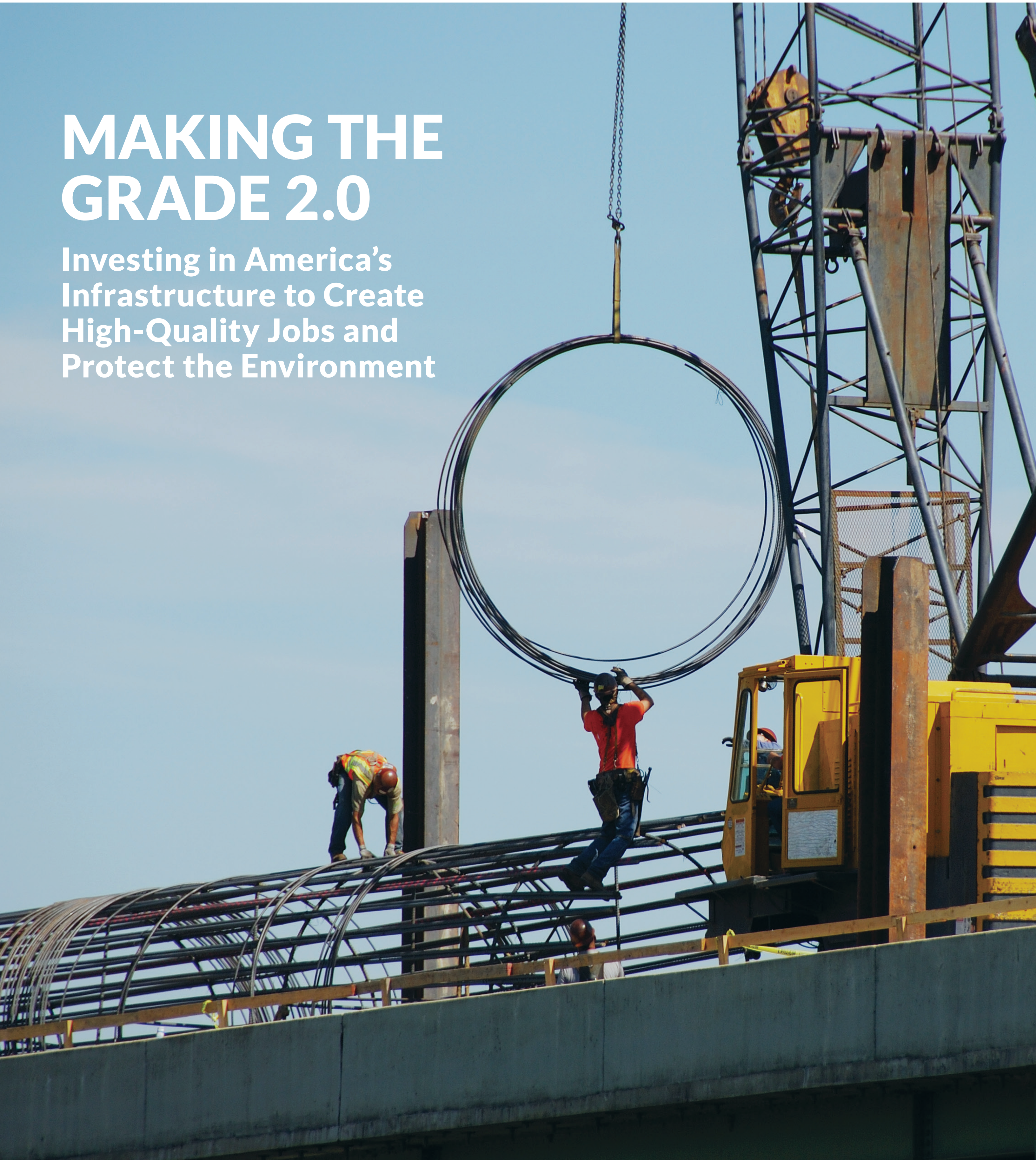
BLUEGREEN ALLIANCE



MAKING THE GRADE 2.0

Investing in America's Infrastructure to Create High-Quality Jobs and Protect the Environment

BLUEGREEN ALLIANCE

The BlueGreen Alliance **unites America's largest labor unions and its most influential environmental organizations** to solve today's environmental challenges in ways that create and maintain quality jobs and build a stronger, fairer economy.

BLUEGREEN ALLIANCE Partner Organizations

UNITED STEELWORKERS USW · SIERRA CLUB · CWA · NRDC · SEIU Stronger Together · National Wildlife Federation · SMART

Union of Concerned Scientists · Utility Workers Union of America AFL-CIO · aft · UA Plumbers · Pipefitters · Steamfitters · Sprinklerfitters · Service Techs · International Union of Bricklayers and Allied Craftworkers · EDF ACTION Political action partner of Environmental Defense Fund

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Authors:

Jim Barrett, PhD.
Jessica Eckdish
Zoe Lipman
Roxanne Johnson

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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 *2017 Report Card for America's Infrastructure*.[1] Unfortunately, America consistently gets barely passing grades because our infrastructure systems are in dire need of modernization.

