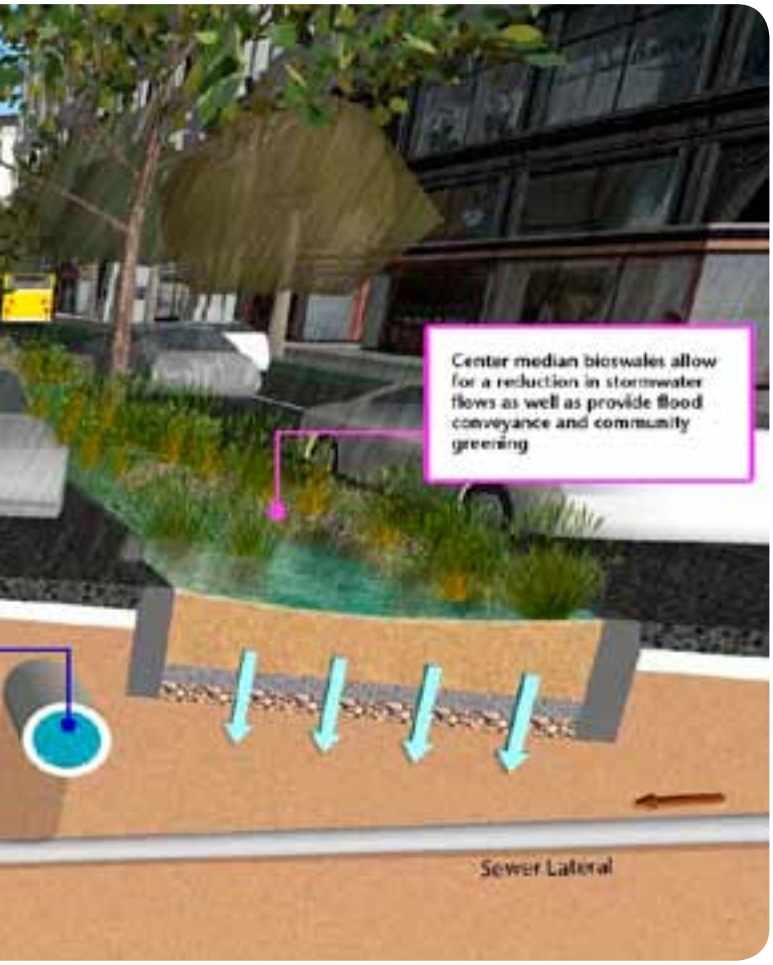
Figure 9: Green stormwater infrastructure applied as part of a 'complete streets' solution



mechanisms including on-bill financing, and elements of energy service company models. As with energy-efficiency retrofits, each of these mechanisms would rely on property owners' savings from reduced utility bills as a cash flow to facilitate repayment of funds invested upfront for the capital costs of retrofits.

As with all new finance approaches, there are risks and challenges associated with pursuing these mechanisms. As the NRDC report highlights, many of these issues can be ameliorated through public policy measures including credit enhancement, facilitating project aggregation, offsite mitigation programs, transparency regarding long-term stormwater fee schedules, and public-private partnerships (PPPs).

One potential priority area for public-private engagement in this area could be for surface parking areas in the city and downtown core. Parking lots present tremendous opportunities to remove large surface area run-off from the local sewer system. A number of GSI practices can be used to manage stormwater in parking lots, including vegetated strips and swales, rain gardens, infiltration beds and trenches and pervious pavements. Retrofit and redesign of existing parking lots can also support other objectives, including improving visual appearance, community renewal, and amenity objectives within these areas.



Source: AECOM

Issues/considerations

- Water quality intersects with many facilities and land-uses, such as parking, streets, underutilized or brownfield properties.
- An integrated solutions approach provides ways to bundle improvements when coupled with measures such as green parking, complete streets, and green infrastructure design and technology.
- GSI provides multiple benefits, particularly when focused on land-uses within downtown Philadelphia.

Next steps & quick wins

- Engage in a stair step approach by initially identifying target areas for pilots, then formulating a vision and objectives for targeted pilot/demonstration project areas. This could focus on surface parking lots that also correlate with neighborhood renewal. Many aspects of surface parking lot and stormwater retrofit design can be bundled with complete streets and broader neighborhood renewal strategies.
- Survey district areas suitable for stormwater management retrofit financing.
- Coordinate with major property owners to achieve economies of scale, and enhance the ability to cluster land-use management with a unified mitigation program.
- Launch pilot projects, monitor results, and evaluate scalability of the project.

Greenworks Philadelphia objectives

- Target 8: Manage Stormwater to Meet Federal Standards.
- Target 11: Increase Tree Coverage Toward 30% in All Neighborhoods by 2025.
- Target 13: Increase the State of Good Repair in Resilient Infrastructure.
- Target 14: Increase the Size of the Regional Clean Economy by 25%.
- Target 15: Philadelphians United to Build a Sustainable Future.

The complete streets concept

In 2009, Mayor Michael Nutter issued an executive order that the city's streets would accommodate "all users of the transportation system, be they pedestrians, bicyclists, public transit users, or motor vehicle drivers." In doing so he made a promise that all of the city's streets would be designed, built and maintained as 'complete streets'.

The complete streets concept is aimed to redesign roads to accommodate diverse transport modes, users and activities including walking, cycling, public transit, automobile, nearby businesses and residents. Such street design helps create more multimodal transport systems and more livable communities. The complete streets approach can help Philadelphia adapt to changing needs, including more pedestrians, more cyclists and more seniors.[8]

Complete streets can provide many direct and indirect benefits, including improved accessibility for non-drivers, user savings and affordability, energy conservation and emissions reductions, improved community livability, improved public fitness and health. They also support strategic development objectives such as urban redevelopment and reduced sprawl. Net benefits depend on the latent demand for alternative modes and more compact development, and the degree that complete street projects integrate with other complementary planning reforms. Complete streets are most effective when combined with mutually-supportive objectives. For example, the UII team recommends coupling complete streets with green infrastructure, stormwater management, and walkability objectives focused on renewal of boulevards and neighborhoods.

Complete streets also provide a new perspective for thinking about community public safety goals, as part of a more comprehensive look at current technologies, policies, and procedures. This is also a new prospective area for PPPs. An example is a major southern U.S. city that realized a quadrupling of available security cameras using a PPP to integrate cameras into a citywide surveillance capability. This integration was done at minimal costs to the city. Another example is a Tennessee city that realized 87% annual savings in energy costs relative to new street lighting. This savings enabled the procurement of new cameras and security systems that, in addition to the improved lighting, have dramatically reduced both major and minor crime rates.

Such approaches can provide the City with a blueprint for success in achieving significant, measureable gains in public safety, as part of a holistic approach to optimizing technology involved in street upgrades and improvement works for other infrastructures (e.g. building technologies, smart grid, lighting, traffic management, water technology).

Issues/considerations

- Bicycle lanes should be protected by a row of parked cars, planters, bollards, or other barricades. Streets with protected bike lanes have been shown to have major benefits, dramatically reducing speeding, crashes, fatalities and the number of cyclists on the sidewalk.

Next steps & quick wins

- Gauge feasibility in subareas and neighborhoods.
- Examine complementary retrofits with green infrastructure and opportunities to link with public safety initiatives.
- Identify complete streets opportunities adjacent to new development.
- Examine funding and finance mechanisms via traditional programs such as city funds, the Community Development Block Grant, plus use of benefit assessment district or local business improvement district resources.

Greenworks Philadelphia objectives

- Target 8: Manage Stormwater to Meet Federal Standards.
- Target 9: Provide Walkable Access to Park and Recreation Resources for All Philadelphians.
- Target 10: Provide Walkable Access to Affordable, Healthy Food for All Philadelphians.
- Target 11: Increase Tree Coverage Toward 30% in All Neighborhoods by 2025.
- Target 12: Reduce Vehicle Miles Traveled by 10%.

