AN INFRASTRUCTURE VISION FOR THE 21ST CENTURY
Founded in 1908, the **National Governors Association (NGA)** is the collective voice of the nation’s governors and one of Washington, D.C.’s, most respected public policy organizations. Its members are the governors of the 50 states, three territories and two commonwealths. NGA provides governors and their senior staff members with services that range from representing states on Capitol Hill and before the Administration on key federal issues to developing and implementing innovative solutions to public policy challenges through the NGA Center for Best Practices. For more information, visit www.nga.org.

**National Governors Association**  
444 North Capitol Street, Suite 267  
Washington, DC 20001  
202.624.5300  
www.nga.org
America’s infrastructure is the backbone of our society. From roads, rails, bridges, and transit to the electrical grid, water treatment plants, broadband networks, schools, and hospitals, infrastructure makes modern life as we know it possible. It is critical to our economic growth, global competitiveness, and quality of life.

Despite its importance, America’s infrastructure has not kept pace with our country’s growing and shifting demands and the changing world around us. A growing pattern of underinvestment and uncoordinated planning has led to a range of concerns that are felt across the country, including widespread congestion, unsafe bridges, inadequate water supply, and an electric grid that is increasingly pressed beyond its ability. More broadly, we have created a system that leaves us dependent on imported oil, vulnerable to rising energy prices, and ill-equipped to address the challenges of climate change.

To ensure our nation’s ability to compete in an evolving global economy and respond to crucial energy and environmental challenges, we must not only maintain our infrastructure system but also enhance and improve it. And, we must do so in a way that is transparent and accountable to the American people.

Accomplishing all of this requires both new investments and a new long-term vision for the 21st century. My yearlong NGA Chair’s initiative—Strengthening Our Infrastructure for a Sustainable Future—enlists the efforts of all governors to rebuild, repair, and extend our nation’s infrastructure to ensure America’s continued economic competitiveness as well as its environmental sustainability. Helping to lead this effort is a task force of governors who have confronted infrastructure challenges in their own states and have seen what can work.

States have a key role to play in reinventing the policies and programs that will help address our nation’s infrastructure challenges. Indeed, states have repeatedly been at the forefront of overcoming these challenges. We must act now to build on our successes while exploring new opportunities. While the federal government must and will be an important partner, strengthening our infrastructure in a way that is both economically and environmentally sustainable calls for states to move forward on a number of fronts.

Strengthening Our Infrastructure for a Sustainable Future will help governors identify and advance actions that embrace:

- Innovative ways to pay for infrastructure;
- New approaches that help identify the most cost-effective investments and ensure top performance and accountability;
- Enhanced coordination across government agencies and levels of government, as well as between states and regions;
- Measures that reduce or manage demand and avoid costly new capacity projects;
- More sustainable alternatives to conventional infrastructure, such as transit and intercity rail, renewable energy and energy efficiency, and plug-in hybrid electric vehicles; and,
- Advanced technologies that can reduce costs and improve performance.

This report, An Infrastructure Vision for the 21st Century, looks at how different infrastructure assets affect states’ ability to compete globally, examines the infrastructure challenges facing states and our country as a whole; and explores new ways, both public and private, to finance our infrastructure needs. Above all, it offers a framework for transforming not only our nation’s physical infrastructure, but also the very way infrastructure investment decisions and policies are planned, financed, and carried out over the long-term.

A robust, well-maintained national infrastructure is essential to sustaining—and growing—America’s economic vitality, environmental health, and quality of life. States that successfully formulate a new, sustainable infrastructure vision for America in the 21st century—and bring it to scale—will be helping to improve the daily lives of all Americans and revitalize the nation for years to come.

Pennsylvania Governor Ed Rendell
NGA Chair, 2008–2009

The Strengthening Our Infrastructure for a Sustainable Future Task Force

Pennsylvania Governor Ed Rendell, Co-Chair
Vermont Governor Jim Douglas, Co-Chair
Indiana Governor Mitch Daniels
New Jersey Governor Jon Corzine
South Dakota Governor Mike Rounds
Washington Governor Chris Gregoire
ACKNOWLEDGEMENTS

This report, *An Infrastructure Vision for the 21st Century*, was researched and written by Darren Springer and Greg Dierkers of the National Governors Association Center for Best Practices (NGA Center).

Editorial assistance was provided by Sue Gander, Andrea Brachtesende, and John Thomasian with the NGA Center and by editorial consultant Allan Andrews.

For their comments and input on this document, the authors wish to thank Robert Padgette, Director of Policy Development & Research, American Public Transit Association; Ev Ehrlich, President ESC Company, former Under Secretary for Economic Affairs, U.S. Department of Commerce; Greg Pellegrino, Managing Director, Global Public Sector, Deloitte; Lawrence Mansueti, Director, State and Regional Assistance, Office of Electricity Delivery and Energy Reliability, U.S. Department of Energy; Mark Bailey, State and Local Programs, Office of Energy Efficiency and Renewable Energy, U.S. Department of Energy; John Atchison, Office of Energy Efficiency and Renewable Energy, U.S. Department of Energy; Stephen Burrington, Manager, Serrafix Corporation, former Undersecretary, Office for Commonwealth Development and Commissioner of Conservation and Recreation, Massachusetts; and Joung Lee, American Association of State Highway and Transportation Officials.
## CONTENTS

**EXECUTIVE SUMMARY** .................................................................................................................. 1

**CHAPTER 1. INTRODUCTION** ......................................................................................................... 3
- Why Infrastructure Matters .............................................................................................................. 3
- Current Infrastructure Funding and Operations ............................................................................. 4
- Evolving Role of Public and Private Sectors .................................................................................. 5

**CHAPTER 2. INFRASTRUCTURE CHALLENGES** ............................................................................. 7
- Underinvestment ............................................................................................................................ 7
- Generating Adequate Revenue to Pay for Infrastructure ............................................................... 8
- The Need for Improved Planning and Coordination ................................................................... 10
- Decreasing Our Reliance on Imported Oil ..................................................................................... 11
- Diversifying the Nation’s Electricity Portfolio .............................................................................. 11
- Responding to Climate Change ..................................................................................................... 12

**CHAPTER 3. ADDRESSING OUR INFRASTRUCTURE CHALLENGES** .............................................. 13
- A. Expand and Diversify Revenue Sources .................................................................................. 14
- B. Coordinate Infrastructure Decisions Across Government Agencies and Levels ................. 19
- C. Undertake Comprehensive Planning Efforts to Reduce or Manage Demand ......................... 24
- D. Look First to Environmentally Beneficial Alternatives to Conventional Infrastructure .......... 31
- E. Set Clear State-Directed Cost-Benefit Criteria and Performance Targets, Collect Data and Measure Success, and Provide for Accountability ......................................................... 32
- F. Incorporate New Technology .................................................................................................... 36

**CONCLUSION** ................................................................................................................................. 38

**ENDNOTES** .................................................................................................................................... 39
The infrastructure of the United States is the backbone of American society. Made up of the assets that deliver services and move people, products, energy, water, and even ideas, infrastructure is critical to economic growth, quality of life, and global competitiveness. Without the assets that comprise our national infrastructure—from roads, rail, bridges, and transit to wastewater treatment plants and the electrical grid—modern life as we know it would not exist. Unfortunately America’s infrastructure has not been maintained to keep pace with growing demand; moreover, it needs to be enhanced to keep the nation globally competitive and responsive to new economic, energy, and environmental realities. Maintaining and enhancing our infrastructure system calls for new investments and a new long-term vision for the 21st century. Governors and states will play a key part in shaping and implementing this effort.

Past investments in our infrastructure, both public and private, have helped to further America’s mobility, connect urban and rural regions, and facilitate commerce and economic development. For instance, our roads support 3 trillion vehicle miles traveled annually; we ship 16.4 billion tons of products annually; our transit system supported more than 10 billion trips last year; and we create and support 35,000 jobs for every $1.25 billion invested in transportation infrastructure development. Infrastructure investments in other areas also support job creation. An investment of $10 billion annually in smart grid deployment for five years could create or save 239,000 jobs per year. An investment of $10 billion over a one-year period to support broadband network deployment could create or retain nearly 500,000 jobs. In addition, infrastructure investments can help achieve other strategic policy objectives. For example, investments in renewable energy and smart grids can spawn new “green” economic sectors, advance clean energy goals, and reduce reliance on imported oil.

Current infrastructure investments, however, fall far short of the levels needed to sustain vital functions and to improve U.S. economic performance. Revenues to fund public infrastructure operations and maintenance have not kept pace with surging demand. In many areas, this has led to deferred maintenance and resulted in a piecemeal—and often less effective—approach to repairs and upgrades. Even as infrastructure spending across some categories increases, a number of factors have led to the erosion of the purchasing power of infrastructure funds.

America’s current infrastructure investments also are not keeping pace with global competitors. Compared with other nations, both developing and developed, America dedicates a small portion of its overall resources toward infrastructure. After making significant investments in the 20th century (such as in the Interstate Highway System), the United States now spends at most 2.6 percent of its gross domestic product (GDP) on infrastructure, meanwhile China invests at a rate of 9 percent to 12 percent of its GDP; India and the European Union spend about 5 percent; and Japan has invested roughly 10 percent of its GDP since the 1960s.

The result is that while there are differences across states, the condition of America’s infrastructure is, on the whole, poor. The American Society of Civil Engineers’ (ASCE’s) 2009 assessment of the nation’s infrastructure awarded the United States a grade of D, unimproved from a D in 2005, down from a D-plus in 2001, and the same as in 1998. Based on the latest assessment, ASCE projected that $2.2 trillion is needed over five years to bring U.S. infrastructure up to a grade of B or good condition. The strain from years of underinvestment in transportation, to take examples from just one sector, is evident: Approximately 12 percent of the nation’s bridges are structurally deficient; more than two-thirds of peak-hour traffic occurs in congested conditions; and 85 percent of public transit systems report capacity problems, while 65 percent lack the funds to meet growing ridership demands. These failures exact a high toll: In 2005, U.S. road congestion cost $200 billion in net economic losses, including 2.9 billion gallons of wasted fuel and 4.2 billion hours of time.

The nation faces a host of infrastructure challenges that are critical to address. These include broad systemic issues of underinvestment, inadequate revenue, and a need to improve planning efforts that affect assets across the board. They also include concerns about reducing our dependence on imported oil, diversifying our nation’s electricity portfolio, and responding to climate change that affect transportation and energy infrastructure in particular. While federal investments expected for 2009 could fund shovel-ready projects in transit, highways, school repair, and other critical areas—helping states put people to work right away on pressing needs—a long-term strategy to address these challenges also is needed.

The public has not been immune to the nation’s infrastructure challenges. In recent polling, 94 percent of Americans have expressed concern about the condition of the nation’s infrastructure. Among the public’s top priorities for infrastructure was accountability in spending and job creation. Energy facilities,
roads and highways, clean water treatment facilities, the electricity grid, schools, public transportation, and bridges topped the list of priorities for repairs and upgrades. Those polled believe that the top infrastructure priorities include improving the nation’s economy, safety, efficiency, and environmental performance.

Many would agree that there is much to be done across all levels of government to improve the nation’s infrastructure and enhance its performance. While the federal government plays an important part, this report will not make specific recommendations on federal actions. Rather, this report focuses on examining the role of states in addressing infrastructure challenges. Many state efforts may be complemented by federal policies and programs, such as the proposed federal infrastructure bank. State experiences may also help to inform federal policies; for instance, some states have already been utilizing their own infrastructure banks. State experiences may also help to inform federal policies; for instance, some states have already been utilizing their own infrastructure banks. For more information on the National Governors Association’s recommendation on federal policy, please visit www.nga.org/federalrelations.

As the nation works to strengthen its infrastructure, states have a key role to play in reinventing a wide range of policies and programs. Some states are expanding infrastructure revenue sources by engaging in public-private partnerships, implementing new user fees, and increasing existing funding streams. States are forming new subcabinets to focus on growth and development and to coordinate policy and planning. States are reducing demand for infrastructure during peak travel periods through congestion pricing systems. They also are investing in environmentally sustainable alternatives to conventional infrastructure, such as renewable energy and transit. States are continuing to hold departments of transportation accountable for spending decisions. They are incorporating new technologies, such as smart meters, to provide consumers with real-time information on their personal energy use to encourage conservation.

While each state is unique and not every recommendation is applicable to every state, governors should consider the following six principles as a guide for reforming infrastructure planning, development, and policy:

- Expand and diversify revenue sources for infrastructure development and maintenance;
- Coordinate infrastructure decisions across government agencies and levels of government, as well as between states and regions, and ensure that energy and environmental costs and concerns are considered;
- Prioritize comprehensive planning efforts that will reduce or manage demand to reduce the cost of or avoid new capacity projects;
- When adding capacity is necessary, look first to environmentally beneficial alternatives to conventional infrastructure, including transit and intercity rail, distributed and central renewable energy, energy efficiency and smart grid projects, and plug-in hybrid and electric vehicle infrastructure;
- Set clear state-directed cost-benefit criteria and performance targets for infrastructure investments, collect data and measure success, and provide for accountability and transparency through performance reporting pegged to a variety of well-defined, outcomes-based metrics; and
- Incorporate appropriate new technology wherever practical.

States increasingly recognize the need to transform not only their physical infrastructure but the very way infrastructure investment decisions and policies are planned, financed, and carried out over the long haul. States that successfully formulate a new infrastructure vision for America in the 21st century, and bring it to scale, will be helping to shore up the backbone of society and to revitalize the nation for years to come.
CHAPTER 1. INTRODUCTION

Infrastructure is a term that includes many physical assets that help to deliver services and move people, goods, energy, water, critical materials, and even ideas. Infrastructure matters to the public and the private sector alike because it plays a vital role in our nation’s competitiveness, quality of life, and environmental sustainability. The list of infrastructure assets includes roads, rail, bridges, transit, airports, and ports, as well as water treatment facilities and drinking water systems. Infrastructure can also include many private sector assets that are important to the national and state economies and are regulated by government, such as broadband networks and the electric grid. In addition, wider definitions of infrastructure may include schools, hospitals, prisons, and security installations. While some assets have traditionally been funded largely by government and others by a combination of both public and private funds, these roles are evolving and present both challenges and opportunities to states. This report focuses in particular on transportation, energy, and communications infrastructure that has a significant impact on competitiveness, quality of life, and environmental sustainability.

The scope of this report is to examine the role of the states in addressing infrastructure challenges. While many readers may be interested in the role the federal government can play, this report will not make specific recommendations on federal actions. Many would agree that there is much to be done across all levels of government to improve the nation’s infrastructure and enhance its performance. Federal policies and programs, such as the proposed federal infrastructure bank, could complement state efforts to make the nation’s infrastructure more robust. Federal policies may also be informed by state experiences, such as from states that have already been utilizing their own infrastructure banks. For more information on the National Governors Association’s recommendations on federal policy, please visit www.nga.org/federalrelations. It should also be noted that while this report does offer some broad recommendations on principles governors and states can use to guide infrastructure policy and decisionmaking, it also recognizes that each state is unique and not every recommendation is applicable to every state.

Why Infrastructure Matters

In considering transportation, energy, and communications infrastructure, three of the largest areas of investment, it becomes apparent why infrastructure matters. Infrastructure assets have traditionally been crucial to fueling economic growth and competitiveness, as well as improving quality of life. They are now set to play a decisive role in helping the nation meet energy and environmental challenges as well.

As the United States competes in the 21st century global economic marketplace, infrastructure will play an increasingly important role. Infrastructure facilitates commerce, knowledge creation, and the exchange of ideas. Infrastructure helps to move agricultural and manufacturing products to markets, and, when run efficiently, can help businesses lower operational costs. An efficient transportation infrastructure that reduces delay and congestion, for example, will be critical in addressing a growing demand for freight shipments.

Infrastructure investments create jobs. For every $1.25 billion invested in transportation infrastructure in the United States, 35,000 jobs are created and supported. An investment of $10 billion annually in smart grid deployment for five years could create or save 239,000 jobs per year. An investment of $10 billion over a one-year period to support broadband network deployment could create or retain nearly 500,000 jobs.

Infrastructure improves health care delivery and provides a foundation for service sectors of the economy. The quality and effectiveness of regional infrastructure such as transportation systems, schools, and communications will be a key determinant of the attractiveness of a state for bringing in new businesses and a highly skilled workforce. Nations that invest in infrastructure that speeds communications, brings goods swiftly to the marketplace, and raises the productivity of its citizens will achieve a competitive edge.

Infrastructure also affects quality of life. Transportation infrastructure provides mobility for employees to commute to their place of work and return to their families; it provides connectivity between rural and urban areas; it provides opportunities for business travelers to get to meetings; and enables shipping for products internationally. Broadband provides high speed Internet and communications access for businesses, government, and individuals to access services, send e-mails, and share documents and information. Infrastructure also supports a modern society by providing critical needs such as education, drinking water, and energy. Without the infrastructure our nation has built and maintained, modern life as we know it would not exist.

Infrastructure also will play a key role in shaping a more sustainable future and addressing energy and environmental challenges. As states and the nation move forward with plans to address dependence on imported oil and to reduce greenhouse gas emissions, clean energy infrastructure investments will determine how successful these plans will be. Transportation and energy infrastructure investments such as roads, rail, electric grid, and power plants, are long-term and capital intensive. Decisions made today will have an impact for decades, and if made without considering sustainability, they could hamper efforts to achieve greater energy security and greenhouse gas emissions reductions. For example, the siting of electric transmission lines will affect the nation’s ability to harness remote sources of clean energy and its ability to ensure reliability of electricity well into the future.

The public is paying close attention to the nation’s infrastructure condition and related challenges. In recent polling, 94
percent of Americans have expressed concern about the condition of the nation's infrastructure. Among the public’s top priorities for infrastructure are accountability in spending and job creation. Americans polled believe that the top infrastructure priorities include improving the nation's economy, safety, efficiency, and environmental performance. Americans believe that energy facilities, roads and highways, clean water treatment facilities, the electricity grid, schools, public transportation, and bridges are at the top of the list in terms of priorities for repairs and upgrades. A number of these assets and how they are currently operated and funded are discussed below.

Current Infrastructure Funding and Operations

The nation has undertaken infrastructure development throughout its history, from early canal projects to facilitate shipping and intercontinental rail projects to connect the nation, to 20th-century investments in airports, ports, electric transmission, and transit. As a result of these past investments, the nation’s infrastructure currently includes approximately “4 million miles of roads, 117,000 miles of rail, 600,000 bridges, 79,000 dams, 26,000 miles of commercially navigable waterways, 11,000 miles of transit (including more than 5,000 miles of rail transit), more than 3,000 transit rail stations, 300 ports, 19,000 airports, 160,000 miles of high-voltage transmission lines, 55,000 community drinking water systems, and 30,000 wastewater treatment and collection facilities.” The government at all levels and the private sector have been involved in making these investments and operating these assets, with variations in each of these roles depending on the asset. Following the New Deal in the 1930s, many infrastructure assets, including transportation and water assets, were publicly funded and operated public works projects. Other assets, such as communications infrastructure, have traditionally been privately funded and operated albeit within a framework of government regulation and oversight. In addition, the nation’s electric infrastructure and transmission lines have received significant public funding as well as both private financing and funding. These traditional funding and management responsibilities are evolving, both between the public and private sectors and between levels of government. In some cases the public sector is partnering with the private sector through public-private partnerships (PPPs), which assign the private sector key responsibilities in one or more aspects of a project, including design, construction, finance, operations, and maintenance. For more discussion of PPPs, please see Chapter 3, Section A.

Transportation Infrastructure

Surface transportation assets in the United States have been largely funded and managed by the public sector. Responsibilities for financing, building, operating, and maintaining transportation assets have been shared among states, local governments, and the federal government, although the private sector has increasingly played a role in all of these aspects (in addition to the traditional private sector role in project design and construction). States play a large role in funding and operating surface transportation assets. States raise approximately 46 percent of all revenues to fund highways and transit, with the federal government contributing approximately 22 percent and local governments contributing 32 percent. In terms of responsibility for operating the system and delivering transportation services for highway and transit users, states account for 47 percent of service delivery, with local governments providing 51 percent and the federal government providing 2 percent. The vast majority of roads, bridges, and highways are state or locally owned. State and local governments also own significant transit and intermodal freight assets; although, independent public entities own the largest share of transit facilities.

Other Public Infrastructure

Other public infrastructure assets, such as drinking water systems, sewer and waste treatment systems, and public buildings such as schools, are typically publicly funded and operated. Wastewater treatment systems receive funding from...
federal, state, and local sources and are typically publicly managed.13 As with other infrastructure assets, there is an emerging effort by some communities to tap into PPPs to help with finance and management of wastewater systems.14 Similarly, drinking water systems are also typically publicly managed and funded by federal, state, and local governments.15 Schools and other public buildings receive significant state and local funding for construction and operations, with some federal funding as well, and are typically publicly operated. While other nations have engaged more extensively in PPPs for water systems and public buildings such as hospitals and schools, these assets are more typically publicly funded and operated in the United States.

