# Invest in green and resilient infrastructure

## Introduction

Until recently, urban populations were declining, leaving cities without the population and financial bases they needed to maintain and upgrade their infrastructure and services. At the same time, demand for those services increased. Consider the increase in vehicle miles traveled per capita as the population became increasingly suburbanized, which has caused increased demand for, and wear and tear on, roads—all of which requires significant budget allocations from cities. Cities have been expected to solve our nation's most intractable social and economic problems with little support.

Despite a new attitude from the federal government, cities today are barely able to recover from the recession; most are still reeling from the fallout of the economic disaster that struck several years ago. This makes it much harder and more complicated—but increasingly more urgent—to implement high-road policies.

Another storm is gathering in the form of global climate disruption, which is already harming cities in concrete ways, including extreme weather. This is compounded by cities' increasingly decrepit infrastructure: storm water systems unprepared for multiple hundred-year floods in the span of a mere decade; uninsulated buildings heated and cooled in new temperature highs, lows, and sustained extremes by energy from unstably priced dirty sources; and roads and bridges unable to handle increased traffic and freight.

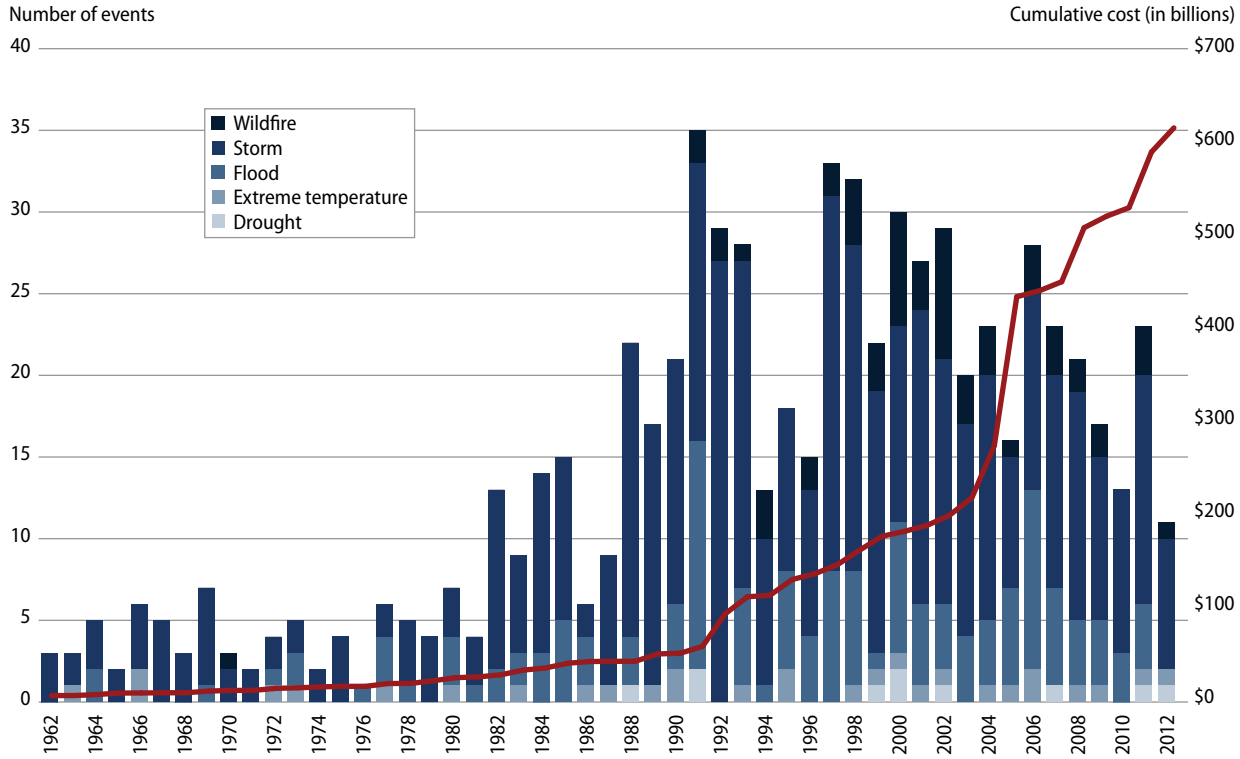
At the same time, cities are continuing the historical trend of pushing external costs of economic development and infrastructure onto low-income neighborhoods. The poorest communities in our cities have carried the brunt of the impacts of the financial collapse, crumbling infrastructure, and climatic turmoil. They live in the most inefficient buildings, spend the most proportionally on energy, and are most vulnerable to the health impacts of extreme temperatures. They have the least access to transit and walkable amenities, resulting in increased

Another storm is gathering in the form of global climate disruption, which is already harming cities in concrete ways, including extreme weather.

FIGURE 5

## Costing us billions of dollars

Extreme weather events in the United States




Source: EM-DAT: The OFDA/CRED International Disaster Database www.emdat.be - Université Catholique de Louvain - Brussels - Belgium

car-dependence and associated spending. Their properties are more vulnerable to flooding. City budgets that deal with increasingly frequent emergency needs divert resources first from the services to the poor.

The physical infrastructure of cities and neighborhoods but also the systems that make our economy possible—such as energy, transportation, food and water systems, and waste management—are critical to economic recovery and climate resilience. The connections here are obvious: Our already aging infrastructure is under increasing pressure as a result of climate disruption and the changing temperature and precipitation patterns it brings. The economy both relies on these systems and affects our ability to construct and maintain them. As a whole, our infrastructure is aging, under maintained, and largely inefficient, and the impacts of that are not shared equally. There is a tremendous opportunity for improvement and almost no money to make that improvement.

We need to maintain, upgrade, and replace our aging, outmoded infrastructure with greener, more efficient, and more effective infrastructure. But that does not mean we need "more." In short, we need to build and rebuild better, not bigger—where "better" means not just efficiency or economy but also better service to the community, more jobs, more equitable outcomes, and more healthy—or less harmful—environments.

We need a built environment that reduces runoff, buildings that use less energy, and healthier transportation solutions. But we also need to distribute infrastructure costs more fairly. The amount of money needed for energy and infrastructure is often discussed, but the issue of distribution of those costs is rarely considered. The question of who pays and how is at least as important as the revenue total. When done right, pricing policy both reduces the total amount needed—as well as negative externalities from energy and infrastructure use—and can reduce longstanding economic inequities.

Through intelligent infrastructure investments, cities can save money, protect the environment, provide jobs to members of their community that need them, and mitigate climate change. Some strategies that can lead to newly vibrant and prosperous cities include: green storm water and energy-efficient investments that pay for themselves; local food systems with streamlined supply chains; and pedestrian and bicycle infrastructure that reduce auto dependence.

To further spur investment in infrastructure, leaders can help make the markets that operate in our communities more efficient and transparent. They could make available information such as one's current energy use provided by a smart meter or the energy use of a prospective new home provided to potential buyers.

## Land-use planning

### Background

The rise of the automobile led to transportation planning that created vast swaths of metro areas devoted to low-density residential neighborhoods, requiring long drives to work, school, and other destinations. This planning has been costly, as traffic volumes and longer distances mean bigger, more expensive highways and utilities—costs often borne by those in older areas of metros.

It has also effectively barred working-class residents, who face daunting costs to operate autos, from access to many jobs, neighborhoods, and other opportunities. Cruelly,

when people without cars do reach a car-centric destination, they often subsidize better-off drivers, whose free parking is built into the cost of rent, goods, and services.

The environment has suffered too, as vehicle emissions increased, and undeveloped and agricultural land was paved over. The planned open spaces of 1912 were parks that aided livability; too often the open spaces of 2012 are parking lots that do little to make cities more livable and degrade streams with tainted runoff.

Today metro areas are struggling to push the pendulum back—away from rigidly exclusive zoning and car-centricity to regain some of the economic and social vitality that was lost in the rush to "modern" planning. There are many obstacles, not the least being the late-20th century built environment. The racism and classism at the root of the white flight that hollowed out our urban cores still plays a role. The media and popular culture have also contributed, setting up suburbia as the American Dream and car-culture as the preferred option, such that many people still consider living in low-density, residential-only neighborhoods a sign of having "made it."

Too often the open spaces of 2012 are parking lots that do little to make cities more livable and degrade streams with tainted runoff.

Yet progress is happening; the move to lower density in U.S. urbanized areas has halted, and many cities and suburbs are relaxing restrictions on use and auto-orientation. Now cities face another challenge—using land-use and planning tools to adapt to climate change, especially extreme weather events.

Many of the policies discussed in the Infrastructure chapter will help with climate change by reducing greenhouse gas emissions and mitigating the intensity of the change. Others will help adapt to climate change—for example, using green infrastructure for storm water management will help adapt to flooding due to more extreme rainfall. Land-use planning needs to consider adaptation as well.

### Plan and zone for compact, mixed-use neighborhoods

Most local governments use zoning codes to regulate land use, often providing guidance for zoning decisions via comprehensive plans. Zoning and planning documents together go a long way toward determining the form and function of the built environment.

An obvious way to combat exclusive, low-density zoning is to rewrite these documents to permit or even require a mixture of uses and densities that foster travel by foot, bike, and transit. Mixed use may be encouraged or required within individual

developments—typically this involves retail on the first floor of a multistory office or apartment building. Or the codes may permit different uses on individual parcels in close proximity, allowing for corner stores in a residential neighborhood, for example.

Examples of resulting development are now numerous, ranging from high-density downtown infill such as Atlanta's Atlantic Station,[1] to moderate-density greenfield projects such as Kentlands[2] in Gaithersburg, Maryland.

Some cities go a step further and decline to regulate uses—a vestige of the time when employment centers meant dirty factories rather than office buildings—and simply regulate the form that development should take, with rules on height, mass, and other physical elements but not on use.[3]

## Reform parking requirements

At the dawn of the auto age, planners scrambled to figure out how to handle the new crush of vehicles on city streets. Cars, streetcars, trucks, and pedestrians all competed for limited space. Planners decided on a straightforward solution: Any new store, office, or residential structure must provide its own off-street parking. Minimum parking standards, based on square footage, employees, bedrooms, or other metrics, were quickly enacted, often with little supporting data.

The problem might have solved itself via the market, with parking meters and off-street garages providing paid spaces, but the new rules dictated such an oversupply that parking became free—or more accurately, became subsidized by the customers, tenants, and others doing business at each site, whether they used the parking or not.

This oversupply of parking spreads out development, making walking, biking, and transit less appealing. It also presents enormous opportunity costs, occupying valuable land with pavement that often goes vacant most of the time. And it contributes to runoff and other environmental ills. Perhaps most important, "free" parking generates more traffic than would occur if it were properly priced.

Some cities, such as Madison, Wisconsin,[4] are reducing or eliminating minimum parking requirements, allowing for multiple sites to share parking, or imposing parking maximums. Others, such as Pasadena, California,[5] are pricing street parking higher to ensure adequate supply, send a price signal to motorists, and capture revenues. One of the seminal thinkers in this area, Don Shoup of the University of California, Los Angeles, provides many more details and examples.[6]

Parking reforms are now fairly common in downtowns but less so in more suburban-style areas, where off-street parking is plentiful. Often chain developers in these areas insist on large parking areas even if codes do not require them. Because the built environment is so auto-centric in these areas, reforms will take longer to produce gains.

## Plan land use and transportation coherently

In the streetcar era, land use and transportation went together. When developers wanted to build, they would provide transportation infrastructure so people could access the site. In the auto era, developers largely pushed that responsibility to local and state governments. They provided streets that were internal to their developments but not the thoroughfares that connected these neighborhoods, malls, or offices to other parts of the region.

Governments had to "chase" development by constructing new or wider roads. These new roads then provided quicker access to outer parts of metros, spurring more development, congestion, and road expansion.

This practice, combined with the planning, zoning, and parking policies described above, led to social exclusion and environmental harm. It is also financially unsustainable, saddling agencies with thousands of miles of now-aging roads and bridges that must be maintained and eventually rebuilt or abandoned.

More efficient land-use and transportation planning starts with the realization that each aspect affects the other, so they must be considered simultaneously. For example:

- Transit, which lessens the need for wide roads and parking areas, fosters the type of compact development that is more livable and equitable. Transit-oriented development[7] marries these explicitly. Provision of transit in areas with zoning that allows compact development more commonly results in a "transit multiplier"[8] effect, which reduces travel distances and costs even for those not using transit.

- "Transportation demand management"[9] encompasses a suite of measures that businesses can use to lessen commuting: subsidized transit passes, bike facilities, carpool matching, emergency rides home, and others. These measures reduce traffic and congestion and are thus attractive to local governments, which can require or encourage them during the zoning-approval process or across the board, as occurs in Bloomington, Minnesota,[10] and many other cities.[11]

## Climate adaptation planning

Adapting to climate change is a large topic that cuts across most of the areas covered in this book. Cities must prepare for climate change in all manner of ways, but particularly in the planning, installation, maintenance, and improvement of infrastructure. The exact nature of adaptation planning depends on the geographic location of the city and the projected climate effects in that region.

Cities must prepare for climate change in all manner of ways, but particularly in the planning, installation, maintenance, and improvement of infrastructure.

Coastal regions, for example, must adapt to rising seas and increased flooding; mountainous regions are likely to see less snow pack overall; and dry regions are likely to experience increasingly severe droughts. Cities will, in general, experience more extremes in temperature and more intense storm events.

Cities should, first and foremost, learn how climate change will impact their region. Based on that, they should assess the vulnerability of the general population, municipal infrastructure, and municipal services to those impacts. Cities should create adaptation plans specific to these effects and vulnerabilities. Many have already started.[12]

The Institute for Sustainable Communities identifies key challenges in adaptation planning and suggests key elements to the planning process:

- Risk assessment and prioritization
- Integration of adaptation into planning and operations
- Commitment on adaptation from government and the public
- Cross-jurisdictional and cross-sectoral collaboration
- Economic evaluation of adaptation measures
- Funding adaptation
- Performance measurement for resilience[13]

Adaptation may seem daunting, but cities already respond to many of the challenges climate change will bring, albeit at a less severe level. What is important is to integrate climate change into planning and to think about the resilience of the community as a whole, with a particular emphasis on vulnerable populations. Probably the single-best way to increase the ability of low-income families to respond to climate change is to increase their overall economic stability.[14] Many of the policies recommended in this report will help local governments either mitigate or adapt to climate change, but cities should still create a specific adaptation plan.

Land-use planning is a particularly important tool in adaptation planning since the resiliency of a community is highly dependent on its land-use policy. Local governments can increase resiliency by discouraging development in areas vulnerable to hazards such as flooding, wildfire, land erosion, and by protecting natural capital such as wetlands and forests.[15] They can adapt to rising temperatures and deadly heat waves with cool roofs, cool pavements, and expanding the urban forest.[16]

Coastal communities in particular should use land-use and planning tools to adapt to sea-level rise and increased flooding. There are a number of tools to do so, nicely summarized in a report by the Georgetown Climate Center.[17] As part of a comprehensive adaptation plan, Chula Vista, California, has revised its land development codes to take into account the vulnerability of sites to flooding and to ensure that storm water infrastructure can accommodate it.[18]

## Fix-it-first and build complete streets

### Background

As car ownership became more widespread, government at all levels focused on expanding the system of roads and highways to reap the benefits of faster, cheaper, and more flexible transportation. But as we enter the 21st century, we are faced with the subsequent problems. Our roads and bridges are falling into disrepair, the cost of adding roadway capacity is increasingly prohibitive, and designing streets solely for cars—which often reduces mobility for walkers, bikers, and transit riders—is an inequitable and inefficient use of public funds.

Responsible transportation policy requires that we fix our existing infrastructure first. We should prioritize the maintenance of existing infrastructure over the expansion of roadway capacity and build complete streets to serve all users, not just drivers.

### Fix-it-first

Fix-it-first policies emphasize the preventive maintenance and repair of existing infrastructure over infrastructure expansion. Applied to transportation, this means maintaining and repairing existing streets, bridges, and other transportation infrastructure first rather than spending money on expansion or new facilities. Where there is a legitimate need for new infrastructure, projects should be supported by the community and as cost effective as possible.

A fix-it-first approach to transportation investment improves safety, reduces maintenance backlogs, encourages smarter land use, and lowers vehicle emissions and operating costs.

Case in point: Potholed roads add to the cost of driving through poorer fuel efficiency, faster vehicle depreciation, and more frequent repairs to tires and suspension systems.[19] This cost is disproportionately borne by urban residents since roads in need of maintenance or repair are concentrated in urban areas. In 2007, 13 percent of all major roads in the United States were rated poor, but more than 25 percent of major urban roads were rated poor. And in many of the nation's largest cities, the situation is significantly worse. In Los Angeles, San Francisco, and New York City, more than 50 percent of all major roads are in poor condition.[20]

Researchers estimate that the average driver pays roughly $335 annually due to costs imposed by poorly maintained roads; drivers in some urban areas may pay nearly $750 annually.[21]

It makes sense for cities to fix bad roads and bridges before adding new capacity.

By maintaining and repairing existing infrastructure in a timely fashion, cities can also maximize the benefits of previous investments and reduce total required maintenance expenses. Beyond a certain point on the pavement lifecycle curve, small delays in maintenance can result in much higher costs. Researchers at Michigan State University have estimated that for every dollar spent on preventive maintenance, $4 to $10 is saved in rehabilitation expenses.[22]

Over the past decade many states and some local governments have implemented fix-it-first policies.[23] The Nashville Area Metropolitan Planning Organization in Tennessee recently embraced the concept in its 2035 Regional Transportation Plan, which identifies "adopt[ing] a 'fix-it-first' mentality in directing transportation funding" as a key objective.[24]

It makes sense for cities to fix bad roads and bridges before adding new capacity.

### Complete streets

Although our transportation system has been largely focused on the personal automobile since World War II, a large percentage of the U.S. population does not drive for reasons of age, income, physical ability, or personal preference. Streets and roadways that only accommodate a single type of travel are "incomplete" because they do not serve all roadway users.

Streets and roadways that only accommodate a single type of travel are "incomplete" because they do not serve all roadway users.

A "complete street" has infrastructure that makes walking, biking, and using transit safe and practical. The public needs to be able to both travel along a corridor (via sidewalks, paths, and bike lanes) and across a corridor (via safe crossings, underpasses, and overpasses), and without undue detour.

The inability to safely walk, bicycle, or access public transportation restricts mobility, social interactions, and job access for anyone that cannot or does not want to drive for every trip.[25] Lack of sidewalks mean children cannot safely walk to school, people with disabilities may not be able to use the roadway at all, and transit users cannot safely access bus or rail stops.