8 The city's population is aging: in 2015 those 65 or older will make up 13.5% of the resident population, and higher in certain areas.

Mobility

To compete in the 21st century economy, Philadelphia must have a transportation network that is convenient, dependable, accessible, and connected. Connectivity and the integrated planning of future mobility services provides the potential for a paradigm shift in travel habits and greater choice for consumers, as well as providing greater equity and efficiency to a diverse range of travelers with varying trip requirements.

Advances in technology are set to facilitate integrated and smart mobility solutions, leveraging existing infrastructure with new concepts and business models. A new mobility system is being created that will allow people to move seamlessly door-to-door within the network to create ubiquitous connectivity. The new system includes peer-to-peer car sharing, shared-use mobility, integrated way-finding and electric vehicle (EV) charging infrastructure.

Integrated corridor management

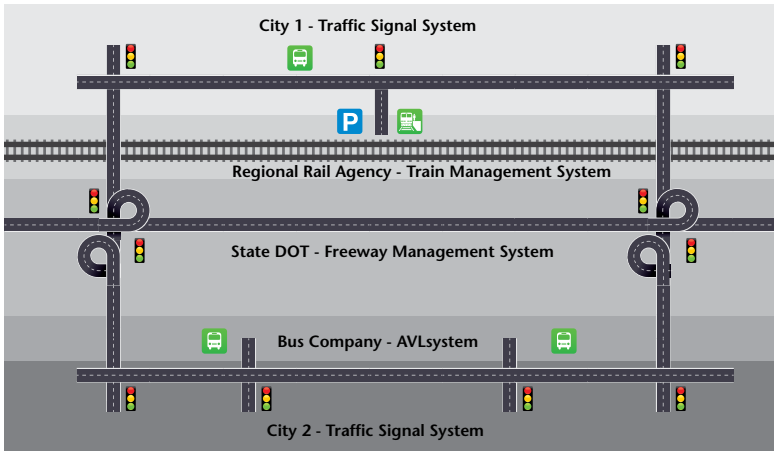
Transportation management systems have traditionally been about reacting to incidents (crashes, special events, etc.) to clear them quickly and restore normal operations. Arterial management systems are set up to change traffic signals based on time of day, day of week and other seasonal variations. Advanced systems can change signal timings by reacting to changes in traffic patterns and demand.

An integrated corridor management (ICM) system takes all of these operational strategies to the next level through the proactive management of total corridor capacity. An ICM takes in real-time information on traffic, transit operations, incidents, special events, parking availability, and weather. The main purpose is to proactively manage the transportation infrastructure (freeways, arterials and transit). ICM enables management strategies to maximize person throughput, not just vehicle throughput. Multimodal traveler information is delivered through multiple channels to allow the traveling public to make informed choices about available modes and routes for their trips. Signal timing on arterials is managed in close coordination with the management of events on the freeways. Traffic flow is dynamically rerouted and mode choices are communicated.

An ICM system marries state-of-the-art hardware, software and services with sophisticated analytical capabilities to deliver better infrastructure management, increased sustainability, and improved City services that optimize the flow of people and goods throughout the urban network.

The City of Philadelphia is putting in place many of the tools necessary to implement the ICM concept. These tools include the new City Traffic Management Center (TMC), currently under construction, which will integrate the operation of hundreds of upgraded smart traffic signals being installed on critical arterial corridors throughout the city. Several corridors within the city and across the region have been identified for ICM projects. The Delaware Valley Regional Planning Commission (DVRPC) has incorporated these ICM projects, as well as other intelligent transportation system projects, into both its long-range and short-term planning.

Figure 10: Integrated corridor management



Source: USDOT

While these actions and plans are necessary to address many of the transportation challenges facing the city, the UII team feels these steps alone may be insufficient. The proposed UII concept for integrated solutions, including smarter mobility solutions, calls for a comprehensive approach. As with most transportation initiatives, this means collaboration and cooperation with multiple stakeholders. Besides the City, the Pennsylvania Department of Transportation (PennDOT) and the Southeastern Pennsylvania Transportation Authority (SEPTA) are the other primary operational agencies and, of course, will be key stakeholders in any ICM initiative.

The good news is that all of the principal operating agencies, the City, PennDOT and SEPTA, have similar missions, goals and objectives. Each will realize benefits from a more collaborative approach and integrated operations. For example, when the PennDOT District 6 TMC has to deal with an incident on one of the area freeways, knowing that the City can make adjustments to signal timing on adjacent arterials (almost in real-time) offers more options to manage the situation. SEPTA plans to implement more transit signal priority (TSP) corridors to make bus travel more reliable and more attractive to commuters. Coordination of traffic signal timing plans with the new City TMC will help maximize the benefit of TSP while minimizing any negative impact on other traffic patterns.

The United States Department of Transportation (USDOT) is strongly behind the ICM initiative and has funded several demonstration projects around the country, including Dallas, San Diego and Minneapolis. Preliminary analysis by the USDOT shows that ICM is an effective investment for all three cities. Cost-benefit ratios and 10-year net benefits are positive and significant across all three sites. Improved reliability is the largest benefit of ICM. Reduced travel time is the second largest benefit, followed by fuel consumption and emissions. ICM strategies produce more benefits at higher levels of travel demand and during non-recurrent (i.e. incident related) congestion. Figure 11 presents the summary results from the USDOT study.

Without requiring significant additional investment, Philadelphia can apply existing and near term resources, such as the new City TMC and SEPTA's transit signal priority program, to create a world-class ICM capability. This could include revisiting the concept of operations for the TMC to incorporate the expanded role of the City in an integrated corridor operation. Aggressive steps are needed to proactively manage critical corridors, prioritizing high occupancy vehicles and buses and making the public aware of alternative modes of travel. After starting with one or two demonstration corridors, the City can continue to expand the program to other main corridors. Key benefits could include:

- Congestion reduction of up to 20%;
- Improved travel time reliability;
- Reductions in wasted fuel and vehicle emissions of up to 15%;
- Mode shift to transit and high occupancy vehicles (HOV) up to 5% measured in terms of reduced vehicle miles traveled (VMT);
- Improved efficiency of the transportation system.

Issues/considerations

- Inventory and assess technology available for implementing ICM; this will include both City owned and operated systems as well as that available to key stakeholders.
- People are a key part of any operational system. The institutional requirements to support ICM (operators, analysts, maintenance, and management) should be considered.

Next steps & quick wins

- Redefine the operations concept for the TMC so that it includes support of the ICM concept (as this is an additional/complex function that is outside its current design purpose).
- When the new TMC is operational, organize a capability demonstration linked to a sporting event or concert. Invite the press to observe and interview selected stakeholders (event goers, city police, etc.) on the improved operations made possible by the TMC.
- Review/revise regional intelligent transport systems (ITS) architecture to support ICM.
- Develop a technology deployment plan to support ICM to leverage and connect existing ITS infrastructure rather than replace systems where ever possible.
- Evaluate and select candidate corridor(s) for pilot ICM programs, considering both mobility needs (safety, traffic, technical feasibility) and economic development needs (improved access to activity centers).

Greenworks Philadelphia objectives

- Target 5: Reduce Greenhouse Gas Emissions by 20%.
- Target 6: Improve Air Quality toward Attainment of Federal Standards.
- Target 12: Reduce Vehicle Miles Traveled by 10%.

