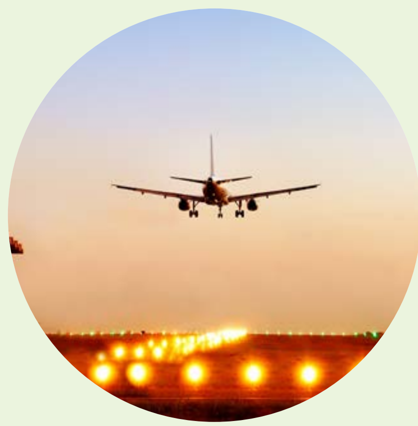
Making the Grade

How Investments in America's Infrastructure Benefit Our Economy and Environment

BLUEGREEN® ALLIANCE






This report is also available at **www.bluegreenalliance.org**.

BLUEGREEN ALLIANCE

The BlueGreen Alliance unites 15 of our country's largest unions and environmental organizations. Acting together, through nearly 16 million members and supporters, we are a powerful voice for building a cleaner, fairer and more competitive American economy.

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EXECUTIVE SUMMARY

Every four years, the American Society of Civil Engineers (ASCE) releases a report card depicting the condition and performance of America's infrastructure across a number of sectors of the U.S. economy, the latest being the *2013 Report Card for America's Infrastructure*.

Unfortunately, America consistently gets barely passing grades and our infrastructure systems are in dire need of modernization. In 2013, ASCE gave the nation's infrastructure a grade of "D+," which is a slight improvement over previous "D" grades, and estimated that to get to a grade of "B" would require an investment of $3.6 trillion over the next seven years. It also showed that the gap between planned infrastructure investment and the amount required to achieve a good state of repair is currently an estimated $1.6 trillion dollars.

This report delves into the economic impacts of closing that gap by accelerating infrastructure investment—using current financing approaches—to achieve a "B" grade over the next 10 years. By doing so, there is the potential to support or create an additional 2.7 million jobs across the U.S. economy and increase Gross Domestic Product (GDP) by $377 billion over 10 years versus a business-as-usual approach.

But that's not the only benefit. Making these investments now will pay big dividends making our country more efficient and in reducing carbon pollution and other greenhouse gas emissions driving climate change. Such an endeavor would accrue significant sustainability benefits across the economy. For each of the sectors examined in the ASCE *Report Card*, accelerated infrastructure investment could help achieve the following environmental benefits, including but not limited to:

- Saving nearly 5.7 billion gallons of fuel and averting the carbon dioxide equivalent of 48 million metric tons per year over the next decade by supporting the current trajectory of transit ridership. Currently, transit ridership levels save the equivalent energy of the gasoline used by more than 7.2 million cars a year—nearly as many cars as are registered in Florida, the fourth largest state;
- Reducing climate change pollution by an equivalent of 225,000 metric tons of carbon dioxide for each 5 percent reduction in leaks from drinking water systems;
- Helping to reduce power plant emissions by 30 percent below 2005 levels over the next three decades by investing in more efficient power plants and the electrical grid; and
- Reducing greenhouse gas emissions by approximately 10 million tons of carbon dioxode—equivalent to the carbon pollution emissions of six million U.S. households—for each 5 percent reduction in the amount of solid waste Americans generate.

In addition to saving energy and mitigating climate change impacts, infrastructure investment would significantly improve quality of life and public health, while strengthening the economy by decreasing traffic congestion, reducing airport delays, expediting freight movement, protecting our lakes and rivers, preserving our open spaces, and ensuring our children learn and play in safe, modern schools. There's also a financial incentive. If these investments were accomplished under the present form of government expenditure, financing the additional $1.6 trillion necessary to achieve an overall "B" grade at today's interest rates of 3.1 percent—versus the pre-recession rate of 4.5 percent—such investments would save taxpayers nearly half a trillion dollars over 30 years.

Stimulating the economy, creating jobs, fighting climate change, and improving our communities—now and for generations to come—are all good reasons to prioritize infrastructure investment.

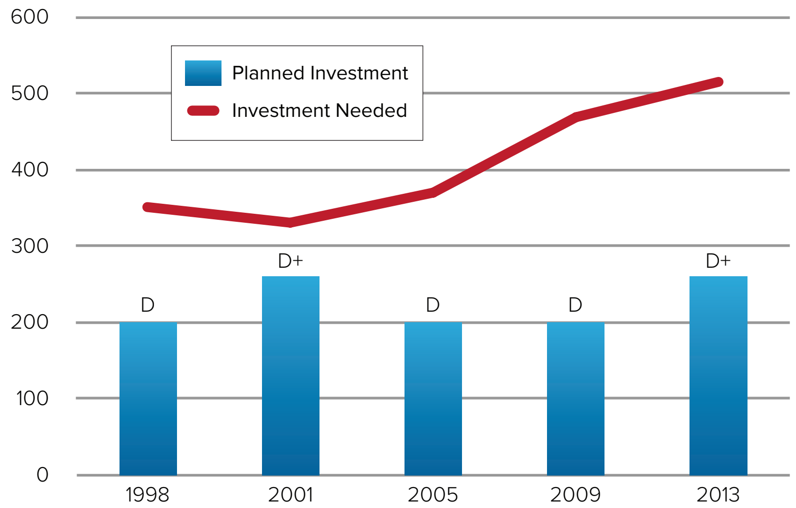
1. INTRODUCTION

Much of the physical infrastructure of the United States is in a state of disrepair. As documented by the American Society of Civil Engineers (ASCE) in their *2013 Report Card for America's Infrastructure,* our roads, transit systems, dams, and airports need billions of dollars of investment to return them to adequacy. Our water, air, and land are threatened by aging systems designed to provide safe drinking water, handle hazardous waste, treat wastewater, and manage our solid waste. Half of our schools were built to educate the generation that is now retiring, and our electric grid is widely recognized as being incapable of meeting the needs of our changing energy system.[1]

While the problem has reached critical levels, it is not new. ASCE gave the infrastructure an overall grade of "D+" in 2013. However, in the five *Report Cards* issued since 1998, the only other overall grade ASCE has given it has been a "D." While last year's "D+" grade represents the unfortunate apex of our infrastructure's status, the amount of funding needed to bring the infrastructure up to a grade of "B" is also at its peak, requiring $3.6 trillion in spending over the next seven years to reach that goal. (Figure 1)

At the same time that the need for infrastructure investment has been growing, however, public investment in infrastructure has fallen precipitously. As a share of Gross Domestic Product (GDP), infrastructure spending is by far at its lowest point in 20 years. (Figure 2)

FIGURE 1. ASCE Grades, Annual Investment, and Investment Needed, Billions



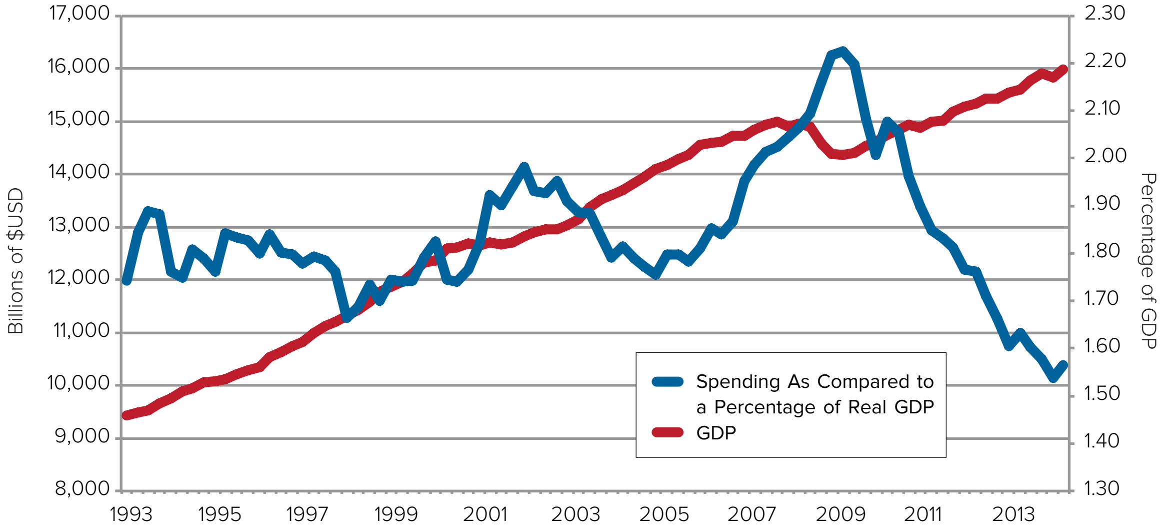
Source: American Society of Civil Engineers

All of this is taking place in the context of an economy still recovering from the recession of 2008-2009 with employment in construction at its lowest level in 16 years.[2] Ironically, as our infrastructure continues to deteriorate and unemployment continues to plague the very workers needed to bring it back to a reasonable state of repair, public investment in infrastructure is flagging. As a share of GDP, public expenditures on infrastructure spiked toward the end of the recession, due both to shrinking GDP and investment funded by the American Recovery and Reinvestment Act of 2009 (the Recovery Act). Since then, however, infrastructure investment has fallen to its lowest levels since peaking in the late 1970's.[3]

As a result, our overall infrastructure grade improved slightly to a "D+," but the gap between planned infrastructure expenditures and the amount of funding needed to bring it to an overall "B" grade has risen to more than $1.6 trillion dollars.