Lack of safe walking and biking infrastructure also prevents many children and adults from using these "active transportation" options. The Centers for Disease Control and Prevention has determined that community design—such as that which discourages active transportation—is a contributing factor in the national obesity epidemic. The lack of safe places to be active—including through daily active transportation—is also a social equity problem.[26]

It is important that accessible facilities be provided on all roadways, regardless of the size, location, or type of adjacent land use. In too many cases, opponents of adding pedestrian, transit, and bicycle infrastructure will argue that there is currently no pedestrian traffic, bicyclists will not ride on the roadway, or there is currently no transit service, so passenger facilities such as sidewalks, bus pull-outs, or loading pads are not needed. The additional cost of providing these facilities is also used as an argument against complete streets.

In almost every case, however, the additional cost is minimal relative to the cost of the roadway project if the facilities are included in road construction or rehabilitation projects. Retrofitting roads as complete streets later is much more costly.

Many cities, counties, and metropolitan planning organizations, or MPOs, are now adopting complete streets policies or passing ordinances requiring the installation of bicycle, pedestrian, and transit accommodations on any new or reconstructed roadway.[27] An example of this language can be found in the Madison Area MPO Regional Transportation Plan 2030 in Wisconsin.[28]

Along with the adoption of complete streets policies and support for ordinances, local governments should ensure that developers pay for pedestrian, transit, and bicycle infrastructure through development impact fees, in addition to the sewers, street lights, and other infrastructure normally paid for with these fees.

The National Complete Streets Coalition[29] and Centers for Disease Control and Prevention[30] both provide model policies and a wealth of other information about complete streets.

## Public transit

### Background

Transit-supportive urban development combines urban densities with a mixture of land uses that include employment, residential, and commercial.[31] This urban development plus the quality and frequency of transit service is critical to the success or failure of a transit system. Transit that is able to move significant numbers of travelers provides a suite of economic, community, environmental, and social benefits.

Transit is an inherently more efficient method of transportation than a single-occupancy or low-occupancy vehicle. A single 40-foot bus can seat just more than 40 passengers with additional room for standing riders. This bus demands far less space on our roadways than individual cars with one or two people inside. Transit also places a much lower demand on our roadways, effectively freeing up limited public funds that cities may use to support other essential services.

Here is how cities can support public transit.

### Establish a dedicated revenue stream for transit

Establishing a predictable revenue stream at the local and regional level, independent of fare revenue and federal funding, makes it possible to improve and support a transit system. Examples include sales, property, gas, income, or payroll taxes; vehicle registration or car rental fees; public-private partnerships; and parking revenue.

Identifying these revenue streams continues to grow in importance, as transit ridership increases in the face of diminishing federal and state support.

A recent report by the Transit Cooperative Research Program identifies the essential elements of a funding campaign to support transit operations.[32] These include engaging stakeholders, building community support, identifying funding sources, planning projects, and educating the public.

Building public support must not be undervalued. When raising revenue for transit, nonusers might question why they must help pay for transit service. One cannot overestimate the importance of fostering a public understanding of the larger value of a healthy transit system, including increased economic activity; decreased roadway congestion; and community, environmental, and lower infrastructure costs.

Cities such as Denver work through a state-established Regional Transportation District, or RTD, to provide long-range planning for transit, system build-out, operations, and financial management.[33] By combining federal and state funding with local sales and use tax revenues, and creative public-private partnerships, the RTD has pursued meaningful system expansions that provide enhanced economic activity, regional connectivity, and improved quality of life for the entire community.

### Support transit-oriented development policies and projects

To support transit-oriented development, or TOD, cities should require new developments to build connected street networks, include transit service, and incorporate a mixture of residential, employment, and commercial uses, making transit a feasible and more appealing alternative to single-occupancy vehicle trips.

Transit-oriented development is more compact by design, reducing overall travel costs by shortening trips. And as demand for expanding lane miles and roadway width decreases, the cost of infrastructure construction and maintenance also decreases. It reduces the perceived need for wider roads and overbuilt parking.[34]

Minneapolis[35] and Denver[36] have included transit interests with other stakeholders to influence TOD policy discussions and project implementation. Examples from these two cities illustrate how TOD fosters the type of compact development that increases livability and equity by providing access jobs, goods, and services to nondrivers and drivers alike.

TOD also increases demand for transit by as much as 10 percent or 90,000 riders per day in the Washington, D.C., area.[37]

### Participate in transportation-demand management programs

Transportation-demand management, or TDM,[38] encompasses a suite of measures that can be used to reduce commuting by workers driving alone. TDM

reduces traffic and congestion, limits stress on existing transportation infrastructure, improves the environment, and improves health by increasing physical activity. Subsidized transit passes, guaranteed ride-home programs, and limits on the availability of subsidized car parking are a few examples of TDM policies.

Transit services should partner with municipalities, educational institutions, and local businesses to develop policies and programs that position transit to play a significant role in community livability efforts. Many transit systems already actively engage in TDM programs. Madison Metro[39] in Madison, Wisconsin; Metro Transit[40] in Minneapolis; and the Regional Transit District[41] in Denver all manage successful TDM programs.

## Freight transportation

### Background

As the economy has globalized, freight transportation has become more economically important, and its effects on society have become more obvious. Whether by truck, train, ship, plane, or barge, freight transportation creates a variety of environmental, economic, and livability challenges. At the same time, it is critical for economic development.

By managing how freight operations affect communities, public officials can support the growth of freight-intensive industries without sacrificing the health and livability of their communities.

Integrating freight transportation into development is the best way to ensure that communities are designed in ways that foster the efficient flow of freight and economic growth while reducing the harms of goods movement and the conflicts that degrade health, safety, and quality of life.

The total tonnage of freight entering, leaving, and moving within the United States is expected to climb more than 65 percent between 2010 and 2040—an average increase of about 1.4 percent per year.[42] With populations growing and most urban areas already experiencing substantial congestion, it is critical that communities plan for these increasing freight volumes. Such plans are best implemented at a regional level to avoid simply relocating freight to suburban areas.

With populations growing and most urban areas already experiencing substantial congestion, it is critical that communities plan for these increasing freight volumes.

### Provide buffers between residential areas and freight facilities

Conflicts often arise when residential or mixed-use areas are adjacent to freight-intensive industrial land uses. The noise, dust, light, vibration, and emissions that often accompany freight activity can reduce the livability of nearby areas and lower property values, and eliminating these negative aspects of freight activity is often not feasible. In order to accommodate the needs of industrial users as well as residents, local governments should ensure that there is sufficient separation.

The buffer zone ordinance in Portland, Oregon[43]—which is used when base zoning standards do not provide adequate separation between residential and nonresidential uses—requires larger buffer areas to separate residences from industrial and commercial land uses. By restricting motor vehicle access, increasing setbacks, requiring additional landscaping, and restricting signage within the buffer zone, the ordinance reduces the negative impacts of commercial and industrial activities on residents.

### Designate truck routes

Many states grant local governments the power to restrict the use of certain roads by commercial vehicles or by vehicles over a certain weight or dimensions. Local governments may restrict truck traffic to protect roads or bridges that may be damaged by heavy trucks; to improve the safety and comfort of pedestrians and bicyclists on the roads; to reduce congestion; or to reduce the exposure of residential areas, schools, and other sensitive areas to truck traffic and associated noise, exhaust, and vibrations.

Orlando, Florida, enacted a system of several designated truck routes in its downtown area to provide better mobility for pedestrians and bicyclists on nontruck routes and target truck-friendly roadway design and pavement maintenance activities to locations with concentrated truck traffic.[44] When traveling to or from locations in the downtown area, trucks are required to use the designated truck routes for as much of their journey as possible.

By designating specific truck routes, the city has also been able to tailor signal timing to the needs of trucks on these roads, providing longer green and yellow phases to account for the slower acceleration and deceleration of trucks, while focusing improvements and signal timing on nontruck routes to the needs of other users.[45]

## Connect industrial land uses with transportation infrastructure

Urban areas once occupied by heavy industry are being redeveloped into shopping districts, office buildings, and condominiums. In cases where the previous industries are no longer in operation, these changes have generally been positive. But when this new development encroaches on areas where industries are still active, conflicts can arise. And once land has been converted from industrial to residential or mixed use, it is very difficult to convert it back to industrial use.

This can be especially problematic near key rail facilities and ports because once industrial land near these facilities is converted to other uses, future industrial development will often be relegated to areas on the urban periphery where large suitable parcels are more available. This "freight sprawl" forces industries that need water or rail transportation to the urban periphery where they are forced to move goods by truck between their location and the ports or rail facilities in the urban center. The problem is particularly serious for industries reliant on waterborne freight transportation because the waterfront they need is in such high demand for residential development.

The U.S. Federal Highway Administration's "Freight and Land Use Handbook"[46] provides a good starting point for public officials interested in dealing with these issues. Baltimore enacted its Maritime Industrial Zoning Overlay District[47] to protect land around its deep-water harbor from residential development.

## Cluster industrial development

Communities should work with private-sector industries to identify locations with access to key highways, rail, water corridors, and airports where freight-related businesses can be clustered and should enact zoning ordinances to prevent nonindustrial uses in these areas. This can reduce conflicts between land uses, ensure that industrial users have access to the transportation infrastructure they need, and reduce the dispersal of distribution centers and other freight-intensive businesses away from ports and rail terminals that serve them—an inefficient development pattern that increases truck traffic.[48]

Metroplan Orlando in Florida identified a number of freight village locations in its 2030 Long Range Transportation Plan,[49] which details how locations were chosen and land-use policy strategies to promote their growth and development.

## Manage truck parking

Although truck transportation is critical to the urban economy, trucks loading and unloading goods to supply businesses in downtown areas significantly contribute to traffic congestion. Increasing truck-parking availability, better enforcement of existing regulations, and pricing parking to promote faster turnover are all strategies that cities can use to reduce congestion and smooth freight pick-up and delivery. The Federal Highway Administration's Urban Goods Movement[50] webpage links to a number of useful resources on local freight issues.

New York City recognized the problems with trucks double parking in congested midtown Manhattan and developed its Commercial Vehicle Parking Plan, which recommended providing additional curbside parking for commercial vehicles, increasing enforcement, and reducing the amount of time that trucks spent parked in the area.

While there is still room for work, there has been some initial success. In order to increase the turnover of curbside commercial-vehicle parking spaces, the city implemented an escalating rate structure, charging $2 for the first hour, $5 for the second hour, and $9 for the third hour.[51] As a result of the city's new approach to parking, it has been able to decrease the average occupancy time of commercial-vehicle spaces from 160 minutes to 45 minutes, and reduce average parking space occupancy from 140 percent—all occupied with double-parked vehicles at 40 percent of the spaces—to 95 percent.[52] Reducing space occupancy has also reduced truck congestion and associated noise and emissions in the area by eliminating the need for trucks to circulate through the neighborhood searching for parking.[53]

## Consider idling restrictions

Many counties and local governments have enacted restrictions on idling to improve air quality, public health, and reduce the noise and odor associated with idling vehicles.

The Idling Reduction Working Group[54] in Louisville, Kentucky, surveyed the idling restrictions in place throughout the country and compared[55] more than 100 different idling restrictions passed at the state, county, and local levels. Most of the restrictions identified were at the local level. Seventy percent of the restrictions limit idling to five minutes or less, although most idling restrictions provide exemptions in extreme temperatures and for vehicles using their engine

to power auxiliary equipment, among other reasons. Idling restrictions can reduce the community toll of truck operations without hindering the ability of trucks to do their primary jobs.

### Clean and safe ports

America's ports are critical to the movement of goods and thus to our economy. The ports in New York and New Jersey alone support almost 280,000 jobs and generate more than $5 billion in tax revenues annually for state and local governments.[56]

The problem is that they tend to be sources of pollution and foster unsafe and unfair working conditions. Air pollution from old or poorly maintained trucks disproportionately harms nearby, often low-income neighborhoods and the port workers and truck drivers themselves.[57] Further, drivers are often classified as independent contractors to avoid paying them fair wages or providing benefits, so they are left with all of the responsibilities and none of the benefits of being a contractor.[58]

Port authorities are public bodies, and they have some, though not unlimited, power to set employment and environmental standards and ensure that ports and trucking companies clean up their fleets, reduce air pollution, and treat workers fairly.

U.S. ports should adopt rules requiring trucking companies to take responsibility for the trucks they operate and forcing those trucks to meet emissions and maintenance standards. These rules would help immediately establish the conditions for a revived, cleaner industry.

The Ports of Los Angeles and Long Beach in California have adopted a Clean Trucks program that creates a direct contractual relationship between each trucking company and the port. The trucking companies receive access to port facilities and in return must meet certain labor, environmental, and other standards.[59]

## Parks and public spaces

### Background

Public spaces—including plazas, streets, sidewalks, parks, and more—are vital to cities and contribute to the health and welfare of their citizens, businesses, and economies. They are the spaces in which citizens interact with each other, and

they contribute to that intangible sense of place that is so important to community. Great public spaces are, according to the Project for Public Spaces, accessible, active, comfortable, and sociable.[60]

The 50 largest U.S. cities contain more than 600,000 acres of parks, ranging in size from just a few acres to tens of thousands. Major parks such as Lincoln Park in Chicago or Griffith Park in Los Angeles serve approximately 12 million people each year.[61]

Parks are an invaluable part of city life, making cities more beautiful, enhancing social and cultural vitality, promoting health through activity, and increasing the land value of surrounding areas. Parks not only function as community gathering places to host civic events and live performances—which in turn increases civic and social engagement—but they also make cities more beautiful.

The Trust for Public Land lays out seven factors that make an excellent city park system:

- A clear expression of purpose
- An ongoing planning and community involvement process
- Sufficient assets in land, staffing, and equipment to meet the system's goals
- Equitable access
- User satisfaction
- Safety from crime and physical hazards
- Benefits for the city beyond the boundaries of the parks[62]

This section will discuss how cities can use their park systems to create jobs for those who most need them, create and fund new parks, and preserve the urban forest, both in and out of parks. The role of parks in promoting health is also covered in the Health chapter.

## Creating parks

Cities should create and implement a plan to increase the quality and amount of parkland and to ensure that every resident has easy access to a park. Land for new parks and public spaces is limited, however, as most developed cities long ago turned farms and forests into cityscapes; finding ideal land for new parks therefore requires policymakers to be innovative.

Parks, however, do not always require new green space or even extensive vegetation. Derelict parking lots can be turned into parkland and unused surfaces such as rooftops can be used to make small green spaces or gardens. Cities have successfully turned abandoned industrial sites into large parks, while others have turned former railways into trails for walking, jogging, and biking.

Columbus, Missouri, received a $200,000 Brownfields Cleanup Grant from the Environmental Protection Agency, or EPA, to turn an abandoned petroleum facility located downtown into a three-acre park, complete with playgrounds, benches, gardens, local artworks, and an amphitheater. The grant covered approximately 20 percent of the total cost, while the city secured an additional 40 percent through donations and other land grants.[63]

A similar grant from the EPA paid for approximately half of a restoration project in Sacramento, California, that turned a contaminated brownfield into a park with community gardens.[64]

Cities also have used the space over highways to build parks—an activity that beautifies a city by reducing the visibility of traffic, dramatically increases surrounding land value and development potential, and thus increases tax revenue.[65] Dallas is currently building a five-acre "green roof" over the Woodall Rodgers Freeway—a project that received one-third of its funding from the federal government and another third from private donors.[66]

Cities are paying attention to the equity of park placement, too. In New York City, Sustainable South Bronx, a community-based organization, successfully lobbied for the creation of Hunts Point Riverside Park between the end of an abandoned street and the Bronx River. Several other parks are slated to open nearby, dramatically increasing neighborhood access to the river and parkland.[67] In the long term, advocates imagine an eight-mile greenway to connect the river, parks, and neighborhood.[68] Los Angeles recently announced that they are locating 50 new parks in high-density areas that currently lack parks, with a particular emphasis on communities of color. The city is taking advantage of the decline in property values to acquire land at a cheaper price that would have previously been possible.[69] And Chicago is converting Meigs Field, an old airport, into a park that will host camping for families and at-risk youth.[70]

Cities are also becoming more creative in increasing park availability. Some are temporarily or permanently closing streets to create public spaces and parks. San

Francisco closes two miles of streets in Golden Gate Park on the weekends, adding 12 acres of space that pedestrians, bicyclists, and kids can enjoy. This doubles overall park use. Kansas City, Missouri, took a similar action in Kessler Park. Both San Antonio and Los Angeles have permanently closed roads in parks. And on a much smaller scale, the mayor of Ithaca, New York, turned his city hall parking space into a pocket park.[71]

Some U.S. cities are adopting the *ciclovia* or "open streets" concept pioneered in Latin America. New York City, Baltimore, Chicago, Miami, and El Paso, Texas, close major roads for a day at a time (some once a summer and some on a monthly basis) to allow walkers, joggers, bicyclists, dancers, musicians—really, anybody but car drivers—to use the street. Tens of thousands turn out for these events.[72]

Another way to increase park use is to increase how accessible they are—particularly if users face steps, walls, streets, waterways, or other barriers when trying to access parks. Access can be improved by adding multiple entries, ramps, crosswalks, or pedestrian bridges; installing traffic signals at key intersections; or adding transit routes to them.[73]

Extending park hours does not create new parks, but it may create new access to them. Sports fields are commonly lit, and many cities, including Atlanta, Miami, and Oakland, California, have made a significant commitment to lighting these facilities. Minneapolis provides lit cross-country ski trails. Lights can extend useable hours between two to five hours a day, depending on the season, and can be cheaper than acquiring land, despite the cost of energy.[74]

Los Angeles keeps the lights on all night in some of its parks as part of Summer Night Lights, a gang and violence prevention initiative started in 2008. The city partnered with the school district and philanthropists to provide entertainment, recreation, education, and artistic activities between 7 p.m. and midnight. Gang intervention workers moderate disputes and negotiate cease-fires, and the activities provide an alternative to gang involvement. This nationally recognized program has achieved a 57 percent reduction in gang-related homicides and created 1,000 jobs.[75]

San Francisco closes two miles of streets in Golden Gate Park on the weekends, adding 12 acres of space that pedestrians, bicyclists, and kids can enjoy.

## Funding parks

As is discussed abundantly in this book, city revenues are down, and every area of city services are suffering as a result. The Center for City Park Excellence estimates that

urban parks have $6 billion in deferred maintenance costs.[76] Lack of funds reduces employment for park workers as well as programs and services. In this environment it is hard to imagine being able to create new parks. But cities are finding a way.