The ASCE's latest 2017 Report Card gave the nation's infrastructure a grade of "D+," which was not an improvement over 2013, and estimated that getting to a grade of "B" would require an investment of $4.6 trillion over the next 10 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 $2 trillion dollars. This gap, they said, could result in $5 trillion in lost U.S. Gross Domestic Product (GDP) by 2040.[2]

In 2014, following the release of the ASCE's 2013 Report Card, the BlueGreen Alliance released a report delving into the economic impacts of accelerating infrastructure investment—using current financing approaches—to achieve a "B" grade over the next 10 years. With ASCE's latest release, we took another look to understand how the investment needed in our infrastructure systems has changed, the latest job creation potential associated with upgrading our infrastructure systems, and the policies and investments that should be made to maximize quality job creation as well as environmental benefits. *Making the Grade 2.0: Investing in America's Infrastructure to Create High-Quality Jobs and Protect the Environment* updates and builds on that 2014 analysis of some of the sectors represented in the ASCE Report Card, and finds that the need for infrastructure investment is greater than ever.

We measure jobs in two ways, as the difference in employment in any given year and as the number of jobs created across multiple years, which is more properly defined as "full-time job-year equivalents." These are an increase in labor demand sufficient to employ one person full time for one year. When reporting full-time job-year equivalents, we will use the abbreviated descriptor "job-years."

Our research suggests that—along with critical upgrades to the nation's natural gas distribution pipeline system not addressed by ASCE—an investment of **$2.25 trillion** has the potential to support or create an additional **14.5 million job-years** across the U.S. economy and to add a cumulative **$1.66 trillion** to the Gross Domestic Product (GDP) over 10 years, versus a business as-usual approach. These jobs will not only increase employment in the construction sector, but will also lift up the entire national economy—including in the American manufacturing sector.

Our nation must move forward with an ambitious plan to rebuild and transform America's infrastructure. Investing now to repair our failing roads and bridges, water systems, and natural gas distribution pipelines, as well as to modernize our buildings and electric grid, transform our transportation systems, and support our urban and rural communities, will boost our economy and create millions of jobs, while also reducing pollution and combatting climate change.

Rebuilding America's infrastructure can and must do more than just make communities safer, reduce pollution, and increase our global competitiveness. A national investment in a new generation of infrastructure must also create middle-class jobs and create economic opportunity for all people in the communities in which they reside. It's critical that we capture the full benefits of our infrastructure investment in terms of the number of jobs supported or created, and to improve the quality of those jobs.

To ensure we maximize the benefits of our infrastructure investments for communities, the environment, jobs, wages, benefits, and retirement security, we suggest the following recommendations:

- Ensure all projects built with public resources are subject to "Buy America" standards that maximize the return to taxpayers and the American economy by utilizing American-made building products, parts, and components;
- Enforce Davis-Bacon[3] prevailing wage provisions that ensure workers are paid prevailing wages on public works projects;
- Utilize project labor agreements (PLAs), a collective bargaining tool establishing terms and conditions for employment on the projects, as well as community benefits agreements;
- Utilize public interest procurement provisions and practices, such as those that prioritize improving training, working conditions, and community benefits,

and those that prioritize use of the most efficient, cleanest materials and products with the lowest carbon and toxicity footprints. These measures help ensure that public investments strengthen domestic manufacturing;

- Instill forward-looking planning that meets environmental standards and builds resilient infrastructure systems;
- Enhance workforce training and development programs to expand the number of skilled workers in new and existing industries and increase economic opportunities for communities and local workers, especially for people of color and low-income communities; and
- Prioritize public funding and financing for infrastructure investment to ensure projects are completed in a timely way and built with products and materials that are of the highest quality and are produced with the lowest carbon intensity. While it is appropriate to consider innovative financing tools to leverage federal funds, like infrastructure banks, grant and loan programs, and public-private partnerships, all financing methods should be held to strong public interest standards.

Beyond the economic benefits to workers, increasing global competitiveness, and growing our economy, making these smart investments will also pay dividends for our environment by reducing air and water pollution—including the emissions driving climate change—as well as repairing structures that contain materials and chemicals that are hazardous to human health. Accelerated infrastructure investment could help achieve significant environmental benefits, including but not limited to:

- Saving nearly 4.4 billion gallons of fuel and averting the carbon dioxide (CO_2) equivalent of 39 million metric tons per year through 2025 by supporting transit ridership increases commensurate with population growth.[4] Currently, transit ridership levels save the equivalent energy of the gasoline used by more than 7.7 million cars a year—nearly as many cars as are registered in Florida, the fourth largest state.[5]
- Reducing the 6 billion gallons of clean drinking water leaked daily from public drinking water systems—enough for 15 million households—as well as associated greenhouse gas (GHG) emissions.[6] A 5 percent reduction in leaks reduces climate change pollution by an equivalent of 225,000 metric tons of carbon dioxide.[7]
- Reducing U.S. CO_2 emissions by 12 percent, equal to preventing 442 million metric tons of carbon emissions from entering the atmosphere each year, through the full implementation of a nationwide smart grid.[8]
- Reducing GHG emissions by approximately 10 million tons of CO_2—equivalent to the emissions of 6 million U.S. households—for each 5 percent reduction in the amount of solid waste Americans generate.[9]
- Retrofitting all existing municipal, university, schools, and healthcare buildings could reduce annual CO_2 emissions by over 52 million metric tons.[10]
- Avoiding GHG emissions by expanidng renewable energy. For example, we could avoid 12.3 gigatonnes of GHG emissions by 2050 by producing 35 percent of America's electricity from wind energy.[11] Every megawatt hour of wind generation avoids 0.70 metric tons of CO_2, which equates to each wind turbine saving over 900 cars worth of CO_2 emissions annually.[12]

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. These investments would decrease traffic congestion and pollution, improve access to safe drinking water, reduce airport delays, expedite freight movement, protect lakes and rivers, preserve open spaces, and ensure children learn and play in safe, modern schools.