**Electric Transmission Infrastructure**

Electric transmission infrastructure is often funded by the private sector (with government playing a regulatory role); although, publicly owned utilities also fund electric transmission infrastructure. Electric transmission infrastructure costs are ultimately paid for by the end-users, although government regulatory authorities at the state (typically a public utility commission) and federal levels (the Federal Energy Regulatory Commission) play a role in setting regulations related to cost recovery for infrastructure investments.16 These regulations help to determine how infrastructure capital costs are recovered from utility customers.

**Communications Infrastructure**

Likewise, broadband communications networks are privately funded, with the costs largely passed on to users. Governments play a regulatory role. States, however, have worked to ensure access to broadband for underserved users via incentives for private deployment of broadband networks to underserved communities, such as those matching funds for projects provided by California or tax incentives on broadband deployment equipment provided by Mississippi.17 In some cases, the public sector will actually fund development of broadband infrastructure itself and lease it to service providers, as is being done by Vermont.18 Another key function that government can, and sometimes does, play in broadband deployment is helping to map service areas and provide data regarding the speed and quality of service.19

**Evolving Role of Public and Private Sectors**

The roles and responsibilities of the public sector and the private sector in funding, building, operating, and maintaining infrastructure described above are not static. While the public sector always retains the role of setting a public policy framework for infrastructure development, the government and private sector roles have evolved and, to some extent, are becoming less clear-cut, presenting both challenges and opportunities. In areas where government was previously the main funder and operator such as highways or airports, there are now opportunities for the private sector to play a larger role. In areas where the private sector has been the main funder and operator, such as broadband, governments are now stepping in to fund and manage infrastructure where it serves a strategic purpose, such as assisting underserved communities. In addition, across the spectrum of infrastructure, the roles of government at the state, federal, and local levels are changing, both in the nature of the responsibilities at each level and the amount of funding provided at each level. These changes are perhaps most clear when examining surface transportation assets such as roads, bridges, and transit. These assets historically have been considered public works projects and largely have been publicly funded and operated for decades. However, that has begun to change as the public sector has engaged the private sector in taking on additional responsibilities for funding, operating, and maintaining transportation infrastructure. Additionally, the responsibilities of the federal government are changing, as funding responsibilities have devolved toward states and localities.

Consider the highway system. The federal government provided approximately 90 percent of the funds for construction of the Interstate Highway System, passing those funds to states, which in turn developed, own, and operate the system.20 The federal funds were generated from federal motor fuels taxes that were placed in a Highway Trust Fund dedicated to funding highways (later some revenues from motor fuels taxes also were dedicated to a Transit Account within the Highway Trust Fund).

The state-federal partnership helped to build the Interstate Highway System. More recently, the roles of governments have been changing. In 1970, federal funding represented 28 percent of all funding (capital and operating) for highways, with states and localities providing 72 percent of highway funding.21 In 2006, the federal contribution had fallen to only 20 percent of all highway funding, with states and localities providing 80 percent.22 In addition to a gradual but definite trend towards the devolution of funding responsibility from the federal government to state and local governments, there have been other changes as well.

One important change in the federal and state roles came through the elimination of rigid funding categories and provision of flexibility in federal transportation funding programs by the Intermodal Surface Transportation Efficiency Act of 1991. Much federal transportation spending is mode neutral—available for roads, transit, bicycle and pedestrian, demand-management projects, capacity expansion, facility enhancement, and reconstruction or repair.23

There has also been increased flexibility for states to derive user fee revenues from Interstate Highway assets. For example, in an effort to raise more revenues for transportation, the federal government has allowed states to toll certain sections...
of the Interstate Highway System. States also have been permitted to pursue innovative congestion pricing schemes (e.g., charging drivers for the option of using free-flowing lanes, typically available for free for carpoolers and buses to reduce congestion) on the Interstate Highway System. States and localities have also begun to utilize PPPs involving Interstate Highway assets. For example, Chicago entered into a PPP to lease the Chicago Skyway, and Indiana developed a PPP to lease the Indiana Toll Road. The federal government has provided finance programs to assist states and to leverage private capital, such as private activity bonds, grant anticipation revenue vehicles (GARVEE), and Transportation Infrastructure Finance and Innovation Act (TIFIA) loans and credit assistance.

As seen in the development of the Interstate Highway System, the role of states, the federal government, and localities have changed over the five decades since the enactment of the Federal-Aid Highway Act of 1956. As the federal government has decreased its share of funding responsibilities relative to states and localities, it also has sought to provide flexibility for states and localities to derive additional revenues from Interstate Highway assets. In addition, the private sector is playing an increasing role not just as a contractor to build highways, but also as lessee, financer, operator, and manager of state-owned highway assets.

Government’s role in other areas of infrastructure is evolving as well. Whereas the private sector typically financed broadband infrastructure, now government is providing incentives and subsidies to promote broadband build-out, or in some cases, directly assuming the responsibility of developing broadband itself. Whereas governments typically owned and operated airports and ports, now in certain instances—for example, Midway Airport in Chicago, Illinois, or the Port of Oakland, California—government is seeking PPP arrangements to lease these assets to private operators.

Amidst all of the changes in the roles of government and the private sector, the nation faces a number of key infrastructure challenges. This paper seeks to examine and address the top concerns affecting competitiveness and sustainability. The paper begins by examining several critical challenges, including underinvestment across the board, inadequate revenue sources, the need for better planning, reliance on imported oil, the need to diversify the nation’s electricity supply, and the need to respond to climate change. It then offers new approaches, including examples from successful state, local, and international efforts that can help states meet these key infrastructure challenges.
CHAPTER 2. INFRASTRUCTURE CHALLENGES

The nation’s infrastructure system is no longer adequately meeting the nation’s needs and faces several long-term challenges that affect our ability to maintain and enhance our competitiveness, quality of life, and environmental sustainability. While the recent economic recovery proposal will provide an important funding boost in some areas, it is not a sufficiently large or long-term solution. Although each state has a unique situation, a number of broad systemic challenges confront the nation as a whole including: underinvestment, inadequate revenue, and the need to improve strategic planning and coordination. We also must address concerns about reducing our dependence on imported oil, diversifying our nation’s electricity portfolio, and responding to climate changes that affect transportation and energy infrastructure in particular.

Underinvestment

According to observers as varied as the American Society of Civil Engineers (ASCE), the U.S. Chamber of Commerce, the American Enterprise Institute, the Brookings Institution, environmental organizations, and labor unions, the United States is underinvesting in infrastructure. This is important from both a relative sense, whereby other nations who invest more are better positioned to compete globally, and a real sense, whereby the nation’s infrastructure fails to adequately meet quality of life needs such as safety and mobility. Investing more in infrastructure will not be enough to improve the quality and performance of the nation’s infrastructure and meet key challenges. Enhanced coordination and planning, more rigorous analyses of cost-benefit and performance, and innovative uses of new technologies will all be necessary to maximize the impact of every dollar invested. However many observers agree that the nation is not currently meeting even the minimum level of investment required to properly maintain the infrastructure systems already in place.

Looking at infrastructure comprehensively across categories (with the exception of communications infrastructure), the American Society of Civil Engineers (ASCE) projects that $2.2 trillion is needed over five years to raise the level of our infrastructure to good condition.\(^\text{27}\) That includes the following estimates:\(^\text{28}\)

- **Transit**: Capital investment of $15.8 billion annually to maintain, $21.6 billion annually to improve to good condition; in 2008, total federal capital investment was $9.8 billion (recent estimates suggest that transit operating costs, which were $33.7 billion in 2006, may need to increase to between $60 billion and $80 billion to accommodate significantly increasing ridership).\(^\text{29}\)

- **Roads**: $186 billion annually to improve to good condition; current spending is approximately $70.3 billion annually.

- **Rail**: $200 billion cumulatively through 2035 for freight and intercity passenger rail to accommodate anticipated growth.

- **Bridges**: $17 billion per year to eliminate necessary bridge deficiencies; annual investment for maintenance and new bridge construction in 2003 was $10.5 billion.

- **Drinking water and wastewater systems**: Additional $11 billion annually to replace aging drinking water facilities and $390 billion cumulatively over 20 years to update or replace existing wastewater systems and build new ones.

Although investment has not been adequate, demand for all forms of infrastructure has been on the rise. Vehicle miles traveled nationwide have increased 95 percent since 1980 and reached 3 trillion miles traveled annually in 2006 (although more recently, vehicle miles traveled have remained steady or declined in many areas, attributable at least in part to higher fuel prices).\(^\text{30}\) Public transit ridership has increased and reached 10.3 billion trips in 2007 (the highest number in 50 years), with 2008 figures expected to be reported even higher.\(^\text{31}\) Tons shipped will rise from 16.4 billion today to 31.4 billion by 2035.\(^\text{32}\) Freight ton-miles will grow from 6 billion today to 11 billion by 2035.\(^\text{33}\) Demand for freight rail is projected to increase 84 percent in ton-miles by 2035.\(^\text{34}\) Water transportation handles 99 percent of overseas trade by tonnage, and international container volumes are projected to triple by 2025.\(^\text{35}\) Electricity baseload generation capacity reserve margins have declined to 17 percent as of 2007, down from 30 to 40 percent in the early 1990s, and near the 12 to 15 percent that is considered the minimum for a reliable electricity system.\(^\text{36}\)

In looking specifically at how to meet transportation needs, The National Surface Transportation Policy and Revenue Study Commission issued its final report in January 2008, and recommended the nation invest $225 billion to $340 billion annually across all modes of surface transportation to maintain and upgrade the system.\(^\text{37}\) The commission found the nation currently spends approximately $85 billion across all modes, less than half of the amount the commission believes necessary. Reports from the National Chamber Foundation of the United States Chamber of Commerce also found that total national transportation infrastructure investment across all levels of government needs to increase. The Chamber Foundation projected that investment would need to be at $368 billion annually by 2015 to enhance the system, or $304 billion by 2015 to maintain the system at status quo levels of performance.\(^\text{38}\) It also noted that based on current revenues, the nation would cumulatively fall $500 billion short of meeting the targeted maintenance investment through 2015.

The same trends of greater needs and funding gaps hold true across other categories of infrastructure as well. For example, while demand for electricity has increased approximately 25 percent since 1990, annual investment in transmission facilities has declined, leading to grid congestion and power out-
The consequences of underinvestment are significant, particularly related to the nation’s competitiveness in a global economy. In 1990, international trade represented 13 percent of the United States economy. This share is projected to grow to 35 percent by 2020 and 60 percent by 2035. Consistent with this growth in trade has been an increase in demand for freight transportation by air, rail, road, and sea. Tons shipped in the United States are expected to rise from 16 billion today to 31.4 billion by 2035. The nation’s previous infrastructure investments in the 20th century have continued to pay dividends as economic productivity has risen and U.S. businesses benefitted from logistics (procurement, storage, shipment, and delivery of products) gains. However, underinvestment is now leading to negative consequences, including congestion which reduces the efficiency of the transportation system. Logistics costs had been steadily declining for decades until recently. In 2003, logistics costs were 8.6 percent of GDP but rose to 9.5 percent in 2005, the largest such increase in 30 years. A full one-third of the increase in cost was attributable to inefficiencies in the transportation system.

This underperformance affects virtually every economic sector. For example, in the Midwestern states, agricultural products represent one of the largest shares of freight transportation, and these states rely on an efficient freight rail system to move products to domestic and export markets. With Internet commerce increasing, manufacturers rely on the nation’s roads, bridges, rails, and airports to deliver products on time to consumers.

In its 2009 report, ASCE graded the U.S. infrastructure system as a D, unimproved from a D in 2005, down from a D+ in 2001, and the same as in 1998. There is a wealth of data to reinforce this point:

- Approximately 12 percent of the nation’s bridges are structurally deficient.
- More than two-thirds of peak-hour traffic occurs in congested conditions, and road congestions in 2005 cost the United States $200 billion in net economic losses, 2.9 billion gallons of wasted fuel, and 4.2 billion hours of lost time.
- Eighty-five percent of public transit systems have reported capacity problems and 65 percent are unable to add needed operational service to meet growing ridership demand due to insufficient revenue.

Perhaps most compelling, however, are the anecdotal examples of infrastructure failures. In 2007, the I-35W Bridge in Minneapolis, Minnesota, collapsed, leading to fatalities. The National Transportation Safety Board determined that a design flaw with the gusset plates—not maintenance issues—caused the bridge collapse. In 2003, an electricity blackout across the northeastern United States led to between $6-$10 billion in lost productivity, left 60 million residents without power, and also led to fatalities. In 2007, a New York City steam pipe burst, causing injuries and a fatality. More than data, events such as these have drawn the attention of the public and policymakers to the need for upgrading the nation’s infrastructure.

**Generating Adequate Revenue to Pay for Infrastructure**

Related to the nation’s underinvestment is the inability to generate adequate revenue to pay for infrastructure. Despite its importance, both the public and private sectors have faced challenges in securing sufficient funding sources. The reasons are many, and include a reduced federal investment relative to states and localities, a reduction in purchasing power...
Report Cards for America’s Infrastructure — Grade Comparison 1988 to 2009

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Aviation</td>
<td>B−</td>
<td>C−</td>
<td>D</td>
<td>D+</td>
<td>D</td>
</tr>
<tr>
<td>Bridges</td>
<td>C+</td>
<td>C−</td>
<td>C</td>
<td>C</td>
<td>C</td>
</tr>
<tr>
<td>Dams</td>
<td>N/A</td>
<td>D</td>
<td>D</td>
<td>D</td>
<td>D</td>
</tr>
<tr>
<td>Drinking Water</td>
<td>B−</td>
<td>D</td>
<td>D</td>
<td>D−</td>
<td>D−</td>
</tr>
<tr>
<td>Energy</td>
<td>N/A</td>
<td>N/A</td>
<td>D+</td>
<td>D</td>
<td>D+</td>
</tr>
<tr>
<td>Hazardous Waste</td>
<td>D</td>
<td>D−</td>
<td>D</td>
<td>D</td>
<td>D</td>
</tr>
<tr>
<td>Navigable Waterways</td>
<td>N/A</td>
<td>N/A</td>
<td>D+</td>
<td>D−</td>
<td>D−</td>
</tr>
<tr>
<td>Public Parks and Recreation</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>C−</td>
<td>C−</td>
</tr>
<tr>
<td>Rail</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>C−</td>
<td>C−</td>
</tr>
<tr>
<td>Roads</td>
<td>C+</td>
<td>D−</td>
<td>D+</td>
<td>D</td>
<td>D−</td>
</tr>
<tr>
<td>Schools</td>
<td>N/A</td>
<td>F</td>
<td>D−</td>
<td>D</td>
<td>D</td>
</tr>
<tr>
<td>Solid Waste</td>
<td>C−</td>
<td>C−</td>
<td>C+</td>
<td>C+</td>
<td>C+</td>
</tr>
<tr>
<td>Transit</td>
<td>C−</td>
<td>C</td>
<td>C−</td>
<td>D+</td>
<td>D</td>
</tr>
<tr>
<td>Wastewater</td>
<td>C</td>
<td>D+</td>
<td>D</td>
<td>D−</td>
<td>D−</td>
</tr>
<tr>
<td>Levies</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>D−</td>
</tr>
<tr>
<td>TOTAL</td>
<td>N/A</td>
<td>D</td>
<td>D+</td>
<td>D</td>
<td>D</td>
</tr>
</tbody>
</table>

Note: Grades were assigned on the basis of condition and capacity, and funding versus need, generally following a traditional grading scale (e.g., if 77% of our roads are in good condition or better, that would earn a grade of C). Base grades were then reviewed by the Advisory Council and adjusted, usually with a plus or minus but sometimes as much as a full letter grade, to reflect positive or negative trends or the critical consequences should a catastrophic failure occur. For example, the failure of a bridge or dam would have much more immediate and deadly consequences than a problem related to solid waste disposal.

Source: American Society of Civil Engineers, January 28, 2009.

as costs escalate but certain revenue sources stagnate, competing priorities for funding, and budgetary constraints states and all levels of government are facing.

States and localities in the United States have provided approximately 75 percent of total transportation and water spending. As noted earlier, federal spending on highways has accounted for less of the overall share of spending than states and localities and CBO notes that since the 1970s when the federal share of infrastructure spending peaked, states and localities spending has increased relative to federal spending (see Figure 2).

However, even though infrastructure spending across categories is increasing as measured in real dollars, a variety of factors including inflation and increases in the cost of construction have reduced the purchasing power of infrastructure dollars. This can be illustrated through highway spending. As noted, today states and localities spend 55 percent of total highway capital expenditures and the federal government spends 45 percent. However, the federal gasoline tax and many state gasoline taxes are not indexed to account for inflation or regularly increased (the federal gasoline tax was last raised in 1993). Some states have indexed their fuel taxes to the price of gasoline or to the consumer price index (a measure of the cost of certain consumer goods) to preserve the fuel tax purchasing power. Some have a sales tax on motor fuels or dedicate a portion of statewide sales tax revenue to transportation. States also look to vehicle fees, and states and localities tap general funds in many cases for transportation.\footnote{In some states, motor fuels taxes cannot be used for non-road projects such as transit, and even in states where motor fuels tax revenues can go toward transit, the recent drop in vehicle miles traveled has reduced fuel tax receipts at the same time that project construction costs have escalated.}

At the state and federal levels, however, fuel taxes are the primary revenue source for highways. The American Association of State Highway and Transportation Officials (AASHTO) estimates that costs for construction will have risen at a minimum 70 percent between 1993, the last year the federal fuels tax was increased, and 2015.\footnote{At the state and federal levels, however, fuel taxes are the primary revenue source for highways. The American Association of State Highway and Transportation Officials (AASHTO) estimates that costs for construction will have risen at a minimum 70 percent between 1993, the last year the federal fuels tax was increased, and 2015. As a result, AASHTO projects that between 1998 and 2015, the federal gasoline tax will lose 55 percent of its purchasing power (in 1998, 4.3 cents of the gas tax dedicated to deficit reduction was allocated back to the Highway Trust Fund). States that have not increased their fuel taxes similarly face eroding purchasing power from their primary transportation revenue source. Just to restore the purchasing power of the Highway Trust Fund to 1993 levels (which is now facing long-term deficits as spending outpaces inadequate revenues), AASHTO estimates that the federal expenditures would need to increase from $43 billion in 2009 to $73 billion in 2015. Were this to happen, states and localities,}
to preserve their current highway funding share of 55 percent, would need to increase expenditures from approximately $53 billion to $89 billion.

It is not just the public sector that is struggling to finance and fund infrastructure operations, maintenance, and upgrades. The nation’s investor-owned utilities face a challenge in needing to invest $1.5 to $2 trillion in investments between 2010 and 2030 to ensure reliability, efficiency, and to incorporate new alternative energy sources. This could require increases in rates for ratepayers already facing higher prices because of a variety of factors including the removal of rate caps instituted following deregulation, higher fuel costs, and the need to recover capital investment costs.

States and the federal government face budgetary constraints across all programs. Before accounting for any stimulus-related expenditures, the annual federal budget deficit could reach nearly $1 trillion in fiscal year 2009. Most states are required to produce a balanced budget, and many are facing deficits that could require spending cuts or tax increases. In the current fiscal environment, it is even more challenging to contemplate how to adequately fund infrastructure. While funding for infrastructure has generally increased, it has not kept pace with needs, and the funding and policy framework for infrastructure is not adequate to meet today’s challenges. The recent economic recovery proposals will provide an important influx of funding, but they do not represent a long-term solution.

The Need for Improved Planning and Coordination

The infrastructure planning process has become more comprehensive in recent years, particularly since the passage of the Intermodal Surface Transportation Act in 1991, but many observers still find that the planning process is not adequately addressing concerns over sprawling development patterns and inefficiencies. Funding and priority has been frequently given to adding capacity and growth without considering energy saving alternatives or land use development that provides alternative transportation choices. In addition, many planning processes may not adequately incorporate future maintenance costs and other factors that require analysis.

While there has been discussion of coordinating and combining funding sources for infrastructure and requiring competition for projects, such as through the proposed federal infrastructure bank, it is not likely that the majority of the nation’s infrastructure dollars will be spent this way in the near future (for more on this, see Chapter 3, Section A). Instead there will likely remain dedicated funding streams for specific categories of infrastructure. However, states can act to ensure that agencies coordinate through the planning process so that state dollars are not spent at cross-purposes. For example, states can work to coordinate expenditures on transportation and housing in an attempt to link communities with transit.