Parkland acquisition and park creation, a capital expense, can be funded through general city revenue or bond sales. Other potential sources of funding are philanthropy and corporate contributions—sometimes in exchange for naming rights—and special taxes, often sales taxes, which may have to be approved by referendum. Oklahoma City added a penny to its sales tax and uses the proceeds to invest in the downtown core, including creating gardens, trails, and a 70-acre central park.[77]

Impact fees are a common source of funding for parks, both for creation and maintenance. Cities charge developers of new residential or commercial buildings a fee related to their impact on the parks system and use the funding to improve the system. Many cities use this tactic, including Los Angeles; Phoenix; San Jose, California; Riverside, California; and Portland, Oregon.[78]

## The urban forest

Urban trees bring benefits of all sorts to cities. They provide traffic calming; improve the pedestrian environment; add value to adjacent properties; and improve retail business.[79] They improve air quality—reducing dust, ozone, auto emissions, and other pollutants[80]—help manage storm water, and can reduce energy bills and lower ground level temperatures.[81] Trees have even been associated with lower crime levels.[82] Dan Burden calculated that "for a planting cost of $250-600 (includes first 3 years of maintenance) a single street tree returns over $90,000 of direct benefits (not including aesthetic, social and natural) in the lifetime of the tree."[83]

Tree planting can also help reverse neighborhood blight. In Philadelphia the Pennsylvania Horticultural Society's Philadelphia Green Program comprehensively greened more than 1,100 abandoned or vacant lots. Among other strategies, they planted trees, removed debris, and created community gardens. An analysis of this program by the University of Pennsylvania Wharton School of Business found that planting a tree within 50 feet of a house can increase its sale price by 9 percent. They also found that being located within a quarter-mile of a park increases property value by 10 percent, and remediating vacant lots increases surrounding property values by 30 percent.[84]

Considering all the benefits they bring, cities should protect and nurture their existing trees on public property—mostly street trees and in parks—and plant more when possible. Some cities conduct tree inventories, including data on the age, health, and species of each tree on public property. In Pittsburgh a partnership between the city, county, state, the U.S. Department of Agriculture, and several nonprofits produced an urban forest master plan, which calls for a 20 percent increase in tree canopy over 20 years. Progress is already being made with funding secured for the planting of 20,000 new trees.[85]

Other cities are incentivizing private tree planting: the San Antonio municipal electric utility offers rebates for planting trees that will shade your house and thus reduce electric demand in the hottest times of year.[86]

To ensure proper care of street trees, some cities are enlisting the help of citizens to maintain the urban forest. Cambridge, Massachusetts, has a tree ambassador who travels by bicycle to each of the city's more than 17,000 trees to check on them and recruits citizens to help weed, water, and mulch young street trees.[87] Pittsburgh's Tree Stewards program is more formal, offering training to citizen volunteers, after which they are certified to work on public trees and shrubs and to assist with other beautification projects.[88]

### Parks, trees, and jobs

The initial development and sustained presence of parks in city neighborhoods bring a great deal of economic opportunity. Parks boost the property value of adjacent neighborhoods and are important factors in attracting and growing businesses. Parks also attract commerce to surrounding areas in the form of coffee shops, food vendors, and retail stores, further strengthening a city's economy. Building parks also creates jobs for planners, construction workers, landscapers, and parks maintenance staff. Nine million parks and recreation jobs exist at the national level, and McKinsey & Co. estimates that there could be as many as 14 million.[89]

Some cities are leveraging their parks systems to train and employ unemployed or underemployed individuals—often youth or those from low-income backgrounds. The Urban Corps of San Diego County in California uses Community Development Block Grant funds to train young adults in tree planning, care, pruning, and watering. They focus their activity in low-income neighborhoods, bringing multiple benefits to the city.[90]

In Hennepin County, Minnesota, the parks system has teamed up with the nonprofit Tree Trust to host a job-training program in exchange for help with maintenance and planting. Young adults in the program provided year-round trail maintenance, planted 700 trees and shrubs, and mowed lawns and shoveled snow at 100 foreclosed properties. In exchange, they received personalized training in life skills—such as leadership and money management—and parks-related skills, expanding their future employment opportunities.[91]

New York City's MillionTreesNYC Training Program, also managed by a nonprofit, pays trainees $11 an hour and teaches them the skills they need to become apprentice arborists. The city Parks Department and Housing Authority have already hired graduates from the program.[92] Any city that starts a similar program should ensure that these are good jobs with career pathways.

## Waste management

### Background

Managing solid waste is one of the basic services that local governments provide. In 2006 the average American produced 4.6 pounds of solid waste daily. Household waste makes up two-thirds of municipal solid waste.[93]

To date, U.S. municipalities have relied heavily on landfills and incinerators to dispose of it all. But these outdated methods are inefficient and unsafe. Landfills leak toxins such as mercury into groundwater, and incinerators put lead and other chemicals into the air. These methods of waste disposal threaten our public health and natural ecosystems and reduce property values and quality of life. In addition, many landfills are at or close to capacity, and siting new ones is extremely difficult.

To deal with these issues, our waste management systems must be updated. New technology and knowledge about how to effectively process waste offers promising results, and cities have already taken steps to update their waste management system. The old adage "reduce, reuse, recycle" still holds true, and it can be a guide to approaching this issue. But the first step to effectively dealing with solid waste is to develop a plan. Cities should do so based on the principles outlined here.

## Reduce and reuse

Waste management is probably more properly looked at as materials management, because reducing waste begins in the purchasing process. Local governments should take a comprehensive look at the way material flows through their processes and the community at large and use this as a basis for a solid waste plan.[94] Most cities already have a program that assures the internal reuse of materials such as furniture and equipment. Similar services are available to the community, usually in the form of resale businesses and charities.

San Jose, California, requires "the use of recycled materials and recycled products" where practical, and has a preference for "replacing disposables with reusables or recyclables" in its purchasing policies.[95] Berkeley, California, has an aggressive ordinance that, in addition to other environmentally friendly purchasing policies, limits the type of packaging the city will purchase, and requires vendors to have take-back policies for products such as electronics that are difficult to dispose.[96] Such policies help reduce the amount of waste a city needs to manage.

## Recycling

Every day in America materials that could successfully reenter our manufacturing sector are unnecessarily buried in landfills. Metals and glass can be recycled essentially without limit, while paper can be recycled up to six times. Local governments can require or promote recycling in many ways.

First and most commonly, cities can require residents and business to participate in curbside pick-up recycling programs. Single-stream recycling is the easiest and most economical way to do this. Many cities have stopped requiring residents to separate their recyclables and are instead relying on new technology that sorts out different recyclables at a sorting facility. This makes participation for citizens easier and has increased turnaround time tremendously. In San Francisco, recyclables can be successfully separated just an hour after arriving at the plant, and the jobs created are unionized and pay a decent wage.[97]

In San Francisco, recyclables can be successfully separated just an hour after arriving at the plant, and the jobs created are unionized and pay a decent wage.

Special attention should be given to multifamily, large commercial, and institutional properties. They are likely to generate large waste streams and may have particular collection needs. The most effective programs are mandatory, and cities

should have a financial penalty for noncompliance. Educating tenants and building managers is also important.[98]

Portland, Oregon, requires all multifamily residences of five or more units to provide recycling services.[99] Long Beach, California, requires private garbage-collection companies that operate in the city to provide recycling service as well.[100] Los Angeles provides free recycling services to eligible multifamily residential buildings, including educational materials for tenants.[101]

Cities should also require large public events to provide both garbage and recycling services to their attendees. In Pittsburgh events of more than 200 individuals per day are required to provide recycling of beverage containers and cardboard. Staff provide technical assistance, and organizers can contract with the city for services, drop-off materials at a collection point, or hire a private hauler.[102] New York City requires[103] recycling at street events and provides guidance on how to best meet the requirement.[104]

Portland, Oregon, provides substantial guidance[105] to event planners on both recycling and composting (see below), such as signs and containers, best practices, and suggestions for reducing waste, including a "Water Event Station" that connects directly to the city water system and allows attendees to fill their own water bottles instead of purchasing bottled water.[106]

Boise, Idaho, created an event-recycling program in 2001. Their experience is that collecting the material is the easy part and working with event organizers and educating attendees is more complicated. The city includes recycling as one of the many things event organizers must address as they apply for permits or request to lease city facilities, and it makes containers, signs, and technical assistance available. Boise has diverted as much as 50 percent of waste from the landfill at participating events.[107]

Cities can sell recyclables not only to the domestic market but also abroad as an export. In recent years West Coast cities have found a large market in China for recycled materials. Cities can help build the domestic market for recycled materials as well. A standard but important tool is a recycled content procurement requirement. While procurement requirements usually apply to paper products, they can be extended to construction materials and pavement.

Many cities have recycled-content procurement ordinances. Pittsburgh's version establishes a preference for recycled content,[108] while the policy in Santa

Monica, California, covers recycled content and many other aspects of sustainable purchasing.[109]

New uses for recycled products are developing all the time, so local governments need to stay abreast of best practices in this area.

### Construction recycling requirements

Buildings are traditionally torn down through demolition—a quick and cheap practice that needlessly fills our landfills with construction materials that could otherwise be recycled. Deliberately deconstructing buildings with recycling in mind can allow for salvageable construction materials to be reused in future construction projects. Cities should require recycling in all municipal construction and demolition projects and in all private construction or demolition projects of reasonable size.

In Oakland, California, the job-training organization Youth Employment Partnership, aided by the state of California, regularly deconstructs warehouses and government buildings. In some cases, they have managed to salvage more than 70 percent of the building materials, most of which would otherwise have filled our nation's brimming landfills.[110] Brawley, California, requires all construction projects with a value greater than $50,000 and all demolition projects greater than 1,000 square feet to submit, follow, and report on a recycling plan.[111] The California Integrated Waste Management Board developed a similar model ordinance to help municipalities comply with state law on waste diversion.[112]

### Hazardous waste

According to the U.S. Environmental Protection Agency, the average U.S. household creates more than 20 pounds of household hazardous waste, or HHW, a year. HHW may be defined as flammable or combustible, explosive or reactive, corrosive, or toxic household products whose disposal may pose a threat to human health or the environment. These include paints, oils, fluorescent lighting, batteries, and medical waste.

One way to confront this challenge is to require manufactures to take responsibility of their products from cradle to grave. Santa Clara County, California, for example, works with retailers in a "retail-take-it-back" program, where retailers collect and dispose of batteries and fluorescent lights.[113]

Most cities provide some sort of HHW drop-off point. Austin, Texas, allows residents to drop off a number of hazardous items at one of their facilities and also provides several reuse options such as re-blended paint.[114]

## Electronic waste

As computers, televisions, phones, and other gadgets become more sophisticated, the old ones are discarded. Electronic waste, or "e-waste," is a rapidly growing component of the solid waste stream. And much of the current "recycling" of electronic waste is done overseas in a manner that is harmful to both the environment and human health.

The best outcome is to refurbish and reuse these products locally. If that is not possible, responsible recycling for materials and energy recovery should be done. A crucial step is to ban the disposal of electronic waste in the landfill, but this should not be done until a viable alternative is in place—otherwise electronics will typically be dumped illegally.

E-cycle St. Louis is a consumer electronics collection program developed by the St. Louis Regional Partnership for Electronics Recovery. The program encourages reuse and recycling of unwanted electronics by expanding opportunities for residents to dispose of their e-waste. While the disposal of most electronics is free, the program does charge a minimal fee for disposing of TVs and monitors to cover the process of safely breaking down and recycling the e-waste.[115]

## Organic waste

Organic matter such as food scraps and yard waste makes up the majority of the solid waste stream. And disposing of millions of tons of organic material in landfills costs money and takes up limited space. Such waste can fortunately be diverted, composted, and turned into a profit for municipalities. Compost can be sold throughout a community, from retail gardening stores to golf courses.

New technology that allows companies to control the temperature and aerate the compost has allowed for a much faster turnaround than traditional composting. Several cities such as Seattle have made the recycling of yard waste and food scraps mandatory, and they use special green bins dedicated solely for curbside collec-

tion of food scraps, grass, and yard trimmings. In Seattle the compost generated by this program is then sold back to consumers, a further profit source. San Francisco reduced the amount of necessary landfill space by almost 25 percent since implementing its composting program.[116]

### Biogas

Although more and more organic waste is being diverted from landfills, there is a substantial amount of it already in them. And when organic material breaks down without oxygen, which can happen in a landfill, it releases harmful gases such as methane. These gases contribute to global warming and reduce air quality. These gases can, however, be captured and converted into biomethane, a low-carbon fuel similar to natural gas. Biomethane is a clean, high-energy fuel that can be used in cars, manufacturing, and electricity production.

The Franklin County, Ohio Landfill—the fifth-largest publicly owned landfill in the United States—operates a landfill gas-collection system and converts methane into liquefied natural gas that is then used to operate sanitation trucks and public buses.[117] This represents not only substantial cost savings but also reduced vehicle emissions and increased energy security for communities.

Moreover, captured biogas can be used for on-site electricity generation that can then be sold back to the grid through net metering tariffs. At least 594 operational biogas projects in the United States supply 1,813 megawatts of electricity while reducing greenhouse gas emissions.[118]

## Urban water systems

### Background

Cities across the country are dealing with the dual realities of decaying infrastructure and increasingly severe weather due to climate change. The inability of this aging infrastructure to handle severe weather causes increased flooding, degraded drinking water quality, lowered drinking water reserves, increased illness, and diminished property values. Sewer overflows send 860 billion gallons of untreated sewage into U.S. waterways each year, harming public health with 20 million becoming ill each year from contaminated water.[119] The EPA estimates that $6

billion will need to be invested over the next 20 years to address storm water and protect water quality, or we risk returning to 1970s levels of pollution.[120]

Believe it or not, cities can solve these problems with existing technology and approaches. Replacing and augmenting aging "grey" water infrastructure, also known as the "big pipes" solutions, with sustainable green infrastructure insulates against climate disruption, reduces pollution, protects local communities, and is ultimately cheaper than traditional cement solutions. Cities should prioritize investments in green infrastructure that reduces water consumption and uses natural processes to deal with water, such as greywater recycling, green roofs, porous pavement, tree planting, bioswales, rain gardens, water capture, and reducing infiltration and inflow to existing water systems.

**Greywater recycling:** The reuse of household water sources for outdoor water use, including irrigation, septic transport, groundwater replenishment, plant growth in dry areas and many other uses.[121]

**Green roofs:** Roofs that replace traditional roofing architecture with vegetation and plants. Green roofs can reduce energy needed to heat and cool a building and can reduce storm-water runoff.[122]

**Porous pavement:** Pavement that allows storm-water to pass through it; thereby reducing water runoff and filtering pollutants.[123]

**Tree planting:** Healthy trees can significantly reduce the amount of rainfall that turns into storm water by capturing rain in their canopies and facilitating the infiltration of water into the ground. [124]

**Bioswales:** Storm water runoff systems that increase the infiltration of water into the ground and help remove pollutants, often using vegetation.[125]

**Rain garden:** A collection of specific plant species chosen and positioned to collect and infiltrate storm runoff.[126]

**Water capture:** The capture of rain water for later use.[127]

These solutions increase air quality, reduce greenhouse gas emissions, reduce the urban heat island effect, provide natural habitat, protect drinking water and public health, reduce storm threats, diminish energy consumption, and can provide public space and increase quality of life.

Measures and practices that reduce consumption, increase water reuse, and reduce pollution also drive economic development. They will create a significant number of jobs—as many as 1.9 million.[128] Despite this, opposition to green infrastructure can come from those who do not believe such solutions can be effective and from those who assert that adding green infrastructure will increase development costs.

Municipal leaders who want to invest in green infrastructure have to address both existing neighborhoods and buildings and any new construction or development. Existing neighborhoods require more intensive interventions, with investments aimed at reducing consumption, making existing grey infrastructure more efficient and augmenting or replacing it with new green strategies.

New construction is easier since it can be required to achieve certain standards. Philadelphia, for example, requires properties to capture the first inch of a storm's precipitation on-site.[129] This first portion of runoff is vitally important, as it carries the vast majority of pollutants.[130]

Municipal leaders who want to invest in green infrastructure have to address both existing neighborhoods and buildings and any new construction or development.

### Drinking water

Two primary concerns regarding drinking water are conservation—which is necessary to ensure future supply—and quality.

Protecting drinking-water quality is achieved through a combination of watershed protection, minimizing pollutants, treating water, and monitoring contaminants. Contaminant monitoring is handled at the local level and is a last line of defense. Protecting the water source is achieved through careful review of any projects that would affect watersheds and through identification and management of sources of contaminants. A single quart of motor oil can contaminate up to 2 million gallons of drinking water, so programs that collect and manage pollutants can make a big difference.[131]

Protecting water sources involves mapping the zone from which a well draws water, identifying contaminant sources in that area—including abandoned underground tanks, lawn pesticide application, dry cleaners, sewer mains, car repair businesses, and road salt application, among others—and planning interventions to address each of them. Madison, Wisconsin, emphasizes conservation with a highly successful low-flow toilet rebate program, and it maps contaminant sources in a wellhead zone, addressing each individually.[132]

Reducing the amount of clean water used is vital to preserving drinking water quality. But in many jurisdictions, residents and businesses have little incentive to diminish their water consumption. If billing does not reflect usage—that is, the variable part of the bill, if there is one, is insignificant compared to the fixed costs—there is little financial reason to reduce use.

Smart-water meters that reflect use can help, as can structuring water rates to tie fixed costs more closely to usage. There is a utility incentive to install smart meters, as smart meters transmit data wirelessly, saving money on personnel—a negative for job creation in the short term. Utilities also "lose" less water with smart meters via nonrevenue water. Further, smart meters detect leaks more readily than traditional meters, which saves water, and can provide real-time usage data to homeowners if the correct technology investments are made.

Cities can encourage the further minimization of water use by creating programs that fund or directly install water-saving measures, including low-flow showerheads, low-flow and dual-mode toilets, faucet aerators, water-saving dishwashers and clothes washers, and diligent attention to finding and fixing leaks. Because pumping water uses so much energy, combining water efficiency measures into energy efficiency programs such as those described in the Energy Efficiency Retrofits section can be an effective approach.

### Greywater

Reusing greywater—the wastewater from washing, laundry, and dishwashers—for irrigation, or, after processing, for toilet flushing or washing, can significantly reduce water consumption. In jurisdictions that have adopted the International Plumbing Code, it is legal for greywater from showers and washing to be used to flush toilets. This measure alone could reduce household water consumption by up to 30 percent.[133] Cities should at least adopt this international standard. The Uniform Plumbing Code in effect in some areas prohibits greywater use indoors but allows it for irrigation. If greywater is used for irrigation, it should not include any toxic substances such as bleaches, dyes, or cleaners.