There's also a financial incentive. The longer we wait to repair these basic systems, the more it will cost in the long run in terms of investment needed, interest accrued, and other factors. If these investments were accomplished under the present form of government expenditure, and financing the $2 trillion in additional funding needed to close the gap necessary to achieving an overall "B" grade at today's interest rates of 3 percent—versus the pre-recession rate of 4.5 percent—taxpayers would save nearly $1 trillion dollars over 30 years. It's in America's best interest to fix our infrastructure sooner rather than later.

Repairing America's infrastructure systems is an opportunity to boost the middle-class, build up American manufacturing, support local jobs, reduce our climate impact, and improve public health. We will accrue all of those benefits only if we tackle this challenge the right way: utilizing public money to support and create local jobs with fair wages and benefits and safe working conditions, adhering to forward-thinking environmental standards to ensure resiliency, and using the safest, healthiest American-made products possible.

MAKING THE GRADE 2.0

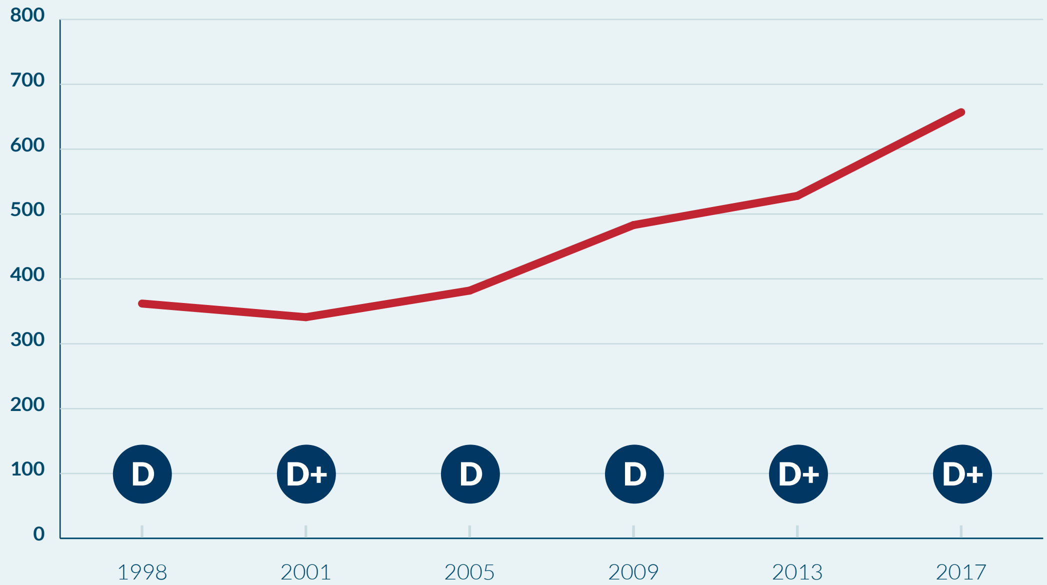
I. INTRODUCTION

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 2017 Report Card for America's Infrastructure, our roads, transit systems, dams, and airports need trillions of dollars of investment to return them to an adequate state. Our water, air, and land are threatened by aging systems designed to—but no longer able to—provide safe drinking water, handle hazardous waste, treat wastewater, and manage solid waste. Half of our schools were built to educate the generation that is now retiring, and the electric grid is widely recognized as being incapable of meeting the needs of our changing energy system.[13]

While the problem has reached critical levels, it is not new. ASCE gave the infrastructure an overall grade of "D+" in 2017. In the five other *Report Cards* issued since 1998, the ASCE has given three "Ds" and two "D+s" (See Figure 1). Our infrastructure has yet to climb above a "D+," and the amount of funding needed to bring the infrastructure up to a grade of "B" continues to rise, currently requiring $4.6 trillion in spending over the next 10 years.[14]

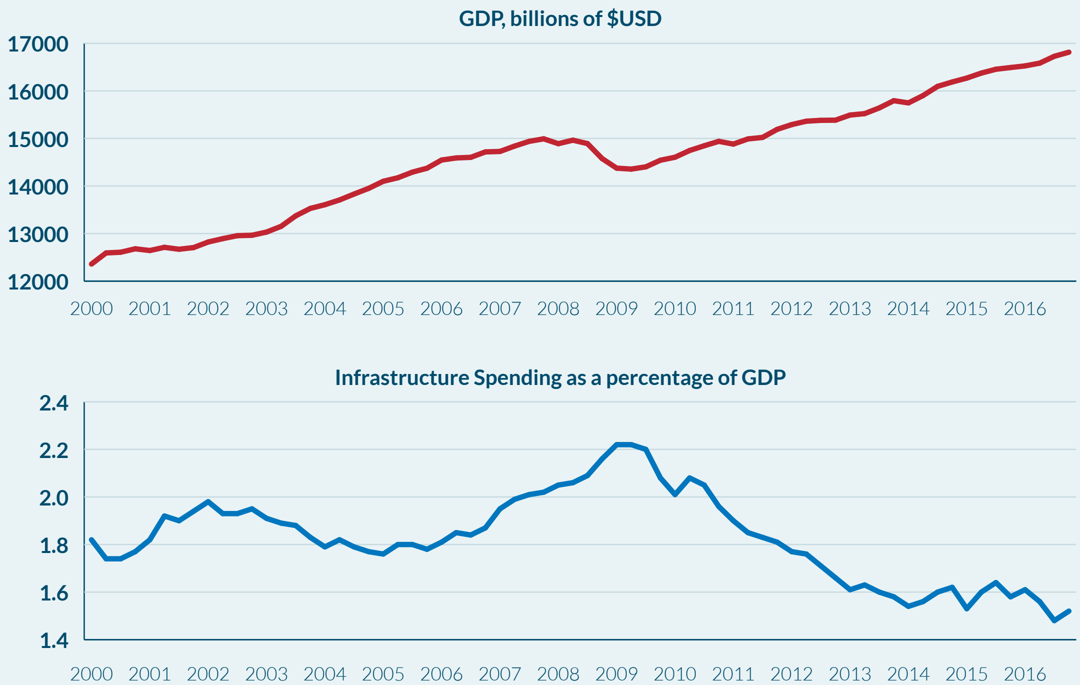
At the same time the need for infrastructure investment has been growing, public investment in infrastructure has fallen precipitously. As a share of Gross Domestic Product (GDP), infrastructure spending remains near its lowest point in nearly a quarter century. (Figure 2)