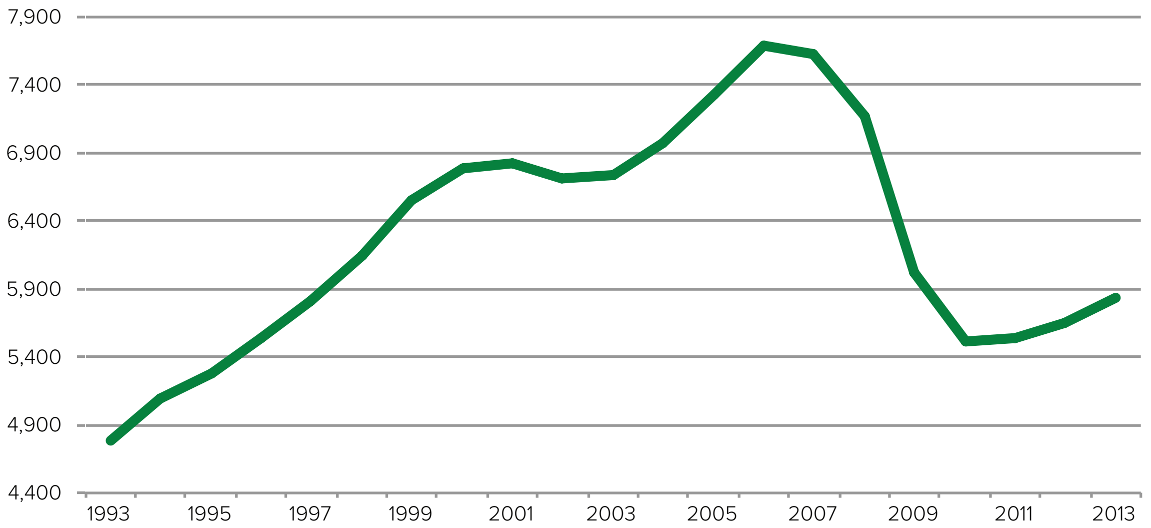
This study examines the economic impacts—and the potential sustainability benefits—of filling that gap by accelerating infrastructure investment sufficiently to achieve a grade of "B" within the next 10 years.

FIGURE 2. Infrastructure Spending: Amount as a Percent of Real GDP



Source: U.S. Bureau of Economic Analysis and Census Bureau

FIGURE 3. Construction Employment, Thousands



Source: U.S. Bureau of Labor Statistics

2. WHY ACCELERATE INFRASTRUCTURE INVESTMENT?

The most straightforward answer to the question of why we should accelerate our investment in public infrastructure is that if we do not, it will continue to fall into disrepair. Investing at the currently planned rates through 2020 will leave an investment gap of almost 45 percent. ASCE estimates the economic cost of allowing the gap to perpetuate to be approximately $1.6 trillion through 2020. Failing to invest in creating and maintaining adequate infrastructure is a classic example of being "penny wise and pound foolish."

Aside from the overall drag our failing infrastructure creates on the economy, there are a number of other reasons to accelerate the pace of investment:

ECONOMIC STIMULUS

As measured by GDP, the economy overall is well into recovery from the recession of 2008-2009. As measured by employment, however, the economy has a ways to go to return to pre-recession levels. While the official unemployment rate has fallen from a peak of 9.7 percent in 2010 to just under 6 percent (September 2014), labor force participation rates have also fallen since 2010, from just over 65 percent at the end of the recession to just under 63 percent. Overall employment is just now returning to its pre-recession levels, leaving almost six years worth of population growth that has not found its way into gainful employment. As shown in Figure 3, employment in the construction sector was hit particularly hard during the recession and remains at pre-2000 levels. The jobs supported or created directly by accelerated infrastructure investment would be focused largely in the construction sector, where they are badly needed—especially compared to the overall employment. (Figure 4)

LOW INTEREST RATES

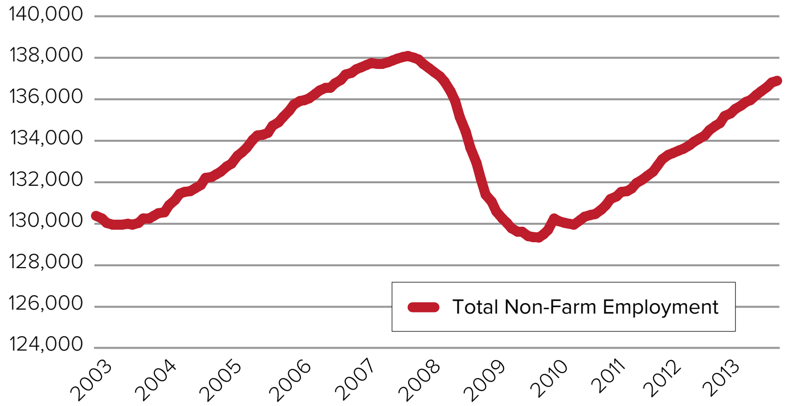
Because many federally funded expenditures on infrastructure are financed through borrowing, the overall cost of investment depends significantly on the interest rate on long-term Treasury bonds. In its efforts to stimulate the private sector, the Federal Reserve has maintained loose monetary policy, keeping sustained downward pressure on interest rates. As a result, the interest rate on 30-year Treasury bonds is just above 3 percent, near its lowest point in history. Comparing the interest costs of financing the additional $1.6 trillion necessary to achieve an overall grade of "B" at today's rates of 3.1 percent, versus the pre-recession rate of 4.5 percent, financing the expenditure today would save taxpayers nearly half a trillion dollars over 30 years.

ENVIRONMENTAL BENEFITS

In addition to the economic costs of a failing infrastructure that could be avoided—and the economic benefits of investing in sectors struggling to recover from the recession—investing in infrastructure can yield potentially significant environmental benefits as well. For example, a failing infrastructure is a drag on overall productivity in terms of increased congestion in multiple transportation modes, inadequate transit infrastructure and other inefficiencies that may be individually small but are significant in the aggregate. This represents waste of scarce resources and emissions of local and global pollutants that would be avoided if the infrastructure were in a sufficient condition.

As the world's climate continues to change, accelerated by carbon pollution and other greenhouse gases, the deteriorating state of our infrastructure becomes a vicious circle. As our systems crumble and become more inefficient, excess pollution that results exacerbates climate change. As our climate changes, more extreme weather—floods, stronger storms, droughts, and other impacts—test our already stressed infrastructure systems, endangering the health and safety of our communities.

FIGURE 4. Historical U.S. Employment, Thousands of Jobs



Source: U.S. Bureau of Labor Statistics

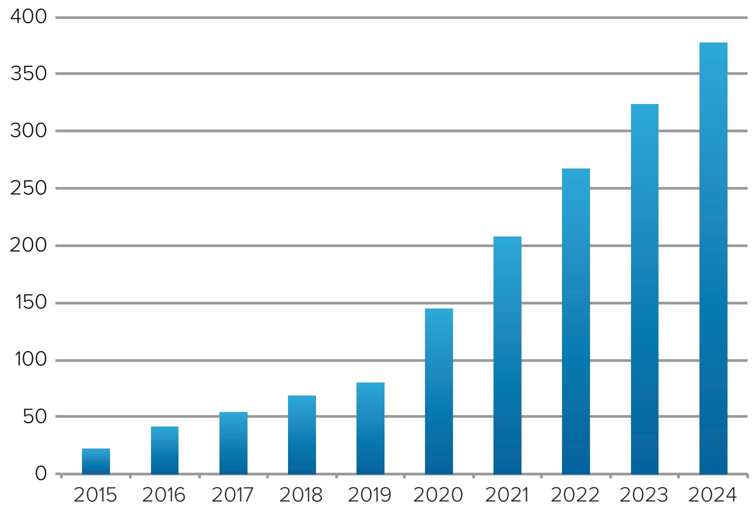
3. ECONOMIC IMPACTS OF ACCELERATED INFRASTRUCTURE INVESTMENT

To estimate the economic impacts of bringing our infrastructure up to a "B" grade, we examined a scenario in which the additional $1.6 trillion in investment was undertaken over the next 10 years. We modeled expenditure in sectors relevant to each of the 11 different infrastructure classes examined by the ASCE in their *2013 Infrastructure Report Card*. We modeled both the stimulus impact of the expenditures—i.e. the increased demand for labor and materials necessary to complete the infrastructure upgrades—and the impact on overall long-term GDP that would result from the investments. Figure 5 shows the impact on overall GDP.