To encourage greywater reuse, Tucson, Arizona, requires residential buildings constructed after 2010 to include greywater accommodations—including separate pipes for sink, shower, and bathtub drains—and an outdoor connection for laundry greywater to allow landscaping use. These requirements allow homeowners to install greywater systems without having to change the existing plumbing system.[134]

## Storm water

In most communities with combined sewers—sewage and storm water carried in the same pipe—combined sewage overflows are a tremendous problem exacerbated by less predictable weather and crumbling infrastructure. When a storm causes large amounts of water to enter the system, soil, sand, pollutants from cars, animal waste, pesticides, rubbish, salt, and anything else on the ground is washed into the storm water system. In areas with combined sanitary sewers and storm water systems, this sudden increase in volume then mixes with sewage and can cause the system to overflow, disbursing the contaminated storm water into streams, rivers, lakes, or oceans.

Cities should reduce the volume of storm water coming into the system and capture and retain the combined sewage and storm water for later processing. Even in cities with separate systems, storm water control is important for preventing polluted run-off from entering surface waters, increasing infiltration into aquifers, and replacing some drinking-water uses such as irrigation.

Cities should approach storm water planning systematically and comprehensively. Representatives from all relevant departments—water, sewerage, storm water, and even transportation and fire departments—need to be included to reach the most efficient and widely accepted solutions. Such planning should look at public and private property and should consider solutions based in buildings such as green roofs or rain barrels, on streets, including vegetated curb extensions and sidewalk planters,[135] and on landscaping such as rain gardens.

In Milwaukee a multijurisdictional stakeholder team led by the Milwaukee Metropolitan Sewer District and the Department of Public Works has implemented programs to create green space, build retaining ponds and rain gardens, and install permeable pavements. It has also focused on the creation of community gardens in low-income areas, which provide significant green infrastructure benefits in addition to their food production and community-building aspects.[136]

As mentioned in the Drinking Water section, many residents and businesses have little incentive to diminish their water consumption or process storm water on site. If billing does not reflect usage—that is, the variable part of the bill, if there is one, is insignificant compared to the fixed costs—there is little financial reason to reduce use. If sewerage rates are billed according to projected use as opposed to actual use, there is also little motivation to address storm water on-site.

Requirements to capture some portion of this discharge are a partial solution. The use of smart water meters that reflect use can also help, as can structuring water rates to tie fixed costs more closely to usage.

Philadelphia, which is faced with tremendous infrastructure needs and federal requirements, has taken an aggressive approach to pricing storm water. Whereas storm water rates previously were tied to how much drinking water was consumed, the city has now calibrated its storm water fees to the amount of a property that is developed. It has significantly raised its storm water fees for commercial properties, specifically targeting properties covered with impervious surfaces such as rooftops and parking lots, which contribute most of the pollutants that flow into the city's drains. For the first time, the city has started to collect storm water fees from parking lots and other structures that were previously treated as not being connected to the water system.

Philadelphia, which is faced with tremendous infrastructure needs and federal requirements, has taken an aggressive approach to pricing storm water.

But if a property owner installs wetlands, rain barrels, green roofs, pervious pavement, or other green infrastructure solutions, the city is willing to forgive at least a portion of, and sometimes the entire, storm water bill. This avoided cost can finance the green infrastructure investments, and opens up the possibility of financing arrangements similar to energy-efficiency performance contracting. (see the Energy Efficiency Retrofit section) The city is also offering grants to assist with the development of projects.[137]

It is of course much easier to incorporate green infrastructure and low-impact design techniques into new construction than into existing streets and buildings. Local governments should adopt standards that require low-impact development, both for public works, especially street construction, and for private development. San Mateo County, California, provides a guidebook for sustainably designing streets and parking lots that deal with storm water.[138] Seattle requires commercial and multifamily developments to meet The Green Factor, a landscape requirement that includes storm water management in its goals.[139]

If cities want to increase green infrastructure on private property, a one-stop shop model that can connect owners with technical assistance, contractors, rebates and incentives, can help to ensure quality control, and can smooth the process and increase uptake rates. The Center for Neighborhood Technology has pioneered a "wetrofit" model to reduce flooding in Chicago by connecting neighborhoods with green infrastructure technology and contractors, funding solutions, and helping to coordinate with multiple agencies and stakeholders.[140] Local governments should support such technical assistance, outreach, and education programs.

Even when owners are interested, architects and contractors may resist using green infrastructure techniques. To overcome this problem, the Houston Land/Water Sustainability Forum—a coalition between the city, county, state Department of Transportation, and numerous design and construction professional organizations—hosted a Low Impact Design Competition. Development professionals were invited to compete for cash prizes by designing a low-storm-water-impact development for one of three actual, ready-for-development sites. The combination of peer pressure, financial gain, and the potential to secure a job brought all the major developers to the table, and many of them discovered that low-impact techniques made financial sense. The competition was a success, not just in producing good designs, but also in educating the professionals who have the most control over how sites are designed and built.[141]

A great deal of water that ends up in sewer systems comes in the form of inflow and infiltration. Inflow occurs where downspouts, sump pumps, and other sources are connected to the sanitary sewer system—sometimes illegally. Inflow can be addressed by disconnecting these sources and dealing with the storm water they channel on-site via green infrastructure. Downspouts can feed rain barrels, cisterns, or rain gardens. Toronto, Ontario, mandates the disconnection of downspouts from the sewer system.[142]

Infiltration occurs where water leaks into pipes through cracks and fissures. It can be addressed by replacing, repairing, or lining faulty pipes and by sealing cracks. Ongoing monitoring can ensure those gains are sustained.

A coalition of communities in the Twin Cities area in Minnesota is working together to reduce inflow and infiltration, imposing a surcharge on areas that do not sufficiently address the issue and providing grants and technical assistance to help meet the targets.[143] Cities should explore similar approaches.

To deal with storm water, local governments should employ the following approaches on their own properties and in their maintenance of existing public facilities and should encourage or require their use in private development:

- **Green roofs:** Covering roofs with plants that process precipitation on-site has a host of benefits. Most immediately, green roofs can process a significant proportion of precipitation on-site, reducing runoff and demand on traditional storm water management systems. For low-intensity periods of rainfall—half an inch or less—green roofs can completely absorb the precipitation. For more intense

rainfall, green roofs diminish flow rates and retain water, slowing runoff.[144] Green roofs also reduce building heating and cooling costs by absorbing heat—or, reducing thermal absorption by nearly 100 percent—and insulating the building by making the structure more energy efficient. They increase air quality, absorb carbon dioxide, provide habitat for fauna, and can frequently provide quality public spaces. Maintenance can be more expensive, though this may be offset by the possibly longer lifespan of a green roof compared to a traditional one. In many areas of the country, energy savings can also be a significant offset.[145] Chicago's city hall green roof is a pioneer example of green roof technology. It significantly reduced the urban-heat island effect, staying as much as an astonishing 100 degrees cooler than an adjacent conventional roof and saving $5,000 annually in energy costs.[146]

Chicago's city hall green roof is a pioneer example of green roof technology.

- **Permeable pavement:** Replacing existing pavement with permeable pavement and using it in new construction immediately reduces one of the largest sources of runoff. An area equivalent to the size of Ohio is covered in nonporous surfaces in the United States—primarily infrastructure devoted to cars.[147] Every nonporous paved surface drains nearly every drop of precipitation that lands on it directly into a city's storm-water system. By addressing at least some of this on-site through porous pavement, storm water processing can be reduced, existing infrastructure is more effective, groundwater is recharged, and surface water is protected.

- **Bioswales:** Bioswales are depressions filled with vegetation that allow precipitation to pool, gradually be absorbed, or slowly discharged into storm water systems if they become overwhelmed. They are highly effective ways of dealing with runoff from large paved or impervious areas. Rain gardens are similarly designed in areas where rainwater will collect, using deep-rooted plants to absorb and process rainwater on-site. Both recharge the water table, process silt, increase air quality, provide habitat, and capture carbon dioxide.

## Building energy benchmarking and disclosure laws

### Background

In most markets, the prospective buyers or tenants of a building have no way of knowing how much they will have to spend to heat, cool, and otherwise operate it. They are thus no more likely to rent or buy an efficient building over an inefficient one, and there is no market pressure to increase the relative efficiency of buildings.

Energy disclosure and benchmarking laws are a low-cost, effective solution. By requiring the disclosure of energy use in a building when it is listed for sale or on an periodic basis, prospective occupants, lenders, and investors can compare how much they are likely to spend on energy—similar to how car shoppers can compare miles per gallon ratings. This creates an incentive for high-performing buildings and an even stronger disincentive to be in the bottom tier.

If such a program is enacted alongside retrofit programs (see the next section), it can help drive demand for efficiency upgrades. Energy-efficiency contractors in New York City and San Francisco have seen business increase by 30 percent as a result of these ordinances.[148] Energy-efficiency upgrades create good, high-paying jobs, too—about 12 direct and indirect jobs per million invested.[149]

By making the expected cost of a building's energy use publicly available, the free market can work. Existing policies will affect 4 billion square feet of space by 2014. A nationally implemented disclosure standard would reduce energy costs by more than $18 billion by 2020 while creating 59,000 new jobs.[150]

### Commercial-energy disclosure ordinances

Commercial tenants should be concerned about their building's operating cost, yet they frequently lack the information to make informed decisions about future costs. Energy benchmarking and disclosure ordinances are relatively simple, low-cost ways to bring market forces to bear to spur investment in building energy efficiency.

A city or state passes the law, requiring that on a fixed yearly schedule or when a building is put on the market, its energy consumption is disclosed either to prospective buyers only or published publicly. Both options are valid, though the compliance costs of a point-of-sale ordinance are lower. Public building energy use should be disclosed on an ongoing basis, and easy-to-use web dashboards such as EnergyStar Portfolio manager enable this.[151]

Seattle;[152] New York City;[153] Washington, D.C.;[154] San Francisco;[155] Austin, Texas;[156] and Washington state[157] have all adopted commercial benchmarking and disclosure laws since 2007. Many other major cities, including Boston and Philadelphia, are considering or currently implementing such policies, and they have been implemented internationally.[158] These programs frequently make use of the EPA's freely available EnergyStar Portfolio Manager tool.

Building owners may oppose this legislation as it represents a cost—which can be rolled into the closing—a hassle, and will make low-efficiency properties less desirable.[159] To avoid posing an undue burden on small business owners, most disclosure ordinances have size cutoffs: Only buildings greater than a certain square footage must participate. The size of buildings required to participate varies from all commercial and public buildings in Austin to commercial and multifamily buildings over 50,000 square feet in New York City.

All public buildings will ideally have their energy use publicly disclosed, and the larger the number of commercial buildings that publish energy data, the more useful it is to prospective renters or buyers.

### Residential energy disclosure ordinances

Residential energy disclosure laws are less common than commercial or public ones. Austin, Texas, has an Energy Conservation Audit and Disclosure ordinance for its residential buildings. Managed by its municipal utility, the program has been in effect since 2008. A certified energy rater must perform the audits prior to sale and disclose the results to the buyer. This information is paired with recommendations on how to improve the energy efficiency of the property and information about the city's energy-efficiency loan program. Properties less than 10 years old that have recently completed energy upgrades or that are eligible for low-income weatherization are exempt. In the year following the ordinance's enactment, 12 percent of properties sold performed energy-efficiency upgrades.[160]

The same model can be applied to rental properties where at least the past energy usage of the property can be disclosed to prospective tenants. This is especially important for low-income renters because properties with lower rent may have very high heating costs. Ann Arbor, Michigan, has required this since 1987.[161]

A significant concern with residential energy disclosure ordinances is that such measures can further burden low-income property owners. Lower-income property owners tend to hold older, less efficient properties. These may already be hard to sell, but if they are slapped with a "D" or "F" energy rating, they will be even harder to sell. This is why cities should ensure that a rating or disclosure program is paired with resources to mitigate bad scores.

Residential labeling ordinances can significantly drive the uptake of retrofit programs, if they are offered, though such offerings should be available to lower-income homeowners.

## High-performance building requirements

### Background

The design of the buildings in which we live, work, eat, shop, relax, and play greatly affects our quality of life, our environmental and carbon footprint, and the economic viability of our communities. Building codes can provide basic protection for all of these things. With ambitious codes, we can move beyond merely protecting consumers and firms to creating incentives for the social, health, environmental, and economic outcomes that we want.

The Federal Energy Independence and Security Act of 2007 defines a high-performance building as "a building that integrates and optimizes on a life cycle basis all major high performance attributes, including energy conservation, environment, safety, security, durability, accessibility, cost-benefit, productivity, sustainability, functionality, and operational considerations."[162]

Building to these specifications also creates more jobs. Spending related to achieving Leadership in Energy and Environmental Design, or LEED, certification alone is forecasted to create 230,000 additional jobs by 2013—many for highly skilled workers maintaining the operation of these technically advanced buildings.[163]

Building codes can specify allowable limits and parameters for variables such as the amount of water that a toilet uses or the number of fire exits per floor. Energy codes in particular can save building occupants money, increase the productivity and health of occupants, and reduce climate pollution—all contributing to local economic development. Putting in place strong building codes is dramatically more effective and less costly than retrofitting existing buildings. Advanced building codes seek to maximize the attributes of a building within economically justifiable parameters, recognizing that retrofitting after the fact is significantly more expensive and less effective.

Putting in place strong building codes is dramatically more effective and less costly than retrofitting existing buildings.

Building codes are of course only as effective as their enforcement. So a comprehensive plan to encourage compliance and enforce standards is vital. And while

building codes are most immediately applicable to new construction and to buildings undergoing major renovation, getting it right matters. Buildings constructed today are likely to be around for at least 80 years on average.[164]

## Code adoption

Building standards vary from state to state or even city to city. The impact that these codes will have depends on how stringent they are. There are international standards from the International Code Council, or ICC, which generates 14 different sets of regulations. These are revised on a near-continual basis. If technical capacity exists locally, these can be improved upon or modified to create incentives for particular attributes, but in many instances existing ICC codes can be adopted locally with minimal alteration. If a jurisdiction is seeking to exceed commonly adopted codes, strong political champions will be required.

Codes are of course far more effective if they are adopted as mandatory rather than voluntary. If voluntary codes are adopted, incentives to encourage projects to meet them can increase uptake rates (see below). Factors that can be encouraged or mandated include building energy use, indoor air quality, parking minimums and traffic impacts, construction methods and techniques, reduced outdoor lighting, and a variety of other factors, many of which overlap with land-use and zoning laws.

At a minimum, cities should encourage their states—or do it themselves in home-rule states—to adopt the most recent ICC codes, especially the International Energy Conservation Code and ASHRAE standards, both of which are updated on a three-year cycle. They should adopt the 2012 ICC for residential and commercial or ASHRAE Standard 90.1-2010 for commercial. These should be exceeded, if possible, as California is doing with its Title 24, aiming for net-zero buildings by 2030.[165]

The major opposition to building codes comes from building developers, construction companies, owners, and designers, who see more stringent codes as adding to the cost and complexity of developing projects. But these initial costs are more than offset over time through energy savings, reduced maintenance costs, building longevity and resilience, and occupant productivity, though that value is not always reflected in the market. Another source of opposition is firms that manufacture materials not compliant with proposed code revisions.

Good outreach, education, advocacy, and developing public champions for these codes are essential to overcoming this opposition.

The Building Codes Assistance Project found that:

> *For the average new home, the 2012 IECC would only increase construction costs within a range of $1,460 to $2,293. When this amount is rolled into the average mortgage, real costs to homebuyers will mean a down payment increase of only $292 to $459, and $6 to $9 added to monthly mortgage bills. The added mortgage will be offset by monthly energy savings of $51.73, helping homebuyers pay off their initial investment in only seven to eleven months. After breaking even during that time, the home will return buyers a profit of at least $43 per month – a total return of $516 every year.*[166]

Decision makers and advocates also should support national efforts to raise building standards via national coalitions such as the Online Code Environment and Advocacy Network.[167]

## Going beyond code

Communities that wish to go beyond current building codes have several options at their disposal. If they are in a state where they are permitted to enact more stringent codes on their own, they can of course do so. Massachusetts has the Massachusetts Stretch Appendix to the Building Energy Code,[168] which cities and towns can choose to opt-in to and is roughly 20 percent more stringent than the IECC 2009 code.

Many states, however, prohibit the local adoption of more stringent mandatory codes. Short of advocating for the repeal of those laws, cities and towns can encourage and reward those who choose to meet more stringent requirements through tax incentives, density bonuses, rebates, expedited permitting, fee waivers, tax credits, and grants.[169]

Arlington County, Virginia, permits larger or taller buildings than code would otherwise allow for developers who achieve LEED certification. Developers who achieve LEED platinum—the highest designation—are allowed a bonus of 0.45 times the normal Floor Area Ratio, or 0.5 for residential, which will likely result in more than enough additional profit to offset the additional building costs.[170]

Many cities require that their public buildings, including those leased, meet certain standards—frequently one of the LEED designations. Greensburg, Kansas, adopted a requirement in 2007 that any city building larger than 4,000 square feet must be certified LEED platinum.[171]

Other than the LEED designations, the National Green Building Standard,[172] the Standard for the Design of High Performance Green Buildings Except Low-rise Residential Buildings,[173] and the International Green Construction Code[174] all provide guidelines that increase the sustainability of a building. There are a host of additional rules that are not strictly "building code" and that if in existence, should be modified or abandoned—bans on clotheslines, rain barrels, parking strip utilization, and front yard vegetable gardening, for example—because they limit the ability of households to engage in sustainable practices.

## Code enforcement

Enforcing codes is absolutely vital to their effectiveness. Recipients of Recovery Act funding are required to have plans in place to achieve 90 percent energy code compliance by 2017, further adding to the importance of increasing enforcement.

A jurisdiction with very high standards but lax enforcement will likely achieve very little. There are many disincentives to complying with code—another reason voluntary code adoption is far less effective. Reasons for lack of compliance include variation between a project's blueprint and its actual construction, use of noncompliant materials in construction, and a lack of compliance training and education for those doing the actual construction.[175]

Lack of education among building inspectors may further result in some aspects of code being less stringently enforced. Determining the effectiveness of energy-efficiency elements requires a specialized skill set that is not widespread in all building evaluation departments. Compounding this in many areas is insufficient enforcement, along with challenging and frequently inaccurate reporting methodology.

Change is difficult as well. In an environment where lax enforcement is expected, championing more aggressive application of the rules is bound to be unpopular.

Effective enforcement requires strong leadership and political support. A strong argument for increasing compliance is that it is highly cost effective. The Institute

for Market Transformation estimates that for every dollar spent on enforcement, $6 is saved on energy costs.[176]

To increase compliance, cities should implement a combination of education and outreach to the contractor community and building trades, advanced education for building inspectors, and increased inspection rates. This requires an additional commitment of resources.