Figure 2. Federal Infrastructure Spending vs. State/Local Infrastructure Spending, 1956–2004

![Graph showing federal vs. state/local infrastructure spending, 1956–2004.](image)

NOTE: Data do not include expenditures (net of federal grants and loan subsidies) on freight rail and, after 1990, water resources. State and local spending on passenger rail that is net of federal grants and loan subsidies has been combined with expenditures on mass transit.

Source: Congressional Budget Office.
Governors and states have a key role to play in ensuring the planning process is balanced and strengthened to guarantee proper consideration of all alternatives, including rail, transit, congestion pricing or other elements that help manage demand to meet needs.

Many infrastructure decisionmaking and planning responsibilities are fragmented, shared across agencies and across all levels of government. Infrastructure planning and investment decisions may involve numerous agencies, including finance, transportation, environment, energy, economic development, agriculture, housing, and emergency management, among others. For example, while most land use planning and zoning decisions are made at the local level, transportation planning decisions are often made at the regional or state levels, and federal grants and finance programs often provide key sources of funding for transportation investments at each level. Proper planning coordination that breaks down silos can help to ensure that investments are leveraged for maximum efficiency and effect. For instance, most local transportation projects are still approved at the local level before advancing. Yet some infrastructure decisions, such as electric transmission that crosses state borders, may be better served if coordinated at a multistate level.

A robust and efficient infrastructure system is necessary for the nation to compete globally. Managing demand and meeting other strategic objectives involves more than just building more capacity. It requires a strategic approach emphasizing preservation, improved coordination, and holistic planning and efficiencies.

**Decreasing Our Reliance on Imported Oil**

Beyond the overarching challenges of underinvestment, inadequate revenue and improved planning, a new approach is needed to address a number of key public policy issues including the desire to decrease reliance on imported oil. Underpinning this concern is a transportation system predicated on an abundant and low cost supply of oil. Oil powers nearly all of the nation’s automobiles and buses, and fuels 97 percent of the overall transportation sector.\(^{60}\) It also provides diesel fuel for many passenger and freight trains (although some run on electricity), and jet fuel for airplanes. There are few viable large scale alternatives to driving for many, particularly given that 95 percent of the nation does not have easily accessible public transportation.\(^{66}\) In addition, many communities are not designed to be compact and pedestrian or bicycle-friendly, limiting these travel alternatives. Our current oil dependence, and its implications for energy security and price volatility, present a host of challenges around what to build and where to build it.

Recent developments have demonstrated there is a desire for alternatives. As oil prices rose in the first half of 2008, vehicle miles traveled on the nation’s roads dropped significantly after years of steady growth (down 5.3 percent year-over-year in November 2008),\(^{67}\) and public transit ridership increased as commuters and travelers turned to alternative modes (up 5.2 percent during second quarter 2008).

While the global economic slowdown and high prices have curbed demand for oil, at least temporarily, the Energy Information Administration (EIA) projects demand for oil and energy will continue to grow over the next 20 years.\(^{58}\) Under a business-as-usual scenario, with no further policy changes, United States demand for liquid fuels for transportation are expected to increase by 1 million barrels per day by 2030, and global energy demand is expected to increase by 50 percent by 2030.\(^{69}\) Increased United States production of oil, increased vehicle efficiency, and increased use of ethanol and renewable fuels could reduce the nation’s reliance on imported oil somewhat. However, even under the best case scenario, the EIA projects the United States will remain reliant on imported oil for at least 40 percent of its consumption.\(^{10}\) A significant portion of the nation’s supply of imported oil comes from adversarial nations, with implications for the United States’ foreign policy and energy security.

The nation has traditionally enjoyed a stable and reliable energy supply, with notable exceptions in the 1970s attributable to global oil shocks relating to geopolitical events. Our near total dependence on oil for transportation leaves the nation vulnerable to price shocks, whether related to global events or supply and demand issues. For example, the price for a barrel of oil in December 1998 was $8.51 (nominal dollars), but in part because of rising global demand, the price rose to more than $145 per barrel in 2008 before declining to less than $40 per barrel in December 2008.\(^{71}\)

Many planners and policymakers are pausing and reassessing infrastructure policy and decisionmaking that entail long-term, capital-intensive investments. These projects last for decades, and the planning decisions made today could lock the nation into infrastructure development that need to be able to meet the challenges the nation will face in thirty years. The nation needs a new approach to infrastructure development that will offer stable and viable alternatives such as moving more freight to rail, increasing transit availability, and offering alternative fueling options such as plug-in electric hybrid vehicles and their attendant recharging infrastructure. This new approach would help ensure that, unlike today, our transportation energy needs would be met by more diverse sources subject to less price volatility.

**Diversifying the Nation’s Electricity Portfolio**

Another leading public policy concern, diversifying the nation’s electricity portfolio, presents a number of challenges to the current electricity infrastructure system. The nation’s electricity system needs to be cleaner to address climate change concerns, more decentralized to increase security and reduce strain on the grid, and more technologically advanced to realize greater efficiencies and avoid the need for building expensive new generation capacity. A more diverse electricity portfolio can help address these needs, but it will require new
ways to move electricity, to access remote sources, and to manage diverse power supplies.

The nation’s electricity system is, along with transportation, a central focus of the concerns regarding climate change (addressed more fully in the next section). Electricity use accounts for approximately 40 percent of the nation’s carbon dioxide emissions, brought about in part by our large reliance on fossil fuels including coal, natural gas and oil. Clean renewable energy accounted for just 7 percent of the nation’s electricity supply in 2007, while fossil fuels such as coal and natural gas accounted for nearly 70 percent. New policies, incentives, and investments in renewable energy, many of which are now being instituted at the state level, could help to increase the share of renewable energy in the nation’s electricity mix and lower its carbon footprint. There is significant potential to diversify the nation’s electricity mix. For example, a recent study found that wind power could provide 20 percent of the nation’s electricity supply by 2030. However, public and private investments will be needed in transmission lines to bring remote renewable energy sources such as wind to energy consumers while also ensuring continued reliability.

Efforts to increase the use of clean distributed generation are also needed to reduce the strain on the electric grid, increase energy security and reliability, and reduce peak power demand. Solar photovoltaic electricity and solar water heating, for example, offer a means of providing distributed generation and distributed heating that do not rely on centralized power plants, the electricity grid, or energy pipelines to power and heat homes and businesses. Increased use of solar energy and other distributed generation can help to reduce peak power needs and avoid the necessity of building new generation capacity. Distributed generation can also feed excess power back to the grid to further stabilize supply during peak times, and in the case of solar power, of course, the fuel cost is zero. While distributed generation represents a very small share of the overall electricity supply market in the United States, there is potential to do more if several barriers can be overcome. These include reducing the high initial capital costs, facilitating strong interconnection and net metering agreements with utilities, and reducing intermittency.

In addition to a cleaner power supply with increased use of distributed generation, there is also a need to incorporate new technologies into the electric supply system to better manage demand and improve security. New smart grid technology could help consumers better manage their energy use and avoid peak period consumption while also supplying utilities with enhanced real-time data and the ability to charge consumers dynamic rates based on time of use to better manage the flow of power. A number of public and private sector entities are working to achieve deployment of smart grid technologies including smart meters and smart appliances. However, a number of barriers exist, including capital costs, the need for common technological standards, and difficulties in demonstrating clear consumer benefits to justify the expense.

### Responding to Climate Change

The emergence of climate change as a national concern also requires a new approach to infrastructure development and investment, particularly in the areas of transportation and energy. Today our nation depends on oil for transportation and largely on fossil fuels for electricity. Infrastructure availability can facilitate sprawling and inefficient development and limit the efficiency and viability of lower-emissions alternatives such as transit if it is not properly planned and sequenced. Needed investments in transmission capacity for clean and renewable energy have not been made. Because of these and other infrastructure policies and decisions, the United States consumes 25 percent of the world’s energy and generates 5 times the world average of carbon dioxide emissions—a key greenhouse gas (GHG)—despite having only 5 percent of the world’s population.

Recent reports from the National Academy of Sciences and the Intergovernmental Panel on Climate Change have contributed to scientific confidence that greenhouse gas emissions resulting from human activities are likely changing the climate with potentially severe effects. The potential effects from climate change are serious and some are already occurring. These include: heat waves, drought, reduced snow cover, changes in regional suitability for agriculture, rising sea levels and coastal population displacement, more intense storms, habitat degradation and species extinctions, and other events.

There are a number of sources of GHG emissions, but the transportation sector in the United States is the end use sector responsible for the largest share of the nation’s energy-related GHGs and is also the fastest growing source of emissions. In 2007, the transportation sector accounted for roughly one-third of all United States energy-related carbon dioxide emissions, and the combustion of motor vehicle fuels such as gasoline and distillate fuels accounts for approximately 82 percent of that figure. Residential and commercial sector energy-related GHG emissions are also increasing significantly.

The implications of climate change for infrastructure planning are two-fold. The first is reactive: Planners and policymakers are now working to assess how climate change events such as sea level rise and more intense storms could affect infrastructure and how to mitigate such effects. The second is proactive: Planners and policymakers are beginning to re-imagine infrastructure development processes to provide the foundation for long-term GHG emission reductions. Many of the solutions to other challenges such as oil dependence and improved planning also apply to reducing GHG emissions. For example, shifting freight to rails from trucks, planning for higher density and transit-oriented communities, and increasing the use of electric or plug-in electric hybrid vehicles all could reduce GHG emissions. As policymakers look to achieve tangible GHG emissions reductions, transportation, energy and other forms of infrastructure will play a key role, and success will require a new vision for infrastructure.

---

1. Electricity use accounts for a larger share of GHG emissions, but is not considered an end use sector.
CHAPTER 3. ADDRESSING OUR INFRASTRUCTURE CHALLENGES

For decades, government has sought to invest in infrastructure to build more capacity, move more goods and more people, facilitate commerce, enhance safety, and create jobs. However, declining performance coupled with underinvestment and inadequate revenue, alongside the need for improved planning and addressing energy and climate change concerns, all point to the need for a refined approach. While increased funding is essential, it alone is not sufficient to address these challenges. A new approach calls for multiple new ways of thinking and for states embracing the following six principles:

Expand and diversify revenue sources for infrastructure development and maintenance. Today, the Highway Trust Fund faces deficits, transit agencies are straining to accommodate increased ridership, and federal and state fuels taxes face eroding purchasing power. To adequately fund transportation infrastructure, the federal government and states may look to restore the purchasing power of the federal and state fuels taxes by increasing them, or indexing them to the price of gasoline or the consumer price index. Government may look to PPPs, revenues from increased tolling, or revenues from congestion pricing or other user fees to provide additional revenue and finance flexibility. A federal infrastructure bank and other new bonding financing mechanisms under discussion could provide additional federal funding or loans for key infrastructure projects of national significance. Additionally, new revenues from GHG cap-and-trade systems at the state level could provide additional funds for green infrastructure projects.

Coordinate infrastructure decisions across government agencies and levels of government as well as between states and regions and ensure that energy and environmental costs and concerns are considered. New efforts are needed to enhance planning and coordination across levels of government. States are pursuing new governance models that seek to break down silos and ensure that state infrastructure investments are coordinated across agencies to leverage maximum benefits. In addition, states are incorporating energy and environmental considerations into state planning efforts and improving coordination with neighboring states in situations where regional infrastructure is involved.

Prioritize comprehensive planning efforts that will reduce or manage demand to reduce the cost of or avoid new capacity projects. The nation’s drivers are facing increasing congestion, and the nation is bearing the costs of lost productivity, wasted fuel, and wasted time. Analysis has demonstrated that it is not necessarily feasible to reduce congestion over the long-term by simply adding new capacity, because new capacity can stimulate increased demand (including from other modes) and lead to additional congestion. There are smarter approaches. For example, data indicates that building two congestion priced lanes (charging drivers variable rates based on congestion) could move the same volume of traffic three times as quickly as four conventional lanes. Similarly, electric power demand has typically been met by constructing new electricity generating plants and transmission lines with much less attention to managing demand or encouraging efficiency. A new approach involves government providing industry and consumers with the tools, incentives, and regulatory structure to encourage efficiency, demand management, and conservation. In addition, states, working with local governments through planning assistance, incentives, and in some cases requirements, can help to shape land use and development policies that provide greater access to transportation alternatives such as transit or bike lanes and reduce the need for costly infrastructure expansion and maintenance.

When adding capacity is necessary, look first to environmentally beneficial alternatives to conventional infrastructure, including transit and intercity rail, distributed and central clean and renewable energy, energy efficiency and smart grid projects, and plug-in hybrid and electric vehicle infrastructure. In addition to efforts to reduce peak demand, efforts to shift demand to more sustainable alternatives and investing more in those alternatives can help to address energy and environmental concerns. This may entail significant investment in new transmission to bring remote clean and renewable energy online. This may also entail building out national plug-in infrastructure for plug-in hybrid and electric vehicles. Today, the federal government invests more in highways than transit by a 4-to-1 ratio, and transit projects face strict approval criteria that highway projects do not. There is frequently flexibility to transfer additional federal highway funds to transit if states choose to do so. An improved approach might involve maintaining and enhancing the existing road network in rural and urban areas, while building more transit capacity and higher-speed intercity rail corridors. While states must retain flexibility to address their particular circumstances, increased implementation of such approaches could serve as an effective way to reduce transportation sector reliance on oil, reduce transportation sector GHG emissions, and provide new transportation alternatives to meet growing demand.

Set clear state-directed cost-benefit criteria and performance targets for infrastructure investments, collect data and measure success, and provide for accountability and transparency by reporting performance pegged to a variety of well-defined, outcome-based metrics. Part of a new infrastructure approach is enhanced coordination, more accountability, and better performance. This could involve the increased use of state-directed cost-benefit analyses for infrastructure investments that take into account energy price concerns, climate change, and access and connectivity in both rural and urban areas. It could also involve state-directed
performance measures for infrastructure projects and measuring past performance to determine success.

Incorporate appropriate new technologies wherever practical. The new infrastructure approach also entails incorporating new materials and technologies. Advanced paving materials can lower costs and extend the life of roads. Enhanced broadband access could make telecommuting a reality for more workers, leading to less traffic and congestion. The expanded use of electronic tolling could likewise reduce congestion. The use of global-positioning satellite (GPS) technology could facilitate new platforms for distance-based fees or congestion pricing systems that charge drivers in real-time for their road use, providing incentives to avoid peak periods and high-traffic areas. Deploying smart meters in homes could allow utilities to charge consumers for electricity use in real-time and provide consumers with tools to reduce and manage home energy use.

The following sections include examples from states, localities, and other nations, and are designed to illustrate six leading ways to build a new approach to infrastructure development and management. These pioneering efforts offer promising practices for states to examine. The examples are primarily drawn from the transportation, energy, and broadband areas where the most significant innovation has taken place, but many of the strategies could be modified or augmented to apply to other forms of infrastructure as well. In addition, many of these strategies are notably cross-cutting across the primary areas.

A. Expand and Diversify Revenue Sources

As noted in previous sections, states face serious revenue challenges to fund necessary infrastructure repairs and improvements. Thus, states are pursuing or considering a variety of new revenue strategies to augment existing sources including: new twists on government funding, private sector funding and financing, and taxes and user fees. While states have long relied on traditional versions of these measures to pay for most categories of infrastructure, new actions to refine or rethink the use of these tools are being employed including inflation-indexing of current fuel taxes, creative use of sales taxes and tax credits, establishing PPPs to leverage private capital, and creating new carbon-based taxes and using proceeds from the auction of emissions credits under GHG cap and trade programs. These funding mechanisms, in addition to serving as a source of new revenue can also help manage demand. These related benefits from such revenue sources mentioned are noted in the following sections.

Government Funding and Financing

One way states pay for infrastructure projects is borrowing money by issuing bonds, which are promises to repay borrowed money by a specific date and based upon a pre-established interest rate. States use bonds to address the need for revenue that will be recouped over the life of the project. The two primary types of bonds are general obligation—backed by the full faith, credit, and taxing powers of the state—and revenue bonds. General obligation bonds can be used to fund schools, prisons, hospitals and other institutions. Revenue bonds are traditionally more limited to water and wastewater, utilities, toll roads and bridges, ports, power plants, or other facilities or other revenue-generating entities.

Transportation Bonding

Traditionally transportation bonding at the state level has been accomplished by issuing bonds on the private market to be paid back from toll revenues, state fuel tax revenues, the general fund, or other sources. However, several new debt financing techniques have emerged in recent years as states have endeavored to make up for gaps in motor fuel tax receipts and sought alternatives to the pay-as-you-go financing method. Innovative debt strategies include the use of bonding instruments, such as Grant Anticipation Revenue Vehicles (GARVEEs) and private activity bonds; federal credit assistance from the Transportation Infrastructure Finance and Innovation Act (TIFIA) loan program; and state infrastructure banks.

Through the end of 2007, the total dollar amount of GARVEE-related transactions reached $7.6 billion. Individual issuances have ranged from relatively small amounts of under $40 million in Arizona, New Mexico, and Ohio to extremely large issuances of over a half billion dollars in California, Colorado, and Georgia.

Bonds for transportation are often approved by voters. In New York, the “Rebuild and Renew Transportation Bond Act” was approved by voters in late 2005. The $2.9 billion Bond Act provided for the purchase of subway and commuter rail cars that replaced older, less reliable cars at the end of their useful life, the purchase of hybrid-electric and clean fuel express buses as well as necessary rail and bridge repairs and upgrades. In addition, the bond provided $450 million for necessary expansion of the Second Avenue Subway in New York City and facilitates the initial elements of creating a rail link between Lower Manhattan and JFK International Airport in the borough of Queens.

In Pennsylvania, the state Department of Transportation’s (Penn DOT’s) Rail Freight Capital Budget/Transportation Assistance program is funded through state capital bond dollars in the General Fund. In addition, Penn DOT administers a separate grant program paid for with General Fund dollars.

Infrastructure Banks

A number of states have created federally authorized state infrastructure banks to leverage federal dollars to fund trans-
The Proposed Federal Infrastructure Bank

There has been significant discussion around the concept of a new federal infrastructure bank. Like the California I-Bank, it would cover a wide range of infrastructure categories. Some have suggested that, similar to state infrastructure banks, the federal infrastructure bank could be used to supplement existing funding sources by making direct loans, offering loan guarantees, issuing bonds, and possibly leveraging private capital. Others have suggested that the federal infrastructure bank replace, rather than supplement, a number of existing funding programs such as current federal transportation and water programs where the federal government typically either directly funds state and local projects or passes money through to states and localities to fund projects. In such a scenario, project proponents would apply for financial support from the infrastructure bank through a competitive process and be selected by the bank’s board of directors (which could include a combination of elected, appointed, or nongovernment officials) based on evaluation criteria.

In a competitive process, infrastructure projects would be competing directly, possibly across categories and modes. In any such process the evaluation criteria would be critical to determine, and if broadly conceived could include factors such as environmental benefits and impacts, how much financial support has been leveraged from other sources, regional or national significance of the project in terms of facilitating transportation projects. In addition, states can consider their own broader infrastructure banks to fund a wide range of infrastructure. For example, in California, the state created an Infrastructure and Economic Development Bank (I-Bank) to finance public infrastructure and private development. The I-Bank has statutory powers to issue tax-exempt and taxable revenue bonds, make loans and provide credit enhancements for a broad array of infrastructure and economic development projects. It can also provide financing to public agencies, provide credit enhancements, and acquire or lease facilities.

Among the I-Bank’s programs is an Infrastructure State Revolving Fund (ISRF) Program. This provides low-cost financing to public agencies for a variety of infrastructure projects, including city streets, county highways, state highways, drainage, water supply and flood control, educational facilities, environmental mitigation measures, parks and recreational facilities, port facilities, public transit, sewage collection and treatment, solid waste collection and disposal, water treatment and distribution, defense conversion, public safety facilities, and power and communications facilities.

In applying for funding from the ISRF, an applicant must describe how the project benefits quality of life and economic competitiveness. Applicants are evaluated according to these and a number of other criteria, including environmental quality, commerce and mobility, job creation projections, and the availability of alternative means of meeting the project’s goals.

It may not be likely that a federal infrastructure bank will replace traditional directed funding streams for specific categories of infrastructure in the near-term. Similarly, there has been discussion for several years around the concept of a federal capital budget, which would combine federal capital expenditures across infrastructure categories and also attempt to make the expenditure process more rigorous and use enhanced cost-benefit analysis. There are challenges in accurately accounting for costs and benefits in federal expenditures, however, as pointed out in a report commissioned by President Clinton in 1999 examining the federal capital budget concept.

Both the infrastructure bank concept and the capital budget concept are about combining funding into a large pool and then distributing it to fund the best projects (based on criteria and analysis). Whether or not a federal infrastructure bank is established, states can continue to work to coordinate on planning across agencies to maximize the impact of state expenditures and ensure that such expenditures meet state objectives relating to economic development, environmental quality, safety, mobility, and quality of life. All levels of government can continue to design enhanced cost-benefit analyses to evaluate projects before they are developed, and use rigorous performance measures to evaluate project benefits and impacts after they are developed. For more please see Chapter 3, Section E.