Note that the jobs estimates reported here are more appropriately called "job-year equivalents." Each "job" represents an increase in demand for employment sufficient to employ one person full time for one year. When labor markets are tight, it is possible that a significant number of jobs created will be workers hired away from other jobs, so not all of the jobs created will be net new employment. In the current economic situation with high unemployment in construction and other key sectors, this problem is largely minimized.

In terms of employment, accelerating infrastructure investment would support or create a significant number of new jobs as shown in Table 1. As indicated, the construction sector would be a major beneficiary of the investment, but job growth would accelerate in every sector of the economy. By 2024, the accelerated investment would support nearly 2.7 million additional full-time equivalent jobs throughout the economy in that year.

FIGURE 5. GDP Growth from Getting America's Infrastructure to a "B" Grade in Billions



Source: Modified IMPLAN Model, see Methodology section on Pg. 7

Table 1. Employment Growth by Sector in Thousands

	2019	2024
Agriculture	14	43
Electric Utilities	1	3
Natural Gas Utilities	-	1
TPU	31	87
Construction	419	894
Other Manufacturing	71	182
Primary Metals	1	2
Fabricated Metals	1	2
Trade	53	172
Services	162	597
FIRE	100	359
Government	23	320
Total Impacts	**885**	**2,662**

4. METHODOLOGY

The estimates developed for this report are based on relatively straightforward input-output analysis. The model is based on core data from the IMPLAN group, their 2011 U.S. national model, with modifications for productivity trends and other factors. We relied on data from the *ASCE 2013 Report Card* for estimates on the total investment requirements needed to bring the overall grade for U.S. infrastructure up to a grade of "B." The investment requirements by infrastructure category are shown in Table 2 (dollars in 2011 billions).

We allocated this expenditure across the individual economic sectors identified in Table 2 using a combination of the pre-defined IMPLAN industry spending patterns for various types of infrastructure investments. We assumed that the expenditure would take place over 10 years, starting slowly and ramping up to a peak in the final year of the simulation.

Because the federal government operates at a net deficit, we assumed that all of the funding required for the investment would be financed over 20 years using the 20-year Treasury bond rate as projected by the Energy Information Administration (EIA) in its *2013 Annual Energy Outlook*. We imposed a balanced budget constraint by accounting for the principal and interest payments required to support the bond financing throughout the simulation, modeled as increased federal taxes.

Table 2. Investment Gap in Billions (dollars in 2011 billions)

Surface Transportation	$863
Water/Wastewater Infrastructure	$86
Electricity	$109
Airports	$40
Inland Waterways & Marine Ports	$16
Dams	$15
Hazardous & Solid Waste	$47
Levees	$73
Public Parks & Recreation	$106
Rail	$11
Schools	$276
TOTALS	**$1,643**

Following Leduc and Wilson (2013), we accounted for the increase in overall economic productivity resulting from improvements in the infrastructure using a modified multiplier effect. Leduc and Wilson found evidence of both a near- and long-term impact on GDP resulting from infrastructure improvements. Their research, which focused on local economies that benefitted from federal infrastructure grants, indicated that the near-term benefits were likely to be transient, but that the long-term effects were more sustained. We used their lower bound estimate of the GDP impact of infrastructure expenditures beginning five years after the investment, and dissipating after three years, for which the lag and persistence they found to be statistically significant. As a result of these assumptions, this productivity impact only appears in the second half of our 10-year simulation. Because it impacts the economy only after a five-year lag and because the expenditures in our simulation are phased in gradually, only a relatively small share of the total economic productivity benefits is reflected in our simulation results. Additionally, in keeping with the practice of static budget scoring, we did not account for the increased tax revenues associated with this accelerated GDP growth, which would have reduced the need for increased taxes to cover the bond payments and resulted in greater economic benefits.

5. SUSTAINABILITY AND INFRASTRUCTURE INVESTMENT

There are significant sustainability benefits that could accrue from improving America's infrastructure to a "B" grade over the next 10 years. In the following sections, potential areas of environmental improvement from infrastructure investment are described in terms of avoided carbon emissions, reduced energy demand, and associated climate change and other quality of life impacts.

This report looks at the economic benefits of repairing and upgrading our nation's infrastructure systems to get them to a grade of "B", up from a "D+" grade assigned in 2013 by the American Society of Civil Engineers *2013 Report Card.* Rebuilding these systems to be more climate resilient presents an enormous opportunity to protect our communities now and into the future.

The following sections look at these potential environmental and sustainability impacts, and for the first time, connects infrastructure investments, which will create quality, family-sustaining jobs across the U.S. economy, to measures to adapt to the current effects and mitigate the future impact of climate chance on our economy and environment.

POWER AND THE ELECTRICAL GRID

Getting our power and electrical grid to a "B" grade over the next 10 years could support or create an estimated 180,000 jobs across the U.S. economy.

America's electricity system powers our economy, and reliable power is absolutely necessary in our increasingly technology-driven world. Power plants are the largest source of carbon dioxide (CO_2) emissions in the U.S. Generating electricity produced more than 2,088 million metric tons of CO_2 (MMTCO2) in 2012[4] and accounted for 32 percent of total U.S. greenhouse gas emissions.[5] While progress has been made—power plant emissions are down 15 percent since 2005—increasing investment to upgrade and modernize our electricity grid will allow us to generate and distribute electricity even more efficiently, further reducing emissions while increasing reliability.

Although investment in electricity infrastructure has improved over the past 10 years, today's vast network of transmission and distribution equipment still includes components from over 100 years ago. Varying age, condition, and capacities make it difficult to provide reliable power, and unreliable equipment, severe weather, and overloading can all cause costly power disruptions. Impacts of climate change are already adding stress to existing electric infrastructure and will increase as more CO_2 enters the atmosphere. Unpredictable and extreme weather events—such as drought (water is needed for more than 90 percent of electricity generation[6]), floods, storms, wind, and sea-level rise—damages electric equipment.

If current investment trends continue, by 2020 the national funding gap in electricity infrastructure is expected to grow to $107 billion—costing the U.S. economy an average of $20 billion each year between now and then.[7] Power unreliability, increased costs of electric power, and more expensive industrial processes, each combined with a lack of funding for electric infrastructure, have the potential to generate this high cost, leading to a $496 billion decrease in GDP and 529,000 fewer jobs by 2020.[8]

What does this funding gap look like? If electricity spending trends continue, necessary investment in generation is estimated to be $12.3 billion more than what will be paid for in 2020, with transmission and distribution estimated at $37.3 billion and $57.4 billion, respectively.[9] Filling these gaps and making investments in the types of electricity infrastructure identified here ensures a more efficient and reliable system:

- New generation including renewables and distributed generation will serve a projected increase in electricity demand.
- Efficient transmission for new power plants including wind and solar farms and upgrades of existing transmission will reduce losses.
- Upgrades to distribution and implementation of smart grid technologies to manage electricity supply, demand, and usage in real time will increase efficiency as well as reduce the impacts of intermittent power failures on the local grid.

All three of these investments also reduce carbon emissions by increasing efficiency, reducing losses, and incorporating more low-carbon generation sources.

According to the ASCE *Failure to Act* report on electricity infrastructure, the past two decades saw significant investment in both transmission and distribution systems.[10] While these investments have improved overall efficiency of electricity infrastructure, there are still ample opportunities for improvement. The Electric Power Research Institute (EPRI) estimates that the electric power industry uses or loses 12 to 15 percent of power produced across the U.S.[11] and the EIA estimates that average losses due to transmission and distribution alone are around 6 percent.[12] Investment in regular upgrades of transmission and distribution systems combined with implementation of new technology such as smart grids and energy storage offer efficiency solutions that would reduce both electricity losses and emissions.

Emissions reductions from electricity generation at existing power plants are on the way. In June 2014, the U.S. Environmental Protection Agency (EPA) released a proposed rule called the Clean Power Plan, which will reduce carbon emissions from existing power plants under the Clean Air Act. According to the EPA, implementing the rule is estimated to reduce U.S. power plant emissions to 30 percent below 2005 levels to a level of about 1,612 million metric tons of CO_2 equivalent (MMTCO2e) per year by 2030.[13] By achieving this, it is estimated by EPA to deliver economic benefits worth between $55 billion and $93 billion in 2030 and reduce electricity bills by 8 percent in 2030.[14] However, this will not occur unless necessary investments are made to ensure capacity meets projected energy demand over the same period.