Parker, Colorado, a town of 50,000, is a success story in building-code compliance. To facilitate broader understanding of how various aspects of code affect building performance, the town offered training—in some cases mandatory—on various aspects of building science. For each builder, they performed a free assessment of one building, demonstrating how code should influence the work. Developers were educated so they could insist on correct installation by their contractors. Inspectors pursuing different inspections were trained to watch for other violations—for example, electrical inspectors could easily notice gaps in insulation around wiring, a violation of energy code. They implemented the building code in phases, to correspond to educational opportunities.

Parker's model has been so successful that many of their building inspectors are now national experts on code compliance.[177]

## Energy efficiency retrofits of buildings

### Background

Our buildings consume more than 40 percent of energy used in the United States. [178] We waste a tremendous amount of this energy on heating and air conditioning that escapes the building, on illuminating vacant spaces, and on running machinery constantly.

Reducing this waste creates jobs for those increasing the building's efficiency, saves money for the building operator, increases occupant productivity and health, and reduces climate pollution. Even more impressive, it is an idea that can pay for itself: You can capture the value of the energy wasted and use that to pay for the cost of the building upgrades over time. Amortized repayments on the upgrades are calculated to be less than the savings over the same period. It is a surprisingly simple idea and one that has been successfully implemented in a variety of ways for many years.

Building energy-efficiency retrofit programs assess buildings for waste, find interventions that will save energy—such as adding insulation, sealing drafts, and installing more efficient mechanical systems—arrange financing, and then install the measures. The building owner pays for the efficiency improvements over time, saving more in avoided energy costs than they spend on the repayments. Although this work has been done for years, we are nowhere near tapping the potential for both savings and job creation in this market.

Governments can help develop what is really a series of related markets—the government and institutional buildings, private residences, businesses, and commercial and industrial buildings. By first addressing municipally owned building stocks, governments can set an example and create structures that can facilitate retrofits in the institutional and commercial space, and even assist other governments. Governments can also help to finance and simplify the retrofit process to help the commercial and residential markets.

Cities are well positioned to support the energy-efficiency market—the programs and companies that will drive significant energy-efficiency uptake. Cities control many buildings directly and should make them the starting point for a retrofit program. They are an important way for governments to save money to support critical programs in a tough economy.

Governments can generally access relatively cheap capital through bonding, grants, or other sources, which they should use for their own buildings. These can also support retrofit work in other markets—institutional buildings, the commercial and industrial sector, and individual residences. When the government spends money, it can negotiate and enforce labor standards, ensuring that jobs created go to those in need, include career pathways, and meet basic wage, benefit, and training requirements.[179] Beyond providing funding and ensuring that jobs are high quality, governments can directly create retrofit programs and should pass policies that make the retrofit market function more smoothly.

Opposition to energy-efficiency retrofit programs can come from a variety of sources, though in many instances this can be overcome with diligent outreach. Opposition tends to be to the financial impact of government subsidies or spending to support retrofit programs. But the focus on saving money and creating jobs makes them attractive to policymakers across the political spectrum.

Opposition to energy-efficiency retrofit programs can come from a variety of sources, though in many instances this can be overcome with diligent outreach.

## Government and institutional programs

Publicly controlled buildings—the city halls, transit centers, schools, universities, sewage treatment plants, and all other government buildings controlled by state, county, or local governments—waste a lot of energy. Potential savings are vast: There are almost 140,000 entities in this sector in the United States, including state and local governments, school districts, colleges and universities, and medical institutions. We estimate that these entities control about 16.5 billion square feet of floor space and use about 3.87 quadrillion BTUs a year at a cost of about $40.7 billion.[180]

Local governments should at the very least retrofit their own buildings. Retrofitting public buildings creates good jobs relatively quickly: There is a single point of control for many buildings; elected officials are the relevant decision makers and thus public pressure can be a driver; there is a developed market with firms ready to do the work; and there is usually low-cost public financing available. Investing in retrofits creates more jobs than most "grey" infrastructure investments, too, with an average of 12 direct and indirect jobs created per $1 million invested.[181]

But to create a significant number of jobs, retrofits have to occur at significant scale. That is why local governments should set aggressive targets for each building. Ambitious projects are achieving as much as 40 percent reduction in use.[182] Focusing on larger-scale projects, as opposed to small changes such as replacing inefficient light bulbs, costs more but is more labor intensive and produces more significant long-term savings. The commissioning, operations, and maintenance of buildings is also critical to realizing energy efficiencies and other sustainable features. So cities should ensure that building-maintenance workers receive training in sustainable building operations.

Cheap capital, such as that provided by bonding, helps facilitate these deeper investments. Of special note are qualified energy conservation bonds, a federally subsidized financing tool available for these projects. To generate additional savings through large-scale investment, cities should assess building energy use, targeted buildings should have their energy use scientifically audited, financing should be secured to retrofit a large number of buildings at the same time, and then contractors should be brought in to do the work. Reno, Nevada, invested $20 million in a combined energy efficiency, solar, and wind generation project for city buildings that will save them $1.3 million a year. It retained or created 279 jobs.[183]

As these are public funds, local governments can require that jobs created from these projects be subject to high-road standards negotiated via a Community

Workforce Agreement or equivalent arrangement that lays out wage standards, certifications, training requirements, targeted hire, and safety provisions. Community Works Oregon's High Road Agreement resulted in nearly three-quarters of program contractor employees receiving health insurance, and 20 percent of the work went to firms owned by historically underrepresented groups.[184]

Minnesota Gov. Mark Dayton signed an executive order setting a 20 percent energy-use reduction goal for the state's 30 million square feet of buildings. It also directs staff to provide technical assistance to other governmental entities interested in doing this work.[185] This approach could be replicated in smaller jurisdictions.

Other ways of scaling government retrofit projects include pooling financing, contracting, and providing technical assistance across a number of different jurisdictions. This saves money on transaction costs and allows significantly larger project volume, which may translate to cheaper financing. The Northeast Ohio Regional Energy Alliance is a group of public, nonprofit, and business organizations working to simplify and streamline the financing, marketing, and policy pieces necessary for large retrofit programs to occur.[186]

### Residential programs

The residential retrofit market offers tremendous opportunities for energy savings and job creation. In addition to financial savings, benefits—such as a reduction in drafts, increased warmth in winter, coolness in summer, and improved air quality—are significant motivations for homeowners' retrofit investments.

Local governments should support programs that educate customers on the value of energy efficiency. WeatherizeDC uses a community organizing approach to build demand for energy efficiency, while Community Labor United in Boston partners with community-based organizations to do education and outreach on the benefits of home retrofits.[187]

Financing is a significant barrier for homeowners considering an energy upgrade. Many middle- and lower-income homeowners cannot readily access sufficient capital at attractive rates to invest in energy efficiency, and if they do, an energy upgrade is not necessarily at the top of their spending priority list. Cities should support programs that provide access to low-cost capital that does not compete with other borrowing priorities to overcome this barrier.

One such program is Property Assessed Clean Energy, or PACE. It creates a municipal special assessment that is placed on a property—similar to an assessment for a new sidewalk—is tied to the property tax bill, and has the same recourse in event of nonpayment.[188] In Sonoma County the California Energy Independence Program offers PACE financing for commercial and residential properties. Since it launched in 2009, it has financed improvements, both energy efficiency and renewable energy, on 1,700 residential properties and 57 commercial ones, worth $58 million, creating or retaining 714 jobs.[189] Guidance from the Federal Housing Finance Authority has limited the creation of new residential PACE programs.[190]

On-utility-bill finance programs similarly provide a source of financing that could not be used for anything else, and cities should work to authorize their creation at a local—especially in jurisdictions with a municipal utility—or state level as needed. By using utility-bill payment history as part of the underwriting criteria, on-bill programs provide energy efficiency as a service to be paid for monthly rather than as a stand-alone loan. They are based on the premise that a customer who is already paying their utility bills will only be more likely to pay following an investment that lowers those same bills. If an occupant moves, the tariff stays with the meter.

In Kansas, Midwest Energy's How$mart on-bill program has successfully retrofitted 680 homes since 2007 with several hundred more pending. The program pays all upfront retrofit costs, which are to be repaid with a tariff on the bill. Eligibility is based on utility-bill payment history. As the program is designed to reduce monthly costs, the repayment should pose no additional burden. This is important from an equity perspective, as programs that simply loan money for retrofits frequently find households with lower credit scores to be ineligible to participate. The monthly charge for How$mart is typically around $42, and the average energy savings are $49.[191]

Another approach is on-bill repayment, where the utility bill serves as a conduit for a loan with more traditional underwriting criteria. It has been implemented in several jurisdictions with amenable utilities and elsewhere, such as New York state, where utilities have been required to provide the option. Community Power Works in Seattle provides the on-utility bill repayment option for low-cost loans issued by a nonprofit lender to participating homeowners via Seattle City Light, the municipal utility. Community Power Works has performed 1,080 residential upgrades with more than 300 in progress as of September 2012, generating more than 109,200 hours of work by 782 workers, including 606 contractors and energy auditors.[192]

Local governments should create or support comprehensive programs that include an attractive financing offer, marketing and outreach, a simple structure that makes every step as easy as possible for the homeowner, and verification of the work to make certain that homeowners are getting the savings they paid for. This approach can significantly increase uptake rates of home energy upgrades.

Clean Energy Works Oregon combines attractive financing options—including using utility bill-repayment history as an underwriting criterion—on-bill repayment, a one-stop-shop approach to guide homeowners through the contracting and retrofit process, and a comprehensive High Road Agreement to ensure labor standards. As of August 2012 they have retrofitted more than 900 homes, generating more than $12 million for the local economy. The program has employed more than 500 people. Through contractor participation requirements, incentives, and support, the program has succeeded in having more than 55 percent of work hours be performed by women and people of color with 87 percent of contractors offering subsidized health insurance.[193]

### Commercial and industrial programs

Commercial building owners face many of the same barriers as the residential market and are in many instances even more constrained in their ability to borrow to finance energy-efficiency improvements. Programs that move energy upgrade costs off the balance sheet—such as a lease model, commercial PACE, or on-bill repayments—are likely to increase the appeal of energy-efficiency upgrades to commercial property owners.

Local governments are creating assessment districts and allowing businesses to pay back efficiency charges on their property tax bills. The recently created CaliforniaFIRST public-private partnership allows qualifying commercial-property owners in the participating 126 cities and 14 counties to tap into the municipal bond market—with its favorable rates—to finance energy-efficiency improvements.[194] Commercial PACE is highly scalable as well: Edina, Minnesota, recently launched a commercial PACE program that has allowed the installation of solar panels on a local garage.[195] In states lacking commercial PACE enabling legislation, its passage should be a top priority.

A promising new approach to energy efficiency for commercial properties is pay-for-performance. Existing efficiency subsidies, which are traditionally disbursed as reimbursements for installing certain efficiency upgrades, are replaced with

payments pegged to certain levels of savings. This creates incentives for deeper retrofits—as rebates increase along with savings—and consistent building energy management, as well as encouraging innovative and cost-effective approaches. Seattle is currently piloting a program where participant businesses can combine retrofits, ongoing operations, and behavior change to achieve energy-reduction targets with rewards pegged to kilowatt-hours saved.[196]

Building energy disclosure laws, where building owners must publicly share building energy consumption data when a property is on the market (see the section on Building Energy Benchmarking and Disclosure), are a particularly powerful tool in the commercial market. They provide a strong incentive to avoid having low-performing buildings.

### Supporting policies and financing options

A strong policy and financing environment facilitates the creation of a functioning energy-efficiency retrofit market. Many state-level policies are important—including energy efficiency resource standards and public benefit funds—and have been widely enacted. Yet despite these available resources, relatively few building owners have increased the energy efficiency of their building systematically or comprehensively. There are a variety of barriers to doing so, cost being only one of them. Other enabling policies—including energy disclosure, labeling that allows performance contracting, and Property Assessed Clean Energy, or PACE, programs—should be implemented at a state or local level as needed.

One of the major reasons that such an obviously good investment has not been made on a larger scale is the lack of a functional market to funnel private investment to fund these projects. Local governments can overcome this by providing funds themselves, stimulating private investment, and creating a more supportive policy environment. The most useful tool that governments have is their tax-exempt borrowing capacity—ready access to relatively cheap capital, subject to borrowing limits and credit ratings. Federally subsidized qualified energy-conservation bonds[197] are available to many jurisdictions at very favorable terms and provide a great deal of flexibility in how they can be spent. Investments that pay for themselves over time are an excellent choice for public tax-exempt bonding—certainly better than many traditional infrastructure projects.

There are a number of different ways to structure public financing programs to support energy-efficiency retrofits—including issuing bonds to directly finance

energy-efficiency programs, establishing "green banks" or revolving loan funds, and creating a loan-loss reserve to buffer private lenders from losses resulting from potential defaults on loans for energy-efficiency projects. Direct investment of bond proceeds in a large-scale energy-efficiency program is an excellent way to rapidly create a large number of jobs.

The state of Delaware issued $63 million in energy efficiency bonds, and provided the funds to departments and institutions of higher learning to retrofit their buildings, paying debt service with the energy cost savings. This initiative has been so successful they're considering a second issuance.[198] While this is a state-level example, a similar approach would be possible in many local jurisdictions.

Another alternative is the establishment of a green bank. In Connecticut the state used some public benefit fund dollars and some Regional Greenhouse Gas Initiative funds to capitalize the Clean Energy Finance and Investment Authority—a green bank that invests in energy-efficiency projects in both the public and private sectors and helps bridge the gap between what the private sector is willing to fund and what project developers are seeking.[199]

An example of a similar program at a city level can be found in the Chicago Infrastructure Bank, which is a public-private partnership that currently invests $225 million in retrofits of city buildings. The Infrastructure Bank is a nonprofit entity established by the city, to which city departments can bring projects in need of funding. Some will be funded traditionally via bonds; some will access a pool of funds from private investors.[200]

Public money can also be used to leverage private investment. By providing a loan-loss reserve, whereby some portion of a potential loss is covered in case of default, governments can attract private financing to the energy-efficiency retrofit market. This reduced risk for lenders can improve the interest rate on money and broaden the underwriting criteria, providing more accessible financing for businesses and homeowners.

The Milwaukee Energy Efficiency and the Green Madison programs in Wisconsin have set aside $3 million from a federal grant as a 5 percent loan loss reserve, guaranteeing that losses sustained by the credit union lending partner in the program will be recoverable up to that amount and making available $60 million to invest. This security also means that the programs' financial partner, Summit Credit Union, is willing to offer lower interest rates and serve households with FICO scores as low as 540.[201]

By providing a loan-loss reserve, whereby some portion of a potential loss is covered in case of default, governments can attract private financing to the energy-efficiency retrofit market.

Bonding for energy efficiency does not work in cities where the borrowing cap has been reached or is close. It can also be politically difficult; councils are often unwilling to accept debt even for the promise of future savings.

In this instance cities should look for alternate funding sources for their retrofit programs. Babylon, New York, has been able to fund its residential retrofit program by reclassifying carbon as a solid waste and applying their solid waste fund of $2 million to capitalize it.[202] Other strategies include using general fund dollars or federal and state funding. Public benefit fund money may also be available.

In addition, jobs created by energy-efficiency programs are not automatically good jobs. To ensure a living wage, apprenticeship utilization, safety and training standards, and benefits, some form of negotiated agreement is necessary. A Community Workforce Agreement[203] governs these issues. In programs using public money, these can be required as conditions of participation.

## Renewable-energy generation

### Background

The installation of clean and renewable generation technologies such as solar, wind, and geothermal stimulates the local economy, builds climate resilience, improves public health, and creates good jobs. Cities are in an excellent position to both directly invest in renewable generation and to foster the creation of residential and commercial renewable projects of varying scales. Money is saved by avoiding costly new fossil-fuel generation, keeping money spent on fossil-fuel imports in the community, and protecting against future fuel price volatility.

While broadly popular across the political spectrum—with 55 percent saying that renewable energy is a better investment than fossil fuels[204]—and increasingly affordable,[205] widespread adoption of clean energy technologies faces many hurdles. First, the fossil-fuel industry is tremendously powerful and has invested significantly in current technologies. And despite some recent investments in renewables, the industry fights, delays, and denies the need for clean generation. Second, local citizens and business groups concerned with the additional cost of renewables also frequently oppose such programs. Some citizens are concerned about the aesthetics of large-scale renewable installations.

There are structural issues as well. Transmission capacity is often an issue for new large-scale renewable installations,[206] and distributed generation requires favorable net metering and interconnection standards.[207]

We primarily address distributed generation here, as it is most readily implemented at the city level, though we also examine the policies and program tools necessary for utility-scale generation and other clean energy purchasing options. Distributed generation further multiplies the benefits of renewable energy by generating electricity on-site or close by, minimizing the need for investment in costly transmission infrastructure, nearly erasing energy loss due to transmission, building local resilience, and avoiding future price fluctuations.

## Set a goal, make a plan

Successful programs are the result of political leadership—little at scale is likely to happen without it. Setting goals for renewable implementation, such as, "Our city will be powered with 50 percent clean energy by 2020," provides a clear direction for utilities, residents, and local businesses to follow. Mapping out the steps necessary to achieve that goal is also important. Many cities have climate action plans or have signed climate protection agreements. Renewable generation must be part of meeting those obligations plans, and these plans must have some muscle behind them. Far too often they remain entirely aspirational. Where possible, renewable generation can and should be integrated with other city programs—building leasing and construction, energy efficiency retrofit programs, and wastewater processing.

Goal setting and planning can have significant results. Bellingham, Washington, set a goal in 2007 of reducing greenhouse gas emissions 64 percent by 2012 and 70 percent by 2020, relative to consumption in 2000.[208] It currently buys 100 percent renewable power for all city facilities and has installed rooftop generation on some city buildings. Local university students agreed to raise tuition slightly so that the Western Washington University campus would be powered entirely by renewable energy.[209]

The city government also sponsored a community green power challenge, resulting in the purchase of enough green power to meet 11 percent of the community's total energy use. The additional cost of this generation is partially offset by the comprehensive energy retrofit and new construction—Leadership in Energy and Environmental Design, or LEED only—programs the city runs.[210]

Additionally, since so many community members signed up for clean energy, the utility was able to negotiate bulk purchase rates, lowering the premium paid by consumers for clean generation by 40 percent.[211] A preferential loan program for solar-energy installation has been created for local businesses.[212] The city additionally supports energy efficiency in a variety of ways, including energy-efficiency challenges, energy-efficient land-use planning, and technical assistance to the public on how to construct green buildings.[213]

### Lead by example

Jurisdictions should lead by example and install renewable generation at their own facilities, paying back the investment over time out of the avoided utility costs. They should invest in reducing energy consumption through efficiency measures first and then install renewable generation where cost effective—a proven and reliable method of reducing municipal expenditures and vulnerability to energy cost increases. Energy expenditures can account for as much as 10 percent of a local government's operating budget, so reductions in that outlay can make a big difference.[214]

For new buildings, cities should build to a high-performance, low-energy-use standard and then meet energy needs with on-site renewable generation. For existing buildings, retrofitting the buildings to minimize their energy consumption and then installing renewable capacity to meet that diminished energy need will frequently prove cost effective, as the size of the renewable installation needed will be smaller.[215]

While many renewable systems can have relatively short payback periods, financing options such as lease-purchase agreements—a form of lease-to-own—and performance contracting or power-purchase agreements—where the government purchases the power and may provide space, but a private entity owns the technology—may make projects possible if local governments cannot manage the upfront cost. Cities can also pay their utility providers for certified renewable energy, although the economics of such arrangements are less favorable.