Figure 1: ASCE Grades and Annual Investment Needs, Billions



Source: American Society of Civil Engineers

Figure 2 : Real GDP and Infrastructure Spending as a Share of GDP



Source: U.S. Bureau of the Census[15]

All of this is taking place in the context of an economy still recovering from the 2008-2009 recession, with employment in construction almost 1 million jobs below its peak in 2006. 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).[16] Since then, however, infrastructure investment has fallen to its lowest levels since peaking in the late 1970s.[17]

As a result, our overall infrastructure grade is at its highest-ever level, 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 $2 trillion dollars, up from $1.6 trillion in 2014.

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.

II. WHY ACCELERATE INFRASTRUCTURE INVESTMENT?

Without accelerated investment in maintenance and development, public infrastructure will fall into further disrepair, costing the U.S. trillions of dollars in lost GDP. Investing at the currently planned rates through 2023 will leave an investment gap of 45 percent. ASCE estimates the economic cost of allowing the gap to perpetuate would be approximately $3.9 trillion lost GDP and 2.5 million lost jobs through 2025.[18] Failing to invest in creating and maintaining adequate infrastructure is a classic example of being "penny wise and pound foolish."

In addition to repairing our failing infrastructure and eliminating the drag it creates on the economy, smart investments can build the next generation of infrastructure needed to support a globally leading economy.

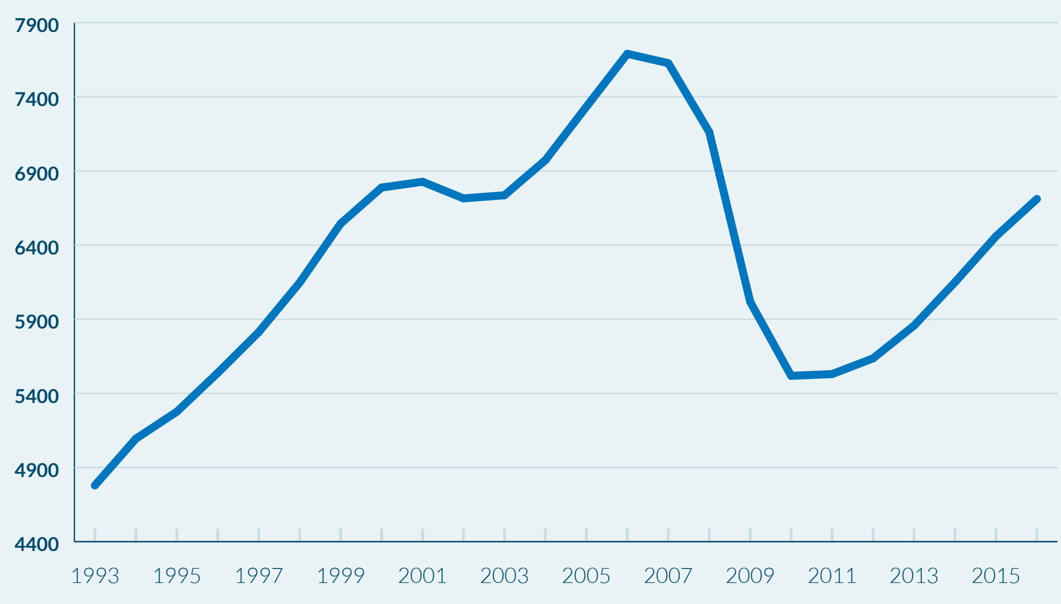
Economic Stimulus – Driving Job Growth

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 9.9 percent in 2010 to 4.4 percent in June 2017, labor force participation rates have also fallen since 2010,[19] from just over 65 percent at the end of the recession to 62.9 percent.[20]

As is 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 jobs are badly needed—especially compared to overall employment. (Figure 4)