SURFACE TRANSPORTATION

Getting our road and transit systems to a "B" grade over the next 10 years could support or create an estimated 1.4 million jobs across the U.S. economy.

America has more than four million miles of public roads facilitating the movement of people and goods. Maintenance, as well as capital investment for improved conditions and performance, is needed to sustain this crucial network. Delays caused by congestion and re-routes to avoid structurally deficient bridges or poor pavement conditions add time, fuel costs and increased emissions. Transportation accounts for 28 percent of total greenhouse gas emissions in the U.S., or about 1,827 MMTCO2e.[15] More than 60 percent of these transportation emissions, or 1,114 MMTCO2e per year, come from light-duty trucks and passenger cars.

According to the ASCE, 32 percent of major roads are currently in poor or mediocre condition.[16] Chronic underinvestment combined with an increase in drivers and vehicles is leading to deteriorating roads and damage to vehicles. By 2020, a funding gap of $756 billion is estimated to have accumulated for the highway system—37 percent of which is needed to address problems that already exist today and the rest to prevent future deficiencies.[17]

Congestion on roads causes delays, costing time as well as money spent on additional fuel burned by idling vehicles stuck in traffic. The extra fuel burned also generates more greenhouse gas emissions. Congestion affects commuters as well as companies transporting goods across the country. According to the *ASCE 2013 Report Card*, 42 percent of America's major urban highways are congested. Congestion in 2011 in urban regions caused Americans to spend 5.5 billion extra hours in traffic—costing $121 billion, wasting 2.8 billion gallons of fuel, and pumping 25 MMTCO2e into the atmosphere during congestion.[18] On highways, costs of highway congestion in 2010 were $27 billion and are expected to grow to $276 billion by 2020.[19]

While advances in vehicle technology are a crucial factor in improving efficiency and reducing energy use and pollution in the transportation sector, optimizing road capacity that itself is in good repair and designed for intelligent management will help ensure travel—both for people and goods—operates more effectively and efficiently across all modes.

America's transit systems provide crucial transportation options for millions of Americans, connecting workers, students and families with access to employment, medical care, education, shopping, and recreation. However, it is by no means as comprehensive as our road system, as 45 percent of American households lack any meaningful access to transit and millions more have sub-par service levels.[20]

Americans who do have access to transit have increased their ridership more than 9 percent in the past decade, totaling more than 10.7 billion trips in 2013, and the past decade has seen eight straight years of more than 10 billion annual trips.[21] This transit ridership record continues a long-term trend of public transportation growth. Since 1995, transit usage has averaged 2.5 percent annual growth, which is 2.5 times the population growth rate and nearly double (1.8 times) the growth rate for vehicle miles traveled (VMT) on our nation's highways for the same period.

Although investment in transit has also increased, deficient and deteriorating transit systems cost the U.S. economy $90 billion in 2010, as many transit agencies are struggling to balance the maintenance and upgrade of aging and obsolete fleets and facilities in the face of diminishing federal support, often leading to service cuts and fare increases.[22] At present, the Federal Transit Administration

(FTA) estimates a current maintenance backlog of nearly $78 billion needed to bring all transit systems up to a state of good repair and an annual deficit of $25 billion per year exists.

If current trends continue, the 2010 investment gap of 40 percent is expected to grow to 55 percent by 2040. Without a significant increase in funding for maintenance and operations of these systems, conditions will inevitably decline as systems and assets age. These deficiencies will cost us $570 billion by 2020 and over $1 trillion in 2040—should current funding trends continue.

Today's level of transit ridership (10.7 billion trips in 2013) saves approximately 4.2 billion gallons of gasoline and helps avert more than 37 MMTCO2e each year. Assuming we drive adequate levels of investment to our existing transit networks over the next two decades to get them to a good state of repair, the level of ridership growth on existing transit systems could continue on its current trajectory, reaching 13.7 billion transit rides by the year 2025. This would result in fuel savings of nearly 5.7 billion gallons of fuel and avert the release of 48 MMTCO2e per year. This would approximate the oil and pollution savings of taking another estimated two million cars off the road annually. Furthermore, this only accounts for improving the existing transit system in our metropolitan areas to a good state of repair and following through on planned upgrades. Expanding reliable access to the majority of Americans who are not presently served or underserved when it comes to transit access could drive these benefits substantially higher.

RAIL

Getting our rail system to a "B" grade over the next 10 years could support or create an estimated 20,000 jobs across the U.S. economy.

Freight rail is a highly efficient mode of transporting bulk goods, especially over long distances, by moving a ton of freight 484 miles per gallon of fuel consumed. Advances in locomotive and rail system efficiency have increased substantially in the past two decades, with the freight rail industry having increased its fuel economy 38 percent since 1990. American companies are developing and producing many of these pollution reducing and energy saving technologies here in the U.S.—strengthening both our domestic economy and our global lead in advanced rail manufacturing processes.

In recent years, railroads have implemented advanced monitoring systems to improve engineers' ability to drive at speeds that maximize fuel savings. Railroads have also invested in lighter freight cars and more efficient locomotives to reduce fuel consumption. These efficiency gains have allowed the freight rail industry to double the number of ton-miles traveled without increasing energy use over the last three decades. In 1980, freight rail transported 919 billion ton-miles of cargo. By 2008, this increased to 1.8 trillion ton-miles, but fuel consumption remained steady at nearly four billion gallons over those three decades. Additional strides in locomotive efficiency—like diesel and hybrid systems, drivetrains, lighter materials, and improved logistics and controls—hold potential to significantly reduce fuel consumption and particulate and greenhouse gas pollution.

These energy savings result in lower emissions. While accounting for nearly half of total U.S. freight ton-miles, rail currently contributes only about 11 percent of freight-related carbon pollution. Continued advancement in technology—augmented by increased investment in capacity and system integrity—would ideally achieve even higher emission reductions, both in absolute terms and in parallel to other improvement throughout the entirety of the multi-modal freight system.

The freight rail industry invests more than four times the proportion of revenues into capital investment compared to most other industries. Freight rail also creates public benefits: investments return a high level of economic output. Freight rail offers an alternative to other modes of transport that can reduce congestion and improve productivity; the freight rail infrastructure system serves as the backbone for national passenger rail; and freight rail achieves efficiencies that significantly reduce energy use and pollution.

As the U.S. economy gets back on track, freight movement will expand, requiring corresponding infrastructure investment. By growing capacity, the freight rail industry can seize significant opportunities to meet projected demand for shipping cargo, save energy, reduce pollution, and support or create tens of thousands of new jobs throughout the economy.

WATER

Getting our drinking and clean water systems to a "B" grade over the next 10 years could support or create an estimated 144,000 jobs across the U.S. economy.

Our nation's water infrastructure—for drinking water, wastewater, and stormwater runoff—is vital to the treatment, distribution, and protection of our clean water resources. Yet, age, continued strain from population growth, lack of investment, and emerging threats from climate change have increased the burden on our current water infrastructure system and waterways.

Many U.S. cities rely on pipes that are, on average, a century old. Each year there are an estimated 240,000 water main breaks per year in America. These leaking pipes lose an estimated seven billion gallons of clean drinking water a day—approximately 12 percent of treated water—which wastes energy, water, and disrupts businesses and communities.

A Chicago State University study showed that by reducing the amount of water leaked annually in the U.S. by only 5 percent would result in saving enough energy to power 31,000 homes for a year and cut 225,000 metric tons of carbon dioxide emissions.[23]

Significant investments and upgrades in appropriate water infrastructure will be necessary for communities to adapt to the effects of climate change, maintain access to safe drinking water, and adequately treat storm and wastewater—climate change, demographics, changing needs for growing populations and business activities, cost, and environmental constraints all demand a more integrated, holistic approach to water services.

Immediate investment in our nation's water infrastructure is critical and will create numerous family-sustaining jobs through the replacement and upgrade of pipelines, treatment plants, storage tanks, and the installation of green infrastructure projects. In addition, gray water systems, water reuse-recycling, hot water circulating systems, and rain water catchment systems help conserve both water and the energy used to treat and transport it, and create demand and jobs for the industries supplying these technologies.

Climate change is placing additional strain on our nation's water infrastructure. Shifting precipitation patterns throughout the country contribute to flooding and other problems, requiring cities to invest in and build infrastructure to effectively manage stormwater. The lingering drought in the Western U.S. is having drastic effects on water availability and supply. In some cases, such as water main breaks occurring in southern California in 2014, practices designed to conserve water create drastic fluctuations in demand that create additional strain to these aging and often overburdened systems.