Opportunities for combined heat and power, sometimes called cogeneration, installations[216] at city buildings should also be pursued. This is frequently possible with wastewater treatment plants. Biodigesters, which generate electricity from gases emitted by decomposing waste at waste-processing facilities, are a possible source of energy as well. In Sheboygan, Wisconsin, the Regional Wastewater Treatment Plant produces nearly all of its energy on-site through a combination of

efficiency, cogeneration, and biodigestion, in a project that paid for itself through savings in seven-and-a-half years.[217] Landfills can be a source of natural gas as well, as discussed in the Waste Management section.

### Municipal utilities

Local governments that control utilities should provide their customers with clean energy. A utility can promote renewable generation in a number of ways, starting with simply investing in it instead of other generation sources. Municipal utilities may be able to develop utility-scale wind or solar, or they may purchase clean generation capacity.

San Antonio's municipal utility recently entered into a 25-year power-purchase agreement for a 400-megawatt solar array to provide electricity for 70,000 households, or around 10 percent of total customers. The city further leveraged this investment to include investment in local manufacturing of solar components and created around 800 new jobs, bringing in an estimated $700 million annually for the city.[218]

Another option for city-controlled utilities is the feed-in tariff, or FIT. Cities that have the capacity to do so should adopt FITs to allow energy producers of different sizes to sell renewable energy back to the grid at a production cost-based price, varying according to the production technology implemented. Efficiently operated projects are thus guaranteed a rate of return, spurring investment.

Gainesville, Florida, has enacted a FIT at the municipal utility that mimics many of the features of the most successful European programs. The tariff is based on the cost to generate the renewable energy plus a 5 percent to 6 percent return, incentivizing businesses and residents to install renewable generation capacity.[219] The program is currently fully subscribed.

Power-purchase agreements, or PPAs, are another tool local governments should use to support renewable-energy generation. Under a PPA, energy buyers such as a municipal utility contract with an energy supplier to buy power at a certain price for a certain amount of time. This means that renewable energy can be purchased for a guaranteed price, and the energy provider has guaranteed revenue, allowing them the certainty needed to invest in large-scale renewable-generation projects. This model is also scalable to smaller rooftop distributed generation. Municipal utilities can offer PPAs to their customers who want to increase renewable generation in the community.

Many of the most innovative renewable energy and energy-efficiency programs are run by municipal utilities. As they are under the control of the municipality's political leadership, they are more likely to be partners in addressing a city's clean energy goals. Investor-owned utilities are inherently guided by profit motives—and they profit by selling energy—and thus may not be as willing to invest in energy-efficiency or renewable-generation programs.

In some places municipalities without a municipally owned utility are considering creating one or buying the existing one. Boulder, Colorado, is currently pursuing the creation of a municipal utility and the acquisition of some of Xcel Energy's assets, and Jefferson County, Washington, will transition to a newly acquired public utility in 2013.[220]

Many of the most innovative renewable energy and energy-efficiency programs are run by municipal utilities.

### Reduce barriers and implement enabling policies

Many policies can increase renewable-energy generation in the private sector. A city can provide education and training, and it can connect project developers with financing, trained installers, and bulk-buy programs. Where city permitting and regulations are involved, expedited or preferential processing can be given to those with renewable-generation components. A city should also comprehensively review building codes, siting ordinances, and zoning regulations for obstacles to renewable generation.

Madison, Wisconsin, went as far as to require that streets in new subdivisions be oriented such that solar access is maximized for new construction.[221] City staff are trained on renewable technologies so that permitting goes smoothly, and the city offers technical assistance to businesses and residents wanting to install renewable generation.

Cities should make it easy for residents to buy renewable energy. While still using existing utilities for transmission and distribution, community choice aggregation—where municipalities aggregate consumers who wish to purchase renewable energy and then bid on their behalf—can provide easier access to this renewable generation. Oak Park, Illinois, negotiated to provide residents with 100 percent renewable energy at a rate 25 percent cheaper than what the existing utility offered. Currently, 20,000 accounts are purchasing 171,000-megawatt hours of wind power.[222]

Because the up-front cost of installing renewable generation can be too high for some in the commercial and residential sector, an attractive and relatively straightforward option is to create a lending program. This can either be a government-

operated revolving loan fund, where loan repayments are then re-loaned in turn, or in conjunction with a lender such as a bank, community development financial institution, or credit union. The partnerships with financial institutions are frequently backed with credit enhancements to make the terms more appealing for borrowers and lending partners and to encourage them to lend to lower-income or lower-credit scoring individuals.

Property Assessed Clean Energy, or PACE, (see also the Value Capture and Energy Efficiency sections) is a financing mechanism that has seen significant interest recently. A clean-energy improvement, either renewable or energy efficiency, is treated by the city in the same way as a sidewalk improvement would be treated. It is an assessment to be repaid via a municipal bill, usually the property tax, and is collateralized in the same way. In this way it stays with the property in the event of a sale, and bill-payment history can be considered as an underwriting criteria.

For the residential market this mechanism has unfortunately encountered some regulatory difficulty at the federal level, but it remains viable for commercial properties, and new programs are appearing at a rapid pace. Edina, Minnesota, recently launched a commercial PACE program that has already resulted in the installation of new solar-photovoltaic systems. It partners private finance and local bonding authority with local businesses.[223]

The purchase of renewable technology becomes significantly cheaper at large scale—equivalent to purchasing at wholesale price. This aggregation also reduces the hassle of finding systems and installers for the end-owner. Cities, other jurisdictions, utilities, community groups, or for-profit entities can create bulk-buy programs for either their own buildings, commercial buildings, or residences, which aggregates the purchasing.

The model was pioneered in Portland, Oregon with the Solarize Portland program, where the city assists neighborhood associations and other organizations with program design, finding contractors, and marketing to participants. Since 2009, the program has purchased 600 solar installations.[224]

## Smart grid

### Background

The electric grid—a huge, complex power distribution system—is in many ways woefully out of date and increasingly unreliable, especially now that climate

change means more severe weather events. The grid, which was built to move electricity from large, traditional power-generation plants that operate primarily on fossil fuels, is a one-way system—taking energy from these plants to end users.

Electric usage has traditionally been metered via a system that required a person to walk to the meter and read it. This system was not designed to be readable by customers, however, and it did not provide feedback on power usage or offer any incentive to conserve energy.

Another problem is that the current grid is sensitive to spikes in demand, and a failure in one place can quickly cascade across the system, as the Northeast United States found out in 2003. In some places grid operators only know that there is a power outage when a customer calls.

The grid is also "unfriendly" to renewable power generation, which tends to be intermittent—available when the sun shines or wind blows. Because generation needs to closely match demand, the grid can have trouble distributing renewable energy.

The proposed solution to the grid's problems is to make it "smart"—to upgrade power plants, transmission lines, electric meters, and appliances so that they can communicate with each other and with the grid managers to provide information about supply, demand, and power interruptions.[225] While the smart grid is primarily a federal, state, and utility venture, local governments are certainly affected and may have a more central role, especially if they control a municipal utility. The American Recovery and Reinvestment Act also contained significant funding for smart grid projects,[226] and many local governments formed or joined partnerships to take advantage of those grants.

### Basic smart grid

The smart grid's basic premise is that rather than simply transmitting energy one way, the grid should transmit both energy and information in both directions. And it should be able to adjust to multiple sources of generation not just large power plants. This requires upgrades to multiple components of the grid, including adding sensors to transmission lines to help sense outages and smart meters that can be read electronically from afar.

This increase in information will both help prevent blackouts and help recover from them by isolating the problems and automatically rerouting power. It will also allow utilities to manage demand and incentivize consumers to reduce their energy use during high-demand times. This can be accomplished by managing when customer's appliances run, which can reduce the cost of generation, or by charging "time of use" rates, which better reflect the actual cost of power at any given time. A further benefit is providing consumers with more information about their power usage, which can promote energy efficiency.

An upgraded grid can more easily accommodate renewable energy, too, by helping to vary demand as well as supply. Grid managers currently can only vary supply effectively.[227]

Finally, evidence shows that smart grids are good for businesses and the economy because they offer companies a way to better manage their energy costs.[228] A fully developed smart grid should realize economic benefit from increased renewable-energy production as well.

A fully developed smart grid should realize economic benefit from increased renewable-energy production as well.

Critics, however, argue that the technology is relatively new and untested, that the information gathered—in most cases by private utility companies—raises privacy concerns, and that full implementation, and thus realization of the full benefits, relies not just on smart grids and meters but also on appliances and consumer behavior and choices.

Cost is a concern as well. Xcel Energy's SmartGridCity pilot in Boulder, Colorado, cost $45 million more than anticipated, and residents have yet to see much value from the project.[229]

The smart meter portion of smart-grid projects, which has been a focus of implementation, has the capacity to save utilities significant amounts of money, partly in the form of avoided travel costs since the new meters can be read remotely. The Salt River Project in Tempe, Arizona, has avoided at least 1.3 million driving miles and saved 135,000 gallons of fuel. It has also saved almost 250,000 labor hours,[230] which is another point of criticism. Unions in particular are concerned that the mechanization involved in the smart grid means fewer jobs for their members.

Tallahassee, Florida, has installed smart meters for electric, gas, and water utilities and is developing a smart grid around them.[231]

## Beyond the basics

In its full implementation, the smart grid would include not just power generation, transmission, and metering systems but also all appliances and distributed generation in residences, including electric cars. It would optimize when certain appliances are run to help balance generation with demand, use batteries or electric vehicles to store renewable generation, and help households both use less and be more efficient in their use of electricity. This would, in general, save consumers money as well.

Austin, Texas, through its municipal utility Austin Energy, has the first fully deployed smart grid in the nation. The first phase of the project was completed in 2009 and included the infrastructure needed to monitor and manage the creation, delivery, and consumption of customers' energy, at a cost of $150 million. The next phase of implementation, called the Pecan Street Project,[232] focuses on how to better integrate and promote distributed renewable generation and electric vehicles into the grid.[233] It also emphasizes demand management through energy efficiency and technology—including the capacity to shed 90 megawatts of demand via remote-controlled thermostats.[234]

Pecan Street is studying how to get the most out of a smart grid both for the utility and the customers. Their research includes looking at:

- Distributed-energy generation, especially solar photovoltaic panels
- Energy storage and advanced battery technology
- Integrating smart irrigation systems
- Smart appliances
- Electric vehicles
- High-performance building techniques
- Ways to price electricity to promote conservation[235]

The Sacramento Municipal Utility District in California is also implementing a smart grid project, which includes a goal of promoting net-zero[236] homes and businesses.[237] Fort Collins, Colorado, is piloting a smart grid as part of FortZED,[238] a net-zero energy district in the city's downtown. This project will incorporate a wide range of distributed-energy generation technologies.

Local governments, especially those with municipal utilities, should consider investing in smart grid advances to facilitate energy conservation and renewable generation.

# Endnotes


1 Atlantic Station, "National Model for Smart Growth and Sustainable Development," available at http://www.atlanticstation.com/about (last accessed October 2012).

2 Kentlands, "History," available at http://www.kentlandsusa.com/sub_category_list.asp?category=19&title=History (last accessed October 2012).

3 Form-Based Codes Institute, "Sample Codes," available at http://www.formbasedcodes.org/samplecodes (last accessed October 2012).

4 Eric Sundquist, "Madison Code Reverses on Parking," *Planning* 77 (6) (2011): 6-8, available at http://www.cows.org/_data/documents/1349.pdf.

5 The City of Pasadena, "On-Street Parking in Pasadena," available at http://ww2.cityofpasadena.net/trans/parking/pkng_street.asp (last accessed October 2012).

6 "Donald Shoup," available at http://shoup.bol.ucla.edu/ (last accessed October 2012).

7 Center for Neighborhood Technologies, "Center for Transit-Oriented Development," available at http://www.cnt.org/tcd/ctod (last accessed October 2012).

8 American Public Transportation Association, "Recommended Practice for Quantifying Greenhouse Gas Emissions from Transit" (2009), available at http://www.apta.com/resources/hottopics/sustainability/Documents/Quantifying-Greenhouse-Gas-Emissions-APTA-Recommended-Practices.pdf.

9 The University of South Florida maintains a clearinghouse of information on transportation demand management, or TDM. University of South Florida, "National TDM and Telework Clearinghouse," available at http://www.nctr.usf.edu/clearinghouse/index.htm (last accessed October 2012).

10 Bloomington MN Government Site CityWeb, "Transportation Demand Management: Zoning Ordinance Update," available at http://www.ci.bloomington.mn.us/cityhall/dept/commdev/planning/regs/zoneproject/tdm/tdm.htm (last accessed July 2013).

11 University of South Florida, "List of Trip Reduction Ordinances," available at http://www.nctr.usf.edu/clearinghouse/tro/trolist.htm (last accessed October 2012).

12 Georgetown Climate Center, "State and Local Adaptation Plans," available at http://www.georgetownclimate.org/node/3325 (last accessed January 2013).

13 Institute for Sustainable Communities, "Promising Practices in Adaptation & Resilience: A Resource Guide for Local Leaders" (2010), available at http://www.iscvt.org/who_we_are/publications/Adaptation_Resource_Guide.pdf.

14 The World Bank, "Guide to Climate Change Adaptation in Cities" (2011), available at http://web.mit.edu/dusp/idg/GuideToClimateChangeAdaptationInCities_102711.pdf.

15 American Planning Association, "Policy Guide On Planning & Climate Change" (2011), available at http://www.planning.org/policy/guides/pdf/climatechange.pdf.

16 Sara P. Hoverter, "Adapting to Urban Heat: A Toolkit for Local Government" (Washington: Georgetown Climate Center, 2012), available at http://www.law.georgetown.edu/academics/academic-programs/clinical-programs/our-clinics/HIP/upload/Urban-Heat-Toolkit_RD2.pdf.

17 Jessica Grannis,"Adaptation Tool Kit: Sea Level Rise and Coastal Land Use: How Governments can use Land-use Practices to Adapt to Sea Level Rise" (Washington: Georgetown Climate Center, 2011), available at http://www.georgetownclimate.org/sites/default/files/Adaptation_Tool_Kit_SLR.pdf.

18 City of Chula Vista, "Climate Action Plan Implementation Progress Report" (2012), available at http://www.chulavistaca.gov/clean/PDF/ClimateActionPlanUpdate_Nov12ProgressReport_FINAL.pdf.

19 Transportation Research Board, "Rough Roads Ahead, Fix Them Now or Pay for It Later" (2009), available at http://roughroads.transportation.org/RoughRoads_FullReport.pdf.

20 Ibid.

21 Ibid.

22 Matthew E. Kahn and David M. Levinson, "Fix It First, Expand It Second, Reward It Third: A New Strategy for America's Highways" (Washington: The Brookings Institution, 2011), available at http://www.brookings.edu/research/papers/2011/02/~/media/Research/Files/Papers/2011/2/highway%20infrastructure%20kahn%20levinson/02_highway_infrastructure_kahn_levinson_paper.PDF.

23 National Governors Association, "State Overview of Fix-it-First Approaches," available at http://www.nga.org/files/live/sites/NGA/files/pdf/0408FIXFIRSTCHART.pdf (last accessed October 2012).

24 Nashville Area Metropolitan Planning Organization, "2035 Regional Transportation Plan: Guiding Principles, Regional Goals, and Major Objectives" (2010), available at http://www.nashvillempo.org/docs/lrtp/2035rtp/Docs/MPO_Goals_and_Objectives_Final.pdf.

25 Transportation for America, "Dangerous By Design," available at http://t4america.org/resources/dangerousbydesign2011/ (last accessed July 2013).

26 International City/County Management Association, "Active Living and Social Equity: Creating Healthy Communities for All Residents" (2005), available at http://www.leadershipforhealthycommunities.org/images/stories/rpt_icma_jan2005.pdf.

27 Smart Growth America, "National Complete Streets Coalition: Local Policy," available at http://www.smartgrowthamerica.org/complete-streets/changing-policy/model-policy/local-policy (last accessed October 2012).

28 Madison Area Transportation Planning Board, "Regional Transportation Plan 2030" (2006), available at http://www.madisonareampo.org/planning/documents/GoalsPolicyObjectives.pdf.

29 Smart Growth America, "National Complete Streets Coalition: Local Policy."

30 For a listing of complete streets resources, see Center for Disease Control, "Resource Center," available at http://www.cdc.gov/CommunitiesPuttingPreventionToWork/resources/physical_activity.htm - complete_streets (last accessed October 2012).

31 Jarrett Walker writes a well-respected blog on transit supportive urban development. "Human Transit," available at http://www.humantransit.org/ (last accessed October 2012).

32 Transportation Research Board, "Local and Regional Funding Mechanisms for Public Transportation" (2009), available at http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_rpt_129.pdf.

33 Regional Transportation District, "Adopted Budget 2012" (2011), available at http://www.rtd-denver.com/PDF_Files/Financial_Reports/Adopted_2012.pdf.

34 Abigail Thorne-Lyman and Elizabeth Wampler, "Transit Corridors and TOD: Connecting the Dots" (Denver: Center for Transit-Oriented Development, 2011), available at http://reconnectingamerica.org/assets/Uploads/RA203corridorsFINAL3.pdf.

35 Metropolitan Council, "Guide for Transit-Oriented Development" (2006), available at http://www.metrocouncil.org/planning/tod/TOD_index_page.pdf.

36 Regional Transportation District, "Adopted Budget 2012."

37 Community Wealth, "Overview: Transit Oriented Development," available at http://www.community-wealth.org/strategies/panel/tod/index.html (last accessed December 2012).

38 University of South Florida, "National TDM and Telework Clearinghouse."

39 "Metro Commute Card" Madison Metro, available at http://www.cityofmadison.com/metro/fares/commutecard.cfm (last accessed October 2012).

40 City of Madison Metro Transit, "Metro Commute Cards," available at http://metrotransit.org/passes-go-to-cards.aspx (last accessed October 2012).

41 Regional Transportation District, "Adopted Budget 2012."

42 Federal Highway Administration, "Freight Facts and Figures 2011," available at http://www.ops.fhwa.dot.gov/freight/freight_analysis/nat_freight_stats/docs/11factsfigures/table2_1.htm (last accessed October 2012).