Figure 11: Projected benefits of integrated corridor management

	Minneapolis	Dallas	San Diego
Annual Travel Time Savings (Person-Hours)	740,000	132,000	246,000
Improvement in Travel Time Reliability	3%	4.4%	10.6%
Gallons of Fuel Saved Annually	981,000	17,600	323,000
Tonnes of Mobile Emissions Saved Annually	9,400	175	3,100
10-Year Net Benefit	$104 million	$264 million	$82 million
Benefit-Cost Ratio	20:1	22:1	10:1

Source: USDOT, Research and Innovative Technology Administration, 2010

Bus rapid transit

Bus rapid transit (BRT) is an innovative, high-capacity, lower-cost public transit solution that can significantly improve urban mobility. BRT uses specialized buses on roadways or dedicated lanes to quickly and efficiently transport passengers to their destinations, while offering the flexibility to meet transit demand. BRT systems can be easily customized to community needs and incorporate state-of-the art, low-cost technologies that result in more passengers and less congestion.

BRT systems are increasingly seen as a cost-effective transport solution for cities all over the world. They have many of the advantages of underground and surface rail systems, and are cheaper, faster and easier to build, and more flexible. Buses can go where other systems cannot and perform within a network and feeder system integration. BRT can also help cities overcome challenges in transport policy and catalyze land-use and walkability changes along the routes.

BRT operations can be implemented through PPPs, where the city government or transit authority handles regulation and infrastructure, and the drivers whose route the BRT is replacing take charge of daily operations. The public-private approach can also be a platform for mandating high-quality services for commuters, and reducing financial exposure for cities and transit agencies.

BRT is already under consideration in Philadelphia. Initiated from the ongoing Central District Plan, the Planning Commission has decided to pursue BRT City Branch in Logan Square. The planning commission envisions this as a 'cultural BRT' connecting some of the most important arts and civic institutions along its route. The current proposal would run buses from the Please Touch Museum and Mann Music Center, eventually connecting to Girard Avenue where it would cross the Schuylkill and connect to the submerged City Branch cut at 30th and Poplar Streets. Eventually the line would re-emerge and run along Race and Arch Streets to link up with the future transit lines along Columbus Boulevard (proposed in the adopted Waterfront Master Plan).

One additional option for consideration is the deployment of BRT within the high-traffic Roosevelt Boulevard corridor that bisects lower northeast Philadelphia. The Boulevard, which has two of the country's most dangerous intersections, has been studied extensively in the past. The corridor connects the far northeast with I-76. It is an auto-centric, 12-lane, 300-foot-wide artery that carries as many as 90,000 vehicles per day. Its high traffic volume and width – including an 80-foot central median – pose a pedestrian challenge. The Boulevard also has several complex, multi-directional travel patterns.

Figure 12: Bus rapid transit

While some of the proposals for Roosevelt Boulevard have focused on extending the existing SEPTA Broad Street rail line along the existing roadway, this option would require substantial financial investments and a construction schedule that would present challenges in providing a timely solution. Implementation of a BRT line on Roosevelt Boulevard would provide a beneficial solution for the Philadelphia region by:

- **Providing a reliable, higher capacity transit service along the corridor.** The BRT line could use existing express lanes and ITS technology for bus priority treatment at intersections, increasing reliability and improving travel times;
- **Providing vital connections.** A Roosevelt Boulevard BRT line would connect the SEPTA Broad Street rail line with communities along the corridor. It could also provide connectivity to the SEPTA Market-Frankford line that terminates a mile from Roosevelt Boulevard.

The Roosevelt Boulevard BRT line would be an effective transportation solution by:

- **Building on the existing roadway and bus infrastructure along the corridor**;
- **Providing a timely transportation solution.** BRT could be implemented more quickly than an extension of the Broad Street line. The BRT line could also encourage more transit use and ridership along the corridor, paving the way for future high-capacity service;
- **Providing a cost-effective solution.** Capital and operating costs towards a BRT service would be more favorable than those required for an extension of a rapid rail transit line. In addition, a proposal for BRT could be considered for Federal Transit Administration (FTA) New Starts funding, and also as part of public-private partnership arrangements for funding and project delivery.

The UII also recommends a phased approach to implementing BRT features beginning with BRT-light and leading to an exclusive right-of-way configuration. The use of technology can enhance the operation of BRT, such as the use of a virtual GPS-based detection zone for transit vehicle traffic management which avoids the need of physical detector equipment at the intersection. This solution allows the fleet's on-board computers to automatically request a green light and other signal priorities when the bus is behind schedule and approaching a busy intersection. This helps riders to get to their destination on time, and it will ultimately encourage more use of the bus system as reliability improves, reducing congestion and greenhouse gas emissions as people switch from car to bus travel.

The Roosevelt Boulevard BRT and Navy Yard extensions could provide a catalyst for the entire Broad Street corridor. Access to and between Amtrak, Regional Rail, and Broad Street Subway services at North Philadelphia Station will be surrounded by a newly rejuvenated commercial and residential center.

Issues/considerations

- Bus rapid transit (BRT) provides an efficient and economical approach to mobility solutions in the city's busiest corridors. BRT can network into larger bus operations, and its design can include walkability improvements.

Next steps & quick wins

- Convene a coordination summit with the Delaware Valley Regional Planning Commission (DVRPC), the Southeastern Pennsylvania Transportation Authority (SEPTA), the City, the Mayor's Office of Transportation and Utilities (MOTU), and stakeholders to scope issues and solutions.
- Engage in upfront coordination with the Federal Transit Administration (FTA) on early-action items to align prior to starting the alternatives analysis/environmental impact statement (EIS). Begin exploring potential public-private partnership arrangements.
- Prepare a business plan that describes and optimizes concept alternatives and presents options for organizational set-up and for funding and finance.
- Commence FTA-compliant alternative analysis/EIS for Roosevelt Corridor BRT system. Carry forward public-private partnership recommendations as appropriate.

Greenworks Philadelphia objectives

- Target 1: Lower City Government Energy Consumption by 30%.
- Target 5: Reduce Greenhouse Gas Emissions by 20%.
- Target 6: Improve Air Quality toward Attainment of Federal Standards.
- Target 12: Reduce Vehicle Miles Traveled by 10%.

Smart parking

The UII team recognizes that personal vehicles are likely to be part of the overall transportation mobility mix for the foreseeable future. The integrated solution approach recommends that this mix be a coordinated, balanced, multimodal and intermodal transportation network, with the sustainable parking garage and parking reform playing a key role. The parking industry is undergoing a transformation toward sustainability in design, operation and function of this unique building type. Furthermore, parking facilities can serve as active resources that seamlessly connect to reliable smart infrastructure.[9]

Key innovations include:

- **Smart parking technology.** Almost a third of traffic congestion in central business districts is caused by drivers looking for parking. Along with parking reform policies, the technologies accessed on smart phones, in-vehicle navigation systems and on-street infrastructure can manage parking availability and pricing and efficiently direct drivers to available parking. The UII recommends further work in the area of smart parking, including exploring technologies available today such as sensors, video, infrastructure-to-vehicle communication, and Internet-enabled software which enhances visibility for capacity and pricing per lot, automated enforcement and potential dynamic pricing structures;
- **Construction & operation.** Beyond the basic attributes of form and function, getting to the next level of sustainability for parking garages requires more advanced and evolving technologies. Recent trends have included the increased use of more-sophisticated lighting controls and sensors to account not only for diurnal cycles, but also for transient day-lighting conditions. Some parking structures have introduced internal light wells to use natural daylight better. The use of rooftop- and façade-mounted solar panels has also grown, with PV films offering more options and greater design flexibility. Surface parking also provides an important opportunity to deploy green stormwater infrastructure (see page 22);
- **Promotion of low-emission vehicles.** Parking facilities can play a role in promoting the market deployment of low-emission vehicles by providing dedicated parking spaces and supporting infrastructure (as appropriate);
- **Reuse and repurposing of parking structures.** Garages should be flexible structures, such as a flat-floored garage built close to core institutional functions which can be converted to more compatible and appropriate uses as the institution expands.