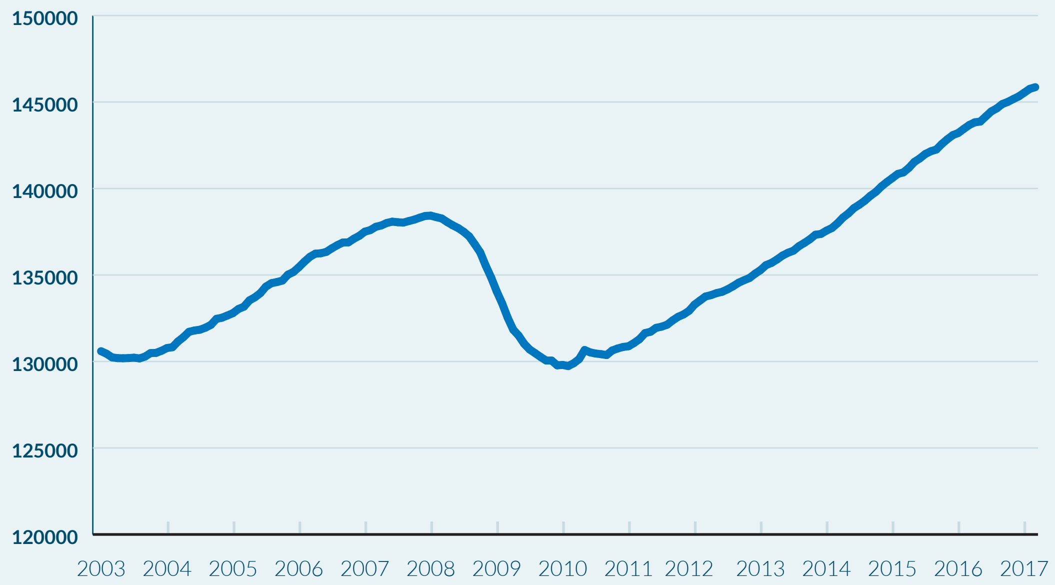
Infrastructure investment also drives growth in manufacturing jobs. The materials and products that construction workers use to install and build our infrastructure can be manufactured in the United States, allowing us to capture indirect economic benefits as well as direct benefits of infrastructure spending. When spending is coupled with policy to incentivize domestic content, we can maximize manufacturing job creation, revitalize manufacturing communities, and maintain strong American competitiveness.

Figure 3: Construction Employment, Thousands



Source: U.S. Bureau of Labor Statistics[21]

Figure 4: Historical U.S. Employment, Thousands of Jobs



Source: U.S. Bureau of Labor Statistics[22]

Low Interest Rates – Saving Taxpayers Money

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 3 percent, near its lowest point in history.[23] However, the Federal Reserve has indicated that this period of low interest rates is coming to a close and interest rates will be gradually increasing.[24] Therefore, borrowing money will soon be more expensive. Comparing the interest costs of financing the additional $2.1 trillion necessary to achieve an overall grade of "B" at today's rates of 3 percent, versus the pre-recession rate of 4.5 percent, financing the expenditure today would save taxpayers nearly $1 trillion dollars over 30 years.

Environmental Benefits and Improving Public Health

In addition to economic benefits, investing in infrastructure can also yield potentially significant environmental and public health benefits.

A failing infrastructure is a drag on overall productivity caused by 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 a 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 dioxide and other GHGs, the deteriorating state of our infrastructure becomes a vicious circle. As our systems crumble and become more inefficient, the excess pollution 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.

III. METHODOLOGY

The estimates developed for this report are based on an input-output analysis. The model is based on core data from the 2015 U.S. national model of the IMPLAN group, with modifications for productivity trends and other factors. We relied on data from the ASCE *2017 Infrastructure Report Card* for estimates of the total investment requirements needed to bring the overall grade for U.S. infrastructure up to a "B." The investment requirements by infrastructure category are shown in Table 1 (dollars in 2015 billions).

We allocated this expenditure across the individual economic sectors identified in Table 1 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 10-year Treasury bond rate, as projected by the Energy Information Administration (EIA) in its *2017 Annual Energy Outlook*,[25] with a fixed spread of 0.34 percent to account for the longer-term bond. 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.

Following Leduc and Wilson (2013),[26] 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 benefited 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.

To estimate the economic impacts of bringing our infrastructure up to a "B" grade, we examined a scenario in which the additional $2 trillion in investment was undertaken over the next 10 years. We modeled expenditures in the 16 different infrastructure classes examined by the ASCE in their *2017 Infrastructure Report Card*. Specifically, 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.

Also included in this report are investments required to accelerate the repair of leak-prone natural gas distribution pipelines, as outlined in a previous BlueGreen Alliance report and updated using 2015 data.[27]

Note that the job estimates reported here are more appropriately called "job-year equivalents." Each "job" represents an increase in demand for employment sufficient to employ an individual 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.

Table 1: Investment Gap in Billions (dollars in 2015 billions)

	Investment Gap, Billions
Surface Transportation	$1,101
Water/Wastewater Infrastructure	$105
Electricity	$177
Airports	$42
Inland Waterways & Marine Ports	$15
Dams	$39
Hazardous & Solid Waste	$3
Levees	$70
Public Parks & Recreation	$102
Rail	$29
Schools	$380
Natural Gas Distribution Pipelines*	$183
TOTALS	**$2,247**

*Not included in ASCE Report Card

IV. ECONOMIC IMPACTS OF ACCELERATED INFRASTRUCTURE INVESTMENT

Our nation must move forward with an ambitious plan to rebuild and transform America's infrastructure. Investing now to repair our failing roads and bridges, water systems, and natural gas distribution pipelines, modernize our buildings and electric grid, transform our transportation systems, and support our urban and rural communities, will boost our economy and create and sustain millions of jobs, while also reducing pollution and combatting climate change.

There are significant economic and sustainability benefits that could accrue from improving America's infrastructure over the next 10 years. We have the potential to support or create an additional **14.5 million** job-years[28] across the U.S. economy and add a cumulative **$1.66 trillion to the GDP[29] over 10 years,** versus a business as-usual approach, as seen in Figure 5.

In Table 2, we see a snapshot of job-years expected to be added in sectors in both 2022 and 2027.

In terms of employment, sufficient infrastructure investment would support or create a significant number of new jobs, as shown in Table 3.