43 City of Portland, "Buffer Zone" (2006), available at http://www.portlandoregon.gov/bps/article/53341.

44 City of Orlando Public Works Department, "The Downtown Orlando Transportation Plan: Final Report" (2006), available at http://www.cityoforlando.net/transportation/TransportationPlanningDiv/pdf/dtp_docs/DTP1106.pdf.

45 Federal Highway Administration, *Urban Freight Case Studies: Orlando* (Department of Transportation, 2009), available at http://ops.fhwa.dot.gov/publications/fhwahop10021/fhwahop10021.pdf.

46 Federal Highway Administration, *FHWA Freight and Land Use Handbook* (Department of Transportation, 2012), available at http://www.ops.fhwa.dot.gov/publications/fhwahop12006/.

47 City of Baltimore, "Maritime Industrial Zoning Overlay District: Summary and Evaluation" (2010), available at http://www.baltimorecity.gov/Portals/0/agencies/planning/public%20downloads/2010/DRAFT%20MIZOD%20Report%202010.pdf.

48 Federal Highway Administration, *FHWA Freight and Land Use Handbook*.

49 Leftwich Consulting Engineers, Inc., "Technical Report 6: Freight Urban Village Land Use Plan and Strategies" (2010), available at http://www.metroplanorlando.com/files/view/tr6-freight-village-land-use-plan.pdf.

50 Federal Highway Administration, "Urban Goods Movement," available at http://ops.fhwa.dot.gov/freight/technology/urban_goods/index.htm (last accessed October 2012).

51 Federal Highway Administration, *Urban Freight Case Studies: New York* (Department of Transportation, 2009), available at http://ops.fhwa.dot.gov/publications/fhwahop10019/fhwahop10019.pdf.

52 Ibid.

53 Ibid.

54 Idling Reduction Working Group, "IRWG Documents and Links," available at http://www.louisvilleky.gov/APCD/Stakeholder/IRWGDocuments.htm (last accessed September 2012).

55 Idling Restriction Working Group, "Idling Restriction Review" (2008), available at http://www.louisvilleky.gov/NR/rdonlyres/467264D8-D8D2-40BD-958A-81F9379F2FBD/0/IdlingRestrictionReview_Draft_2008_11_12.xls.

56 "Regional Economic Benefits" Port of New York and New Jersey, available at: http://www.panynj.gov/port/regional-economic-benefits.html (last accessed January 2013).

57 Clean Air Task Force, "Problems with Diesel," available at http://www.catf.us/diesel/problems/ (accessed January 2013).

58 Rebecca Smith, Dr. David Bensman, and Paul Alexander Marvy, "Big Rig: Poverty, Pollution, and the Misclassification of Truck Drivers at America's Ports" (2010), available at http://nelp.org/page/-/Justice/PovertyPollutionandMisclassification.pdf?nocdn=1.

59 The Port of Los Angeles, "About the of Los Angeles Clean Truck Program," available at http://www.portoflosangeles.org/ctp/idx_ctp.asp (last accessed January 2013).

60 Project for Public Spaces, "Resources: What Makes a Successful Place?" available at http://www.pps.org/reference/grplacefeat/ (last accessed September 2012).

61 Peter Harnik, "The Excellent City Park System" (Washington: The Trust for Public Land, 2006), available at http://cloud.tpl.org/pubs/ccpe_excellentcityparks_2006.pdf.

62 Ibid.

63 Environmental Protection Agency, "Flat Branch Park" (2010), available at http://epa.gov/brownfields/success/columbia_mo.pdf.

64 Environmental Protection Agency, "Fremont Community Garden" (2006), available at http://epa.gov/brownfields/success/sacramento_ca_BRAG.pdf.

65 For more information, see the section on Value Capture.

66 Klyde Warren Park, "About the Park," available at http://www.klydewarrenpark.org/About-the-Park/index.html (last accessed December 2012).

67 Michael Kilmmelman, "River of Hope in the Bronx," *The New York Times*, July 19, 2012, available at http://www.nytimes.com/2012/07/22/arts/design/bronx-river-now-flows-by-parks.html?_r=3&pagewanted=all.

68 Majora Carter Group, "Hunts Point Riverside Park" (2009), available at http://www.majoracartergroup.com/services/case-histories/hunts-point-riverside-park/.

69 Joe Linton, "Villaraigosa Announces Ambitious Initiative for 50 New Parks," LA Streetsblog, August 24, 2012, available at http://la.streetsblog.org/2012/08/24/villaraigosa-announces-ambitious-initiative-for-50-new-parks/.

70 "Northerly Island Reimagined As Urban Camping Destination," CBS Chicago Local, August 16, 2012, available at http://chicago.cbslocal.com/2012/08/16/plans-for-northerly-island-park-set-to-go-ahead/.

71 Pop-Up City, "Ithaca's Fabulous Mayor And The World's Smallest Park," available at http://popupcity.net/2012/06/ithacas-fabulous-mayor-and-the-worlds-smallest-park/ (last accessed October 2012).

72 Peter Harnick, "Proceed Without Caution: Cities Add Parkland by Closing Streets and Roads to Cars," City Parks Blog, April 12, 2012, available at http://cityparksblog.org/2012/04/12/proceed-without-caution-cities-add-parkland-by-closing-streets-and-roads-to-cars/.

73 Ibid.

74 Peter Harnick, "Adding Hours Rather than Acres: Extending Playing Time to Create Parkland," City Parks Blog, June 29, 2012, available at http://cityparksblog.org/2012/06/29/adding-hours-rather-than-acres-extending-playing-time-to-create-parkland/.

75 City Parks Alliance, "Summer Night Lights: Gang Reduction & Youth Development," available at http://www.cityparksalliance.org/summer-night-lights (last accessed July 2013).

76 Angelina Horn, "Parks Breathe Life (and Jobs) into Cities," City Parks Blog, December 22, 2011, available at http://cityparksblog.org/2011/12/22/parks-breathe-life-and-jobs-into-cities/.

77 J. Green, "Parks = Jobs," The Dirt, July 20, 2012, available at http://dirt.asla.org/2012/07/20/parks-jobs/.

78 Coleen Gentles, "Developer Impact Fees Pay for Parks," City Parks Blog, February 29, 2012, available at http://cityparksblog.org/2012/02/29/developer-impact-fees-pay-for-parks/.

79 Dan Burden, "22 Benefits of Urban Street Trees" (Port Townsend, WA: Walkable Communities, 2008), available at http://www.walkable.org/assets/downloads/22%20Benefits%20of%20Urban%20Street%20Trees.pdf.

80 USDA Forest Service Northeastern Area, "Values of Urban Trees" (1993), available at http://www.na.fs.fed.us/spfo/pubs/uf/techguide/values.htm.

81 Arbor Day Foundation, "The Value of Trees to a Community," available at http://www.arborday.org/trees/benefits.cfm (last accessed October 2012).

82 Austin Troy, J. Morgan Grove, and Jarlath O'Neil-Dunne, "The relationship between tree canopy and crime rates across an urban–rural gradient in the greater Baltimore region" *Landscape and Urban Planning*, 106 (3) (2012): 262-270, available at http://www.sciencedirect.com/science/article/pii/S0169204612000977.

83 Burden, "22 Benefits of Urban Street Trees."

84 Susan Wachter, "The Determinants of Neighborhood Transformations in Philadelphia Identification and Analysis: The New Kensington Pilot Study" (Philadelphia: The Wharton School, University of Pennsylvania, 2005), available at http://kabaffiliates.org/uploaded-Files/KAB_Affiliates.org/Wharton%20Study%20NK%20final.pdf.

85 Diana Nelson Jones, "The maple plan: Bringing the forest to the city," *Pittsburgh Post-Gazette*, June 30, 2012, available at http://www.post-gazette.com/stories/local/neighborhoods-city/the-maple-plan-bringing-the-forest-to-the-city-642591/.

86 CPS Energy, "Green Shade Tree Rebates," available at http://www.cpsenergy.com/Residential/Rebates/Green_Shade_Trees/index.asp (last accessed October 2012).

87 Auditi Guha, "Cambridge launches tree ambassador program," *Wicked Local Cambridge*, August 30, 2011, available at http://www.wickedlocal.com/cambridge/news/x1131633347/Cambridge-launches-tree-ambassador-program#axzz1XJaPGG7y.

88 "Tree Pittsburgh," available at http://www.city.pittsburgh.pa.us/cp/html/shade_tree_volunteer.html (last accessed October 2012).

89 J. Green, "Parks = Jobs."

90 Urban Corps San Diego County, "Urban Forestry," available at http://www.urbancorpssd.org/forestry.html (last accessed October 2012).

91 Tree Trust, "Young Adult Conservation Corps (ages 18-24)," available at http://treetrust.org/jobs/youth-young-adults/yacc/ (last accessed October 2012).

92 Sam Dolnick, "Learning to Climb New York City's Trees," *The New York Times*, February 14, 2010, available at http://www.nytimes.com/2010/02/15/nyregion/15tree.html?_r=0.

93 Sustainable Cities Institute, "Materials Management," available at http://www.sustainablecitiesinstitute.org/view/page.basic/class/tag.topic/materials_management (last accessed October 2012).

94 This can be done via a waste characterization study. Sustainable Cities Institute, "Conducting a Waste Characterization Study: Overview," available at http://www.sustainablecitiesinstitute.org/view/page.basic/class/feature.class/Lesson_Waste_Characterization_Study (last accessed October 2012).

95 City of San José, "Environmentally Preferable Procurement Policy" (2001), available at http://www.sustainablecitiesinstitute.org/view/page.basic/legislation/feature.legislation/Ord_Env_Pref_Purch_San_Jose_CA.

96 City of Berkeley, "Environmentally Preferable Procurement Policy" (2004), available at http://c0133301.cdn.cloudfiles.rackspacecloud.com/Model Ordinance - Bekeley EPP Policy SF.pdf.

97 "The Truth about Recycling," *The Economist*, June 7, 2007, available at http://www.economist.com/node/9249262.

98 Environmental Protection Agency, "Multifamily Recycling: A Golden Opportunity for Solid Waste Reduction" (1999), available at http://www.epa.gov/wastes/conserve/pubs/multi.pdf.

99 City of Portland, "Multifamily Recycling and Waste Reduction," available at http://www.portlandoregon.gov/bps/41466 (last accessed October 2012).

100 Environmental Services Bureau, "Residential Recycling Program," available at http://www.longbeach-recycles.org/recycling/residential.shtml (last accessed October 2012).

101 City of Los Angeles, "Multi-Family Recycling Program," available at http://www.larecycles.org/ (last accessed October 2012).

102 City of Pittsburgh, "Special Events Recycling," available at http://www.city.pittsburgh.pa.us/pw/assets/Special_Events_Recycling_Brochure.pdf (last accessed October 2012).

103 New York City Council, "Street cleaning and the collection and removal of recyclable materials and refuse at street events" (2009), available at http://legistar.council.nyc.gov/LegislationDetail.aspx?ID=449023&GUID=EDCE41D8-84CB-43F2-9DA9-B531EC70B4D3&Search=recycling&Options=ID%7cText%7c.

104 NYC Recycles, "Recycling at Street Events," available at http://www.nyc.gov/html/nycwasteless/html/recycling/streetevents.shtml (last accessed October 2012).

105 City Of Portland Event Recycling Program, "Recycling System Set Up Guide" (2012), available at http://www.portlandoregon.gov/bps/article/345875.

106 City of Portland, "Event Recycling and Composting," available at http://www.portlandoregon.gov/bps/43211 (last accessed October 2012).

107 Environmental Protection Agency, "Boise City Events Recycling," available at http://www.epa.gov/wastes/conserve/tools/rogo/documents/boise-events.htm (last accessed October 2012).

108 CalRecycle, "Recycled Products Procurement Policy," available at http://www.calrecycle.ca.gov/LGCentral/Library/Innovations/procurement/pittpol.htm (last accessed October 2012).

109 City of Santa Monica, "Sustainable Procurement Policy" (1994), available at http://www.smgov.net/uploadedFiles/Departments/OSE/Categories/Buying_Green/Sustainable_Procurement_policies.pdf.

110 Kivi Leroux and Neal Seldman, "Deconstruction: Salvaging Yesterday's Buildings for Tomorrow's Sustainable Communities" (Washington: Institute for Local Self Reliance, 2000), available at http://c0133311.cdn.cloudfiles.rackspacecloud.com/Report%20-%20Deconstruction%20SF.pdf.

111 City of Brawley, "Ordinance No. 2004-7" (2004), available at http://c133301.r1.cf0.rackcdn.com/Ordinance%20-%20Brawle%20CA%20CD%20waste%20diversion%20SF.pdf.

112 Sustainable Cities Institute, "Construction and Demolition Diversion Model Ordinance"(2004), available at http://www.sustainablecitiesinstitute.org/view/page.basic/legislation/feature.legislation/Model_Ord_Const_Demo_Diversion_CA.

113 Rob D'Arcy, "The Road to Product Stewardship: Local Government as Catalysts" (Santa Clara, CA: Department of Environmental Health, 2009), available at http://www.productpolicy.org/ppi/attachments/Local-Governments-as-Catalysts_Santa-Clara-County-CA_Oct-2009_Rob-D%27Arcy.pdf.

114 City of Austin, "Household Hazardous Waste," available at http://austintexas.gov/hhw (last accessed October 2012).

115 E-Cycle St. Louis, "Welcome!", available at http://www.ecyclestlouis.org/ (last accessed October 2012).

116 BPI, "Municipal Composting Programs," available at http://www.bpiworld.org/Default.aspx?pageId=190309 (last accessed October 2012).

117 Edwards and Kelcey, "Franklin County Sanitary Landfill – Landfill Gas (LFG) To Liquefied Natural Gas (LNG) Project" (2005), available at http://www.afdc.energy.gov/pdfs/landfillreportfinal.pdf.

118 Environmental Protection Agency, "Landfill Methane Outreach Program," available at http://www.epa.gov/lmop/basic-info/index.html#a03 (last accessed December 2012).

119 Charles Duhigg, "As Sewers Fill, Waste Poisons Waterways," *The New York Times*, November 22, 2009, available at http://www.nytimes.com/2009/11/23/us/23sewer.html?adxnnl=1&pagewanted=all&adxnnlx=1311701767-rtXVgVcSXsdFByH6yx7YYw&_r=0.

120 Environmental Protection Agency, "The Clean Water and Drinking Water Infrastructure Gap Analysis" (2002), available at http://www.epa.gov/safewater/gapreport.pdf.

121 "What is Greywater Recycling?" available at http://www.letsgogreen.com/greywater-recycling.html (last accessed June 2013).

122 "What is a Green Roof" available at http://dcgreenworks.org/programs/rainwater-conservation-and-reuse/green-roofs-2-0/ (last accessed June 2013).

123 "Permeable Pavement Fact Sheet Information for Howard County, Maryland Homeowners" available at http://extension.umd.edu/sites/default/files/_docs/programs/master-gardeners/Howardcounty/Baywise/PermeablePavingHowardCountyMasterGardeners10_5_11%20Final.pdf (last accessed July 2013).

124 Arbor Day Foundation, "The Value of Trees to a Community," available at http://www.arborday.org/trees/benefits.cfm (last accessed October 2012).

125 "Bioswales absorb and transport large runoff events" available at ftp://ftp-fc.sc.egov.usda.gov/IA/news/BioswalesFS.pdf (last accessed July 2013).

126 "What is a Rain Garden?" available at http://www.lowimpactdevelopment.org/raingarden_design/whatisaraingarden.htm ( last accessed July 2013).

127 "Rainwater Harvesting: Rainwater Basics" available at http://rainwaterharvesting.tamu.edu/rainwater-basics/ (last accessed July 2013).

128 Emily Gordon and others, "Water Works" (Washington: Green For All, 2011), available at http://greenforall.org/wordpress/wp-content/uploads/2012/07/Green-for-All-Water-Works.pdf.

129 Alisa Valderrama and Larry Levine, "Financing Stormwater Retrofits in Philadelphia and Beyond" (New York: NRDC, 2012), available at http://www.nrdc.org/water/files/StormwaterFinancing-report.pdf.

130 Steve Wise, "Green Infrastructure Rising" (Chicago: American Planning Association, 2008), available at http://www.cnt.org/repository/APA-article.greeninfrastructure.080108.pdf.

131 Environmental Protection Agency, "Protect Your Drinking Water for Life," available at http://water.epa.gov/action/protect/ (last accessed October 2012).

132 City of Madison, "Wellhead Protection Program," available at http://www.cityofmadison.com/water/programs/wellheadprotectionprogram.cfm (last accessed October 2012).

133 Mike Lee, Residential 'grey water' rules eased," *San Diego Union Tribune*, August 1, 2009, available at http://www.utsandiego.com/news/2009/Aug/01/1m1gray23733-residential-gray-water-rules-eased/.

134 City of Tucson, "Ordinance #10417" (2007), available at American Society of Landscape Architects,inable Development," http://cms3.tucsonaz.gov/files/dsd/Ordinance10417.pdf.

135 Environmental Protection Agency, "Green Streets: A Conceptual Guide to Effective Green Streets Design Solutions" (2009), available at http://mayorsinnovation.org/pdf/briefing_book_0110/5GreenStreets.pdf.

136 Kari Lydersen, "Milwaukee pioneers innovative stormwater controls," Great Lakes Echo, April 5, 2011, available at http://greatlakesecho.org/2011/04/05/milwaukee-pioneers-innovative-stormwater-controls/.

137 Tom Arrandale, "The Price of Greening Stormwater," Governing, April 20, 2012, available at http://www.governing.com/topics/energy-env/price-greening-stormwater-philadelphia.html.

138 Nevue Ngan Associates and Sherwood Design Engineers, "San Mateo County Sustainable Green Streets and Parking Lots Design Guidebook" (2009), available at http://mayorsinnovation.org/pdf/briefing_book_0110/4SanMateoGuidebook.pdf.

139 City of Seattle, "Seattle Green Factor," available at http://www.seattle.gov/dpd/cityplanning/completeprojectslist/greenfactor/whatwhy/ (last accessed JULY 2013); for legislative authority see City of Seattle, "City of Seattle Legislative Information Service" (2013) available at http://clerk.ci.seattle.wa.us/~scripts/nph-brs.exe?s1=&s3=&s4=123495&s2=&s5=&Sect4=AND&l=20&Sect2=THESON&Sect3=PLURON&Sect5=CBORY&Sect6=HITOFF&d=ORDF&p=1&u=%2F~public%2Fcbory.htm&r=1&f=G.

140 Center for Neighborhood Technology, "Reduce Flooding with the Wetrofit Service" (2012), available at http://www.cnt.org/news/media/Factsheet-Wetrofit.FINAL.pdf.