Improving drinking water infrastructure through investments in water recapture, reuse, and transport will save water and energy; reduce the carbon dioxide emissions that result from energy used to pump water; and create employment to meet these emerging needs.

Additionally, investment in low-water and no-water technologies in the energy sector will further support sustainable infrastructure objectives. The water dependence of many power plants—combined with rising electricity demands—creates a strain on the nation's water resources. Modernizing fossil fuel and nuclear plants with more water-efficient cooling technologies and investing in energy efficiency and renewable energies—such as wind and solar—will save water and energy; lessen risks of water-related power conflicts; benefit local ecosystems; and create jobs through an innovating energy sector.

SUSTAINABLE STORMWATER – AN INFRASTRUCTURE OPPORTUNITY

An estimated 10 trillion gallons a year of untreated stormwater runs off roofs, roads, parking lots, and other paved surfaces, often through the sewage systems, into rivers and streams that serve as drinking water supplies and to beaches and other large waterways. This increases health risks, degrades ecosystems, and damages tourist economies. As stated by the EPA, "urban runoff is the leading source of pollutants causing water quality impairment related to human activities in ocean shoreline waters and the second leading cause in estuaries across the nation. Urban runoff is also a significant source of impairment in rivers and lakes."[24]

As land is paved over and built upon, the amount of stormwater running off roofs, streets, and other impervious surfaces into nearby waterways increases. The increased volume of stormwater runoff and the pollutants carried within it degrade the quality of local and regional waterways. As development continues, the watershed's ability to maintain a natural water balance is diminished.

During dry periods or typical rainfall events, combined sewer systems (CSSs) carry untreated sewage and stormwater to a municipal wastewater treatment plant where the combination is treated prior to discharge. However, during heavier downpours the system is designed to discharge untreated sewage and stormwater directly to nearby water bodies through outfalls. These combined sewer overflows (CSOs) carry untreated sewage and other pollutants directly into local waterways.

Today, CSSs are present in 772 municipalities where approximately 40 million people reside nationwide. As of 2002, 43,000 overflow events occurred per year, discharging an estimated 850 billion gallons of raw sewage and stormwater annually. Under the National Pollutant Discharge Elimination System (NPDES) program, CSSs are required to implement mitigation measures, such as infrastructure upgrades that increase the capacity to capture and treat sewage and runoff when it rains, and stormwater management measures that reduce the volume of runoff entering the system. However, approximately one-fifth of CSSs still lack enforceable plans either to reduce their sewage overflows sufficiently to meet water quality standards in the receiving waters, or to rebuild their sewer systems with separate pipes for stormwater and sewage. Many are years, or even decades, from full implementation.

The Solution to Urban Stormwater: Green Infrastructure

Green infrastructure helps stop runoff pollution by capturing rainwater and either storing it for use or letting it filter back into the ground, replenishing vegetation and groundwater supplies. Examples of green infrastructure include green roofs, street trees, increased green space, rain barrels, rain gardens, and permeable pavement. These solutions have the added benefits of improving urban spaces and neighborhoods, reducing urban heat island effects, reducing asthma and heat-related illnesses, lowering heating and cooling energy costs, stimulating local investment, and supporting American jobs.

Because of these benefits and because green infrastructure can often help meet clean water goals at a lower or equivalent cost to conventional approaches, leaders in communities around the country have embraced these techniques as part of their stormwater infrastructure programs. Today, cities throughout the nation have regulations, stormwater system permits, incentive programs, and other innovative tools in place that are driving the use of green infrastructure approaches as part of a larger reassessment of water management, treatment and delivery methods.

The 2012 joint policy statement from the BlueGreen Alliance, *Clean Water, Good Jobs,* notes:

"[The stormwater and sewage overflow] problem can be mitigated by constructing additional sewer pipes, retention basins, and treatment facilities, along with incorporating green infrastructure projects such as permeable pavement, vegetated roofs, parks, and other natural areas. These types of 'green infrastructure' allow for rainwater to be absorbed naturally, which reduces runoff and protects important ecosystems. At the same time, green infrastructure investments provide additional benefits, like enhancing biodiversity in cities, providing habitat for wildlife living in and around urban areas, reducing energy costs and resulting carbon emissions from treating wastewater, reducing urban heat island effects, and providing opportunities to connect urban residents with nature while increasing recreational opportunities.

"Green infrastructure, like all water infrastructure, must be installed and maintained correctly to be effective. Skilled workers are needed to ensure the installation and construction of green infrastructure projects are effective and maintain water quality standards. In addition, green infrastructure, along with traditional water systems, requires routine maintenance and upkeep to function optimally, thus sustaining job creation and employment opportunities."

Green Infrastructure – An Economic Opportunity

In a separate but similarly constructed approach to the economic impacts of infrastructure investment outlined in this report, the BlueGreen Alliance—working with Natural Resources Defense Council and the Duke University Center for Globalization, Governance and Competitiveness—undertook an analysis to estimate the employment effects of widespread adoption of green infrastructure/low impact development (LID) techniques.

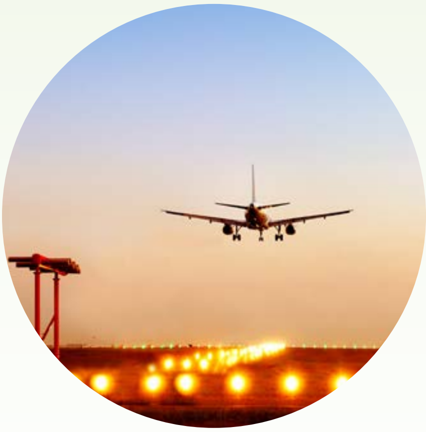
A case study assessment of current green infrastructure best practices across site development factors—pervious pavements, roofing, lawns and landscaping, and natural runoff systems—established a per acre cost of conventional stormwater management techniques, along with green infrastructure/LID techniques across a set of implemented projects. This cost per acre was evaluated both in terms of site construction as well as operations and maintenance costs over time, assuming the full array of these approaches were implemented to achieve retention of rainwater from all but the strongest of storms.

Comparing the approaches, green infrastructure/LID approaches had slightly lower estimated development costs—approximately $400 less per acre than conventional stormwater/CSS construction. This is in line with additional research on the subject, finding green infrastructure/LID to conventional approaches costing approximately 17 cents less per gallon in mitigating CSOs.[25]

The estimates had more pronounced differences between conventional and green approaches when it comes to operations and maintenance costs. The case study assessment predicted an annual cost increase of $4,700 per acre in the initial years of green/LID implementation versus conventional. However, over time these annual costs decrease and break even around the 12th year of operations.[26]

Overall, were the full array of green infrastructure techniques to be adopted at a nationwide scale for new construction projects above one acre in size, the job creation potential was estimated at approximately 84,000 direct, indirect and induced jobs created and supported throughout the U.S. economy per year. The job effects would be due largely to the labor-intensity of ongoing operations and maintenance activities for well-functioning green infrastructure. While at present, there is no regulatory program directing a national move to these sustainable approaches, they are increasingly being employed successfully as their effectiveness is consistently demonstrated.

This represents a unique opportunity to better and more equitably manage polluted stormwater runoff and protect our communities' clean water supplies. Cost-effective green infrastructure practices, combined with investment in conventional stormwater mitigation efforts (i.e. increasing sewage/wastewater capacity) have the potential to provide wide-ranging benefits to communities nationwide.



AIRPORTS

Getting our airports to a "B" grade over the next 10 years could support or create an estimated 67,000 jobs across the U.S. economy.

America's airports provide a critical passenger and freight conduit for both our domestic and in connection to the global economy. Airport infrastructure in the U.S. includes more than 3,000 airports, more than 222,000 aircraft, and the air traffic control system. The Federal Aviation Administration (FAA) reported in 2009, aviation was a $1.3 trillion industry that supported more than 10 million jobs.[27] Commercial aircraft generated more than 113 MMTCO2e in 2012,[28] and aviation generally is estimated to produce between 2.6 and 3.4 percent of emissions in the U.S.[29] The Obama administration adopted a goal for commercial aviation to achieve carbon neutral growth compared to 2005 levels by 2020. Given forecasts of industry growth, this goal could lead to a reduction of 115 MMTCO2e by 2020 and another 60 MMTCO2e by 2026 (note that this is for aircraft only and does not include other airport facilities such as related buildings or ground transportation).[30]

According to the FAA, the number of passengers boarding planes across the country is expected to grow more than 25 percent by 2020 and more than 93 percent by 2040.[31] Additionally, airfreight tonnage is expected to grow nearly 200 percent by 2040. This growth is adding stress to aviation infrastructure, causing costly congestion and delays—wasting fuel, time and dollars.