The Philadelphia Parking Authority (PPA) owns and operates nine facilities in Center City with approximately 9,000 spaces, and 19,000 spaces at the PPA-owned facilities at the airport. The scale of its footprint will allow the PPA to act as a thought leader in parking and continue its adoption of technology and green guidelines, as shown in its smart card and red light enforcement projects and redevelopment of the Arch Street Garage as an asset for community revitalization.

Next steps & quick wins

- Start smart parking pilot projects at locations in Center City.
- Evaluate if smart parking adds value to existing parking technology operated at the Philadelphia International Airport.
- Align green parking guidelines with stormwater management and climate-proofing/storm resiliency measures.
- Launch pilot projects focusing on stormwater retrofit at surface parking lots that leverage neighborhood renewal, place-making and added value to district vitality.

Greenworks Philadelphia objectives

- Target 2: Reduce Citywide Building Energy Consumption by 10%.
- Target 5: Reduce Greenhouse Gas Emissions by 20%.
- Target 8: Manage Stormwater to Meet Federal Standards.
- Target 13: Increase the State of Good Repair in Resilient Infrastructure.

9 Additional Information/Resources: Green Parking Council: www.greenparkingcouncil.org; Intelligent Transportation Society of America (ITS America) Smart Parking Symposium.

Integrated mobility platform

Public authorities are looking for tools to support a modal shift. Their goal is the reduction of greenhouse gas emissions and a free flowing transport network without limiting an individual citizen's mobility.

A key driver of this modal shift is improved information and coordination of transport options. A seamless transition between transport modes makes travel more comfortable and reduces travel time. It also gives passengers more choice and lets them optimize their journey – reaching their destination faster, more cheaply and with less environmental impact.

An integrated mobility platform (IMP) is an IT-infrastructure that enables mobility providers to offer transportation services in a straightforward and efficient manner. The transportation services may include various modes and may be provided by distinct service providers. It offers a single point of interaction for a traveler with transport services (through the Internet or a smartphone) enabling users to:

- Obtain real-time information on the transportation network;
- Plan multimodal routes based on real time data;
- Reserve transportation facilities as applicable and receive the required tickets;
- Make car-share bookings and locate EV charging stations;
- Manage their customer data and travel preferences;
- Pay for transportation trips and parking.

The overall objective is to provide real-time, personalized and localized information along the travel chain with integrated and easy-to-use planning, booking and payment systems.

Such an approach could be a value-adding enhancement of the City's existing impressive progress in driving modal shift. Between 2005 and 2010, the average daily vehicle miles traveled in the city decreased by 7.4%. In 2012, SEPTA registered a 22-year high in transit ridership with 334 million passenger trips, accompanied by a 10% improvement in customer satisfaction. SEPTA is also in the process of implementing a new payment technologies project to facilitate fare payment and movement between public transport options. The City has also had significant success in promoting other low-impact mobility options, including cycling and car-sharing schemes. An IMP could facilitate further uptake in all these options by enhancing and enriching the travel experience for citizens.

IMP also offers new strategy options to a City traffic manager. For example, under certain weather and traffic conditions, the traffic in cities can sometimes lead to emission limit values being exceeded. Linking air quality monitoring and traffic management with an IMP could act as a tool to provide citizens with real-time information that could encourage immediate shifts in commuter behavior. This approach could make a direct contribution to the attainment of federal air quality standards (*Greenworks* target 6).

The key success factor to make the multimodal vision come true in Philadelphia is the cooperation between different transport service providers and the willingness to work jointly on mobility processes. Transport modes compete with each other and one of the key questions to be answered is: Who owns and manages the customer? An IMP gives different transport service providers the opportunity to care for existing customers, to win new customers, to generate more revenues, and to offer value-added services without losing the ownership of the customer.

Issues/considerations

- Start engagement with key stakeholders regarding various modes of transport.
- Make an inventory and assess technology available for implementing IMP; this will include both city-owned and operated systems as well as those available to key stakeholders.

Next steps & quick wins

- Identify target areas for pilots, then formulate a vision and objectives for targeted pilot/demonstration project areas.
- Examine funding and finance mechanisms.
- Launch pilot projects, monitor results, and evaluate project scalability.

Greenworks Philadelphia objectives

- Target 5: Reduce Greenhouse Gas Emissions by 20%.
- Target 6: Improve Air Quality toward Attainment of Federal Standards.
- Target 12: Reduce Vehicle Miles Traveled by 10%.
- Target 15: Philadelphians Unite to Build a Sustainable Future.

Financing

Start-up and ongoing funding remain critical issues for transformative deployment of integrated solutions for urban sustainability.

A range of financial models and project delivery options can enable cities to catalyze the investment in innovation that will be crucial for the next phase of the market and for implementing capital investment plans and projects. Philadelphia has already shown leadership in exploring new approaches to financing and in driving wider market transformation within the city:

- In 2011, the City's EnergyWorks revolving loan for energy-efficiency retrofits lent more than $12 million and leveraged $142 million, supporting the upgrade of more than 660,000 square feet of building space. The City has also established its own competitive internal energy-efficiency fund to support upgrades within municipal facilities;
- The Stormwater Management Incentives Program (SMIP) stimulates customer investment/utilization of stormwater best management practices in tandem with the shift to a parcel-based stormwater billing structure;
- Tax increment financing (TIF) is enabled within the City through the PIDC. TIF is a public finance tool to enable the redevelopment of buildings, places and infrastructure by leveraging public funds to initiate private/public sector activity in a target area. This could be a key platform for the support of district-scale sustainability improvements. It is used by other cities to develop green streets, improve connectivity for multimodal transportation, energy retrofits and feasibility studies for district-scale energy and wastewater schemes.[10] The transit revitalization district (TRID) program incorporates TIF tools and is also applicable.

Scaling up the financing and delivery of infrastructure is a major challenge facing all levels of government in the US. Many administrations are faced with major legacy maintenance requirements and backlogs for infrastructure renewal. This is at a time of major constraints on public finances and commercial debt in the wake of the global financial crisis. These circumstances are made even more challenging by the need for transformational investments to promote sustainability and improve resilience to the impacts of climate change.

The UII team suggests that the way forward will require effective public-private sector engagement leveraging local resources. Innovative finance and public-private partnerships can also promote greater collaboration across state and municipal lines and with the private financial sector, businesses, capital markets, and lending institutions.

Some specific financing recommendations are included in the infrastructure and other sections earlier in this report. In addition, the UII proposes the following:

- Increase the productivity of existing and planned infrastructure;
- Scale up the deployment of PPPs for the elements of infrastructure requirements that are suited to this model of financing and project delivery;
- Create collaborative groups of cities to work with the private sector to encourage innovation and drive economies of scale;
- Convene a financing summit to bring together key stakeholders to strategize on the future architecture of project delivery and investment to order to accelerate change.

Infrastructure productivity

A recent report by McKinsey[11] suggests the importance of focusing on the productivity of existing and planned infrastructure as one type of strategic response for resource constraints. This involves making better choices about which projects to execute, streamlining the delivery of projects, and making the most of existing infrastructure.

Making the most of existing assets is a key strategy in enhancing the overall sustainability performance of infrastructure. Intelligent transportation systems (ITS) can greatly increase the efficiency of transport networks at a fraction of the economic and environmental cost of new capacity. Smarter water and energy networks can significantly reduce losses, can avoid additional production capacity and can be implemented quickly. Technology is a key driver in achieving greater infrastructure productivity in the near term and is a core potential benefit of many of the solutions presented in this report (smart grid, smart water networks, BRT and integrated corridor management).