141 Houston Land/Water Sustainability Forum, "Low Impact Development Design Competition" (2010), available at http://www.houstonlwsforum.org/documents/LID-Competition_White_Paper_02-21-2011_Final.pdf.

142 City of Toronto, "Mandatory Downspout Disconnection," available at http://www.toronto.ca/water/protecting_quality/downspout.htm (last accessed October 2012).

143 Metropolitan Council, "MCES Inflow and Infiltration (I/I) Program," available at http://www.metrocouncil.org/Wastewater-Water/Funding-Finance/Rates-Charges/MCES-Inflow-and-Infiltration-%28I-I%29-Program.aspx (last accessed October 2012).

144 Federal Energy Management Program, "Green Roofs" (2004) available at http://www1.eere.energy.gov/femp/pdfs/fta_green_roofs.pdf.

145 Corrie Clark, Peter Adriaens, and F.Brian Talbot, "Green roof valuation: A Probabilistic Economic Analysis of Environmental Benefits" *Environmental Science and Technology* 42 (6) (2006): 2155–2161, available at http://www.erb.umich.edu/News-and-Events/colloquium_papers/Clarketal.pdf.

146 American Society of Landscape Architects, "Chicago City Hall Green Roof," Press release, October 8, 2012, available at http://www.asla.org/meetings/awards/awds02/chicagocityhall.html.

147 Lance Frazer, "Paving Paradise: The Peril of Impervious Surfaces" *Environmental Health Perspectives* 113 (7) (2005): A456–A462, available at http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1257665/.

148 Andrew C. Burr, "Energy Disclosure & The New Frontier for American Jobs" (Washington: Institute for Market Transformation, 2012), available at http://www.imt.org/uploads/resources/files/Energy_Disclosure_New_Frontier.pdf.

149 Robin Pollin, James Heintz, and Heidi Garrett-Peltier, "The Economic Benefits of Investing in Clean Energy" (Washington: Center for American Progress, 2009), available at http://www.peri.umass.edu/fileadmin/pdf/other_publication_types/green_economics/economic_benefits/economic_benefits.PDF.

250 Burr, Majersik and others, "Analysis of Job Creation and Energy Cost Savings: From Building Energy Rating and Disclosure Policy" (Washington: Institute for Market Transformation, 2012), available at http://www.imt.org/uploads/resources/files/Analysis_Job_Creation.pdf.

151 Energy Star, "Portfolio Manager Overview," available at http://www.energystar.gov/index.cfm?c=evaluate_performance.bus_portfoliomanager (last accessed October 2012).

152 Department of Planning and Development, "Director's Rule 6-2011" (2011), available at http://www.buildingrating.org/sites/default/files/DR2011-6.pdf.

153 NYC.gov, "PlaNYC Green Buildings & Energy Efficiency," available at http://www.nyc.gov/html/gbee/html/home/home.shtml (last accessed October 2012).

154 D.C. Municipal Regulations and D.C. Register, "Energy Performance Benchmarking of Privately Owned Buildings" (2012), available at http://www.dcregs.dc.gov/Gateway/NoticeHome.aspx?NoticeID=2818546.

155 City of San Francisco, "Environmental Code: Existing Commercial Buildings Energy Performance Ordinance" (2010), available at http://www.sfbos.org/ftp/uploadedfiles/bdsupvrs/committees/materials/LU012411_101105.pdf; State of California, "Assembly Bill No. 531" (2009), available at http://www.leginfo.ca.gov/pub/09-10/bill/asm/ab_0501-0550/ab_531_bill_20091011_chaptered.pdf.

156 City of Austin, "ORDINANCE NO. 20110421-002" (2011), available at http://www.austinenergy.com/About%20Us/Environmental%20Initiatives/ordinance/ordinance.pdf.

157 Washington State Legislature, "SB 5854 - 2009-10: Reducing climate pollution in the built environment" (2013), available at http://apps.leg.wa.gov/billinfo/summary.aspx?bill=5854&year=2009.

158 "BuildingRating.org," available at http://www.buildingrating.org (last accessed July 2013).

159 Rebecca Baker and others, "Full Disclosure: the Debate on Mandatory Energy Benchmarking and Building Labeling" (Seattle: Every Building Conference and Expo, 2012), available at http://www.bomaconvention.org/boma2012/Custom/Handout/Speaker0_Session459_2.pdf.

160 American Council for an Energy-Efficient Economy, "Austin Energy Conservation Audit and Disclosure (ECAD) Ordinance" (2011), available at http://aceee.org/files/Case-Study--Austin-Energy-ECAD.pdf.

161 City of Ann Arbor, "Chapter 105 - Housing Code" (1987), available at http://library.municode.com/HTML/11782/level2/TITVIIIBURE_CH105HOCO.html.

162 *Energy Independence and Security Act of 2007*, Public Law 140, 110th Cong. (January 12, 2007), available at http://www.gpo.gov/fdsys/pkg/BILLS-110hr6enr/pdf/BILLS-110hr6enr.pdf.

163 Booz Allen Hamilton, "Green Jobs Study" (2009), available at http://www.usgbc.org/ShowFile.aspx?DocumentID=6435.

164 United Nations Environment Programme, "Buildings and Climate Change: Summary for Decision-Makers" (2009), available at http://www.unep.org/sbci/pdfs/SBCI-BCCSummary.pdf.

165 Drury Crawley, Shanti Pless, and Paul Torcellini, "Getting to Net Zero" (Washington: National Renewable Energy Labratory, 2009), available at http://www.nrel.gov/docs/fy09osti/46382.pdf.

166 Paul Karrer, "Success Story: Kansas City Pushes Strong Energy Code Update To Spur Metropolitan Area In Home Rule State," Online Code Environment & Advocacy Network, August 28, 2012, available at http://energycodesocean.org/news/2012/august/28/success-story-kansas-city-pushes-strong-energy-code-update-spur-metropolitan-are.

167 Building Codes Assistance Project, "Online Code Environment and Advocacy Network," available at http://energycodesocean.org/ (last accessed October 2012).

168 City of Boston, "Stretch Appendix to the Building Energy Code in Massachusetts" (2010), available at http://www.cityofboston.gov/Images_Documents/EOEEA%20q_and_a_stretch_code_tcm3-21504.pdf.

169 U.S. Green Building Council, "Green Building Incentive Strategies," available at http://www.usgbc.org/DisplayPage.aspx?CMSPageID=2078 (last accessed October 2012).

170 Arlington Economic Development, "Green Building initiative," available at http://www.arlingtonvirginiausa.com/major-initiatives/green-building-initiative/ (last accessed October 2012).

171 Database of State Incentives for Renewables & Efficiency, "City of Greensburg - Green Building Requirement for New Municipal Buildings," available at http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=KS06R&re=0&ee=0 (last accessed July 2013).

172 National Association of Home Builders, "Green Building, Remodeling & Development," available at http://www.nahbgreen.org/ngbs/default.aspx (last accessed October 2012).

173 Illuminating Engineering Society, "Standard for the Design of High-Performance Green Buildings" (2009), available at http://www.ies.org/store/product/standard-for-the-design-of-highperformance-green-buildings-brexcept-lowrise-residential-building-1216.cfm.

174 International Code Council, "International Green Construction Code," available at http://www.iccsafe.org/cs/igcc/pages/default.aspx (last accessed July 2013).

175 Harry Misuriello and others, "Lessons Learned from Building Energy Code Compliance and Enforcement Evaluation Studies" (Washington: American Council for an Energy-Efficient Economy, 2010), available at http://www.aceee.org/files/proceedings/2010/data/papers/2185.pdf.

176 Institute for Market Transformation, "Building Energy Code Compliance" (2010), available at http://www.imt.org/uploads/resources/files/PolicymakerFactsheet-EnergyCodeCompliance.pdf.

177 Jim Meyers, "Energy Code Enforcement: Best Practices from the Southwest" (Boulder: Southwest Energy Efficiency Project, 2012), available at http://www.swenergy.org/publications/documents/Energy%20Code%20Enforcement.pdf.

178 Department of Energy, "Buildings Share of U.S. Primary Energy Consumption (Percent)," available at http://buildingsdatabook.eren.doe.gov/TableView.aspx?table=1.1.3 (last accessed May 2011).

179 See the Job Quality chapter for more information.

180 James Irwin and others, "Making M.U.S.H. Energy Efficient" (Madison: Center on Wisconsin Strategy, 2011), available at http://www.cows.org/_data/documents/999.pdf.

181 Pollin, Heintz, Garrett-Peltier," The Economic Benefits of Investing in Clean Energy."

182 City of Reno, "Energy Efficiency and Renewable Energy Initiative" (2013), available at http://mayorsinnovation.org/pdf/8Reno.pdf.

183 Ibid.

184 Stacy Ho and Jeremy Hays, "High Road Outcomes in Portland's Energy Efficiency Upgrade Pilot" (Oakland, CA: Green For All, 2011), available at http://craft3.org/docs/case-studies/high-road-outcomes-in-portlands-energy-efficiency-upgrade-pilot-green-for-all-030111.pdf?sfvrsn=0; see the Contracting and Procurement chapter for more information.

185 Gov. Mark Dayton and Mark Ritchie, "Providing for Job Creation through Energy Efficiency and Renewable Energy Programs for Minnesota's Public Buildings" (Minneapolis: State of Minnesota, 2012), available at http://www.leg.mn/archive/execorders/11-12.pdf.

186 Paul Ettorre and Mark McDermott, "A Northeast Ohio Regional Energy Alliance" (Cleveland: Cleveland Sustainability Summit 2019, 2010), available at http://www.slideshare.net/GreaterCea/state-alliance-presentationpaulettorre.

187 Stacy Ho and Jeremy Hays, "Increasing Demand for Home Retrofits: Community-Based Outreach and Mobilization" (Oakland, CA: Green For All, 2010), available at http://www.skill-works.org/documents/FinalCommunityMobilization4HomeRetrofits-1_6-10.pdf.

188 See the Value Capture section for more information.

189 Energy Independence, "Sonoma County Energy Independence Program," available at http://www.sonomacountyenergy.org (last accessed October 2012).

190 Federal Housing Finance Authority, "FHFA Statement on Certain Energy Retrofit Loan Programs" (2010), available at http://ase.org/sites/default/files/nodes/2200/FHFA_PACE.pdf.

191 Michael Volker, "How$mart" (Hays, KS: Midwest Energy, Inc., 2010), available at http://meeaconference.org/fck_uploads/MES_2010_presentations/MES_2010_Volker_1-15-2010.pdf.

192 Community Power Works, "Investment," available at http://www.communitypowerworks.org/about-community-power-works/investment/ (last accessed October 2012).

193 Ho and Hays, "Increasing Demand for Home Retrofits."

194 California Statewide Communities Development Authority, "About CaliforniaFIRST," available at https://californiafirst.org/about (last accessed October 2012).

195 PaceNow, "Commercial PACE in Edina, Minnesota," available at http://pacenow.org/about-pace/feature-c-pace-in-edina/ (last accessed October 2012).

196 Mike McGinn, "Seattle promotes innovation in achieving energy efficiency," City of Seattle, October 12, 2012, available at http://mayormcginn.seattle.gov/seattle-promotes-innovation-in-achieving-energy-efficiency/.

197 Department of Energy, "Qualified Energy Conservation Bond (QECB)," available at http://www1.eere.energy.gov/wip/solutioncenter/qecb.html (last accessed October 2012).

198 Energize Delaware, "Energize Delaware and the Sustainable Energy Utility," available at http://www.energizedelaware.org/Sustainable-Energy/ (last accessed October 2012).

199 Clean Energy Finance and Investment Authority, "Who We Are," available at http://www.ctcleanenergy.com/Default.aspx?tabid=62 (last accessed October 2012).

200 See the Revenue chapter for more information.

201 Mark Zimring and others, "Delivering Energy Efficiency to Middle Income Single Family Households" (Berkeley, CA: Lawrence Berkeley National Laboratory, 2011), available at http://emp.lbl.gov/sites/all/files/REPORT%20lbnl-5244e.pdf.

202 Long Island Green Homes, "About Us," available at http://ligreenhomes.com/about_us (last accessed September 2012).

203 Charles Rolland and others, "Community High Road Agreement" (Seattle: Community PowerWorks, 2010), available at http://www.communitypowerworks.org/wp-content/uploads/2010/10/Community-High-Road-Agreement.pdf; see the Job Quality section for more information.

204 Scott Rasmussen, "Energy Update: 51% Say U.S. Has Enough Shale Oil to Become World's Largest Energy Producer," Rasmussen Reports, July 25, 2012, available at http://www.rasmussenreports.com/public_content/politics/current_events/environment_energy/energy_update.

205 Kees van der Leun, "Solar PV rapidly becoming the cheapest option to generate electricity," Grist, October 11, 2011, available at http://grist.org/solar-power/2011-10-11-solar-pv-rapidly-becoming-cheapest-option-generate-electricity/.

206 See the section on Smart Grid for more information.

207 See, for example, ALICE's model law. Alice, "Welcome to ALICE," available at http://www.alicelaw.org/ (last accessed July 2013).

208 City of Bellingham, "Municipal Facilities Energy Conservation Project," available at http://www.cob.org/services/environment/facilities-energy-project-2011.aspx (last accessed September 2012).

209 Western Sustainability, "Green Energy Fee Grant Program," available at http://www.wwu.edu/sustain/gef/ (last accessed September 2012).

210 Environmental Protection Agency, "Green Power Partnership: Partner Profile," available at http://www.epa.gov/greenpower/partners/partners/cityofbellinghamwa.htm (last accessed October 2012).

211 Environmental Protection Agency, "State and Local Climate and Energy Program: Case Studies," available at http://epa.gov/statelocalclimate/local/local-examples/case-studies.html#wa (last accessed October 2012).

212 Eileen Quigley and Elizabeth Willmott, "Powering the New Energy Future from the Ground Up" (Seattle: New Energy Cities, 2012), available at http://newenergycities.org/files/powering-the-new-energy-future-from-the-ground-up.pdf.

213 City of Bellingham, "Energy Efficiency and Conservation Program," available at http://www.cob.org/government/departments/pcd/eecbg-program.aspx last accessed October 2012).

214 Environmental Protection Agency, "Energy Efficiency in Local Government Operations" (2011), available at http://www.epa.gov/statelocalclimate/documents/pdf/ee_municipal_operations.pdf.

215 See also the sections on Building Retrofits and Building Codes.

216 Combined heat and power, or cogeneration, is the use of the excess heat generated by the production of energy to heat buildings, frequently in the form of hot water for district energy or district steam systems, or to drive a turbine to further generate electricity.

217 Dale Doerr, "Sustainable Wastewater Treatment from a Vision to a Reality" (Washington: Mayors Innovation Project Conference, 2012) available at http://www.mayorsinnovation.org/pdf/Doerr.pdf.

218 CPS Energy, "CPS Energy, OCI Solar Power Launch Largest Municipally Owned Mega Solar Project" (2012), available at http://www.cpsenergy.com/About_CPS_Energy/News_Features/News/PF-072312_OCI_Agreement_NR.asp.

219 Karlynn Cory, Toby Couture, and Claire Kreycik, "Feed-in Tariff Policy: Design, Implementation, and RPS Policy Interactions" (Golden, CO: National Renewable Energy Laboratory, 2009), available at http://www.nrel.gov/docs/fy09osti/45549.pdf.

220 Laura Snider, "Boulder's municipal utility effort follows few forerunners," *Daily Camera*, May 11, 2011, available at http://www.dailycamera.com/energy/ci_19270136.

221 City of Madison, "Legislative Information Center," available at http://www.cityofmadison.com/cityHall/legislativeInformation/ (last accessed October 2012).

222 Jenny Heeter and Joyce McLaren, "Innovations in Voluntary Renewable Energy Procurement" (Washington: National Renewable Energy Laboratory, 2012), available at http://www.nrel.gov/docs/fy12osti/54991.pdf.

223 PaceNow, "Commercial PACE in Edina," available at http://pacenow.org/about-pace/feature-c-pace-in-edina/ (last accessed July 2013).

224 Heeter and McLaren, "Innovations in Voluntary Renewable Energy Procurement."

225 "The Smart Grid," available at http://www.smartgrid.gov/the_smart_grid#smart_grid (last accessed October 2012).

226 "The Ten Largest US Smart Grid Projects," Telecom Engine, September 6, 2011, available at http://www.telecomengine.com/article/ten-largest-us-smart-grid-projects.

227 Environmental Defense Fund, "What consumers need to know about the smart grid and smart meters" (2011), available at http://www.edf.org/sites/default/files/EDF-smart-grid-benefits-fact-sheet_0.pdf.

228 "Jones Lang LaSalle's 'Connected City' Study Ties Cities' Smart Grid Use to Economic Drivers for CRE Health," PRNewswire, October 8, 2012, available at http://www.prnewswire.com/news-releases/jones-lang-lasalles-connected-city-study-ties-cities-smart-grid-use-to-economic-drivers-for-cre-health-173106951.html.

229 Phil Carson, "Can (should) a city build a smart grid? Boulder, among others, ponders the choice," IntelligentUtility, May 3, 2011, available at http://www.intelligentutility.com/article/11/05/can-should-city-build-smart-grid.

230 FierceSmartGrid, "Salt River Project-FierceSmartGrid Fierce 5," available at http://www.fiercesmartgrid.com/special-reports/fiercesmartgrid-names-top-5-smart-grid-utility-leaders-201-your-company-fie/2-salt-r#ixzz2A3GiTU8R (last accessed October 2012).

231 City of Tallahassee, "Smart Grid Technology," available at http://www.talgov.com/you/you-learn-energy-smart-grid.aspx (last accessed January 2013).

232 Pecan Street Research Institute, "The Pecan Street Project," available at http://www.pecanstreet.org/projects/smart-grid-demonstration/ (last accessed October 2012).

233 Andres Carvallo, "LIGHTSON: Austin Energy Delivers First Smart Grid in the US," Electric Energy Online, March 1, 2012, available at http://www.electricenergyonline.com/?page=show_article&mag=60&article=451.

234 Zach Pollock, "Top Ten Utility Smart Grid Deployments in North America," Greentechgrid, May 7, 2012, available at http://www.greentechmedia.com/articles/read/top-ten-utility-deployments-in-north-america/.

235 Pecan Street Research Institute, "The Pecan Street Project."

236 Net-zero buildings are buildings that produce as much energy as they use.

237 Jim Parks, "Smart Grid Implementation at the Sacramento Municipal Utility District" (San Francisco: Green Summit, 2010), available at http://www.green-technology.org/gcsummit/images/Smart_Energy_2.pdf.

238 FortZED, "Smart Grid," available at http://fortzed.com/what-is-fortzed/smart-grid (last accessed October 2012).