As indicated, the construction sector would be a major beneficiary of the investment, but job growth would accelerate in every sector of the economy, including manufacturing. By 2027, the accelerated investment would support just under 3 million additional full-time equivalent jobs throughout the economy in that year.

Figure 5: Additional GDP Growth from Getting America's Infrastructure to a Good State of Repair (in Billions)

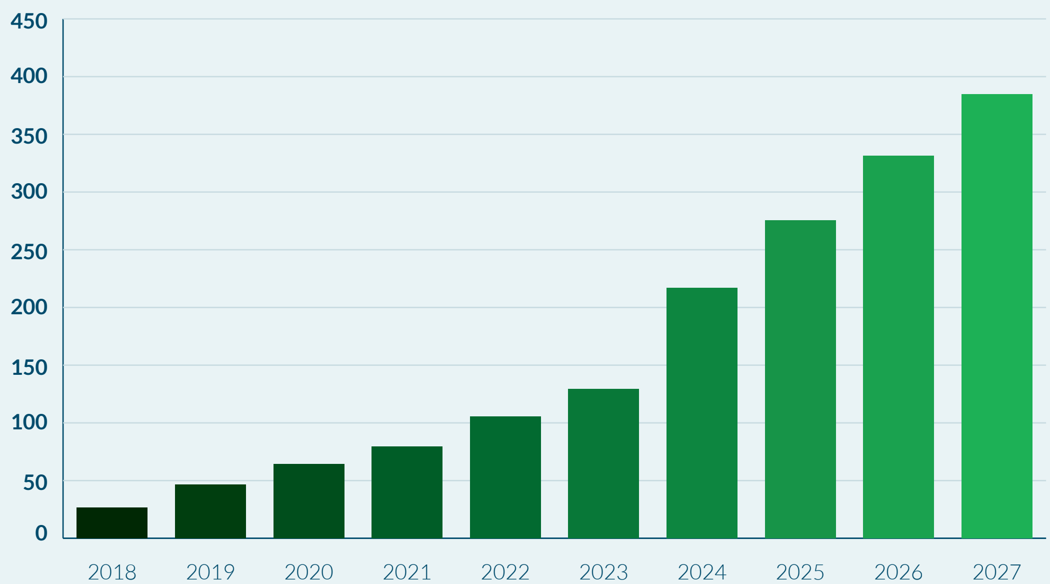


Table 2: Employment Snapshots in 2022 and 2027 (in thousands of job-years)

	2022	2027
Agriculture	24	69
Oil & Gas Extraction	11	38
Mining	9	19
Electric Utilities	2	6
Natural Gas Utilities	1	2
Transportation and Public Utilities	50	137
Construction	397	934
Other Manuf	106	255
Primary Metals	3	7
Fab Metals	1	7
Trade	56	239
Services	193	917
Finance, Investment, Real Estate	75	319
Government	20	302
Total Impacts	**948**	**3,252**

Table 3: Cumulative Job Creation by Category for Investment over 10 Years

	Thousand Job-years
Surface Transportation	6618.454
Water/Wastewater Infrastructure	654.101
Electricity	1088.467
Airports	264.3583
Inland Waterways & Marine Ports	99.53669
Dams	248.4866
Hazardous & Solid Waste	26.28262
Levees	435.2845
Public Parks & Recreation	632.46
Rail	187.4416
Schools	2303.341
Natural Gas Distribution Pipelines	2014.873
TOTALS	**14573.09**

V. INFRASTRUCTURE INVESTMENTS NEEDED

The following sections describe in more detail where these investments should be made. Potential areas of infrastructure investments are described in terms of potential for job creation, avoided carbon emissions, reduced energy demand, and associated climate change and other quality of life impacts.

This section of the report looks at these potential impacts and 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 change on our economy and environment.

Power & the Electrical Grid

Getting our power and electrical grid to a "B" grade over the next 10 years could support or create nearly 1.1 million job-years across the U.S. economy, including family-sustaining union jobs building solar and wind power.

POWER & THE ELECTRICAL GRID

EXPECTED JOB-YEAR GROWTH

+202K THROUGH 2022

+1.1M THROUGH 2027

America's electricity system, which received a "D+" from ASCE, powers our economy, and reliable power is absolutely necessary in our increasingly technology-driven world.[30] Power plants are the largest source of CO_2 emissions in the United States. Generating electricity produced more than 1,900 million metric tons of CO_2 in 2015[31] and accounted for 29 percent of total U.S. GHG emissions. While progress has been made—power plant emissions are down 20 percent since 2005[32]—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. The 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[33]), floods, storms, wind, and sea-level rise—damages electric equipment.

If current investment trends continue, by 2025 the national funding gap in electricity infrastructure is expected to grow to $177 billion—costing the U.S. economy an average of $117 billion each year between now and then. 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 $819 billion decrease in GDP and 102,000 fewer jobs by 2025.[34]

What does this funding gap look like? If electricity spending trends continue, necessary investment in generation is estimated to be $39 billion more than what will be paid for by 2025, with additional needs of $42.5 billion in transmission and $95.6 billion in distribution.[35] Filling these gaps and making investments in the types of electricity infrastructure identified here will ensure a more efficient and reliable system in the following ways:

- 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; and
- 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 sources of generation.

According to the ASCE *Failure to Act* report on electricity infrastructure, the past two decades saw significant investment in both transmission and distribution systems.[36] 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 United States[37] and the EIA estimates that average losses due to transmission and distribution alone are around 5 percent.[38] 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.