In September 2008, the I-Bank issued $48.4 million in tax-exempt revenue bonds to provide additional funding for its ISRF loans. The I-Bank is located within the Business, Transportation and Housing Agency and is governed by a five-member board of directors.

Public-Private Partnerships

In order to leverage private capital and finance projects, states are increasingly tapping the ability of the private sector to help generate initial capital and secure financing and have forged a number of PPPs within the transportation and broadband sectors. There are several types of PPPs, but the fundamental concept of the PPP is that both the public and private sectors have expertise that can complement the other. PPPs entail various provisions to allocate resources, risks and rewards among the two parties. PPPs may not be well-suited for certain states or regions, particularly user-fee based transportation PPPs, which require certain traffic levels to generate adequate returns on private investment.

PPPs pose many new opportunities for states to approach infrastructure financing, management, and construction of new facilities in new and creative ways. Such arrangements can provide a number of benefits to states, evidenced by the more than 26 states that have some sort of PPP-enabling leg-
ile. In some cases the private sector can help to bridge the gap between needs and resources. PPPs have been in use successfully throughout Europe, Asia, and South America for decades, and the United States is only in the early stages of realizing their full potential to help address the infrastructure needs of the country. A crucial element of successful PPPs for states is creating a public policy framework and criteria for developing PPPs as well as establishing needed internal expertise and external relationships to ensure that state objectives are carried out effectively in any PPP arrangement. For a more in-depth discussion of transportation PPPs, see the recent report by the NGA Center for Best Practices, *Innovative State Transportation Funding and Financing - Policy Options for States.*

Because of their expense and the significant role of the private sector, freight projects were early successful examples of transportation PPPs. One example is in Maine, where the state Department of Transportation produced an Integrated Freight Plan for the state, emphasizing the use of rail and marine in lieu of trucks. In one project implemented under the plan, the state secured a mix of public and private funding in order to build a truck-to-rail Intermodal Freight Transfer Facility in the city of Waterville, Maine. The facility is owned by the City of Auburn, Maine, and leased to a private sector intermodal transportation firm. The 37-acre intermodal facility has redirected truck traffic to rail and enabled double stack container train service to and from Vancouver B.C., allowing West Coast shippers to avoid congestion in the Chicago region, reducing travel times and emissions. Because of these benefits, the project qualified for $2.3 million in federal Congestion Mitigation and Air Quality (CMAQ) funds and also was supported with $0.7 million from the City of Auburn and the private St. Lawrence and Atlantic Railroad Company.

Another type of PPP, the concept of selling or leasing state toll roads to private companies to raise transportation revenues, has gained momentum after the city of Chicago, Illinois, and the state of Indiana finalized such deals in recent years. Signiﬁcant upfront capital was raised by these deals: $1.8 billion for a 99-year lease of the Chicago Skyway Toll Bridge, $3.8 billion for a 75-year lease of the Indiana Toll Road. This capital was used (with respect to the Skyway) for refinancing city debt, schools, and the creation of a $500 million “rainy day fund,” while the Indiana Toll Road funds were used to fund the state 10-year highway construction plan.

Germany has privatized certain aspects of its transportation systems. There are currently 22 tolled projects on federal highways that have been pre-ﬁnanced by the private sector, amounting to 4.2 billion euros (including 1.4 billion in capital costs). Efforts to privatize some bridges and tunnels has proven more challenging because stakeholders did not anticipate that drivers would divert their routes—even traveling great distances—to avoid paying bridge or tunnel tolls. As a result, this privatization scheme is now under further study. Beyond such freight and tolled-facility projects, the private sector also works closely with the public sector to realize increased private land values associated with public investments in rail transit infrastructure. The synergies created through rail transit and transit-oriented development (TOD) can also create signiﬁcant growth in public and private real estate. The proximity of rail transit often makes nearby retail projects more attractive from a development and ﬁnancing perspective, in part due to the certainty of access from the rail link. Recognizing this, many local governments and transit agencies are partnering with the private sector in order to promote TODs with PPP elements. These PPPs provide access to additional capital and operating revenues for transit agencies through the receipt of lease payments, access fees, and increased fare revenues as well as direct private sector funding of transit, commercial, and housing capital facilities.

One example is the Rosslyn-Ballston corridor, located in Arlington County, Virginia, which has ﬁve stations that are part of the Washington, D.C., region’s Metrorail system. In 1973, Arlington adopted a General Land Use Plan to concentrate development at the Metrorail stations and developed individual station plans that include incentives for zoning to attract private-sector transit-oriented development. The development plans ensure public and private sector input and set goals for type of use, open space, infrastructure, and design. This effort has led to the addition of over 18 million square feet of ofﬁce space since 1973, as well as signiﬁcant new residential and housing development. In addition, transit ridership doubled or tripled at all stations in the corridor, and trafﬁc generation remained level or decreased on several major roads nearby.

**Parking Pricing**

Another source of revenue for transportation is parking fees, which are traditionally ﬂat hourly or daily fees to park in urban areas or other locations where vehicle use is necessary but space limited. Given growing revenue needs and trafﬁc congestion, municipalities are exploring variable parking pricing strategies. This is being done for several reasons: to reduce vehicle trafﬁc in an area, as a management strategy to reduce parking problems in a particular location, to pay for parking facilities, to generate revenue for other purposes, or a combination of these objectives. The U.S. Department of Transportation (USDOT) has worked with municipalities on several variable priced parking programs by funding the start-up costs in San Francisco and San Diego, California; Seattle, Washington; and Chicago, Illinois under its Value Pricing Pilot Program. These programs differ to some degree in terms of how the fee varies by time of day or level of demand, the extent of the area covered, whether off-street as well as on-street parking is covered, and other details.

Pending commitment of $153.1 million in federal grant funds, Chicago will explore parking pricing, in conjunction with bus rapid transit (BRT). The city will use a portion of the money to
implement a parking pricing strategy aimed at encouraging motorists to come to the Central Business District outside the normal peak hours or to shift travel to transit.

The city of Chicago will require vendors to use state-of-the-art parking meters that monitor parking space availability and adjust rates to ensure an open space on every block. Chicago’s plan also would create truck loading zones downtown where delivery companies would pay on a sliding scale to use the precious street space. The longer a delivery truck sits in a loading zone, the higher the fee. Over a longer-term, Chicago, which has 36,000 parking meters that generated $23 million in 2007, expects to raise more than a billion dollars by awarding a 50-year concession to operate its curbside parking meter system.

### Taxes and User Fees

#### Fuel Taxes

The largest single source of transportation funding—approximately 33 percent—comes from local, state, and federal per-gallon taxes on motor fuels. Currently, the nationwide average tax on gasoline is 48.4 cents per gallon, and the tax on diesel is 53.2 cents per gallon. In addition to federal and state taxes, this figure accounts for sales taxes, gross receipts taxes, oil inspection fees, county and local taxes, underground storage tank fees, and other environmental fees. Federal gasoline tax funds are primarily directed towards national highway programs, and most transit vehicles do not pay these taxes. Of the 18.4 cents federal tax levied on motor fuels, 2.86 cents goes to the federal Mass Transit Account; the remaining funds go toward highway programs that provide states with some flexible spending.

Only a few states are able to use their gasoline tax revenues to support a wider range of transportation projects and programs, including transit projects. On the other hand, nearly 30 states require, either through constitutional or statutory requirements, that state gas taxes must be spent on highway or other road construction and maintenance projects. For example, the Pennsylvania constitution states that the motor-fuels taxes must be spent on roads, highways, and bridges, which effectively prohibits shifting these monies to support mass transit.

While state taxes generate a significant share of needed transportation revenue, efforts to increase state fuel taxes often face political obstacles. Twenty-eight states have raised their gas tax rates since 1992, but only three raised it enough to keep pace with inflation. In April 2005, Washington adopted a 9.5 cent per gallon increase in the gasoline tax to be phased in over four years. The plan will raise an additional $8 billion over 16 years to carry out major repairs on the state’s roadway infrastructure and provide funding for safety and preservation projects, freight mobility improvements, and public transportation rail service. Advocates of the tax increase noted that the planned use of these new taxes to address the state’s aging infrastructure contributed to the passage of the tax increase. Additionally, the state DOT’s transparency and accountability to the public through performance measurement has increased public confidence in the effective use of these revenues. Other states, including Minnesota, have recently increased gasoline taxes, with Minnesota’s two-cent hike the largest increase. Additionally, gubernatorial task forces in Ohio and Oregon have proposed considering fuel tax increases in each of those states.

Every state imposes an excise tax on motor fuel. State excise tax rates vary depending on the type of motor fuel being purchased. For example, gasoline may be subject to one rate while diesel is subject to a different rate. The average state gasoline excise tax is currently 18.4 cents per gallon. Some states dedicate sales tax revenues for transportation expenditures.

Some state gas taxes automatically adjust for the price of gas, the volume of consumption of gas, or the consumer price index. Indexing gas tax rates to the consumer price index appears to be the best way of ensuring that fuel tax revenues keep pace with inflation. In California, Illinois, Indiana, and Michigan, the amount drivers pay in sales tax rises with the overall price of gas. Currently, three states have gas taxes that vary automatically: Florida, Nebraska, and North Carolina. Several other states, including Kentucky, Ohio, and Rhode Island, have statutes that allow for variable rates.

Some states allocate tax revenue to fund transportation infrastructure—dedicate some portion of their sales taxes to transit and transportation infrastructure needs. The Massachusetts Bay Transportation Authority’s (MBTA) Forward Funding legislation dedicates 20 percent of the general sales tax revenues to the agency and makes the MBTA responsible for its capital and operating expenses.

A combined revenue approach was suggested in Ohio’s 21st Century Transportation Priorities Task Force report to Governor Ted Strickland, to the Ohio General Assembly, and to the director of the Ohio DOT. This report, released in January 2009, recommended a new special motor fuel tax that could fund transit, intercity rail, general aviation airports, ports, and bikeways. The current fuel tax is constitutionally required to be used towards highway projects. The task force also recommended that the special tax be used to secure bonds and make both the proceeds of the bonds and the increased revenue available to all transportation modes. While not recommending a specific tax amount, the task force noted that a 13-cent tax would generate more than $800 million per year for transportation projects. It also recommended that a new tax require passage of a voter approved constitutional amendment.

In addition to various revenue allocation approaches, multiple incentives have been used by states to encourage the purchase and use of higher efficiency vehicles by individuals,
businesses and governments. Some of the strategies include: vehicle rebates, tax credits and tax deductions,99 reduced sales and excise taxes for passenger cars and trucks, and scaled vehicle registration charges based on emissions rates. A number of states—including Massachusetts, Oregon, Vermont, Washington, and others—offer some form of these taxes and incentives. For example, Oregon offers tax credits to insurance companies offering pay-as-you-drive insurance (which can serve as an incentive to reduce vehicle miles traveled), and has proposed a variable automobile title fee that would be higher for less efficient vehicles and lower for vehicles with 30 miles-per-gallon and above.100

VMT Taxes

Several recent national policy studies have considered the viability of a vehicle miles traveled (VMT) fee over the long-term. VMT fees charge users (drivers) a direct fee per mile traveled and have the potential to help address demand for travel while generating revenue. States are developing pilots and other projects that can reduce VMT growth, which in turn can help avoid the need for new capacity, freeing up funds for maintenance and other purposes. Over the long-run, a VMT tax approach may serve as an alternative to a fuel tax based funding system.

In Iowa, a 2005 study estimated that a one-cent per-mile fee would generate $316 million per year, based on 31.6 billion miles traveled in Iowa annually. State transportation agencies from across the country also have supported the idea of VMT fees, with phase-in beginning about 2025 as issues of system architecture and interoperability are resolved and a shift to electric and alternative fuel vehicles makes continued reliance on the gas tax less viable.101

The Iowa study will also test options to vary the VMT fee, both for different vehicles and different times. Some possibilities include:

- Higher fees for heavy trucks to reflect their share of pavement wear and tear;

- A rush-hour premium to cover the cost of freeway congestion; and

- Lower fees to encourage more alternative-fuel and low-emission cars.

In 2006-2007, the Oregon DOT equipped 285 vehicles in the Portland area with GPS receivers identifying the location of the vehicle and its speed and then registering the amount of miles driven within certain zones at certain times (i.e., in state, out of state, urban area, and rush hour). The receiver registered the mileage driven in each zone and uploaded the information to a central database automatically at refueling stations. It should be noted that some observers have raised questions about privacy related to a VMT fee system since the system could use a GPS receiver. These concerns can be addressed by, among things, assuring that individual users can not be tracked through the VMT fee collection system’s aggregated data. Many road users already use GPS systems for navigation and EZ pass systems for toll collection.

The Oregon pilot program required a revenue neutral VMT fee, meaning the charge to users would be approximately the same as the gas tax, but would be applied on a mileage basis instead of a fuel consumption basis. The pilot project established the technical feasibility of this type of road pricing while reducing driver use of the system during rush hour by 22 percent (for those charged a congestion fee on top of the VMT fee). The cost of retrofitting filling stations with automatic vehicle reading devices was estimated at $35 million statewide, with annual administration charges of $2 million.

Following this pilot program, Oregon is now moving forward with efforts to continue working toward implementation of a VMT fee system. The state is considering a temporary two-cent gas tax increase to continue to fund transportation projects during a transition to a VMT system.102

Another example of a VMT charge is in use on the Autobahns of Germany, where trucks pay a variable VMT tax based on total vehicle emissions as well as total miles traveled. Starting in 2011, the Netherlands has decided to implement a VMT tax for trucks along with one for passenger cars that begins in 2014. The Netherlands scheme goes beyond the Oregon scheme by combining the per-kilometer tax (initially a flat rate but capable of varying between road category and time of day) with other fixed transportation taxes such as a 25 percent sales tax on new cars, a vehicle tax based on the price and weight of the car, and a tax based on the type of fuel used. All these taxes will be bundled into one tax so that users will pay these taxes based on kilometers driven. The goal is to (1) discourage unnecessary driving by translating all fixed costs of driving to variable costs; (2) meet obligations under the Kyoto Protocol to reduce carbon emissions; (3) reduce traffic congestion; and (4) provide funds needed for road maintenance. The system will protect the privacy of users by using a system similar to the one piloted in Oregon.

With respect to freight, a VMT-based fee could be in a form of a federal weight-distance tax on commercial trucks (or some subset thereof) to more closely align truck VMT charges with the costs imposed on the system, especially by heavy trucks. The scheme could then be expanded to include all trucks and, eventually, to reach all system users. This would follow the German and Dutch models for a phase-in of VMT financing schemes. In these countries, with the required technology now in place, experts say nationwide VMT schemes could be brought online within six years.

Carbon Taxes

Currently, more than 35 states have plans in place designed to address the challenge of climate change. Many of these cl-
climate mitigation plans identify taxes as one solution of a menu of carbon dioxide emission mitigation policies. Most economists agree that taxing carbon-generating energy sources is an economically prudent method of reducing carbon dioxide emissions and has the potential to generate new revenues.

In November 2006, voters in Boulder, Colorado, passed a tax on carbon-based electricity consumption that will fund programs by the city of Boulder to reduce GHG emissions. In May 2008, the Bay Area Air Quality Management District, which covers nine counties in California’s San Francisco Bay Area, passed a carbon tax of 4.4 cents per ton applied to business emissions. Starting on July 1, 2008, the Canadian province of British Columbia became the first jurisdiction in North America to implement a 2.4-cent carbon tax. A number of European countries also have adopted carbon taxes, many covering both electricity and fuels sources. In the 1990s and early this decade, states—including California, Michigan, Minnesota, Texas, and Vermont—have considered legislative and agency proposals for taxing the emissions of carbon dioxide. However, no state currently has such a tax in place.

Allocation of GHG Auction Revenues

As noted above, states are developing plans and considering other actions to confront climate change. In addition to state-specific policies, regional, or multistate approaches can minimize transaction costs and offer streamlined market opportunities for states to reduce GHG emissions. In recent years, organizations have formed to reduce GHG emissions, including the Northeast States Regional Greenhouse Gas Initiative (RGGI), the Midwestern Regional Greenhouse Gas Reduction Accord, and the Western Climate Initiative.

Of these regional efforts, RGGI states have signed a memorandum of understanding that establishes a regional emissions budget (or cap) and divides the region’s emissions cap among participating states. Each state will be allocated allowances up to the amount of its share of the cap, with each allowance permitting a regulated source to emit one ton of carbon dioxide. The box below describes how the RGGI cap will work and how states are likely to allocate their auction revenues. The RGGI system, with its current focus on the clean electricity sector, provides some opportunities for support of clean electricity infrastructure. As economy-wide efforts are developed, such as the one being pursued under the Western Climate Initiative, a link to broader infrastructure efforts could be developed.

B. Coordinate Infrastructure Decisions Across Government Agencies and Levels

As states seek to develop improved governance and planning models, they are examining several approaches including establishing new integrated cabinets, enabling new statewide strategic planning efforts, and enabling local government responsibilities. Through this improved coordination, decision-making can be more effective, particularly in ensuring that energy and environmental costs and concerns are approached holistically.

Integrated State Cabinets

Recognizing the need for multiple stakeholder input, states are adopting new approaches to governance to inform and provide accountability for transportation infrastructure decisions. Arizona has an innovative governance approach designed to improve mobility and facilitate greater use of transit. The Governor's Growth Cabinet was established by Governor Janet Napolitano via Executive Order 2007-05 to coordinate state agency activities and better and more efficiently serve the public. It is made up of the directors (or their designees) of 15 state agencies. The cabinet’s main charge is to collaborate with cities, towns and tribal communities to develop and implement a smart growth and development process that integrates today’s transportation, land use, and water use planning with the planning and development of future state

RGGI Auction Revenues

States participating in RGGI—Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, and Vermont—will cap carbon dioxide emissions from the power sector and then require a 10 percent reduction in these emissions by 2018. Taken together, the 10 individual state programs will function as a single regional compliance market for carbon emissions.

RGGI modeling indicates that using auction revenues for energy efficiency programs lowers cost of complying with the cap. Thus, under RGGI, each state’s regulated power plants will be able to use a carbon dioxide allowance issued by any of the 10 participating states to demonstrate compliance with the state program governing their facility. Proceeds from the sale of allowances will fund state programs that promote energy efficiency and projects for clean renewable energy, such as solar and wind power.

States are taking similar approaches to allocating their revenues toward such reinforcing programs. For example, in Vermont, the legislature determined that RGGI credit sales revenues should be devoted primarily to enhanced energy efficiency investments to help to attain the goals of the RGGI program by reducing demand and by lowering the cost of the RGGI program by reducing consumers’ energy bills.
infrastructure needs in these areas. The Department of Commerce, Office of Smart Growth, is the convening state agency.

The Governor’s Growth Cabinet is supported by two entities. First, in 2008 Governor Napolitano issued Executive Order 2008-05, creating the Growth Cabinet Advisory Board. This is comprised of public and private sector stakeholders and functions as a citizen’s advisory committee to the Growth Cabinet. Second, the Interagency Committee Governor’s Growth Cabinet was created to provide planning expertise, tools, training and assistance to aid local, county, and tribal communities in the implementation of smart growth efforts and also to develop the Arizona Smart Growth Scorecard. This scorecard is being designed to be a simple, clear, usable means of evaluating how well prepared these communities are for the pressures of growth and to help spur action in local and regional approaches to smart growth.

Enhanced Planning for Sustainability

In addition to improved agency coordination, states are seeking to establish and implement statewide strategic planning activities that link a broad array of priorities. These linkages include duties covered by different agencies such as land use, housing, economic development, transportation, natural resource conservation, agriculture and farmland retention, recreation, urban and suburban redevelopment, historic preservation, and public facilities and services. While supported by this enhanced coordination, statewide sustainability initiatives aim to provide regional and local communities with the tools, resources, and planning practices necessary to implement such linked objectives.

Under the redesigned Arizona Growth Cabinet described above, the state’s Department of Commerce, Office of Smart Growth is tasked with coordinating multiagency outreach and technical assistance efforts to help Arizona communities with their growth challenges and assist them in developing smart growth tools. It also continues to focus on responsible growth through the Growing Smarter Planning Grant Program; the provision of staff resources and support to the Governor’s Growth Cabinet, Smart Growth Interagency Committee, and the Governor’s Growing Smarter Oversight Council; and focused local and regional technical assistance. Other duties include formation of a smart growth leadership academy and facilitating local and regional smart growth workshops.

Before Arizona’s initiative, an early planning initiative was launched in 1997, when the Maryland General Assembly enacted the Smart Growth and Neighborhood Conservation Initiative, an attempt by state government to use the state budget to concentrate urban development in certain areas.