Both freight and passenger traffic is concentrated in major cities: 80 percent of U.S. passenger flights totaling 343 million trips serve just 35 airports in 15 distinct major markets, and these markets are expected to grow more than the national average. Additionally, 92 percent of exported and imported airfreight tonnage goes through customs in these markets.[32]

Starting in 2003, the FAA has been working to replace old radar technology with a satellite air traffic control system. This Next Generation Air Transportation System (NextGen) will improve efficiency and safety as well as minimalize delays associated with congestion. The system is projected to cost $22 billion and will be completed in 2025.[33] The FAA vision for full NextGen implementation falls in line with the goal set by the U.S. government mentioned previously, and adds that all aviation emissions have net reductions by 2050.[34] For example, one NextGen project called Greener Skies over Seattle utilizes satellite-based navigation for arrivals and is estimated to reduce fuel consumption 2.1 million gallons a year—cutting carbon emissions by 22,000 metric tons.[35]

SCHOOLS

Getting our schools to a "B" grade over the next 10 years could support or create an estimated 452,000 jobs across the U.S. economy.

Enrollment in public schools is expected to increase through 2019. The ASCE *2013 Report Card* identified three significant issues for education facilities in the U.S. The first is that nearly half of America's school buildings were built in the 1950's and 1960's to educate baby boomers, which means repairs, renovations, and modernizations are needed to ensure these buildings are in good shape for students today. Second, school funding has decreased significantly after the recession. Post-recession funding is half of pre-recession levels. Third, both the *2013 ASCE Report Card*, as well as several previous state-level report cards, identify a lack of data on school facilities—making the actual condition of school infrastructure across the country difficult to quantify. The most recent actual data on repairs needed is a 1999 report finding more than 59,000 schools (76 percent of all schools) needed repairs, renovations, or modernizations in order for the school to be in good condition.[36]

In the U.S., some 50 million students attend almost 100,000 public schools in grades K-12. These buildings are estimated to have a cumulative $271 billion in deferred maintenance costs needed to bring them to a state of good repair. Additionally, the condition of school facilities affects student attitudes, health, and achievement, and can also affect the entire community—schools can be community emergency shelters and housing values near good schools tend to be higher.[37] Since school funding often comes mostly from property taxes, there is a large disparity between schools in high-income and low-income neighborhoods and, when housing values plummeted during the recession, schools saw the impact on their funding.

Efforts to green America's schools will modernize school facilities, reduce energy costs and greenhouse gas emissions, and also improve the quality of indoor learning environments. The second-highest operating expenditure for schools is energy (after personnel) and schools spend more than $8 billion annually on energy.[38] According to the U.S. Green Building Council, green schools use an average of 33 percent less energy (resulting in 585,000 pounds of avoided CO_2 emissions, as well as other pollutants) and 32 percent less water, lowering utility costs savings of a typical green school by an estimated $100,000 per year.[39] These savings can be achieved from a variety of efficiency initiatives like energy efficient heating and air conditioning systems, lighting, water efficient fixtures, Leadership in Energy and Environmental Design (LEED) certification, and others.

DAMS, LEVEES, WATERWAYS, AND MARINE PORTS

Getting our dams, levees, waterways and marine ports to a "B" grade over the next 10 years could support or create an estimated 177,000 jobs across the U.S. economy.

There are more than 83,000 dams in the U.S. that provide energy generation, allow inland river navigation and flood control, are used for municipal water storage and irrigation, and ensure hazardous waste retention.[40]

The average age of these dams is 52 years old and, by 2020, 70 percent of our nation's dams will be more than 50 years old.[41] The overall number of high-hazard dams—dams where mis-operation or failure would result in loss of life—is on the rise, representing nearly 14,000 in 2012. From 1998 to 2009, the number of deficient dams—those with structural or hydraulic deficiencies leaving them susceptible to failure[42]—rose by 137 percent to more than 4,300. An estimated 2,000 of those are classified as both high-hazard and deficient.

Additionally, an estimated 13,000 dams are currently labeled as a significant hazard, meaning a failure would not necessarily cause a loss of life, but could result in significant economic loss.

At the time of their construction, many of these dams were built as low-hazard dams to protect undeveloped agricultural land. More and more of the watersheds of these dams are seeing increased population as development increases, exposing more communities to potential impacts.

In addition to dams, levees—structures constructed along waterways that contain, control, and/or divert the flow of water—play a crucial role in facilitating waterway travel and reducing the risk to public safety from flooding. As population and development increase, levees often protect major urban and residential areas, and the deficiencies of our levee system are best exemplified by failure of flood control measures during Hurricane Katrina in 2006, contributing to devastating floods throughout the New Orleans metro area and resulting in more than 1,000 deaths, 120,000 jobs lost and total costs to the economy exceeding $200 billion.[43]

In the wake of Hurricane Katrina, efforts have been redoubled to assess and address the state of the nation's levee system. The Federal Emergency Management Agency (FEMA)'s Midterm Levee Inventory (MLI) identified levees in approximately 30 percent of the nation's counties, with 43 percent of the nation's overall population living in a county with at least one levee. FEMA's inventory documents an estimated 36,000 miles of levees, with assessments of the levee condition and impacted populations still underway.

The U.S. Army Corps of Engineers maintains a separate inventory (National Levee Database) of most of the levees that the Army Corps has designed, maintained, and inspected. The NLD inventory documents approximately 14,700 miles of levees. The FEMA levee inventory will eventually be combined with the NLD, then additionally integrate data from states and local authorities to include almost all levees in the country, which in total are estimated to mitigate flooding along more than 100,000 miles of waterways.

The levees in the NLD average more than 55 years old and protect approximately 14 million people.[44] In 2011, these levees are estimated to have helped prevent $141 billion in flood damages, providing a six to one return on flood damages prevented compared to construction costs, and some larger levee systems along the Mississippi River network are estimated to provide as much as a 24 to one return. Of the NLD levees that have been rated, only 8 percent are found to be in acceptable condition, while about 69 percent are minimally acceptable, and 22 percent are labeled as unacceptable.

In recent decades, significant development in floodplains, along with the building impacts of rising sea levels from climate change add to the urgency of having both a comprehensive assessment of our levee system, and as Hurricane Katrina demonstrated, the need to upgrade systems to mitigate future hazards. Ideally, recent efforts to update inventories will provide the foundation from which to build and maintain comprehensive and sound flood management systems, along with concurrent investment to upgrade those tens of thousands of miles of facilities.

Inland waterways and rivers—our nation's "marine highways"—ship an estimated 540 million tons of freight a year, accounting for nearly 5 percent of total domestic freight shipped.[45] The inland waterway system includes 12,000 miles of commercially navigable channels (minimum nine feet in channel depth) serviced by nearly 200 lock sites. The average age of these commercially active locks in the U.S. now exceeds 50 years. Many locks in operation today were constructed during the 1930s—including most locks on major systems such as the Mississippi, Illinois, and Tennessee Rivers. Even many "second generation" higher-lift locks on the Ohio River were built largely in the 1950s.[46]

The price of services is on the rise because of system age and delays increased due to insufficient funds for proper operation and maintenance of the waterway facilities.

Ninety percent of locks and dams on the U.S. inland waterway system experienced some type of unscheduled delay or service interruption in 2009, averaging 52 delays a day. Lock downtime more than doubled in recent decades to an annual average of over 100,000 hours system-wide. Due to the age of the system, maintenance and repairs are required more often, at more locations, and are taking longer to complete; and unscheduled closures due to lock system failures are occurring more often at more locations, and are likewise taking longer to fix.

By 2020, traffic on inland waterways is expected to increase by 51 million tons of freight from 2012, an overall 11 percent increase. By 2040, this increase is expected to exceed 118 million tons above 2012 levels—an overall increase of 25 percent.

Such trends have serious implications for reliability, the confidence of shippers and carriers in committing to waterway transport, and for the physical capacity of the system in terms of its ability to accommodate future freight traffic growth—expected to increase overall by 50 percent over the next 25 years.[47] Such curtailment would be unfortunate, since waterway movements reduce overall strain on the nation's multi-modal freight network, and also provide a benefit for moving goods—in particular non-perishable and/or non-time sensitive items—efficiently. Waterway transport averages 576 ton-miles per gallon of fuel, versus 454 per ton-mile for rail and 155 per ton-mile for trucking.

The U.S. has more than 300 commercial marine ports, through which passes 2.3 billion short tons of cargo a year. The U.S. also has more than 600 smaller harbors—vital for international trade—through which nearly 800 million tons moves offshore, which represents 70 percent of U.S. imports in 2010 valued at more than $944 billion, which is approximately 50 percent of all imports by value. In 2010, 51 percent of the potential capacity of container yards in U.S. ports was fully utilized. The system accommodated more than 16,800 annual vessel arrivals.