Implementing smart grid technologies will improve reliability, reduce operating costs for utilities and household expenditures on energy, provide better support for green technologies, and reduce GHG emissions from power generation. Currently, the average customer still encounters power outages or quality disruptions for 2.5 hours per year, causing frustration for households and serious economic impacts to businesses and critical infrastructure.[39] There is a lack of data for utilities and consumers, so utilities often have trouble tracking disruptions or handling peak loads, while consumers have little knowledge of their energy consumption, limiting incentives for conservation or energy efficiency.

The current grid also is not designed for future demands. For one, it was designed for distributing energy from centralized, steady power stations to end users, while renewable energy is highly distributed between many small generators and is highly variable. Demands on the grid will increase rapidly in coming years from plug in electric vehicles. Smart grid technologies provide better data and communications to customers and utilities, improved controls and decision support, and use advanced technologies that increase grid capacity and make every part of the system more efficient. A 2008 report by the ERPI suggests that a national smart grid could reduce annual GHG emissions by 60 to 211 MMTCO2e equivalent.[40] Additionally, a 2010 report showed full implementation of a nationwide smart grid could lead to a 12 percent reduction in U.S. carbon emissions. This equates to preventing 442 million metric tons of carbon dioxide from entering the atmosphere each year, the equivalent of 66 typical coal-fired power plants.[41]

Despite slow growth in electricity demand since the 1950's and reduced demand during the recession, the EIA predicts that demand for electricity will grow steadily and most capacity added will be natural gas and renewables.[42] Additionally, America's power plant fleet is aging: the average age of a coal plant is 37 years, natural gas 45 years, and nuclear 32 years.[43] As these plants retire, there will be opportunities to replace lost capacity with wind and solar. According to the EIA, in 2016 more than 27 gigawatts of new electrical capacity were added to the grid; more than 60 percent of these capacity additions were from wind and solar.[44]

This growth in renewables is creating large amounts of jobs across the country. In 2016, solar energy supported almost 374,000 jobs and wind supported 102,000. And these numbers are increasing rapidly. In 2016, solar employment grew by 25 percent and wind grew by 32 percent.[45] According to the National Solar Jobs Census, solar employment has tripled since 2010,[46] and added one out of 50 new jobs in 2016. With accelerated investment in renewables, large numbers of jobs in multiple sectors, including manufacturing, construction, and engineering, will continue to be created.[47] Equally critical are measures to ensure the new jobs are good jobs that can support a family and that we do not roll back progress by instituting unnecessary punitive fees on renewable generation.

Building Efficiency – An Energy Opportunity

Building efficiency is a key part of any strategy to reduce energy and GHG emissions. For every $1 spent on building efficiency, $2 is saved in new power generation and distribution infrastructure.[48] An estimate of U.S. GHG abatement potential per year through 2030 found increases in energy efficiency of buildings, and their appliances, is projected to eliminate 710 to 870 million tons of GHG emissions.[49] A study by the International Energy Agency shows that if implemented globally, energy efficiency measures in the building sector could deliver CO2 emissions savings as high as 5.8 billion tons by 2050, lowering GHG emissions by 83 percent below the business-as usual scenario.[50]

A major part of this potential is in upgrading Municipal, University, School, and Hospital buildings, or MUSH, for short. MUSH does not just include government, educational, and healthcare facilities, but all public and institutional buildings. All buildings in this category are heavy energy and water users that can be made more efficient on a large scale while creating good jobs. Another benefit is that everyone uses these buildings regularly, so MUSH buildings are a great way to lead by example, showing the effectiveness of energy efficiency technologies and green practices to communities.

Strategies and technologies used to green MUSH buildings include LED lighting, efficient HVAC systems and climate control, window replacement, sealing air leaks, and insulation. Green buildings can also design their windows and other openings to provide effective natural internal lighting and passive solar heating during the day, a practice called daylighting. These retrofits not only save energy, but also improve the health and comfort of building occupants.

MUSH buildings are good targets for energy efficiency because of the massive amounts of energy that they use—these facilities use 3.87 quadrillion BTU per year, spending $40.7 billion annually.[51] Energy and water are a major expenditure for all types of MUSH buildings and, by reducing these costs, they will be able to direct that funding to other priorities. These entities are also large—most entities own multiple buildings and can aggregate smaller buildings into one large project, or they own massive buildings with significant energy needs. Due to the energy usage in these facilities, retrofits have the potential to make a huge impact on emissions and power usage. But what really sets them apart from the industrial and commercial market is that public entities and institutions are more likely to implement local content requirements and job advancement standards due to the larger scale of projects and already established high road practices and standards.

However, there are multiple issues with MUSH retrofits. Many MUSH buildings are historic buildings or have special requirements and uses, and organizations often own diverse building stock, so they require specialized staffing and equipment. Energy efficient systems require maintenance staff to have specific training to install and operate to fully maximize retrofit benefits, especially with buildings that have special needs. Energy efficiency is also often not a high priority for governments, and requires a large upfront cost. Additionally, there can be a lack of data on energy usage and the special needs of facilities.

Beyond the direct impacts of GHG reductions and financial savings from energy efficiency on buildings in the MUSH sector, there is an opportunity to drive job growth through the use of energy efficient products. Across the United States, there are 289,000 workers[52] at over 1,600 facilities employed in the manufacturing of energy efficient products.[53] By driving demand and incentivizing domestic procurement, there is an opportunity to continue supporting existing manufacturing workers and grow their numbers. This approach not only increases jobs in the United States, it also decreases GHGs by procuring these products in closer proximity to the project, versus purchasing overseas and having the products shipped thousands of miles from countries with lower environmental compliance requirements.