Massachusetts’ Comprehensive Approach to Sustainable Infrastructure Development

Over the last several years, Massachusetts has pioneered an approach designed around enhanced prioritizing, planning, and funding for infrastructure. New governance and financing efforts have been launched to help the state prioritize transportation and infrastructure projects. Since fuel consumed by transportation comprises a large share of total energy consumption, these transportation and infrastructure efforts are expected to have a tangible impact on energy consumption.

In June 2007, Massachusetts Governor Patrick issued Executive Order 487 creating the Development Cabinet. Chaired by the governor, the cabinet draws together the lieutenant governor and the secretaries of Administration and Finance, Energy and Environmental Affairs, Housing and Economic Development, Labor and Workforce Development, and Transportation and Public Works for biweekly discussions. The goal of this cabinet is to break down “silos” in state government to identify opportunities where agencies can work together to improve intergovernmental coordination. Key to this improved coordination are efforts to ensure that any new or expanded public transportation expansion efforts are properly integrated with land use planning efforts that bolster transit use and pedestrian-oriented communities.

In May 2008, the Governor’s Development Cabinet overhauled the state’s development policies to integrate clean energy goals. In addition to requiring more renewable energy, the goals call for reductions in emissions of GHGs. The modified development principles also include building homes near jobs to reduce commuting and building pedestrian-friendly developments that include commercial, cultural, and recreational facilities in residential neighborhoods. To accomplish this, Governor Patrick convened senior state officials from several agencies, including the Massachusetts Division of Energy Resources Commissioner, to examine how the state’s Sustainable Development Principles affect capital expenditures.

Related to the Massachusetts Development Cabinet, Governor Patrick has also issued a set of Sustainable Development Principles that guide the creation and implementation of state agency policies and programs as well as any investments in land and infrastructure. Municipalities are asked to modify their planning, regulatory, and funding actions to achieve consistency with these statewide principles. The principles include promoting clean energy, in the form of energy efficiency and renewable power generation, in order to reduce GHG emissions and the consumption of fossil fuels.

Additionally, Massachusetts has developed Commonwealth Capital, which endorses planning and zoning measures that are consistent with the Sustainable Development Principles and encourages municipalities to implement them by using state funding as an incentive. Municipal smart growth and energy use policies are assessed through a Commonwealth Capital Application. The local efforts are scored as part of the proposal evaluation process for Commonwealth Capital grant and loan programs and now include new criteria, including several related to municipal energy practices.

(Continued on next page)
Chapter 40R of the Massachusetts General Laws is designed to encourage the state’s cities and towns to establish new overlay zoning districts that promote higher density housing and smart growth development. Chapters 40R and 40S provide financial incentives to communities that adopt these zoning districts, including additional educational funding and preference for discretionary funds.110

Related to Commonwealth Capital, the state also has an inter-agency permitting board under the Department of Economic Development that must monitor the development of priority sites and investigate ways to expedite site projects. This includes five permitting specialists to walk businesses through local and state permitting procedures. It also has established a six-month deadline for the local authorities to make final land-use decisions.

In July 2008, Governor Patrick released an updated version of the Commonwealth Capital Policy and the Commonwealth’s Sustainable Development Principles. Consistency with these principles is assessed through an application that examines municipal implementation of 32 land use planning and regulatory practices. Almost 300 (out of 351) of the Commonwealth’s communities have applied, and municipal consistency with the Sustainable Development Principles has improved significantly—up 10 percent—in fiscal year (FY) 2008. In FY 2009, new criteria address regional planning, environmental equity, clean energy, permitting, and transportation. Commonwealth Capital will support distribution of $600 million in grants and low-interest loans from the following programs:

Regional Planning: This criterion rewards those communities that have taken formal and significant action to work with neighboring communities or those in the region to foster development projects, land and water conservation, and other outcomes that have a regional or multi-community benefit.

Environmental Equity: This new criterion rewards those communities that have taken actions to avoid, minimize, or mitigate disproportionately high and adverse human health, environmental, social, or economic effects on foreign-born, minority, and low-income populations; ensure the full and fair participation by all potentially affected communities in municipal environmental decision-making; and provide infrastructure, services, and other benefits to minority and low-income populations.

Clean Energy: Clean energy decreases global warming emissions and other pollutants, enhances public health, and reduces spending on fossil fuels while promoting use of innovative technologies that enhance economic development.

New criteria encourage municipalities to purchase or produce renewable energy and to apply energy efficiency measures.

Expedited Permitting: Earlier this year the Commonwealth’s 13 regional planning agencies collaboratively produced and issued a best practices model for streamlined local permitting. This criterion encourages communities to utilize techniques from the model in order to regulate development in ways that safeguard local government prerogatives and are more efficient and effective, without reducing environmental, public health, and other protections.

Innovative Transportation Measures: Communities have at their disposal a variety of important tools to avoid potential negative consequences of excessive reliance on cars, including congested roadways, excessive energy use, and polluted air and water. Through two new criteria, the Commonwealth encourages communities to construct roads and other transportation infrastructure in ways that are sensitive to their surroundings, such as historic downtowns, and to utilize other innovative transportation measures, including parking and traffic calming techniques.

These grants and loans are offered by the Executive Offices of Administration and Finance, Energy and Environmental Affairs, Housing and Economic Development, and Transportation and Public Works.

While not a transportation project per se, an investment fund aimed at supporting infrastructure, job growth, and economic development by emphasizing partnerships between the state, communities and businesses has been created in the state. On June 12, 2008, Governor Patrick signed legislation authorizing a total investment of up to $250 million for an unspecified number of economic development projects. The goal of this Infrastructure Investment Incentive Program, called I-Cubed, is to finance new public infrastructure improvements that support major new private development. These projects will be financed using bonds issued by MassDevelopment and will be secured by a general obligation of the Commonwealth of Massachusetts.

The I-Cubed legislation grants the secretary of Administration and Finance and the commissioner of Revenue the power to promulgate regulations or guidance with respect to the implementation of the program.111 Under revised draft regulations, I-Cubed developers must demonstrate that projects are likely to result in new state revenues at least 1.5 times the projected debt service on the related bonds, and their projects would not have been pursued if not for the state investment.

The primary vehicle for this approach was embodied in the Smart Growth Areas Act that seeks to better coordinate economic development with planning. The law designates Priority Funding Areas (PFAs), defined as those areas that are already served by water and sewer infrastructure or are planned to receive infrastructure (both urban and rural). Under the initiative, the state will spend infrastructure and economic development money only within these PFAs. Areas outside the PFAs are ineligible for state assistance in the form of infrastructure spending or economic development incentives.

As noted in the Massachusetts case study above, state efforts to implement compact land use and alternative transportation measures can produce benefits such as reduced energy and
fuel usage while helping to preserve their existing transportation infrastructure.

In this regard, Oregon has long maintained a strong statewide program for transit planning and managing land use. The foundation of that program was a set of statewide planning goals requiring Oregon cities and counties to adopt comprehensive plans according to state statutes, planning goals, and administrative rules. In 1973, the state Land Conservation and Development Commission adopted 19 statewide planning goals that provide the framework for the statewide program of land use planning; all land use plans must be consistent with these goals. The goals include land use, energy conservation, transportation, housing, and natural resources. Notably, most of the goals are accompanied by voluntary guidelines to aid to cities and counties in their implementation efforts. In addition, local plans and goals are reviewed by the commission, whose members are appointed by the governor and confirmed by the senate. The commission also administers the land use planning statutes and policies, oversees grants, and provides technical assistance.

Building on these efforts, Portland, Oregon, in 1993 became the first U.S. city to adopt a plan to reduce carbon dioxide emissions. To achieve the plan’s goal, transportation planning efforts were supported by the city and county governments. Specifically, transportation reductions included reducing per capita VMT to 10 percent below 1995 levels by 2010. A 2006 study found that the Portland metro region has achieved progress, reducing VMT 8.8 percent over 20 years. Further, since 1999 Portland has increased its transit ridership by 30 percent. These benefits are credited with the combination of efforts to contain growth within the region’s urban growth boundary, to invest in new transit, and to adopt pedestrian-oriented infrastructure improvements.

To support states in their transportation, land use planning, and GHG mitigation efforts, scenario planning processes are increasingly being utilized. Scenario planning provides a planning framework for analyzing various forces (e.g., health, transportation, economic, environmental, land use, etc.) that affect a region’s growth and development. These include modeling techniques that compare a traditional road-based development pattern to one or more compact alternatives. The alternatives usually have higher densities, mix land uses, and target development towards urban centers. They also seek greater investment in transit.

Additionally, Portland piloted one of the first nationally recognized regional scenario analyses, the Land Use, Transportation, Air Quality Connection (LUTRAQ). The LUTRAQ effort integrated the travel demand models of the metropolitan planning organization (MPO) with its land use planning efforts. It reviewed scenarios comprised of more traditional road-building approaches to a series of developments that focused more on expanding transit and travel alternatives. Under the transit-friendly scenario, Portland’s VMT was estimated to decrease by almost 8 percent, with subsequent benefits in peak congestion and criteria pollutant emissions. Based on this study, Portland adopted a regional plan that incorporated the LUTRAQ alternative, including an emphasis on transit and land use integration.

One study in California, conducted by the California Energy Commission, provides an estimate of total transportation energy reduction statewide resulting from such policies. The authors concluded that California could reduce statewide transportation energy consumption by 3 to 10 percent with the implementation of smart growth policies. This 3 to 10 percent reduction leads to energy savings of 60 to 237 trillion BTUs or 0.6 to 2.3 billion gallons of fuel annually.

To meet the state's GHG reduction targets, California Governor Arnold Schwarzenegger directed the secretary of the California Environmental Protection Agency (CalEPA) to coordinate with the secretary of the Business, Transportation and Housing Agency, secretary of the Department of Food and Agriculture; secretary of the Resources Agency; chairperson of the Air Resources Board; chairperson of the Energy Commission; and president of the Public Utilities Commission. The secretary of CalEPA also heads a Climate Action Team comprised of representatives from these agencies to implement emission reduction programs and report on the progress made toward meeting the statewide GHG targets established in the Governor Schwarzenegger’s executive order.

In support of these statewide initiatives, regional organizations such as the Association of Bay Area Governments, the Metropolitan Transportation Commission, the Bay Area Air Quality Management District, and the Bay Area Conservation and Development Commission, have joined forces implementing programs that target future growth near transit, infill development, mixed-land uses and promoting conservation efforts through partnerships with local governments and community groups. For example, Marin County has prepared a Greenhouse Gas Plan, which sets a target of GHG reductions 15 to 20 percent below 1990 levels by 2020 for government and 15 percent countywide. The plan contains measures such as reductions in building energy use, transportation, waste management, and land use.

Recognizing the progress made in Oregon, the city of Sacramento and other communities in California are using the Regional Blueprint Planning Program to inform regional and local decisionmaking, through engagement of critical stakeholders in the community, including business interests, builders, and environmental advocates, to foster consensus on a vision and preferred land use patterns.

In signing Senate Bill (SB) 375, Governor Schwarzenegger expanded this effort and required that the state’s 18 MPOs to use the Regional Blueprint Planning Program pioneered in California (as well as in Utah and Colorado). Specifically, the bill requires that California’s largest regions engage in a process to
California’s Strategic Growth Initiatives

In California, economic growth and environmental leadership remain closely tied to improving how infrastructure—including schools, bridges, hospitals, parks, levees, housing and more—is built, operated and maintained. Governor Arnold Schwarzenegger is committed to further boosting economic growth, preserving our environment, enhancing services for citizens and getting taxpayers the most for their money by strengthening how California plans, finances and delivers infrastructure projects.

The California state Department of Finance estimates that the state needs $500 billion worth of infrastructure over the next two decades. More pressing, California has an enormous backlog of infrastructure investment needs, estimated to be in the range of $80 billion over the next decade.

Recognizing these challenges, Governor Schwarzenegger - has supported the idea of a Strategic Growth Plan (SGP). In November 2006, voters approved $42 billion for the plan, and in November 2007, the legislature authorized $7.7 billion to address prison overcrowding and improve health care delivery in the prison system. As a result, California is now undertaking the largest infrastructure improvement plan in a generation.

To build on these funding sources, Governor Schwarzenegger in 2008 proposed two new infrastructure policy institutions: The Strategic Growth Council and the Performance-Based Infrastructure Initiative. The council’s objective is to improve interagency infrastructure planning and coordination, and to better align investment proposals with strategic development and sustainability objectives. Pending legislation to permit the broad use of Performance Based Infrastructure is designed to boost service for citizens or lower costs for taxpayers through infrastructure procurement and project delivery.\textsuperscript{118}

In 2002, a New Jersey executive order reinforced state planning requirements by establishing a Smart Growth Policy Council and directing state agencies to incorporate smart growth and state comprehensive plan principles into their plans, regulations and spending programs. In addition, the executive order required agency rulemaking activity to be preceded by the completion of a smart growth impact statement.

In response, the New Jersey State Planning Commission approved a new plan intended to encourage local governments to develop and implement plans that achieve the goals, policies, and strategies of the state comprehensive plan. Under this effort, local governments in New Jersey voluntarily submit their plans to the state for review and endorsement. In return, they receive technical assistance and, if their plans are endorsed, higher priority for available state funding, select streamlined permit reviews, and coordinated state agency services. Local governments seeking plan endorsement must meet guidelines established by the commission.\textsuperscript{119}

Related to this localized planning assistance, the New Jersey DOT has partnered with municipalities and counties to target investments in areas planned for new development and where the cross-acceptance process\textsuperscript{120} assures coordination between local, county and statewide smart growth goals.

In addition to sustainable planning and economic development efforts, states are also collaborating on regional initiatives that require cross-border cooperation. This need for cooperation is increasingly relevant for road and rail access between U.S. states and Canadian provinces because of trade agreements and greater demand for goods. In the Northeast, four states and five Canadian provinces are cooperating on an ongoing study that will identify and assess opportunities to attract economic development by promoting east-west trade corridors and improving multi-modal transportation access for the region. The study covers parts of Maine, New Hampshire, Vermont, and New York as well Nova Scotia, Prince Edward Island, and New Brunswick through Quebec to Ontario. It will assess how transportation improvements can reduce business costs, improve operating efficiencies, enhance job markets within the region, and address port safety issues related to truck traffic and other commerce.\textsuperscript{121}

Local Examples of Improved Governance

The average state enables and oversees more than 30 different state and local economic development programs.\textsuperscript{122} One increasingly popular economic development program is revenue sharing. These are increasingly being deployed by localities, often to aid revitalization efforts for older neighborhoods and business districts that are often already well-served by public transportation.
The revenue sharing technique involves each community designating some part of its assessed value base, or of a stream of tax revenues, for inclusion in a regional pool of assessed values or tax revenues that is then divided among all localities in the pool by some formula, usually involving population size and other variables. In theory, these strategies reduce competition among localities for non-residential properties, provide fairer sharing of taxable assessed value, create greater equality among per-capita assessed value bases across the entire region, and can make possible land-use planning that encompasses the entire region encompassed. In addition to fostering economic development/jobs, these programs may help simultaneously support sustainable infrastructure by boosting the real estate value in these communities. Consider these examples:

• In the Twin Cities Region of Minnesota, revenue-sharing has reduced property value disparities among the localities. When this arrangement was put into effect in 1975, the greatest disparity was 50 to 1; today it is 12 to 1.

• In the Dayton, Ohio, region, local revenue-sharing has made it possible for multiple municipalities to cooperate in promoting the economic development of the entire region, including the provision of affordable housing and cultural facilities serving the entire region.

• In the Hackensack Meadows District of New Jersey, revenue-sharing has made it possible for a regional body to develop a land-use plan that is rational from the perspective of an entire region, and that encompasses parts of 14 municipalities and two counties without causing fiscal disadvantages to any of the entities.

C. Undertake Comprehensive Planning Efforts to Reduce or Manage Demand

The past four decades have seen an increase in automobile travel and significant growth in freight traffic as population and incomes have grown. Similarly, electricity demand continues to grow every year. Continuing these trends will further stress our infrastructure and likely challenge long-term environmental and energy goals. States are developing a number of solutions to moderate demand through enhanced planning, in many cases looking to international approaches that also reap environmental benefits. In the transportation sector, efforts to manage both peak and long-term demand often provide opportunities for states to generate alternative or new revenues. Several of these policies, including VMT taxes and parking pricing, were described in an earlier section. Others include congestion pricing and, in the electricity sector, time-of-use-pricing and demand response programs.

Congestion Pricing and Tolling

The core principle of congestion pricing is that the price of accessing available roadway capacity should be higher at the places and the times of day when demand is greatest. A study by Deloitte found that the cost of congestion in Organization for Economic Cooperation and Development (OECD) countries alone amounts to nearly 3 percent of gross domestic product, or about $810 billion. The study details the success user pricing has achieved in reducing congestion in Singapore; Oslo, Norway; and London. Benefits from each include:

- Singapore’s fee (equivalent to almost 5 percent of household income) cut down commuter traffic entering the zone by more than 40 percent;
- Norway (a three-city program with fees between $0.80 and $1.75US) reduced congestion 5 to 10 percent; and
- London ($8 charge to enter the central city) reduced congestion 40 percent and round-trip times by 13 percent; notably, program organizers are considering long-term opportunities for GHG emissions credits.

In the United States, roadway fees are less prevalent but interest is increasing among states and cities. The Minnesota DOT and the Twin Cities Metropolitan Council are planning to convert bus-only lanes to “priced dynamic shoulder lanes,” on I-35 in Minneapolis. Transit vehicles and carpoolers will be allowed to use the lanes without a charge. Single-occupant vehicles will be allowed to use the lanes by paying a toll that varies depending on traffic volume. The toll revenues will be used to initiate a bus rapid transit (BRT) network in the corridor, which includes vehicle purchases and the construction of stops and other infrastructure such as park-and-ride lots. Transit fare reductions also will be funded through the toll revenues. More examples of BRT are included below.

New Jersey and New York have increased tolls during weekday peak hours and discounted tolls during off-peak hours to help spread roadway demand. Lee County, Florida, discounts off-peak tolls. Other regions and states, including Virginia and California, have established a variety of high-occupancy vehicle and pricing projects on express lanes. While these appear to have had some success in terms of relieving congestion and increasing carpooling, environmental benefits can be difficult to quantify and depend on available transit alternatives.

In California, SR91 is a 12-lane freeway that connects the employment centers of Orange County to the residential developments in San Bernardino, Riverside, and Corona. Population growth in the region has put a severe strain on the SR91 to accommodate commuting traffic. Before the implementation of four toll lanes, the average commuting time for the people using the SR91 was about 65 minutes each way. Users are required to purchase an Automatic Vehicle Identification (AVI) device that is used to collect tolls electronically. The additional capacity provided by these toll lanes resulted in a 20 minute reduction in peak period travel time on the free lanes and the lanes also guarantee free-flow speed of 65 miles per hour, saving drivers approximately 12 to 13 minutes of driving.
Reducing Travel Demand

Beyond managing congestion, reducing demand on surface transportation and electricity grid is a long-term effort that must be achieved through a variety of measures. These include development and redevelopment policies that promote compact, walkable, transit-oriented communities, and using more efficient modes of transportation, including bus rapid transit, high speed rail, light rail and enhanced freight rail access as well as plug-in-hybrid-electric vehicle networks. In addition, as noted above, states are working with local and private partners to implement complementary land use planning, and transportation and behavioral measures known as transit-oriented development (TOD). Similarly in the area of electricity demand, states are acting to reduce peak power load and better plan for renewable power development.

As states across the country are adopting such actions, with support of local and private sector partners, they not only preserve and maximize these infrastructure investments but also to reduce reliance on imported oil and to address related environmental goals. A few examples are described below.

A recent report, *TOD in the United States: Experiences, Challenges, and Prospects*, identifies 117 TODs on the ground or substantially developed as well as more than 100 lifestyle centers (open-air shopping centers fashioned after main streets) in the United States. The U.S. Green Building Council’s new rating and certification system for green development, LEED (Leadership in Energy and Environmental Design) for Neighborhood Development, generated 370 applications from land developers, many more than expected by the program sponsors.

The densely populated urban areas of New York, New Jersey, and Connecticut, known as the Tri-State region, are each embracing TOD efforts. In New Jersey, a leading example is NJDOT’s and NJ Transit’s Transit Village Initiative. The initiative seeks to redevelop and revitalize communities around transit facilities. Under this program, dozens of cities and towns have helped foster the development of thousands of land parcels, including homes, offices and retail development, within walking distance of commuter rail and transit stops. In New York, the MTA has begun a similar initiative and the MTA’s Sustainability Commission is proposing a major TOD program across its service area. New York Governor David Paterson’s Smart Growth Cabinet is also investigating state initiatives that could further advance state TOD efforts. In Connecticut, the General Assembly has adopted legislation promoting TOD plans, including issuing a state statute that requires the state Office of Policy and Management to distribute grants to municipalities developing TOD efforts.