The U.S. depends heavily on waterborne trade for its growing export markets, especially agricultural products, manufactured goods, and, increasingly, the exporting of energy and refined petroleum products. In 2010, more than 76 percent of U.S. exports (by tonnage), valued at $469 billion—approximately 35 percent of total exports by value—were transported by water for foreign markets. Trade volume for marine ports is expected to double by 2021, and double again shortly after 2030.

Investments have the potential to offset economic and environmental impacts of ports in two major ways. One is to reduce bottlenecks by maintaining and expediting cargo throughput from ship to intermodal means of transport (truck, rail, pipeline or inland waterway). In addition, improvements would reduce waste and pollution created by port activities and would reduce the carbon footprint of freight transport.

Port operations directly and indirectly produce emissions, including port administration vehicles, power for offices, buildings and cargo storage facilities, electric and fuel-powered cargo handling equipment, harbor craft, and conveyances such as trucks and rail locomotives. Each of these modes has the potential to reduce emissions and improve operations. For example, requiring advanced technology for the more than 110,000 heavy-duty vehicles offloading cargo at maritime ports immediately reduces emissions and fuel usage by 10 percent per unit of distance traveled,[48] along with reducing heavy carbon pollutants that concentrate in port communities, affecting more than 87 million Americans.[49] Capacity improvements that facilitate faster cargo processing would reduce idling times for these trucks even further.

PARKS AND RECREATION

Getting our parks and recreation facilities to a "B" grade over the next 10 years could support or create an estimated 175,000 jobs across the U.S. economy.

At the federal level, the National Park System, the United States Forest Service, and the U.S. Army Corps of Engineers are the main providers of forest and park facilities by area, while states and localities host the numeric majority of park and recreational facilities that Americans use on a day-to-day basis.

State parks and recreation areas cover nearly 14 million acres, while our nation's federally maintained forests cover an estimated 797 million acres. About 35 percent of America's land is forested, of which an estimated 22 percent of that is designated national forest. Other public forests make up an additional 16 percent of forestland.

However, governing agencies at all levels are challenged to support these resources. Across the country, cities and localities have increasingly been faced with declining state and federal funding for parks. Chronic underfunding of National Park Service (NPS) budgets has led to an $11 billion backlog of deferred maintenance at NPS sites, and the United States Forest Service, which manages a vast series of national forests, grasslands, and other natural areas, also has a significant deferred maintenance backlog of $5.3 billion. Additionally, the U.S. Army Corps of Engineers manages 12 million acres of recreation sites, and 20 percent of all recreation visits to federal lands are to these sites. Visitation has steadily increased in recent years.

America's forests are currently a carbon "sink," and play a major role in the carbon cycle, because of their capacity for carbon uptake and storage. By and large, forests take up more carbon via photosynthesis and store it in living trees and soil than they release through decay and respiration. National forests store an average of 69.4 metric tons of carbon per acre, while state forests store an average of 63.1 tons per acre—a greater density than on private forest lands.[50]

In addition, America's forests provide carbon benefits while also providing other important benefits such as clean water, flood control, outdoor recreation opportunities, wildlife habitat, and job creation. Investing in our forests and parkland would deliver manifold benefits to quality of life, both from a recreational, economic, and sustainability standpoint.

SOLID AND HAZARDOUS WASTE

Getting our solid and hazardous waste systems to a "B" grade over the next 10 years could support or create an estimated 79,000 jobs across the U.S. economy.

In 2010, Americans generated 250 million tons of trash, of which 85 million tons were recycled or composted. This represents a 34 percent recycling rate, more than double the 14.5 percent rate in 1980.[51] Per capita generation rates of waste have been steady over the past 20 years and have even begun to show signs of decline in the past several years. As we see progress in reducing solid waste, cutting the amount of waste Americans generate by another 5 percent could reduce greenhouse gas emissions by another approximately 10 MMTCO2e—the equivalent emission of six million U.S. households.[52]

There is also room for improvement regarding methane production from landfills, which are the third largest source of methane emissions in the United States, accounting for approximately 18.2 percent of these emissions in 2012, or approximately 100 MMTCO2e per year. About half of all greenhouse gas pollution from landfills is comprised of methane, which has at least 20 times the climate change impact on a pound-for-pound basis when compared with carbon dioxide. Decreasing solid waste and improving recycling and composting rates would decrease these levels even further. Methane from landfills also represent an opportunity to capture and use a significant energy resource.

Broadly defined, hazardous waste is waste that is directly dangerous or potentially harmful to human health or the environment, and includes waste chemicals and other byproducts of manufacturing processes that remain pervasive in the environment. Total hazardous waste production in the U.S. in 2009 was slightly above 35 million tons. An estimated one in four Americans live within three miles of a hazardous waste site.

In 1980, Congress created the U.S. Environmental Protection Agency (EPA)-administered Superfund hazardous waste cleanup program. Since then, scientists and engineers have developed increasingly sophisticated approaches to identifying and remediating hazardous waste sites.

There has been significant progress in the cleanup of the nation's hazardous waste and brownfields sites. However, annual funding for Superfund site cleanup is estimated to be as much as $500 million short of what is needed, and 1,280 sites remain on the National Priorities List (identified by EPA as releasing or threatening release of hazardous substances, pollutants, or contaminants) with an unknown number of potential sites yet to be identified, and more than 400,000 brownfields sites await cleanup and redevelopment.

6. CONCLUSION

The U.S. employment situation and our physical infrastructure are both well below their potential. While the severity of the employment problem is relatively new, our infrastructure problem is not. It is heartening that the state of our infrastructure has improved relative to the past, but it still has a long way to go before it achieves a state that reflects the economic power it is meant to support. At the same time, the economic inefficiency it causes and represents also imposes human and environmental costs, including increased pollution, wasted energy, and at-risk drinking water systems.

A joint solution to at least partially address all of these problems would be a modest but sustained investment program to replace and repair aging infrastructure in a range of categories. From our treatment of water and hazardous waste to maintaining safe roads, bridges, schools and dams, such a program would provide much-needed improvements in almost every area of public service provision. The economic impacts would include not only direct employment in repairs, but widespread hiring across various supply chains and in the broader economy as overall economic productivity improves.

Environmental benefits would follow as the waste of energy and other resources was reduced.

Improving the state of our infrastructure would not be free, and would require a commitment of both economic resources and the commitment to follow a long-term investment path. This analysis demonstrates, however, that the environmental and economic returns to that investment would be well worth the cost.

ENDNOTES

1 American Society of Civil Engineers (ASCE), *2013 Report Card for America's Infrastructure*, Washington, D.C., 2013. Available at http://www.infrastructurereportcard.org.

2 U.S. Bureau of Labor Statistics (BLS). Washington, D.C., accessed September 2014. Available at http://data.bls.gov/cgi-bin/surveymost?ce.

3 Congressional Budget Office, *The Economic Effects of Federal Spending on Infrastructure and Other Investments.* Washington, D.C., June 1998. Available at https://www.cbo.gov/sites/default/files/cbofiles/ftpdocs/6xx/doc601/fedspend.pdf.

4 Calculated using 32 percent of total 2012 GHG emissions, which were 6,526 MMTCO2e. U.S. Environmental Protection Agency (EPA). Washington, D.C. Available at http://www.epa.gov/climatechange/ghgemissions/sources.html.

5 U.S. EPA. Washington, D.C. Available at http://www.epa.gov/climatechange/ghgemissions/sources/electricity.html.

6 Union of Concerned Scientists, *How it Works: Water for Electricity 2013.* Available at http://www.ucsusa.org/clean_energy/our-energy-choices/energy-and-water-use/water-energy-electricity-overview.html.

7 ASCE, *Failure to Act: The Economic Impact of Current Investment Trends in Electricity Infrastructure*. Washington, D.C., 2011. Available at http://www.asce.org/uploadedFiles/Infrastructure/Failure_to_Act/Failure_to_Act_Report.pdf.

8 Ibid.

9 Ibid. p. 25

10 Ibid. p. 32-36

11 Electric Power Research Institute Transmission Efficiency Initiative, p. 1-6. 2009. Available at: http://mydocs.epri.com/docs/CorporateDocuments/SectorPages/PDU/1017894TransmissionEfficiencyWorkshop11-09.pdf.

12 U.S. Energy Information Agency (EIA), *FAQ: How much electricity is lost in transmission and distribution in the United States?*. Washington, D.C. Available at http://www.eia.gov/tools/faqs/faq.cfm?id=105&t=3.

13 U.S. Climate Action Report, Chapter 5: Projected Greenhouse Gas Emissions p. 135 states that 2005 levels were 7,196 MMTCo2e total GHG emissions. Available at http://www.state.gov/documents/organization/218993.pdf.