10 Portland Sustainability Institute *Financing an EcoDistrict* (2011)

11 McKinsey Global Institute & McKinsey Infrastructure Practice *Infrastructure productivity: How to save $1 trillion a year* (2013)

Scaling up the deployment of public-private partnerships (PPPs)

Public-private partnership (PPP) models are and will be an important approach for advancing transformational solutions.

PPPs are not a panacea but are a proven model in a number of infrastructure asset classes. They appear to be best-suited to large, complex projects with acknowledged need and strong government support. PPPs can provide substantial benefits. They may accelerate project development and construction, transferring construction and performance risk, providing more efficient operation and superior service, introducing new technologies, and attracting new investment capital.
As noted previously, PPPs are likely to be a key mechanism for the funding some of the larger infrastructure requirements (including district-scale utilities) that will be central to many EcoDistrict developments.

A further emerging concept that could also be considered by Philadelphia is to consider unsolicited proposals for PPPs from the private sector. This can create a potential platform in catalyzing private sector innovation and creative solutions.

Recent developments are improving opportunities for PPPs and demonstrating their value locally. In mid-2012, Pennsylvania Governor Tom Corbett signed important legislation that authorizes PPPs for road, transit and other transportation-related projects. In the city, the Philadelphia Water Department (PWD) has entered into a PPP with Ameresco to design, build, and maintain the biogas-to-energy system. Bank of America financed and owns the facility that cost $47.5 million to construct. PWD entered into a 16-year lease agreement to provide operations, with the option to renew the contract, purchase the co-generation system at fair market value, or terminate the arrangement outright. The partnership provided the municipality with an innovative, non-mission critical technology, without the upfront capital commitment and associated risk.

The National Council for PPPs identifies a number of key success factors for PPP development:

- Identification of a PPP champion within the administration;
- Assessment of the near-term and long-term structural and institutional capacity to carry forward funding arrangements and project delivery;
- Development of a feasibility study that defines project needs, objectives, financial capacity, initial funding architecture, risks and costs;
- Involvement of a wide range of stakeholders and interested parties, which is as transparent as possible.

Cities working together

A more novel approach UII proposes is collaboration between cities to grow the market for sustainable infrastructure solutions as a means of scaling business innovation and achieving economies of scale. Tailored solutions for individual cities can be high risk and difficult to transplant to other cities without considerable cost, therefore relatively unattractive for the private sector. If the cities and the private sector joined forces to evaluate and prescribe core replicable solutions, cities they would achieve a critical mass of needs and acceptable solutions. Cities could solve their infrastructure needs at the lowest cost and highest degree of efficiency.

Such an approach could incentivize and better leverage private R&D funds, give entrepreneurs the ability to respond with innovation for critical infrastructure issues that serve the greatest number of cities, and also focus the contributions of academia and the not-for-profit sectors. It would also allow financial markets to create new investment opportunities and financial innovations that serve cities and subsequently lower the cost of capital. Ultimately, it could build the critical business case for these investments and provide cities with clear benchmarks for the operations, efficiency and the sustainability of their infrastructure.

Brokering dialogue and collaboration

Cities provide unique opportunities for collaboration. Delivering significant projects means developing and nurturing complex collaborations across multiple levels of government, local partners, financial institutions, and local and global businesses.

A useful way forward for the City in the near term could be to convene a funding/finance summit that would provide a forum on the future architecture of project delivery and investment. Such an event could involve government, government authorities, utilities, technology providers and the finance and banking community. It could also be an opportunity to explore possible collaboration between cities on infrastructure solutions.

Next steps & quick wins

- Convene a funding/finance summit that provides a forum for owners, operators, and the finance and banking community to strategize on the future architecture of project delivery and investment in order to accelerate change.
- Engage private sector technology companies and businesses upfront in the capital investment planning process to advise on strategic direction and priorities.
- Prioritize capital plans and evaluate projects for alternate delivery methods and/or PPP arrangements.
- Examine third party and pooled financial instruments that could pay for upfront energy-efficiency retrofits, innovation, and capital projects that result in life-cycle cost savings.
- Monitor and track successful PPP projects in the region in terms of liquidity, cash flow, loan fidelity, and performance indicators that could set the stage for future project delivery arrangements.

Fleet management

The development of operational and technical solutions to improve the sustainability of the City's 6,000-plus vehicles focused on vehicle optimization, the use of telematics, training and alternative fuel technologies. The key value proposition in this engagement was to leverage the knowledge and best practices of the private sector in managing large vehicle fleets to help the City identify cost-effective solutions to advance progress towards operational and sustainability objectives.

Overview

The City of Philadelphia Office of Fleet Management (OFM) is a centralized agency responsible for strategic planning, acquisition and maintenance of vehicles and large equipment to support citywide functions. The OFM is responsible for approximately 6,300 vehicles and equipment.

The fleet is diverse, including ambulances, trash compactors, police cruisers, highway paving equipment, riding mowers, motorcycles, passenger and cargo vans, sport utility vehicles (SUVs), buses, and sedans for 43 departments. The OFM operates 16 repair and maintenance facilities throughout Philadelphia and 64 fuel sites citywide. All departments depend on the OFM to maintain and have available at any given time the equipment needed to keep the city operating.

The OFM operates on a budget that is dictated by the City controller's office. Budgetary constraints, abuse of equipment, and lack of training interfere with the department's ability to maintain the fleet. Despite these circumstances, the OFM is seen as an effective service department that provides a high-quality service to the City, measured by a continued high level of availability and internal customer satisfaction surveys.

UII worked with the OFM to identify potential operational and technical solutions to support improvements in the performance and efficiency of City vehicle fleet management. The idea was to explore opportunities to learn from processes and technology used by the private sector to support the OFM to:

- Establish modernized, automated and efficient processes which would lead to a reduction in operating expenses and an increased vehicle availability to critical services such as the police and fire departments;
- Support the achievement of the objectives of *Greenworks Philadelphia* through improved operational efficiency and an integrated strategy for the deployment of alternative fuel technologies in the vehicle fleet.

UII created three specialized teams with the following mandates:

- **Leadership team.** This team was formed to engage with OFM's stakeholders across several departments to identify the areas where the UII could have the most actionable impact. The team's tasks involved initial research into the problem, setting targets, conducting interviews, and performing initial site visits;
- **Logistics team.** This team was formed to analyze (through interaction with the field) the current operations and identify industry best practices which would be applicable and could be leveraged by OFM. Specific areas of concentration were asset management, facility logistics and use, and leveraging telematics (vehicle sensors and software) to enhance maintenance performance and reduce operating costs;
- **Alternative fuel team.** This team was formed to understand the vehicle types, the operational model for each type, and current alternative fuel options.
  The primary objective was to develop a model and trade-off analysis which would enable the city to make decisions about alternative fuels as the industry and options evolved. The secondary objective was to apply the model given today's information and constraints and make initial recommendations for each vehicle class.

Vehicle optimization

When a concerned resident dials 911 they expect the arrival of a fully functional emergency vehicle. When highways and community streets are in need of snow plowing, it is the responsibility of the City to ensure there are adequate resources to meet peak demand. A vehicle optimization system is critical for the OFM, especially when safety and public health are the drivers of need.

The City has already shown leadership in thinking clearly about the mobility needs of the city administration and the appropriate size and composition of the vehicle fleet. Philadelphia recently won an award for "being the first government worldwide to share cars with local residents in a major fleet-reduction effort."[12] This move is viewed as a paradigm shift, one that saves the City millions of dollars annually by reducing its depreciable assets and vehicle maintenance expenses.