Another example of TOD in Connecticut is the town of Redding, which is developing a blighted and contaminated brownfield site and turning it into a village center with 416 units of varied housing and 300,000 square feet of commercial space next to railroad station on the New Haven railroad line into Manhattan. The 55-acre site of the former Gilbert and Bennett wire mill provided the town of Redding and the Georgetown Land Development Company with the opportunity for redevelopment near an existing transit line. The legislature created a Special Taxing District, encompassing the mill site that is able to issue bonds secured by taxes and fees. In 2006, the U.S. Department of the Treasury designated the Georgetown Special Taxing District as a qualified green building and sustainable design project, which made the district eligible to issue $72 million in tax-exempt, private activity bonds. Another $5 million was received from the U.S. Department of Agriculture to finance the development of a wastewater treatment facility. The award-winning Georgetown development will add an estimated $5 million to the town tax base, and create 1,500 new jobs.

In Virginia, Arlington County has focused high-density commercial and residential development around the Metrorail station in the Rosslyn-Ballston corridor. As described earlier, Arlington County’s government began planning dense redevelopment around rail stations when designs for the Metrorail system emerged in the 1960s. Typically, this redevelopment targets the tallest and most dense development within one quarter mile from the Metro station entrance. Boundaries for these stations have been drawn based on a combination of major transportation routes, census geography, and neighborhood boundaries. They have been carefully planned for walkable, mixed-used development. In addition, over 50 percent of the county’s tax base is now concentrated in transit corridors that comprise less than 8 percent of county land. Office space in these areas has increased from 4.1 million square feet in 1969 to 30 million in 2003, while housing in the immediate vicinity has increased from 4,300 units to 34,000. Arlington County now has more private office space than downtown Boston, Los Angeles, Dallas, and Denver.

Light Rail and Bus Rapid Transit

Directly related to TOD strategies are bus and rail efforts. Bus rapid transit (BRT) is an attempt to use buses to provide a service that is of a higher quality than an ordinary bus line. BRT includes a variety of improvements, notably dedicated roads that have their own rights-of-way and fewer stops than a typical bus route. Light rail transit (LRT) is a metropolitan-electric railway system characterized by its ability to operate in a variety of environments such as streets, subways, or elevated structures. A growing number of cities across the U.S. and internationally, are pursuing investments and seeing benefits from BRT and LRT corridors.

In Pennsylvania, the Port Authority of Allegheny County operates two 2-lane bus routes in the Pittsburgh metropolitan area: the 7-mile East Busway, which shares right-of-way with light rail transit, and the 4-mile South Busway. These facilities serve express buses traveling to the downtown area, where several bus lanes operating on city streets expedite local access and
distribution. The opening of the East Busway in 1983 reduced travel times by 15 to 23 percent on the various bus routes served. In Hawaii, the state uses HOV lanes and dedicated freeway lanes for its CityExpress bus services that provide limited stop buses on pre-existing routes.

Serving the city of Bogotá, Colombia, the TransMilenio Bus Rapid Transit (BRT) systems are already one of the world's most successful BRT systems. Introduced in January 2006, the BRT is the centerpiece of a long-term transport and mobility strategy that prioritizes walking and cycling and discourages private vehicle use. Ridership is approximately 1,050,000 passengers per day, with busy sections carrying as many as 41,000 passengers per hour, and the system is expected to carry 1,400,000 passengers per day, approximately 30 percent of the city's total transit trips. TransMilenio, along with other actions in the transport plan, has increased transit mode share within the city from 64 percent in 1999 to 70 percent in 2005. There is also a role for the private sector, as four different firms—formed by the traditional bus service operators—won the state contracts to provide service on the trunk corridors.¹²⁷

Like BRT, LRT systems can operate on streets with other traffic and with boardings taking place on specialized street stations or platforms. Unlike BRT, they rely on an overhead source for their electrical power. Both systems have generated new mixed-use developments. Studies also show that residents living in TOD developments can generate up to 20 percent fewer GHG emissions per capita because of the pedestrian amenities and transit access afforded by recent research by the Transit Cooperative Research Program that shows residents living near TODs maintain lower rates of vehicle ownership.

In Denver, Colorado, the city Regional Transportation District (RTD) manages 15.8 miles of existing track and a 19-mile expansion to Denver’s southeast corridor. According to RTD data, Denver’s entire LRT system carries an average of nearly 61,000 rider-trips each weekday, 7,000 more rider-trips than RTD expected. Nearly 3 million passengers have ridden the Southeast line since it opened in November 2006. The Denver LRT also has increased developments near existing and planned light-rail stations. Along the light rail line, nearly 5,500 housing units, over 2,200 hotel rooms, 624,000 square feet of retail, 2.3 million square feet of office space, and 2.4 million square feet of institutional space built or under construction; another 900,000 square feet of retail and 1.1 million square feet of office space are proposed. While not all of these developments are within walking distance of the stations, the region’s goal is to encourage TOD opportunities whenever possible.¹²⁸

In Dallas, Texas, the Dallas Area Rapid Transit (DART) was founded in 1983. It is operated by a 15-member board appointed by member-city councils based on population. This regional transit authority is funded in part through a local sales tax. DART and its 45 miles of light rail transit, along with 31 freeway miles of high occupancy vehicle (HOV) lanes, is noteworthy especially because it has attracted significant ridership in a region formerly reliant on automobile travel. The 44-mile light rail was initiated in 1996. It covers 34 stations and serves 58,000 weekday riders and 43,074 weekend passengers. A total of 16.5 million passenger trips were generated through DART in 2004. In addition, complementary transit expansions, such as 130 bus routes and a commuter railway, merges DART and the Fort Worth Transportation Authority. The stations have so far attracted $1.3 billion in mixed-use development. In December 2008, the Dallas City Council approved a tax-increment financing district focused on multi-station TOD. Creation of the District is a culmination of a four-year collaboration among the city of Dallas staff and city council, DART, as well as a number of public and private partners.¹²⁹

Other LRT systems have also exceeded ridership expectations and generated TOD revenue. In Charlotte, North Carolina, a new Lynx light rail transit system has drawn commuters out of their cars, and ridership has exceeded projections since the new line opened in November 2007. Streetcar systems have also shown a particularly strong and positive impact on urban redevelopment. In Little Rock, Arkansas, the Regional Chamber of Commerce River Rail streetcar line, which opened in 2004, became a magnet for new businesses and development in the restoration of two reviving downtown areas.

Another leading example of TOD is the Pearl District in Portland, Oregon. Formerly a largely unpopulated railroad freight yard and warehouse district, the city incorporated an electric-furred streetcar line running between the city’s central business district and the Pearl District. The Portland Streetcar, which began operation in 2001, has generated over $1.4 billion in development along its 4.7-mile loop. The city of Portland supplied $8 million to cover a $6 million loan for the construction of a three-level, 1,350-space underground parking facility, and a $2 million grant for infrastructure improvements. Another $292 million came from private sources, producing a 36:1 private-to-public investment ratio. These funds have supported a clustering of new residential and commercial spaces that have well over 10,000 residents, with goals of close to 50,000 residents. Notably, these Pearl District residents have high incomes but comparatively low levels of vehicle ownership, gasoline consumption, and per capita GHG emissions.¹³⁰

**High Speed Rail**

High speed rail can be defined as rail that reaches 125 miles per hour and is time competitive with air or automobile travel at distances of 100 to 500 miles. It is often cited as a solution to many transportation problems because it reduces congestion on roads and near airports, is secure and convenient, improves mobility, and has environmental benefits over air and automobile travel.¹³¹
High speed train service is becoming a key feature for any advanced, globally competitive economy, with systems currently in place or planned in France, the United Kingdom, Spain, Italy, Belgium, the Netherlands, Taiwan, Japan, and China. In the United States, high speed rail has received less attention over the past several decades, because of governance and budget issues. Amtrak’s public-private governance structure, the lack of a long-term capital budget, and to some extent, freight traffic and even the dispersed U.S. population, have all been cited as barriers to full-fledged high speed rail service in the United States.

However, high speed rail in the United States is receiving a second look by many states and regions, in light of higher fuel prices, road and airport congestion, and security concerns. In the Northeast, Amtrak ridership of the new Acela Express was 3.1 million in FY 2007, while ridership in the Northeast Corridor as a whole, including Acela Express, Regional, and Keystone ridership was approximately 12 million. 132 States from Maine to Florida are seeking to expand Amtrak’s service even further. While the Acela operates at higher speeds of up to 150 mph, Amtrak trains in the rest of the United States are slower and often run on tracks owned and operated by freight railroads.

In North Carolina and Virginia, for example, state officials are seeking to address these infrastructure needs by adding double-track trains to the corridor that would allow for more frequent and faster train service between Washington, D.C.; Richmond, Virginia; and Charlotte, North Carolina. In addition, such investments would benefit regional freight rail services in the northeastern United States and possibly provide relief to the region’s congested airspace. 133

The Midwest, with 10 major cities within a 400-mile radius of Chicago, represents another opportunity for high speed rail service of up to 125 miles per hour. Today, nine state departments of Transportation have embraced the Midwest Regional Rail Initiative and are working to implement it. Over 125 miles of track between Springfield, Illinois, and Chicago is being upgraded for higher speed service. Wisconsin has completed its environmental studies for new higher speed service between Madison and Milwaukee. Michigan hopes to reduce travel time between Chicago and Detroit this year.

On the West Coast, California passed a $9.95 billion bond in November 2008. Of this amount, $9 billion will go to fund high speed rail, and the remainder will cover necessary transit connections. Nearly $9 billion of these funds are expected to be used by the California High Speed Rail Authority (CHSRA) to construct the core segment of San Francisco to Los Angeles, known as the Capitol Corridor.

Of the remaining costs for the Capitol Corridor, $950 million of bond funds would be used to link urban and commuter passenger rail services to the high speed rail system. 134 The remaining bond proceeds would be used to acquire right-of-way, trains, and related equipment, and to construct the required power systems, tracks, structures, and stations.

Total costs of the full statewide high speed rail network could reach $37 billion. Thus, the CHSRA is seeking to attract private and other public funding sources to cover these remaining costs. For the Capitol Corridor HSR link alone, in addition to federal and state funding, the CHSRA anticipates the need for up to $7 billion in additional PPP funding to cover debt financing, vendor financing, and system operations.

Assuming costs for air and automobile transportation remain constant, at least 88 million passengers are projected to ride the high speed train annually by 2030. Statewide studies suggest that high speed rail will generate a moderate increase in overall jobs in California. A reliable 220-mile-per-hour electric high speed train system could offset 12 million barrels of oil per year, reduce GHG that cause global warming by 12.7 billion tons, and create 450,000 new jobs. Sectors such as finance, insurance, real estate, and similar services would account for half of this anticipated growth, while wholesale and retail trade, transportation, communication and utilities would account for approximately one-quarter.

Enhanced Freight Rail Access

Over the past two decades, growth in international trade has created greater demand for goods, and states and regions have been pioneering new intermodal connections that enhance cost-effective infrastructure, including rail and barge. As states and regions seek ways to address this growing demand, freight PPPs have emerged as a leading form of procurement for new capacity. However, unlike transit and roads, the arrangements are different since fares cannot usually generate the net revenues necessary to attract private investors. Successful PPPs designed to deal with increased freight traffic around ports exist in metropolitan areas like Raleigh, North Carolina; Chicago, Illinois; Seattle, Washington; Reno, Nevada; Los Angeles, California; and Miami, Florida.

Through partnerships with Norfolk Southern, CSX Transportation, North Carolina railroad and local governments, NCDOT’s ongoing program of modernizing the railroad has enhanced safety and capacity by systematically protecting highway-railroad crossings, adding passing sidings, straightening curves and the installation of up-to-date computer controlled train dispatching and traffic control systems. The NC DOT, which purchased the track, has also recently completed a $7 million train signal and track project between downtown Raleigh and downtown Cary, North Carolina, that will enhance freight and passenger rail efficiency and continue to improve service reliability.

In Illinois, a notable public-private effort has lead to the creation the Chicago Region Environmental and Transportation Efficiency Program (CREATE). This partnership centers on a plan to streamline the regional freight rail network through an initial capital investment of $1.5 billion. CREATE, a partnership among USDOT, the state of Illinois, the city of Chicago, Metra, Amtrak, and the nation’s freight railroads, seeks to devise new economic development plans for local communities that will
allow railroads to improve intermodal interchanges and reduce the number of truck movements across the Chicago region. The project will address 25 new roadway overpasses or underpasses, replacing grade level crossings for automobile and pedestrian traffic; new rail overpasses or underpasses to separate passenger and freight train tracks; viaduct improvements; safety improvements for grade crossings; and upgrades of tracks, switches, and signal systems. In one community, for instance, this effort has helped support a $42 million investment to build approximately 1.3 million square feet of plant space and value-added logistics uses, creating 400 jobs.

In Pennsylvania, the state funds annual grants for rail freight rehabilitation and construction projects that aim to create economic development opportunities in the Commonwealth. These projects assist private railroads with major capital investment and upgrade projects as well as seek to ensure reliable service to businesses on the rail lines. Examples include energy related projects, including ethanol and coal programs, that not only expand infrastructure but also support energy needs for state residents.

In addition to maintenance needs, freight rail infrastructure must also continue to enhance safety and security. This is important in Pennsylvania, which is home to more railroad companies than any other state, has 6,000 miles of rail that haul more than 200 million tons of freight annually, including an estimated 11 million tons of hazardous materials. A recent study by the Rand Corporation found that this dense rail network is an asset to Pennsylvanians in that it offers alternative evacuation routes throughout the state. The study recommends that Pennsylvania leverage its Rail Freight Assistance Program and Rail Transportation Assistance Programs as a means to enhance rail transportation, safety and security.\(^\text{135}\)

Pennsylvania Governor Ed Rendell in December 2008 provided $30 million as part of PennDOT’s Rail Freight Capital Budget/Transportation Assistance program and a separate $8.5 million in Rail Freight Assistance grants. In addition, Governor Rendell added $10 million to Pennsylvania’s Capital program, bringing the total to $30 million. The program is funded through state capital bond dollars in the General Fund. The grants, authorized by the General Assembly, are administered by PennDOT’s Bureau of Rail Freight, Ports & Waterways. All of these grants were approved by the 15-member State Transportation Commission.\(^\text{136}\)

In 2006, Rhode Island completed the state’s first Freight Rail Improvement Project (FRIP).\(^\text{137}\) The $225 million project included the construction of 12 miles of new track, five miles of upgraded track north of Providence, and five miles that will remain as shared track. Thus, the FRIP makes freight rail feasible but also builds on RIDOT’s efforts to expand commuter rail service in the state.

Beyond upgrading existing facilities there may be new ways to plan for strategic projects. One approach to building freight infrastructure is seen in the case of the Alameda Corridor, a rail expressway connecting the ports of Los Angeles and Long Beach, California, to transcontinental rail yards near downtown Los Angeles. This is a PPP among the port authorities; railroad companies; and government at the local, state, and federal level. These two ports are the major gateways to Asian markets, and the cities, ports, nearby communities, and policymakers desired to improve freight movement and minimize effects on local communities. The result was a PPP designed to create an efficient connection to all domestic markets via Los Angeles’ primary rail facility. The $2.4 billion project has eliminated 200 rail-street crossings, improved automobile travel and subsequent port investments in on-dock rail have reduced the number of short-haul truck trips. It is estimated that intermodal investments in the Los Angeles region have eliminated 1.4 million truck trips per year, and the county elected to enact container fees to finance the debt. Despite the costs, payments on the debt are 10 years ahead of the repayment schedule as a result of high cargo levels.

Similarly, there are a number of places where freight upgrades offer an upgrade for passenger rail. Other examples include the Capitol Corridor in California, the Cascades in Washington, and the Keystone Corridor in Pennsylvania.

Another rail financing project is the upgrading of the Heartland Corridor, which connects Columbus, Ohio, to Hampton Roads, Virginia. The agreement among the Federal Highway Administration, three states, and Norfolk Southern Rail is expected to reduce truck traffic in Virginia and reduce delivery times by up to one day between the Mid-Atlantic and the Midwest. The deal also works in concert with an arrangement between Norfolk Southern and the Columbus Regional Airport Authority, which constructed an intermodal facility adjacent to Columbus’ airport. The project is estimated to cost $151 million, $95 million of which is expected to come from the federal government; $10 million from a Virginia rail enhancement grant; and nearly $1 million from an Ohio rail development commission grant, with the remainder (about $45 million) to come from Norfolk Southern Corporation. West Virginia will contribute additional funding.

As states move forward with enhanced transit and related infrastructure, it should be noted that other measures can help support greater use of these fixed infrastructure investments. As described in Section A, parking pricing can generate revenue to fund alternatives; moreover, it serves to enhance the viability of transit, can ease congestion and help reduce single occupant vehicle trips. In Chicago, Illinois, the parking price effort is coupled with a plan for 10 miles of a dedicated BRT system that will ultimately be 100 miles.

Flexible Work Arrangements

Flexible work arrangements can include reducing the work week from five to four days, adopting telework programs and alternative work schedules. While often established to address high energy costs, all of these can serve simultaneously to reduce the strain on the transportation infrastructure, particularly if telecommuters drive less during peak periods on their days working from home than they would during their commute.
Partially as a response to higher energy prices, states are developing lead-by-example telecommuting programs. In 2008, Utah Governor Jon Huntsman issued an executive order calling for a year of four-day work weeks in Utah government offices. The program, Working 4 Utah, adjusts the work week for most state employees from five eight-hour days to four ten-hour days. The program aims to increase energy efficiency and save state workers the cost of one round trip to work each week. Certain essential government services, such as public safety, corrections, and emergency services will continue to be provided daily.

Similarly, Hawaii Governor Linda Lingle has instituted a three-month pilot program that reduces the work week to four days for one state agency. Hawaii will monitor the impact to services and measure possible savings and benefits during the pilot. Gasoline savings, commute times, and employee productivity and morale will also be measured throughout the program.

Virginia Governor Tim Kaine has announced a state telework policy that directs state agencies to consider expanding telework and alternative work schedules. The governor also implemented a telework initiative for his gubernatorial appointees. A Telework Roadmap was released in February, 2008, as a resource for employees and managers in moving forward with this concept. An Office of Telework Promotion and Broadband Assistance was also codified in the Virginia office of the Secretary of Technology to encourage the telework policy. In addition to energy savings, this policy aims to promote productivity, improve air quality, and reduce traffic congestion.

**Time-of-Use Electricity Pricing, Demand Response Programs**

As with efforts to manage scarce transportation resources (roads) to better meet user needs and alleviate congestion, states are confronting an electricity infrastructure that is similarly capacity constrained. Most electricity users are charged rates that are the same regardless of the time or level of usage, some rates even decline with level of usage, which misses an opportunity to encourage more efficient use of the system and more efficiency overall. By shifting demand from peak to non-peak periods, electricity generators can delay (in the face of overall rising electricity demand) the need to build new capacity. Approaches such as time of use pricing and other forms of demand response can be useful.

Through time-of-use pricing, whereby electricity charges are higher at established peak periods (certain times of day and seasons), users can be induced to shift their usage patterns, for instance, by running their clothes washers or production lines at night rather than during the day. There is much successful experience with such rate structures for large industrial users, and opportunity to make greater use of them, especially for commercial and residential customers.

Similarly, through demand response programs, whereby users are rewarded economically for reducing their usage or agree to direct utility control of customer equipment when the overall demand on the system reaches a set level, users can be encouraged to shift their usage patterns or employ onsite generation modes. Both these approaches also can encourage, but do not necessarily provide overall demand reduction. Demand response programs also may result in higher overall emissions levels if increases in onsite generation are achieved through use of higher emitting sources such as diesel fired generators. Time-of-use pricing rates may require the installation of specialized meters and may be enhanced by smart grid technologies, which are discussed in a later section. However, any use of these rates needs to consider electricity users such as low-income and elderly people, who may be unable or unwilling to shift their electricity use.

In a 2001, time-of-use pricing effort by Puget Sound Energy, the largest electricity provider in Washington, the average residential customer shifted 13 kilowatt-hours from peak to off-peak periods, representing nearly a 4 percent shift. In aggregate, this amounted to a significant 25,000 kilowatts of reduced peak demand.

The Day Ahead Demand Response Program offered by the New York System Operator allows large users to bid their load reductions (an amount of reduced load for a dollar amount) into the wholesale electricity market and compete with generators’ offers. If the customer’s bid is accepted and the customer fully curtails, they receive the greater of the bid price or the day-ahead market price.

In California, San Diego Gas and Electric (SDG&E) offers all customers online software with an optional time-of-use meter for free. This allows users to view up to 17 months of historical energy consumption, graph their usage, and download data. Additionally, customers with a time-of-use meter can view historical 15-minute interval data. SDG&E also allows customers with smart meters to enable more immediate availability of data for analysis, also for free, including the ability for customers to download 15-minute interval data the next morning.