14 U.S. EPA Fact Sheet: *Clean Power Plan Overview 2014*. Washington, D.C., 2014. Available at http://www2.epa.gov/carbon-pollution-standards/fact-sheet-clean-power-plan-overview.

15 Calculated as 32 percent of total GHG emissions 6,526 MMTCOe in 2012. EPA, Washington, D.C.. Available at http://www.epa.gov/climatechange/ghgemissions/sources.html.

16 ASCE, *2013 Report Card for America's Infrastructure*. p. 79-80. Washington, D.C., 2013. Available at http://www.infrastructurereportcard.org.

17 ASCE, *Failure to Act: The Economic Impact of Current Investment Trends in Electricity Infrastructure*, p. 9-10. Washington, D.C., 2011. Available at http://www.asce.org/uploadedFiles/Infrastructure/Failure_to_Act/Failure_to_Act_Report.pdf.

18 Texas A&M Transportation Institute, *Inconsistent traffic conditions forcing Texas commuters to allow even more extra time*. College Station, TX. Available at http://d2dtl5nnlpfr0r.cloudfront.net/tti.tamu.edu/documents/tti-umr.pdf.

19 ASCE *Failure to Act: The Economic Impact of Current Investment Trends in Electricity Infrastructure*. Washington, D.C., 2011. Available at http://www.asce.org/uploadedFiles/Infrastructure/Failure_to_Act/Failure_to_Act_Report.pdf.

20 ASCE *Failure to Act: The Economic Impact of Current Investment Trends in Electricity Infrastructure*. Washington, D.C., 2011. Available at http://www.asce.org/uploadedFiles/Infrastructure/Failure_to_Act/Failure_to_Act_Report.pdf.

21 American Public Transportation Association (APTA), *2013 Ridership Report*. Washington, D.C., March 2014. Available at http://www.apta.com/mediacenter/pressreleases/2014/Pages/140310_Ridership.aspx.

22 ASCE, *Failure to Act: The Economic Impact of Current Investment Trends in Electricity Infrastructure*. Washington, D.C., 2011. Available at http://www.asce.org/uploadedFiles/Infrastructure/Failure_to_Act/Failure_to_Act_Report.pdf.

23 Chicago State University, *The Carbon Footprint of Water*. Chicago, IL, May 2009. Available at http://www.csu.edu/cerc/researchreports/documents/CarbonFootprintofWater-RiverNetwork-2009.pdf.

24 U.S. EPA, *Guide to Stormwater*. Washington, D.C. Available at http://water.epa.gov/scitech/wastetech/guide/stormwater/upload/2006_10_31_guide_stormwater_usw_b.pdf.

25 University of New Hampshire, *The Economics of Low Impact Development*. Durham, NH. Available at http://www.unh.edu/unhsc/sites/unh.edu.unhsc/files/docs/FTL_Chapter3%20LR.pdf.

26 City of New York, *NYC Green Infrastructure Plan*. New York, NY. Available at http://www.nyc.gov/html/dep/pdf/green_infrastructure/NYCGreenInfrastructurePlan_LowRes.pdf.

27 ASCE, *2013 Report Card for America's Infrastructure*. Washington, D.C., 2013. Available at http://www.infrastructurereportcard.org.

28 U.S. EPA, Entry for Commercial Aircraft for 2012 in Table 2-12, p. 3-20. Washington, D.C. Available at http://www.epa.gov/climatechange/Downloads/ghgemissions/US-GHG-Inventory-2014-Main-Text.pdf.

29 Congressional Research Service, *Aviation and Climate Change,* p. 1. Washington, D.C., January 2010. Available at http://assets.opencrs.com/rpts/R40090_20100127.pdf.

30 Federal Aviation Administration (FAA), *United States Aviation Greenhouse Gas Emissions Reduction Plan*. Washington, D.C., June 2012. Available at http://www.faa.gov/about/office_org/headquarters_offices/apl/environ_policy_guidance/policy/media/Aviation_Greenhouse_Gas_Emissions_Reduction_Plan.pdf.

31 FAA, *Fact Sheet – FAA Forecast – Fiscal Years 2014-2034.* Washington, D.C., March 2014. Available at http://www.faa.gov/news/fact_sheets/news_story.cfm?newsId=15934.

32 Ibid.

33 FAA, *Fact Sheet – NextGen*. Washington, D.C., February 2007. Available at http://www.faa.gov/news/fact_sheets/news_story.cfm?newsId=8145.

34 FAA, *NextGen and the Environment.* Washington, D.C., Available at http://www.faa.gov/nextgen/media/nextgenAndTheEnvironment.pdf.

35 FAA, *NextGen – Greener Skies over Seattle = Green Skies Ocer the U.S.* Washington, D.C., June 2012. Available at http://www.faa.gov/nextgen/snapshots/stories/?slide=6.

36 American Society of Civil Engineers (ASCE), *2013 Report Card for America's Infrastructure*. Washington, D.C., 2013. Available at http://www.infrastructurereportcard.org/.

37 The Center for Green Schools, *2013 State of Our Schools Report*, p. 6-8. Available at http://centerforgreenschools.org/Libraries/State_of_our_Schools/2013_State_of_Our_Schools_Report_FINAL.sflb.ashx.

38 U.S. Department of Energy, *Guide to Financing EnergySmart Schools 2008*, p. 1. Washington, D.C. Available at http://apps1.eere.energy.gov/buildings/publications/pdfs/energysmartschools/ess_financeguide_0708.pdf.

39 The Center for Green Schools, *Myths and Facts*. Available at http://centerforgreenschools.org/myths.aspx. The Center for Green Schools, *Better for the Planet*. Available at http://centerforgreenschools.org/our-planet.aspx.

40 Federal Emergency Management Agency (FEMA), Risk Map. Washington, D.C. Available at http://www.fema.gov/media-library-data/20130726-1737-25045-8253/1_2010esri_damsafety061711.pdf.

41 ASCE, *2013 Report Card for America's Infrastructure*. p. 79-80. Washington, D.C., 2013. Available at http://www.infrastructurereportcard.org.

42 Association of State Dam Safety Officials, *Dam Safety 101*. Available at http://www.damsafety.org/news/?p=d42cd061-cae2-4039-8fc6-313975f97c36.

43 U.S. BLS, *The effects of Hurricane Katrina on the New Orleans economy*. Washington, D.C., June 2007. Available at http://www.bls.gov/opub/mlr/2007/06/art1full.pdf. ASCE, *The New Orleans Hurricane Protection System: What Went Wrong and Why.* Washington, D.C., 2007. Available at http://levees.org/2/wp-content/uploads/2010/06/American-Society-of-Civil-Engineers-What-Went-Wrong-ERPreport-1.pdf.

44 ASCE, *2013 Report Card for America's Infrastructure*. p. 79-80. Washington, D.C., 2013. Available at http://www.infrastructurereportcard.org.

45 U.S. Department of Transportation Federal Highway Administration, *Freight Facts and Figures 2013.* Washington, D.C., 2013. Available at http://www.ops.fhwa.dot.gov/freight/freight_analysis/nat_freight_stats/docs/13factsfigures/pdfs/fff2013.pdf.

46 U.S. Army Corps of Engineers, *The Declining Reliability of the U.S. Inland Waterway Systems.* Alexandria, VA. Available at http://onlinepubs.trb.org/onlinepubs/archive/Conferences/MTS/4A%20GrierPaper.pdf.

47 U.S. Department of Transportation Federal Highway Administration, *Freight Facts and Figures 2013.* Washington, D.C., 2013. Available at http://www.ops.fhwa.dot.gov/freight/freight_analysis/nat_freight_stats/docs/13factsfigures/pdfs/fff2013.pdf.

48 Carbon Footprint Working Group, *Carbon Footprinting for Ports.* Los Angeles, CA, June 2010. Available at http://wpci.iaphworldports.org/data/docs/carbon-footprinting/PV_DRAFT_WPCI_Carbon_Footprinting_Guidance_Doc-June-30-2010_scg.pdf.

49 Coalition for Clean and Safe Ports, Clean Ports Act. Available at http://cleanandsafeports.org/clean-ports-act-of-2011/.

50 U.S. Department of the Interior, *U.S. Forests and Carbon.* Washington, D.C., October 2010. Available at http://www.fia.fs.fed.us/Forest%20Carbon/forest%20carbon%20fact%20sheet%2020101012.doc.

51 U.S. EPA, Municipal Solid Waste. Washington, D.C. Available at http://www.epa.gov/epawaste/nonhaz/municipal/.

52 U.S. EPA, Climate Change and Municipal Solid Waste. Washington, D.C. Available at http://www.epa.gov/waste/conserve/tools/payt/tools/factfin.htm.

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