A software-based vehicle optimization system will continue to move the city in an efficient and sustainable direction. As a core element of a scalable asset management system, vehicle optimization software gives clear insight to decision-makers and stakeholders alike. There are numerous benefits:

- **Service & cost management.** This system will allow the City to track data for each vehicle. The data should be reviewed quarterly with OFM and stakeholders. Cost components such as maintenance, fuel, miles driven and insurance can be plotted against response times and down time to provide a holistic view of operational performance;
- **Life cycle analysis.** Monitoring vehicle usage by type including mileage, repair expense and time in service. The City is looking to establish baseline measures for purchase cost vs. depreciation. This system will help establish a predictive model for replacement across multiple fleets;
- **Vehicle reduction.** The continued assessment of vehicle requirements and the reduction of unnecessary vehicles in the fleet;
- **Benchmarking.** Vehicle optimization software should allow the City to coordinate with the private sector to establish standards. The City will be able to benchmark itself against other cities throughout the country as well businesses located in Philadelphia.

When attempting to manage a fleet (in the case of the City, it is multiple fleets), diverse and scalable information management platforms are essential. These platforms can be as simple as databases and spreadsheets or more complex fleet routing software. This software will provide the City and the OFM with greater flexibility with fiscal policy, budgeting and capital management.

Issues/considerations

- **Cost.** Training, technology, implementation and maintenance must be considered with this type of system. Does the city have the proper technology infrastructure? What cities have already implemented such a system? Do stakeholders recognize the value of the system?
- **Return on investment (ROI).** Budget constraints impose a minimum ROI for funding and transition to be viable. The city needs to consider if it has the resources (intellectual capital) to manage such data-intensive applications.
- **Scalability.** The city cannot afford to be locked into a solution which does not support future enhancements to meet the continual and changing needs of the fleets, stakeholders, and the Office of Fleet Management.

Next steps & quick wins

- Work with the private sector, especially those companies in the transportation industry and/or fleet management, to review the benefits and use of such a system.
- Build consensus with stakeholders, OFM, and the Mayor's Office of Sustainability for investment support.
- Consider generating additional revenue by selling destroyed assets as scrap. Currently, only vehicles pulled out of service are sold at auction and generate revenue.

Greenworks Philadelphia objectives

- Target 1: Lower City Government Energy Consumption by 30%
- Target 6: Improving air quality toward attainment of federal standards
- Target 12: Reducing vehicle miles traveled by 10%
- Target 15: Making Philadelphia the Greenest City in America

12 http://www.mayorsinnovation.org/pdf/PhiladelphiaFleetManagement.pdf

Telematics

Telematics is a robust tool used in fleet management, a highly customizable vehicle information package which can include engine, sensor and/or GPS data. Today's vehicles capture a full range of data, from the time drivers spend idling to the number of times a vehicle is in reverse, and even what voltage the battery is receiving at certain intervals of the day. Telematics helps end users and fleet managers better understand how their vehicles are being used and their location geographically throughout the course of the day.

Telematics can give the OFM better information to make informed decisions. The challenge (as with most data-driven applications) is making use of the information obtained to its fullest potential.

A telematics solution for Philadelphia would support current initiatives for vehicle reduction and optimization, operational management improvements and idle reduction. The greatest benefits to the OFM would be:

- **Reduced maintenance costs.** The OFM does not currently use a proactive vehicle maintenance approach, which impacts overall cost. Running telematics on a vehicle will tell mechanics about potential problems before they become costly. Maintenance of a telematics-enabled vehicle is proactive instead of reactive;
- **Driver behavior and safety.** One of the largest contributors to maintenance costs is driver behavior, which can be monitored and corrected early in the process. Telematics can produce output from sensors that tell management if idling, excessive speeding, braking and acceleration are occurring. City programs like idlefreephilly.org can be enhanced as a result of telematics output;
- **Route optimization.** Telematics will enable the OFM to assess mileage by individual vehicles to reduce overlapping routes. This will reduce unnecessary mileage and emissions and will contribute to greater operational efficiencies and fuel savings, especially in heavy duty vehicles;

Figure 13: Telematics overview platform

ENGINE DATA	GPS DATA	SENSOR DATA	MAP DATA
Automotive	**Dispatch**	**Safety**	**Process**
• Vehicle diagnostics • Fault codes • Conditional maintenance	• Dispatch planning	• Seatbelt • In reverse • Driving habits	• Enhanced capabilities for work measurement processes

- **GPS.** GPS tracking helps route optimization and vehicle accountability. Telematics enabled with GPS will help the OFM in vehicle optimization because each vehicle's exact location can be tracked during the entire day.

Telematics is an integrated solution for the OFM although its impact reaches further, to the end user and to those served by the public sector. As a standalone solution it is valuable, but tied to an asset management platform and vehicle optimization package, it makes major improvements in cost and operational efficiency possible.

Issues/considerations

- **Safety and environment.** It is necessary to ensure compliance with Federal Motor Carrier Safety Administration (FMCSA) regulations and to take opportunities to align with the City's environmental performance objectives.
- **Cost.** The overall cost associated with outfitting equipment-ready facilities and level of vehicle integration. Telematics will require capital investment, but there are a range of equipment choices depending on the data required. The OFM needs to consider the ROI and what is the marginally accepted range for implementation.
- **Training.** Telematics integration will produce a need for enhanced training of end users and mechanics.

Next steps & quick wins

- The most effective way for the OFM to assess telematics as a solution would be to:
  - Obtain agreement from stakeholders.
  - Interview current and leading telematics service companies to determine best options for the City.
  - Consider a review of requests for quotations and information in conjunction with stakeholders, possibly with an initial pilot-scale application.

Greenworks Philadelphia objectives

- Target 1: Lower City Government Energy Consumption by 30%.
- Target 5: Reduction of Greenhouse Gas Emissions by 20%.
- Target 6: Improve Air Quality Toward Attainment of Federal Standards.

Training

As described on page 36, one of the largest contributors to maintenance costs is driver behavior. Regular certification training programs and safety training will help to reduce the cost associated with injuries and misuse of equipment. The use of telematics can further support the monitoring of driver behavior and can be linked to corrective training. Scaling up driver training programs can therefore be a key management strategy in improving operational performance, cost efficiency, and driver and public safety.

Specialized equipment needs specialized training to operate properly. For example, operators of fire apparatus are not required to have a commercial driver's license (CDL) to operate the equipment. However, these vehicles have air brake systems that cause damage and very expensive repairs when operated improperly. A training program to address this would be a cost saving.

Studies of injuries and time out of work can identify any opportunities to improve availability. When employees are injured and can not work, the work still has to be done and this usually incurs greater expense.

Due to the mission critical nature of fire and police needs for vehicle availability, funding and expense for rapid repair cannot be benchmarked against other City fleet needs. The fleets of these two critical departments need to be benchmarked separately from other departments such as water, DHS, and departments where the vehicle needs may not be as critical.

The City of Philadelphia already provides motorcycle training for outlying municipalities and training on City owned equipment. Establishing a cost recovery model for this external service can help support the expansion and enhancement of its own training activities.

Issues/considerations

- **Cost.** Training and the cost associated with developing and implementing training programs. What are other cities doing in the area of training? Do stakeholders recognize the value and the cost benefits of training?
- **Location.** Training facilities need to be centrally located in the city.
- **Sharing.** Developing a fleet forum to develop best share practices, working with and learning from private sector companies that operate fleets.

Next steps & quick wins

- Develop the training facility/program.
- Recommend the restructuring of the Daily Vehicle Inspection Driver Report.
- Recommend greater visibility between OFM and key decision-makers. Document the correlation between driver or operator behavior and maintenance expense.