**Reducing Peak Power Load**

While new grid technologies are important, states are also seeking to maximize the efficient use of the current grid. Once way to do this is through improved regional partnerships and interstate planning processes. For example, Idaho, Montana, Oregon, and Washington entered into an interstate compact as a means of coordinating the usage of key resources common to all four. Authorized by the Northwest Power Act of 1980, and approved by a vote in the four State legislatures, the Northwest Power and Conservation Council’s (NPCC’s) recent fifth power plan sets a high priority for energy efficiency to meet resource adequacy needs going forward.

Another benefit of regional electricity planning is advancing new electricity savings markets. The New England region’s Forward Capacity Market (FCM). The FCM is an auction-based program designed to work with the electric energy
market to send consumer and industry price signals that will ensure a reliable electric power system in New England. A pioneering element of the FCM settlement is that demand resources—including energy efficiency, load management, distributed generation, and demand response—can be eligible to receive capacity payments. In addition, non-utility entities can bid their demand resources into the market, which makes for a more robust demand-side marketplace.

A statewide approach to electricity demand management is the use of a loading order. In California, the Public Utility Commission’s loading order policy was established in the 2003 joint CPUC/California Energy Commission Energy Action Plan. To meet its growing electricity demand, California’s energy agencies—the California Energy Commission, the California Public Utilities Commission, and the California Consumer Power and Conservation Financing Authority—established an energy resource loading order to guide their energy decisions. It requires the state’s electric utilities to prioritize clean energy resources to meet the growing energy needs: first, with energy efficiency and demand response; second, with renewable energy and distributed generation; and third, with clean fossil-fueled sources and infrastructure improvements.

Other statewide planning processes aim for use of advanced grids to support locally based renewable electricity generation and to offset peak power demand. In Florida, Governor Charlie Crist signed into law House Bill 7135 that directs the state’s Public Service Commission to adopt a renewable portfolio standard (RPS) and also requires utilities to develop standardized net metering programs that allow customers to sell limited amounts of home-generated renewable energy back to the grid. Some 35 states have adopted similar policies, which set broad goals for increased use of renewable power. These states are in various stages of authorizing and implementing customer generated and utility-scale renewable power resources.

**Fix-It-First Initiatives**

Given greater knowledge on the costs of sprawl and the benefits from repairing existing infrastructure, a growing number of states are examining and implementing a Fix-It-First policy that gives priority to repair and reinvestment of existing roads, bridges, water, sewer, and power infrastructure by fixing and maintaining this current infrastructure. Funding for expansion, growth, and new purchases is limited, and occurs after existing infrastructure has been properly taken care of and adequately funded. Such a strategy can help communities avoid subsidizing sprawl.

In Georgia, the Department of Community Affairs provides a variety of community development programs to help the state’s communities realize their growth and development goals. This includes construction codes that help Georgia’s local governments, building professionals, and citizens consider sustainable development in buildings. On May 6, 2008 Governor Sonny Perdue signed the Energy Efficiency and Sustainable Construction Act of 2008. This act requires the Department of Community Affairs in consultation with the Georgia State Financing and Investment Commission to adopt policies and procedures for all buildings owned or managed by the state that:

1. Optimize the energy performance;
2. Increase the demand for construction materials and furnishings produced in Georgia;
3. Improve the environmental quality in this state by decreasing the discharge of pollutants from such state buildings;
4. Conserve energy and utilize local and renewable energy sources;
5. Protect and restore the state’s natural resources by avoiding the development of inappropriate building sites;
6. Reduce the burden on municipal water supply and treatment by reducing potable water consumption;
7. Establish life cycle assessments as the appropriate and most efficient analysis to determine a building project’s environmental performance level; and
8. Encourage obtaining Energy Star designation from the U.S. Environmental Protection Agency.

This act also will allow major facility projects to be up to 30 percent more efficient than the standards set forth in ASHRAE and requires major facility projects to achieve a 15 percent reduction in water.

In Massachusetts, structurally deficient bridges, pavement condition, and other existing infrastructure are targeted for first priority in maintenance and repair. Limited state resources also are available to support city and town center development. The communities of Worcester and Pittsfield offer examples of a Communities First effort to use context-sensitive design and prioritize multi-modal transportation options. The Massachusetts Highway Department recently revised its highway design guidelines, utilizing a 28-member Task Force of regulators, interest groups, planners, highway design experts, and community leaders. Released in January of 2006, the resulting Project Development & Design Guidebook places greater emphasis on design flexibility, streamlined procedures, and improved collaboration between MassHighway and the cities and towns it serves. Further, the guide has reshaped the way transportation projects are implemented, including ensuring principles and objectives of context-sensitive design are integrated into highway planning and design on a statewide level.
In Pennsylvania, the Department of Transportation is guided by “Ten Themes of Smart Transportation” that incorporate a fix-it-first principle and other concepts discussed above. Specifically, the Department suggests leveraging and preserving existing investments when creating and funding new programs and projects is a priority.

**Efficient Use of Water Infrastructure**

Water utilities are utilizing strategic water-efficiency programs that facilitate not only capital and operating savings but allow systems to defer significant expenditures for water supply facilities and wastewater facilities. In 1999, the city of Cary, North Carolina, placed a greater emphasis on cost-benefit analyses to devise measures that would reduce peak-day demand during the summer months. The resulting 10-year Water Conservation and Peak Demand Management Plan is based on a CBA of potential conservation programs. The plan is estimated to reduce the city’s water production by 16 percent by 2028. Water conservation efforts will also help Cary reduce operating costs and defer considerable capital expenditures and has helped the city delay the need to build two water plant expansions based on the 10-year savings projections from water conservation.

In South Dakota, Governor Mike Rounds has worked with the Board of Water and Natural Resources to provide more than $7.5 million in grants for low-interest loans for drinking water, wastewater and waste management projects. The grants, which total seven in all, include several aimed at ensuring clean drinking water as well as one grant and two loans to the Solid Waste Management Program. These funds support solid waste disposal and recycling and also support efforts to utilize waste tires.

In 1984, the Massachusetts legislature created the Massachusetts Water Resource Authority (MWRA), a public authority organization charged with providing wholesale water and sewer services to 61 communities in eastern and central Massachusetts, including the city of Boston. The MWRA has developed an Integrated Water Supply Improvement Program (IWSIP) to improve the reliability and quality of the water and to meet all the stringent requirements of the federal Safe Drinking Water Act. MWRA’s IWSIP is a 10-year, $1.7 billion series of projects to protect watersheds and to build new water treatment and transmission facilities. This program includes projects in five critical areas, known as the multiple barrier approach: Watershed Protection, Water Treatment, Transmission and Reliability, Covered Water Storage, and Distribution Pipeline Rehabilitation. Over the last decade this included the rehabilitation of 63 miles of distribution system pipeline and the construction of 22 miles of new pipeline. It also included a program of leak detection and elimination together with water efficiency measures for homes and businesses.

**D. Look First to Environmentally Beneficial Alternatives to Conventional Infrastructure**

When adding capacity is necessary, states can look to environmentally beneficial alternatives such as transit, which was already discussed. In addition, the transportation and energy sectors are part of an active discussion around potentially game changing infrastructure developments such as a plug-in hybrid electric car network and grid scale renewable energy generation.

**Plug-In Hybrid Electric Car Networks**

Plug-in hybrid electric vehicles offer the promise of significantly reducing demand for oil and alleviating constraints on oil related infrastructure while reducing GHG emissions. While plug-in hybrid electric vehicles build upon the existing electricity generation and transmission infrastructure, their widespread use calls for a new electric-charging infrastructure and other grid-applications, as well as the need for lightweight battery technology that does not yet exist.

**Hawaii** is working with several plug-in hybrid electric vehicle manufacturers, the Advanced Vehicle Testing Activity of the Idaho National Laboratory, Hawaiian Electric Industries, and Project Better Place PBP, which aims to incentivize the build-out of the infrastructure for plug-in hybrid electric vehicles. In addition to its efforts in Hawaii, PBP is working on similar initiatives in Israel and Denmark.

In Japan, Toyota produces a hybrid minivan that provides 8 kW of electric power through household outlets. This vehicle is a favorite of construction contractors who drive it to worksite and use the charged battery to operate their equipment. In North Carolina, Governor Mike Easley announced the creation of a public-private partnership designed to explore and develop practical technology for plug-in hybrids and other energy efficient transportation. North Carolina State University, Progress Energy and Duke Energy will participate in the partnership with the Advanced Energy Transportation Center housed at North Carolina State University. The Advanced Energy Transportation Center hopes to lower the cost of converting a traditional hybrid vehicle and will seek further partnerships, funding, and ideas from a variety of sources, including motorsports and transportation industries as well as the federal government.

A new start-up company, V2Green has partnered with Xcel Energy in Minnesota to test six Ford Escape hybrids converted to plug-in hybrid electric vehicles, including an assessments of grid-applications for these plug-in hybrids. As noted earlier, smart meters are already being tested by utilities in California and Texas and these meters and other electricity infrastructure has promise for plug-in hybrids. A U.S. Department of Energy study found that if every car and light-duty
The state of Vermont will support the installation of about 250 MW of capacity.149 In addition to wise management of electricity demand and complementary deployment of small-scale renewable, states are working with federal and private partners to deploy—through policies and financial incentives—grid-scale renewable energy generation. For example, Montana recently instituted a 15 percent RPS along with a property tax breaks for wind farms. These policies are being complemented by efforts to expand transmission necessary to meet the state RPS. In 2007, the legislature passed Montana Governor Brian Schweitzer’s property tax incentive legislation for new transmission lines and funded a new Energy Infrastructure Promotion and Development office in the State Department of Commerce. The office is currently working with more than 50 wind energy projects that are in planning and development and that represent more than 4,000 MW of generating capacity.

In November 2008, Governor Schweitzer announced that the Montana Alberta Tie Ltd. transmission line (MATL) has completed the permit process and is ready to move forward. The MATL transmission line is a 230 kilovolt, 214-mile line that will connect Montana energy to markets in Alberta, Canada. This project is expected to attract nearly $1 billion in wind development. Montana’s current wind energy production is 271 megawatts (MW), an increase from 1 MW in 2005 and these developments are expected to add or support another 200 MW of capacity.150

In Vermont, Governor Jim Douglas has announced that Vermont Department of Public Service will award $2 million in grants through the Clean Energy Development Fund (CEDF). Limits have been placed on the maximum level of funding awarded, ranging from $25,000 to $250,000, based on the category to which a project belongs. Funding is available to projects that fall into the following categories:

- Pre-Project Financial Assistance;
- Small-Scale Systems;
- Large-Scale Systems; and
- Special Demonstration Projects.

The CEDF also provides low-interest loans for renewable electric projects to individuals, businesses, nonprofits, and municipalities. Vermont state-supported colleges, public schools and municipalities investigating the installation of renewable energy can apply for grants through CEDF’s Municipal Technical Assistance program. The funding programs provided by the state of Vermont will support the installation of about 250 renewable energy systems that could generate approximately 540 megawatt-hours of electricity annually. The CEDF was established in 2005 and is currently funded through proceeds to the state from Entergy Corporation.151

In March 2008, Utah Governor Jon Huntsman signed SB 202, The Energy Resource and Carbon Emission Reduction Initiative through which electric utilities will provide 20 percent of their power from renewable energy by 2025 if cost effective.152 This legislation establishes Utah’s RPS and marks an important step in meeting Utah’s Clean Energy Objectives. The next steps include: (1) identifying renewable energy zones (REZs); (2) quantifying electrical generation potential; and (3) identifying new and existing transmission needed to bring renewable energy to market. In order to maximize stakeholder collaboration, the UREZ Task Force will include representatives from cooperative, municipal, and investor-owned utilities; renewable generation developers; environmental organizations; federal and state agencies; and state and local government representatives.

E. Set Clear State-Directed Cost-Benefit Criteria and Performance Targets, Collect Data and Measure Success, and Provide for Accountability

Government cannot monitor what is not adequately measured. The challenge of gathering accurate infrastructure data is compounded by a number of factors, including the lack of tools to measure infrastructure investments and land use planning objectives as well as the need for better estimates of energy availability and accurate quantifying of the impacts of climate change. Related to this is lack of communication and information exchange among experts in the cross-cutting topics of energy and infrastructure, which make it difficult to set clear goals.

As states and regions are seeking to address these challenges of infrastructure investments and their broader implications, they are exploring how to make better use of cost-benefit analysis to evaluate projects before they are developed and the use of increasingly sophisticated set of performance metrics to measure, monitor and validate a wide range of infrastructure projects after they are developed. In addition, there is a renewed effort to ensure accountability in state transportation initiatives and other infrastructure investments.

Cost-Benefit Analyses

Currently, several states use cost-benefit analyses (CBA) for transportation projects. These analyses might take into account factors such as how a proposed project compares to alternative projects or project designs in terms of travel times, user safety, and cost savings. There are a number of factors and alternatives that typically may not be considered in CBA,
such as the cost of free parking and pollution (including GHG emissions), the benefits of alternative demand management strategies, or impacts of climate change on infrastructure. There are a number of CBA models that have been used to capture some of these factors.

For example, a CBA study in Seattle, Washington, examined the social benefits and costs of highway, transit, and pricing at the regional level. Another CBA study looking at Wisconsin transit investment found significant benefits (such as saving riders money and mitigating traffic congestion and pollution) that outweighed the cost of investment across several varied investment scenarios.

States are using improved CBA approaches to right-size multimodal transportation projects that are then carried through all planning, programming, and project development phases. Since 2002, the Pennsylvania Department of Transportation (PennDOT) has incorporated land use policies through the development and implementation of an annual Sound Land Use Implementation Plan, and state transportation planning is focused around a set of principles that examine financial resources on maintaining existing infrastructure, choosing projects with high value-to-price ratio, and enhancing the local network to relieve congestion. Related to these principles, PennDOT recently initiated four right-sizing pilot studies that use a best fit project approach for meeting transportation needs considering community and regional goals/objects, quality of life concerns, economic development initiatives, fiscal constraints, and other social or environmental issues.

States are using other methods similar to CBA to prioritize and evaluate infrastructure sectors projects. For example, the California I-Bank (discussed in Section A) examines a number of factors including environmental benefits and impacts, field utilization, job creation and retention, project readiness, and leveraging other public and private sources of funds to evaluate project. In addition, states through their public utility commissions, engage with utilities in energy resource planning to meet electricity needs. This can include examination of several alternative scenarios that include varied estimates of electric load growth and means of meeting growth. States are looking for ways to incorporate energy efficiency and renewable energy options into energy resource planning. California requires utilities to implement all cost-effective energy efficiency opportunities before seeking to bring new power generation assets online as a strategy to reduce costs, diversify resources, and achieve environmental benefits. If new power generation is needed, California requires utilities to consider renewable energy resources first before conventional generation. Wisconsin and Connecticut have similar provisions. A number of states have worked to integrate their environmental objectives into the energy resource planning process, including their state climate goals. Washington and California require that new long-term contracts for power generation meet GHG emissions standards equivalent to combined-cycle natural gas turbines.

Increasingly rigorous use of comprehensive CBA can assist states in examining the value of individual projects and approaches. The more factors, scenarios, costs, and benefits that can be included in CBA, the more information state policymakers will have in deciding whether to pursue strategies and projects. Oregon Governor Ted Kulongoski has proposed to direct the Oregon Department of Transportation (ODOT) to adopt a least-cost planning model aimed at accounting for carbon dioxide emissions in transportation planning. In this model, ODOT would consider least cost options for reducing congestion and meeting demand, including transit and rail, on par with other options such as building more road capacity.

Related to CBA, states are stressing accountability in their transportation programs. In October 2006, Virginia Governor Kaine created the Transportation Accountability Commission to increase accountability and performance in state transportation programs. The Commission was charged with evaluating Virginia’s current accountability methods and making recommendations to ensure that the state’s transportation agencies deliver maximum value for taxpayers, employ rigorous management techniques, and are held accountable for the performance of the state’s transportation system. In December 2007, Governor Kaine released the final report of the Commission, which recommended seven broad goals and 34 performance measures to improve the Commonwealth’s transportation network. The report’s seven broad goals include increasing transportation safety, improving mobility and accessibility in the transportation network, and improving coordination of transportation and land use planning. The 34 performance measures will track pertinent information for each goal, such as the number of transportation related fatalities, percentage of bridges in need of repair, congestion, or other social or environmental issues.

**Performance Measures**

Performance is the accomplishment of a promise or a claim and therefore must be measured relative to a benchmark like a prior measurement or a set of goals and objectives. For many state DOTs performance measures are used to determine whether infrastructure and other transportation improvements meet pre-established goals and objectives, the later which can range from mobility, to cost-effectiveness to quality of life. Further, performance measurement is also a matter of continuing interest and attention: Of DOTs that have adopted performance measures, several—including Colorado, Florida, New York, Ohio, and Virginia—have ongoing initiatives to renew, redevelop, or transform these measures. It is important that such measures remain state-directed so sufficient flexibility is available to meet wide-ranging transportation needs across the country.

In Kansas, the DOT runs the three priority formulas to update priority ratings for project decisions. The output from the formulas, prioritized lists of roadway control sections and bridges,
are used to identify logical projects. Projects with the highest relative need are programmed for improvement first within available funding and based on scheduling considerations.

Because of the number of federal permits required and the diverse staffing needs to process and manage these permits, all states face performance measurement challenges in this area. The Washington State Department of Transportation (WSDOT) has developed a Multi-Agency Permitting Team (MAP) to enhance the coordination between state agencies when developing and implementing transportation projects. The MAP teams consist of the WSDOT, the departments of Ecology and Fish and Wildlife, the U.S. Army Corps of Engineers, and the King County Department of Development and Environmental Sciences. The aim of MAP is increased permitting process, and better integration of environmental and other concerns into the early stages of the planning process. The purpose of the MAP team is to cooperatively process environmental permits for Washington State Department of Transportation (WSDOT) transportation projects while protecting natural resources in the public interest.161

For environmental as well as other necessary planning permits, the WSDOT uses performance measures identified in three categories—time, cost, and changes in business practices—to track progress in processing permits and to identify areas for improvement. The MAP team concept is currently being tested on approximately 52 transportation projects in western Washington alone. These include a variety of road, bridge, transit, and other infrastructure projects. Related to its MAP effort, WSDOT publishes a quarterly report called Measures, Markers and Milestones, which evaluates the performance of the agency and the transportation system.161

In Tennessee, key performance measures have been identified to help monitor progress towards the goals the state DOT’s long-range transportation plan, known as Plan GO. A total of 12 measures are evaluated that help to establish project evaluation criteria. These criteria are: 1. Average highway bridge condition; 2. Pavement Quality Index Interstates; 3. Maintenance Rating Index Interstates; 4. Average accident rates for rural; 5. Percentage of shortline track miles; 6. Average age of urban transit fleet; 7. Average annual service miles of rural transit fleet; 8. Percentage of congested miles of state-maintained rural highways; 9. Percentage of congested miles of state-maintained urban highways; 10. Annual urban transit vehicle hours per capita; 11. Annual rural transit vehicle hours; and 12. Percent of functionally obsolete bridges.

Similar to the efforts in Washington, the Tennessee DOT (TDOT) issues periodic report cards of these 12 criteria measures to revise targets and for further planning. The transportation system performance results in the report cards may then be used by TDOT to revise and update its 10-Year Strategic Investments Program. The Strategic Investments Program defines TDOT’s long-term spending expectations at a program or corridor level. For example, the plan might identify highway maintenance and bridge replacement objectives and spending levels, the portion of the TDOT budget allocated to public transportation or to bicycle/pedestrian programs, or major highway corridors that will be improved during the 10-year period. The performance measures will help the state:

• Gauge how well TDOT is meeting its goals;
• Rate transportation system performance against established benchmarks that define expected performance standards;
• Identify system deficiencies and opportunities for improvement; and
• Guide allocation of resources and help to determine the level of investment necessary for a particular mode, program, or project.

Other state DOTs also evaluate their own performance. The California Department of Transportation (Caltrans) also has provided quarterly reports on performance measures to the Business, Transportation and Housing Agency, most recently published in June 2008.162 The Florida Department of Transportation (FDOT) operates within a performance measurement framework that monitors performance in three dimensions. From a transportation system perspective, FDOT has developed quantifiable objectives for meeting its responsibilities in implementing Florida’s long-range transportation plan, the 2025 Florida Transportation Plan. From an agency perspective, FDOT also monitors Key Performance Measures on a monthly basis to track organizational improvements. From an external perspective, the Florida Transportation Commission, an independent oversight entity, issues an Annual Performance and Production Review of how well the needs of the traveling public and business community are being met.163

Beyond evaluating traditional mobility standards, New York is including environmental sensitivity in its transportation planning efforts. The State Department of Transportation Commissioner recently launched a Green Leadership in Transportation and Environmental Sustainability (Green LITES) scoring program, under which all state road and bridge project designs will be ranked as certified, silver, gold, or evergreen, depending on their eco-friendly elements. Similar to the U.S. Green Building Council’s Leadership in Energy and Environmental Design (LEED) certification system, Green LITES will rate transportation projects in four categories, including site selection, water-quality and air-quality protection, waste minimization, and overall innovation.