Alternative fuels

The City of Philadelphia operates and maintains the diverse set of vehicles needed to provide mobility and services to employees and its citizens. The UII was asked to help facilitate a modernization of the City's fleet and contribute towards meeting *Greenworks* targets 1, 5 and 6. The analysis and recommendation in this section are specific to Philadelphia, but the approach and methodology could serve as a template for other cities.

The UII team approach and recommendations emphasize neutrality with regard to specific manufacturers, vehicle models, and technology. The objective was to provide a comprehensive assessment and inform the City of the risks, opportunities, costs and benefits of different vehicle, fuel, and propulsion options for the major vehicle types. The analysis ultimately recognizes that the City leadership is best positioned to make purchasing decision and decide on a strategy that best meets its technical, socio-economic, and political objectives.

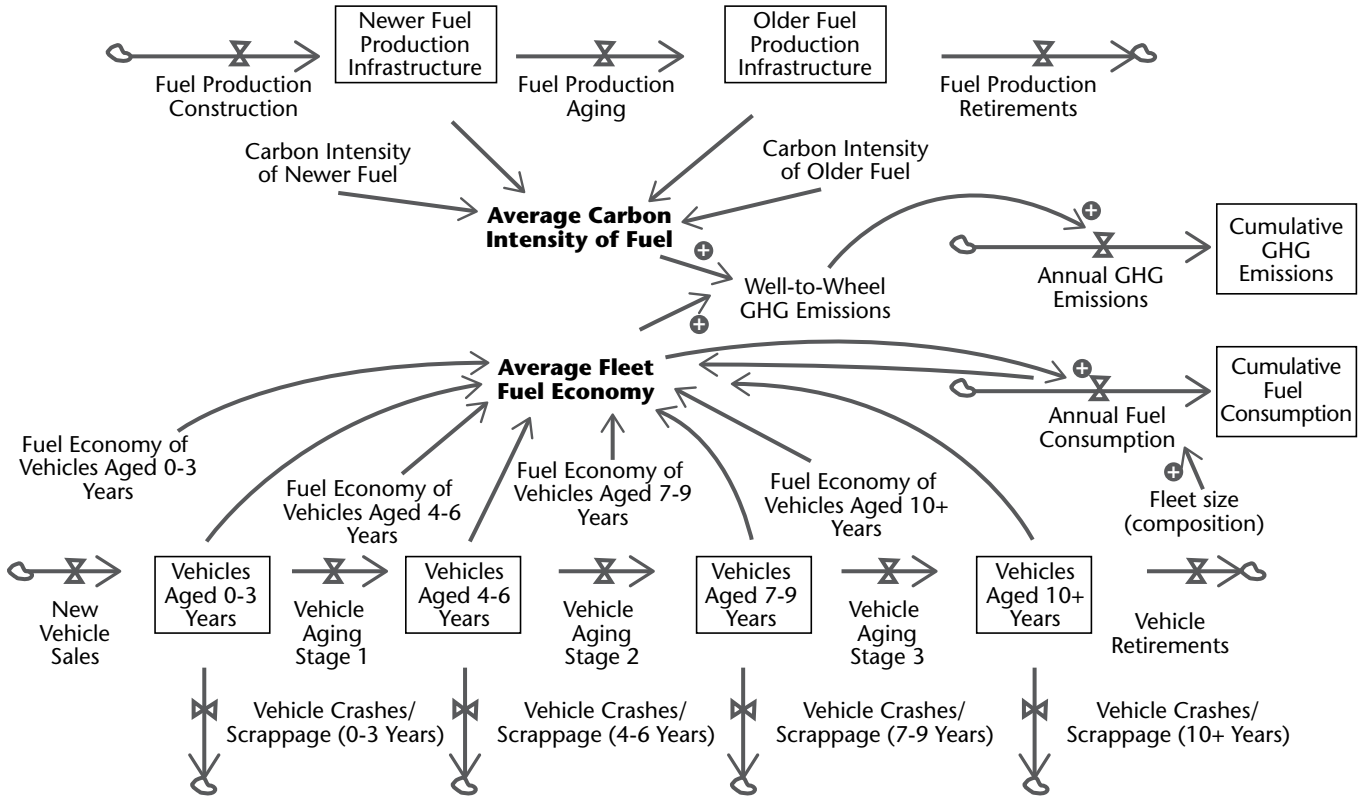
The UII team engaged with the OFM and conducted several visits to the fleet facilities and vehicles. The purpose was to gain the requisite understanding of the vehicles, the environment they operate in, practical constraints, and cultural issues specific to Philadelphia that influence or impact the relative merits of each option.

Alternative fuel analysis

Fuel and powertrain technologies were each considered for the primary vehicle types used by the City: biofuel (ethanol and biodiesel); natural gas; hydrogen; methanol; gas-to-liquid; electricity; hybrid; and advanced internal combustion engines (ICE). Five primary topic areas were evaluated: operational requirements; location dependencies; infrastructure requirements; energy and environment benefits; size and capability needs for each vehicle. Other factors considered include the cost and availability, and infrastructure investment.

The UII team recommends a system-level approach using a continuous improvement pathway that maximizes the vehicle turnover rate and total number of vehicles that incorporate an alternative or advanced powertrain. This approach recognizes that the cumulative benefit achieved is not a function of the absolute performance of a single vehicle, but that of the fleet and its fuel. This is dependent on the level of technology, the depth of penetration, and the rate of vehicle turnover. At the same time, a co-evolution of the fuel mix can occur depending on the propulsion system technologies chosen. This concept is illustrated in figure 14 and reflects the team's recommended three-year decision timeframe.

Figure 14: Vehicle fleet performance analysis



The UII team recommends that the City revisit vehicle selections on a three year basis. This is based on the typical industry vehicle development life cycle of 5-6 years with a mid-cycle refresh. On average, the City can expect half of the vehicle options to be new and should provide options for meaningful improvements. It reflects the need to balance contracting and purchasing options with the reasonable rates of vehicle development.

UII recommendations

The UII team envisages prioritizing the light-duty fleet (cars and SUVs). A simple system dynamics (SD) model (figure 14) evaluating fleet roll-over indicates that the City can readily achieve a 20% reduction in fuel consumption within four years. Greater reductions will be achieved as the City continues to improve the overall performance of the fleet. The team recommends that the City invest in creating a more detailed SD model and in evaluating a range of purchasing and fuel scenarios and options across the entire fleet.

The proposed approach minimizes risk and the cost and complexity per reduction of fuel and emissions. This is achieved through an emphasis on advanced ICE and hybrid powertrains with targeted investment in other alternatives (figure 16). Advanced ICE and hybrid technologies are prioritized due to their relatively low-risk and easy reduction in fuel consumption. Concurrently, the relative maturity of the technology, and available powertrains and vehicle platforms maximizes the options and potential for more competitive pricing for the City. The team does recognize that the application of hybrid or any advanced technology into demanding environments such as police cruisers does pose challenges. The individual performance of any vehicle or power train will likely vary from the label values for the vehicle. A first step should be to measure the real-world fuel economy of individual vehicle types and also to test new options first to characterize their performance against the normal use values reflected on the label.

Figure 15 illustrates the diminishing returns of fuel consumption reductions for linear increases in fuel economy. This is the difference between fuel economy and fuel consumption. Moving older vehicle types to hybrid powertrains can achieve significant petroleum usage reductions. Moving beyond this first step given the current and near-term state of the technology will achieve minimal additional fuel savings but will cost considerably more and will increase the uncertainty of the performance of the vehicle. For a fixed budget, it will also result in fewer vehicles purchased and slower fleet turnover, leading to more limited GHG and petroleum consumption reductions (figure 14).

Significant uncertainty remains on future fuel and powertrain development. Minimizing infrastructure investment and avoiding lock in of technology pathways for 20-30 years through specialized infrastructure provides the best opportunity for the City to take advantage of an evolving vehicle market that is improving efficiency every year.

Specific high-level recommendations are illustrated in figure 16. These recommendations reflect the current state of technology. The vehicle types reflect the five largest volumes of vehicles operated by OFM and comprise a large majority of the entire fleet.

Figure 15: Vehicle fuel consumption vs. fuel economy

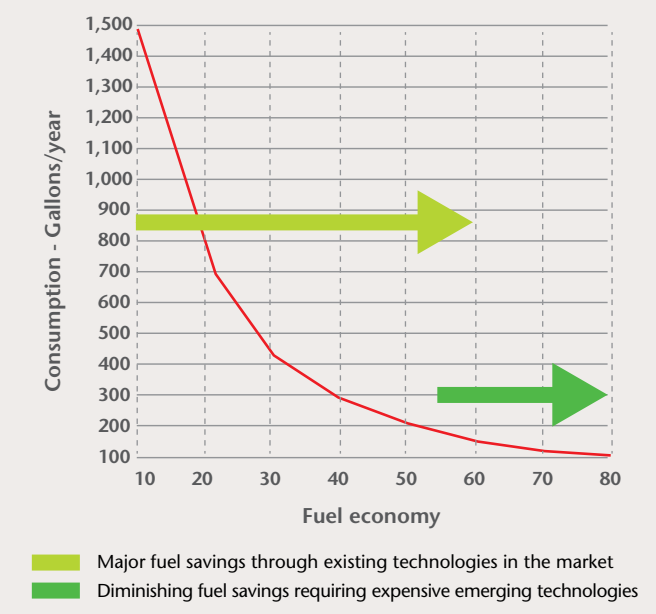


Figure 16: Initial recommendations modernization pathway

Passenger	P) Hybrid	Range, duty-cycle, and fueling flexibility. Significant O&M savings.
	A) Plug-in hybrid electric vehicle (PHEV)	Appropriate for limited applications. Maintains flexibility. Manageable charging investment.
Pick-up	P) Biofuel	Flex-fuel vehicles (FFV) and higher efficiency ICE powertrains available.
	A) Hybrid	Not available yet. In development. Option next round.
Sport utility	P) Hybrid	Best available alternative option. Full operational flexibility.
Compactor	P) Hydraulic hybrid	Some availability. Balanced cost with savings for given duty cycle.
	A) CNG	Appropriate for central refueling. Well characterized. Potential ROI.
Medic & vans	P) Biofuel	Risk adverse segment. Limited powertrain production options.
	A) Hybrid	Possible to leverage other platform technology in future rounds. No vehicle availability limitations due to charging requirements.

P) Proposed
A) Alternative

Natural gas

The team was specifically asked to consider the role of compressed natural gas (CNG) and liquefied natural gas (LNG) for the fleet. This reflects Pennsylvania's increasing production of natural gas from shale reserves and the current low prices for natural gas.

The UII team believes caution is required because the price could rise as the supply and demand ratio changes, eroding the current price advantage. The most promising applications are in commercial vehicle applications rather than light-duty vehicles. Applications such as trash compactors have a high market penetration of CNG and may be suitable for the city if infrastructure can be built.

For the majority of vehicles other than trash compactors, several issues suggest caution is necessary in relation to natural gas. First, the environmental attraction of CNG/LNG as a gasoline or diesel replacement may diminish if concerns grow about methane leakage and local environmental impacts from shale gas production.

Another consideration is the significant infrastructure investment needed for fueling and maintenance. This could delay deployment of the vehicles and detract from the cost-competitiveness of the fuel. Investing in CNG could commit the city to a longer term commitment to this fuel choice and preclude the use of other options such as fuel cells, plug-in electric vehicles (PHEVs), and biofuels sourced from Pennsylvania feedstocks.

If the City does use CNG/LNG, the team recommends signing a contract with a third party fuel provider to avoid long-term infrastructure commitment and uncertainty.

The city as a catalyst for more sustainable mobility

The approach recommended by UII should serve as a catalyst for broader sustainability throughout the city. The current market share for advanced technology, including hybrids, remains low. The changes and evolving fleet, and a more ubiquitous presence of vehicles with high fuel economy will allow the City to lead by example and continuously report on improvements as it evolves its fleet. The City can avoid some of the polarizing debate over alternatives and subsidies and instead demonstrate more cost-effective improvements and real value to its constituents.

Conclusion

The UII engagement with Philadelphia ranged from the specific needs of fleet management to the broad opportunities for integrated solutions in EcoDistricts. In addressing these wide-ranging topics, the engagement benefitted from excellent cooperation by City officials and wide access to information. The multi-company approach also contributed to effective engagement with the City, allowing for wide-ranging discussions at a strategic level.

The UII proposals benefitted from the team members' experience in several cities and the knowledge and experience they brought from different sectors. This supported the development of practical solutions connecting technologies and City functions. The UII's integrated approach resulted in solutions which cut across the City's departmental responsibilities. Similarly, proposals for mobility solutions covered various modes and different service providers. This highlights the connections between challenges which may often be considered separately, such as energy and water, and the need to consider sustainable city development holistically.

The engagement has confirmed the potential for businesses to work with cities early in infrastructure strategy development, bringing a broad perspective to tackle the interconnected issues cities have to deal with in developing sustainable infrastructure. The City found the engagement helpful in accessing private sector insights which are not easily available to public sector bodies. It brought new ideas, technical expertise and external validation of the *Greenworks Philadelphia* program. The work also demonstrated that sharing thinking with the private sector can help a city to look beyond the immediate imperatives which typically preoccupy officials.

While this report presents suggested solutions specific to Philadelphia's needs, many of the solutions will also be applicable to other cities facing similar challenges.

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Mayor Michael A. Nutter with members of the UII team

Photo by Mitchell Leff, City of Philadelphia

Acronyms and abbreviations

APMs	Automated people movers
ARRA	American Recovery & Reinvestment Act
BMS	Building Management Systems
BRT	Bus Rapid Transit
CNG	Compressed natural gas
DOE	Department of Energy
DVRPC	Delaware Valley Regional Planning Commission
FMCSA	Federal Motor Carrier Safety Administration
FTA	Federal Transit Administration
GIS	Geographic information system
GSI	Green stormwater infrastructure
HARA	A commercial, cloud-based database to measure greenhouse gas emissions and carbon footprints.
HOV	High occupancy vehicles
HVAC	Ventilation and air-conditioning
ICE	Internal combustion engine
ICM	Integrated Corridor Management
IMP	Integrated mobility platform, an IT-infrastructure enabling mobility providers to offer transportation services
ITS	Intelligent transport systems
LNG	Liquefied natural gas
MOTU	Mayor's Office of Transportation and Utilities
NRDC	Natural Resources Defense Council
OFM	Office of Fleet Management
PennDOT	Pennsylvania Department of Transportation
PHEV	Plug-in hybrid electric vehicle
PHL	Philadelphia International Airport
PIDC	Philadelphia Industrial Development Corporation
PJM	Local wholesale electricity market
PPA	The Philadelphia Parking Authority
SCADA	An IT infrastructure enabling control and data acquisition for smart water network
SEPTA	The South Eastern Pennsylvania Transportation Authority
SMIP	Stormwater Management Incentives Program
SUV	Sport utility vehicle
TIF	Tax Increment Financing
TOD	Transit oriented development
TMC	Traffic Management Center
TRID	Transit revitalization district
TSP	Transit signal priority
US EPA	US Environmental Protection Agency
VMT	Vehicle miles travelled

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