The National Transportation Operations Coalition (NTOC) published a report in July 2005 outlining major performance measures—data and metrics used to evaluate infrastructure and mobility—that should be implemented nationwide to determine the status of the nation’s transportation systems. The report describes these needs in the context of highway and roadway performance; however, performance measures can be
applied to multimodal and intermodal transportation challenges, including goods movement and public transit. Examples of state-based performance measures are described below.

**Ohio** recently released the findings of its state’s first Transportation Conversation. These findings were developed under the auspices of Ohio’s 21st Century Transportation Priorities Task Force, via a report to Governor Ted Strickland, the leadership of the Ohio General Assembly, and the director of the Ohio Department of Transportation. The report recognizes that a fully integrated, well-managed transportation system can make Ohio a leader in the national and global economies, driving business growth and prosperity, creating good jobs, and allowing Ohioans to get where they want to go safely and in an environmentally sound way. The report identifies seven fundamental principles that provide guidance for meeting the broader priorities of the task force:

1. Keep Ohio competitive in the global and national economies;
2. Transportation must be aligned with economic development, environmental and land use policies and practices;
3. Transportation planning and development should be focused on multimodal, multiuser systems;
4. Transportation is a shared responsibility for state government and local communities, with synchronized public policies and public-private collaboration;
5. Transportation policies should balance the preservation and maintenance of existing assets with strategic investments in new capacity;
6. The mobility of all Ohioans, including those who are transit-dependent (e.g., senior citizens and persons with disabilities), needs to be improved; and
7. Transportation funding must be reliable, sustainable, and adaptive to changing environmental factors.

In **Colorado**, the state DOT has developed performance measures to make investment decisions that are more cost-effective and that enhance accountability. These are system quality, safety, mobility, program delivery, and strategic projects. System quality, safety and mobility are structured to report the effect of transportation investment decisions on the transportation system. Program delivery reports the efficiency and effectiveness of DOT staff in delivering timely projects, and programs and strategic projects tracks the construction of 28 strategic projects.

In **California**, an example of improved data collection is an effort by Caltrans to partner with California Partners for Advanced Transit and Highways, Berkeley Transportation Systems, and the Department of Electrical Engineering and Computer Sciences at the University of California, Berkeley, to create the Freeway Performance Measurement System. The project is designed to collect historical and real-time freeway data from freeways in the state in order to compute freeway performance measures.

Another method of improving data collection is the use of computer tools and models. A Geographic Information System (GIS) is an organized collection of computer hardware, software, geographic data, and personnel designed to efficiently capture, store, update, manipulate, analyze, and visually display all forms of geographically referenced information. The unique capabilities of GIS help highlight the transportation system’s reach, coverage, modal relationships, key corridors, and relationship to our nation’s economic activity and environment.

GIS has been successfully deployed in both **Arkansas** and **Nevada**. The Arkansas State Highway and Transportation Department (AHTD) used GIS to streamline the transportation decision making and permitting processes. GIS enabled AHTD to share and consolidate environmental and engineering data, and to refine and analyze large amounts of study area information.

The **Nevada** Department of Transportation (NDOT) developed the Safety Management System (SMS), a transportation GIS, to merge crash data with a roadway base map. To create the

---

**Integrating Transportation, Economics, and Land Use System**

The Transportation, Economic, and Land Use System (TELUS) is a fully integrated information-management and decision-support system designed to help metropolitan planning organizations (MPOs) and state departments of transportation (DOTs) prepare annual transportation improvement programs and to carry out other responsibilities under the Transportation Efficiency Act of SAFETEA-LU. As of April 2008, this system has over 300 registered user agencies including 231 MPOs, 33 state DOTs, and 50 other local/regional governments.

TELUS is coupled with TELUM, land use computer modeling software. TELUM is an integrated interactive software package for evaluating the land use impacts of regional transportation improvement projects. The software utilizes sophisticated computer models to produce long term forecasts of spatial patterns of jobs and residences in the planning area. Based on the user’s inputs, TELUM uses current and prior residential, employment, and land use data to forecast their future values and locations by employment sector, household income group, and land use type. This system is primarily for small and medium-sized MPOs.
system, NDOT staff compiled partial datasets from several state and local offices into a single, consistent base map in a new database. SMS can locate crashes using a nearby address, the distance from an intersection, the distance from a milepost, or other methods that the police use. After locating the crashes, the system then can identify them on a roadway base map.\textsuperscript{166}

Measurement of performance is also a way to build an environmentally sound, sustainable transportation system. In Minnesota, federal and state statutes give responsibility for planning, developing, and measuring the performance of the Twin Cities’ regional transportation system to Minnesota Department of Transportation (Mn/DOT) and the Metropolitan Council. The Mn/DOT and the Metropolitan Council are also responsible for planning and investing in the regional transportation system are incorporating performance measurement at various levels of their operations. A new report by the Surface Transportation Policy Project praised these and other efforts by Mn/DOT, but also concluded that the state’s performance measurement efforts should integrate data collection and develop goals to reduce GHG emissions and better integration of transportation and land-use policies.

**F. Incorporate New Technology**

To support the policies and objectives described above, states are looking to the use of new materials to lower costs and improve efficiencies, and new technologies to provide information and automation. The use of new technologies is well-illustrated in the transportation sector, which incorporates new technology. Technologies such as electronic tolling or GPS-enabled transit systems serve as a platform to enable greater success rate of demand management measures, such as regional integration of tolling facilities or the greater use of mass transit. Related to transportation technologies, the electricity sector is incorporating advanced technologies into their decision making and data collection, which coincides with utility and state efforts to provide consumers and business with the tools to better manage power demand.

**New Transportation Construction Materials**

State-by-state, increasing costs of building and maintaining roads and bridges are stretching tight transportation budgets. An FHWA study looked at the direct costs associated with corrosion on infrastructure and transportation and determined that the economic impact of corrosion and developing implementation strategies could be well over $200 billion.\textsuperscript{169} Several states are making use of new construction materials, including new materials for road paving and bridge construction to help contain costs.

In South Carolina, a portion of State Route 5 widening was replaced with a plant-mixed Cement Stabilized Aggregate Base Course that is seen as an economical and structurally competent alternative to traditional materials used in pavement design. This product has been used extensively by the South Carolina DOT in pavement design at the design-build level for its economics, structural capability and speed of construction.

In Texas, several cities including Dallas are giving procurement preference to cement providers that use dry process kilns. Dry process kilns emit less pollution than wet process kilns.\textsuperscript{170} In Ohio, modular bridges, made of plastic reinforced with fiber glass improve the speed of installation and portability of bridge design. While more expensive upfront, these bridges are expected to last longer and save the state money in the long run.

Alternative materials, made from synthetic, renewable, or high-tech compounds, are also gaining increased popularity because they may offer environmentally friendly alternatives. For example, permeable paving, used in Maryland, is a method of paving methods for roads, parking lots and walkways that allow the movement of water and air around the paving material.

**New Transportation Technologies**

New technologies and technological advances play an important role in helping states and localities manage demand for transportation infrastructure. In addition, there are a number of new technology applications discussed in previous sections, such as GIS-based programs and broadband to facilitate state telecommuting programs, or tolling efforts and GPS to facilitate a VMT tax program.

Intelligent transportation systems (ITS) can include efforts at real-time traffic management to reduce congestion and reroute traffic. Virginia is using ITS to help manage traffic on its portion of the congested Washington, D.C., beltway known as I-495. Using cameras and sensors to monitor conditions, Virginia has deployed real-time electronic speed limit signs that are adjusted according to traffic conditions.\textsuperscript{171} Specially trained operators will monitor the cameras, and the two-year program is projected to cost $3 million. VDOT will provide updated traffic information to the public at nearby interchanges, and the programs are expected to regulate traffic flow during lane closures related to construction, and to help avoid accidents.

Maryland Governor Martin O’Malley launched GreenPrint, an interactive mapping tool designed to guide land conservation and growth in Maryland. GreenPrint is a planning tool, and centerpiece of Maryland: Smart, Green & Growing, a multi-agency, statewide initiative to create a more sustainable future for Marylanders by linking community revitalization, transportation improvements, economic development, smart growth and natural resources restoration. GreenPrint combines cutting edge GIS technology with management princi-
ples Governor O’Malley implemented via StateStat and BayStat to achieve progress by setting goals and measuring success in addressing challenges presented by the population growth.

In Nevada, after completing a study on the potential for alternative funding mechanisms for critical transportation infrastructure improvements, the state Board of Transportation has recommended that the state enter into a public-private partnership to improve capacity along a major corridor through Las Vegas. Under the recommendation, NDOT will conduct a demonstration project in Clark County that will create a public-private partnership charged with converting high-occupancy vehicle and emergency lanes into managed electronic tolls with video enforcement along I-15.

A collaborative effort between the Washington DOT, Oak Ridge National Laboratory, and the U.S. Environmental Protection Agency is documenting the use of remote sensing to find better ways of completing the environmental assessment processes. The Washington DOT case involved a very large number of projects and used a survey method in conjunction with project costs to determine cost and time savings associated with remote sensing. The study noted several cost advantages to using remote sensing techniques that the state should consider when making a final decision on the use of this technology.

**Smart Grid**

In the electricity sector, several states are examining the use of smart grid technology. Smart grid refers to an array of advanced technologies such as smart meters and appliances that enable utilities and consumers to better monitor energy use. Smart meters, for example, provide both the utility and the consumer with real-time data about energy consumption. Fully equipping homes and businesses with smart grid technology could provide a platform to increase conservation and better manage demand, and allow utilities to institute real-time pricing to charge more during peak power usage periods. This could lead to, for example, consumers programming their smart dishwasher and washing machines to run only during off-peak periods to save money, or programming their home heating system to reduce the temperature by a few degrees during peak periods. In addition to saving consumers money, a full integration of smart grid technology and real-time pricing could help to reduce peak demand and reduce the need for peak power generation.

With the Energy Policy Act (EPAct) in 2005 and the Energy Independence and Security Act (EISA) of 2007, the federal government set the foundation for building the smart grid by, among other things, asking state and local electricity regulators to consider policies on the smart grid, energy efficiency, distributed generation interconnection, and net metering and demand response. According to a new report by IBM, the Smart Grid vision is that the technologies will: 1) provide customers with information and tools that allow them to be responsive to system conditions; 2) ensure more efficient use of the electric grid; and 3) enhance system reliability.

Governor’s energy advisors, state energy directors and state public utility commissions are seeking to tap the full potential of the smart grid. States such as California, Illinois, Ohio, New York, Texas, and a growing contingent in New England and the Mid-Atlantic states are developing policies to ensure interoperable communication systems are used. This will allow states and regions to enhance demand response, integrate renewable energy, and improve energy efficiency and grid reliability.

States are working with utilities to develop pilot programs that test smart grid technologies via small pilots. In Maryland, Baltimore Gas & Electric Co. is moving forward with plans to measure customers’ electric and natural gas use on an hourly basis, with the goal of reducing peak decrease peak demand in homes. The Maryland Public Service Commission is working on the pilot, which will include a test of its new smart meter in 5,000 homes. The meters will report energy use remotely to customers at any time, via an online monitoring program.

In Colorado, Governor Bill Ritter has announced that Xcel Energy, a major utility operating in the Midwest and western U.S., will make Boulder a Smart Grid City. The smart grid system will provide customers with a portfolio of smart grid technologies that could provide operational savings, improved customer-choice energy management and increased grid reliability. The project will also track any environmental impact and integrates renewable energy (by incorporating Boulder homes with solar rooftops) into this new energy infrastructure.

In the first phase of the project, Xcel Energy and the Smart Grid Consortium will study Boulder’s electricity infrastructure to develop a scope and preliminary design plan. Implementation is expected to continue through 2009, including a technology assessment. Following the initial implementation, Xcel plans to use the results to talk with state, federal and regulatory officials about broader deployment efforts.

Smart meters involve enabling real-time power outage notification, and power quality monitoring. While there are efforts underway in the United States, a number of other countries have invested in developing a smart grid network, including Italy, France, Germany, the United Kingdom, Spain, the Netherlands, Scandinavia, and Denmark. A new study on smart meters estimates that installations of smart meters in Europe will be more than 80 million by 2013. Italy is leading the way with a massive roll out. Enel SpA, Italy’s largest utility, deployed smart meters to its entire person customer base, installing 27 million by the end of 2005. The Italy-based smart meters have integrated bi-directional communications, advanced power measurement and management capabilities, and an integrated, software-controllable disconnect switch. These features allow Enel to remotely turn power on or off to a customer, remotely read power usage information from a
In the United States, California’s energy regulators approved a program to retrofit conventional meters with communications co-processor electronics for 9 million PG&E customers. Like those in Italy, these meters can report electricity consumption on an hourly basis, which enables PG&E to set a peak-usage pricing that rewards customers who shift energy use to off-peak periods. A similar effort is being launched by the Los Angeles Department of Water and Power. As part of a five-year peak pricing pilot program, the municipal utility has purchased 9,000 advanced meters for select commercial and industrial (C&I) customers. Participating commercial and industrial customers can tailor their daily energy consumption around the data provided by the smart meters, creating potential for reducing their monthly electricity bill and, at a broader level, contributing to less energy use and fewer GHG emissions.

**CONCLUSION**

To compete sustainably in the 21st century, the United States needs to rebuild and revitalize its infrastructure under a new way of thinking. States and governors are advancing a number of successful examples of programs and policies to meet our economic, energy, and environmental challenges. From these efforts, and in the context of the challenges the nation faces, policymakers should consider the following six principles to guide infrastructure planning, development, and policy going forward:

- **Expand and diversify revenue sources for infrastructure development and maintenance.** In 2006, the state of Indiana finalized a $3.8 billion 75-year lease of the Indiana Toll Road capital fund. The Indiana Toll Road funds were used to fund the state’s 10-year highway construction plan.

- **Coordinate infrastructure decisions across government agencies and levels of government, as well as between states and regions and ensure that energy and environmental costs and other concerns are considered.** In Massachusetts, Governor Deval Patrick created a Development Cabinet that draws together the lieutenant governor and the secretaries of Administration and Finance, Energy and Environmental Affairs, Housing and Economic Development, Labor and Workforce Development, and Transportation and Public Works. This is coupled with efforts to prioritize state transportation funding for sustainable development projects and to ensure planning approaches emphasize transit and land use planning measures that save energy.

- **Prioritize comprehensive planning efforts that will reduce or manage demand to reduce the cost of or avoid new capacity projects.** In Dallas, Texas, the 45-mile DART (Dallas Area Rapid Transit) has attracted significant ridership in a region formerly reliant on automobile travel. The DART has generated almost 18 million passenger trips in 2007 and is supporting 130 bus routes and a commuter railway. The DART has also generated TOD and walkable, mixed-use development investments valued at over $1.3 billion.

- **When adding capacity is necessary, look first to environmentally beneficial alternatives to conventional infrastructure, including transit and intercity rail, distributed and central renewable energy, energy efficiency and smart grid projects, and plug-in hybrid and electric vehicle infrastructure.** Montana’s property tax incentive legislation for new transmission lines is one example. The funds support the state’s ongoing efforts to work with over 50 wind energy projects representing more than 4000 MW of new renewable energy transmission capacity.

- **Set clear state-directed cost-benefit criteria and performance targets for infrastructure investments, collect data and measure success, and provide for accountability and transparency through performance reporting pegged to a variety of well-defined, outcomes-based metrics.** Washington and California publish quarterly reports that evaluate the performance of the respective state transportation agencies and travel networks. In Colorado a new smart grid system in the city of Boulder will provide customers with a portfolio of smart grid technologies that could provide improved customer-choice energy management and track environmental impacts from this clean energy infrastructure.

- **Incorporate appropriate new technology wherever practical.** In Maryland, Baltimore Gas & Electric Co. plans to measure customers’ electric and natural gas use on an hourly basis, with the goal of reducing peak decrease peak demand in homes. The Maryland Public Service Commission is working on the pilot, which will include a test of its new smart meter in 5,000 homes. The meters will report energy use remotely to costumers at any time, via an online monitoring program.

The need for new infrastructure investments is great and equally pressing is the need for a new planning and development approach. States are developing the policies, strategies, and management approaches necessary to implement such a new vision for U.S. infrastructure. Taking these measures to full scale will be important steps in efforts to strengthen our infrastructure for a sustainable future.
ENDNOTES


3. Ibid.


8. Ibid.

9. Ibid.

10. Ibid.


12. Ibid.


18. Ibid.


22. Ibid.

23. The following summarizes the flexibility afforded states in using funds under the six major federal surface transportation funding programs:

<table>
<thead>
<tr>
<th>Program</th>
<th>SAFETEA-LU Authorization</th>
<th>Flexibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface Transportation</td>
<td>$33 billion</td>
<td>Complete – highway, transit, ped/bike, etc.</td>
</tr>
<tr>
<td>Nat’l Highway System</td>
<td>$31 billion</td>
<td>Can shift 50% to STP, or 100%, + NHS transit</td>
</tr>
<tr>
<td>Interstate Maintenance</td>
<td>$25 billion</td>
<td>Can shift 50% to STP</td>
</tr>
<tr>
<td>Highway Bridge</td>
<td>$22 billion</td>
<td>Limited to highway bridges</td>
</tr>
<tr>
<td>CMAQ</td>
<td>$9 billion</td>
<td>Extensive – eligibility incs. transit, bike/ped</td>
</tr>
<tr>
<td>Highway Safety</td>
<td>$5 billion</td>
<td>For motorist, bike or ped safety on any facility</td>
</tr>
</tbody>
</table>


28. Ibid.


33. Ibid.

34. Ibid.

35. Ibid.


43. Ibid.


48. Ibid.

49. Ibid.

50. Ibid.

51. Ibid.


56. Minnesota Department of Transportation. Interstate 35W Bridge in Minneapolis. Available at: http://www.dot.state.mn.us/35wbridge.


70. Ibid.
78. Ibid.
90. While these two assets leases involved state assets, USDOT has recently proposed that the entire federal-aid highway system, including the Interstate Highway System, be eligible for tolling at state option including the leasing of system segments to private operators. See USDOT, “Relocus, Reform, Renew: A New Transportation Approach for America,” 2008.
94. In August, 2008, San Francisco opted to scrap its proposal to impose a congestion fee on the Golden Gate Bridge in favor of a variable parking fee scheme along roads near the bridge including Doyle Drive, the major road from the bridge into San Francisco. Net revenues from these parking fees will be dedicated to partially underwriting the cost of stabilizing Doyle Drive from earthquakes, a $1.1 billion project.
99. Tax rebates offer a direct payment to the purchaser after the payment has been made. Tax credits are a direct reduction in taxes owed, independent of tax bracket.


106. Ibid.


108. In addition, much of the Growth Cabinet’s work builds on or complements previous efforts. These include: the Growing Smarter Oversight Council and the Growing Smarter Guiding Principles; Growth Cabinet Listening Sessions, various state agency task forces; the Governors Institute on Community Design workshop; and the Climate Change Action Plan. Available at: http://www.aecommerce.com/SmartGrowth/.


115. For the full set of LUTRAQ reports, see http://www.one thousandandfriends of oregon.org/resources/lutraq_reports.html.


120. Cross-acceptance is a negotiating process by which local governments and residents compare their local master plans with the State Development and Redevelopment Plan to identify potential changes that could be made to achieve a greater level of consistency with statewide planning policy.


128. On March 4, 2002, the City Council adopted Blueprint Denver: An Integrated Land Use and Transportation Plan as a supplement to the Denver Comprehensive Plan 2000. This reinforced the need to TOD that integrates transit use with complementary land use development.


131. Center for Clean Air Policy and the Center for Neighborhood Technology, Growing Smarter Guiding Principles; Growth Cabinet Listening Sessions, various state agency task forces; the Governors Institute on Community Design workshop; and the Climate Change Action Plan. Available at: http://www.aecommerce.com/SmartGrowth/.


134. Bay Area Council Economic Institute, California High-Speed Rail: Economic Benefits and Impacts in the San Francisco Bay Area (San Francisco: Author, October 2008).


164. Freeway Performance Measurement System, PeMS. This project is conducted by the Department of Electrical Engineering and Computer Sciences at the University of California, at Berkeley, with the cooperation of the California Department of Transportation, California Partners for Advanced Transit and Highways, and Berkeley Transportation Systems. Available at: https://pems.eecs.berkeley.edu.