Investment in building efficiency will also create thousands of jobs in construction and building operations, providing opportunities for building owners to create well paying, quality jobs in the community. Most of these jobs require specialized skills to fully utilize the benefits of green building systems, and as a result communities need to invest in creating skill standards for all workers, along with apprenticeship and training programs for construction and maintenance workers. Several cities and organizations are creating comprehensive training programs for green building systems that educate existing operations and maintenance staff on new technologies and provide new staff with the skills needed to work in green building construction, operations, and maintenance, like the "Green Supers" program in New York.[54]

Several municipalities are already leading the way on greening their municipal buildings. For example, both the cities of Portland and San Francisco require all new municipal buildings and renovations to existing buildings to be LEED Gold certified.[55] Many more cities and states across the country are leading the way on developing strong energy efficiency standards for new construction and renovation of public buildings.

The benefits to building efficiency are proven: commercial LEED certified buildings consume 25 percent less energy and 11 percent less water while also producing 34 percent less CO2 emissions. Green building owners also reported 20 percent lower maintenance costs and higher occupant morale and productivity.[56] Public building retrofits have bigger impacts than just savings for occupants, but can make a massive impact on GHG emissions while providing economic benefits to their community. A 2012 study states that if all existing MUSH buildings were upgraded, this could reduce annual CO2 emissions by over 52 million metric tons.[57] Building efficiency is critical in every city to meet climate goals and provide better spaces for communities.

Carbon Capture – An Energy Opportunity

Carbon capture and sequestration (CCS) is a rapidly growing technology that has potential to create economic benefits for multiple industries while significantly reducing CO2 emissions. According to the Intergovernmental Panel on Climate Change (IPCC), the world will not be able to achieve its goal of limiting global surface temperature rise to 2 degrees Celsius without carbon capture. The IPCC further concluded that without CCS, the costs of mitigating climate change could increase by 138 percent, an investment estimated to total $2 trillion over the next 40 years.[58]

Industrial facilities, in particular, are huge sources of carbon emissions, and very few solutions exist beyond carbon capture technologies to reign in these emissions. According to the EPA, currently, direct emissions from industrial activities account for 21 percent of annual U.S. GHG emissions—totaling 6,587 MMTCO2e equivalent annually. While these numbers are projected to decrease slightly, they will remain a large share of U.S. emissions in the future.[59] CCS is necessary to limit emissions from industrial activities since for many manufacturing processes, there are few alternatives for controlling emissions. Industrial facilities are the easiest, lowest cost targets for deploying CCS technologies, since they often produce pure streams of carbon dioxide that can be easily captured and sequestered.

An example of a successful CCS project is the Archer Daniels Midland ethanol facility in Decatur, Illinois. Completed in 2016, it is expected to capture 1 million metric tons annually and store CO2 locally in a deep saline reservoir. In all, recent DOE investments in the industrial sector have stored 12 million metric tons of CO2 safely and effectively.[60] However, current federal incentives for CCS do not apply to industrial facilities, so CCS is not being used to its fullest potential in the sector.

Right now, there are over 4,500 miles of carbon dioxide pipelines. Approximately 30 million metric tons of CO2 are produced at industrial facilities within 50 miles of a CO2 pipeline. However, to fully utilize CCS, several large corridors for pipelines from industrial regions like the Midwest and the Gulf Coast, to locations where the carbon can be sequestered or otherwise beneficially used, need to be built. Expanding this pipeline infrastructure is a win-win solution for all involved. It could drive billions of dollars of capital investment, stimulate economic activity, and support thousands of quality jobs in construction, manufacturing, and related fields.

Industrial facilities that capture and sell CO2 will reduce their emissions while also gaining an extra revenue stream, creating jobs in their company as well as downstream industries and suppliers. The economic benefit of this would encourage more carbon producers to capture their emissions, and could result in reduction of stationary source CO2 emissions from current levels. Adoption of CCS also means that we can find more effective ways to safely utilize CO2 emissions in ways that do not damage the environment. CO2 is already used in some industrial processes, and has the potential to shift from a burden to a valuable commodity in the future as research into safe carbon utilization advances. One example of a potential use is bio-refining. Micro-algae are incredibly efficient at processing CO2, and some have been engineered to create biofuels and other useful chemicals. There is also research into converting CO2 into advanced chemicals and materials, including concrete.[61]

Federal investment and incentives are necessary to provide short-term financing and encourage industrial CO2 producers to build the infrastructure for and invest in CCS. One major barrier is a lack of incentive for industrial facilities to implement CCS. The quickest and most effective way to encourage the rapid deployment of CCS for industrial uses is extending and expanding the 45Q tax credit, which is provided to facilities that implement CCS technologies. This tax credit recently expired, and it only covers facilities that produce over 500,000 tons of carbon per year, which rules out major carbon producers like ethanol and other industrial facilities.[62] The 45Q credit should be expanded to include more types of facilities, and incentives must be increased, especially for industrial facilities that sequester captured emissions.[63]

Natural Gas Distribution

Tripling the rate of repairs of and upgrades to our natural gas distribution systems could create over 2 million job-years through the economy over the next 10 years.

America has the opportunity to create tens of thousands of jobs by investing in the replacement and repair of natural gas distribution pipelines in communities across the country.

While this work has already begun, much more needs to be done to replace the critical segments of the distribution network that are made of cast iron, unprotected steel and/or older plastic—materials that are more likely to corrode or become compromised, resulting in accidental release of emissions that are making climate change worse.

America's natural gas pipeline system is a vast network with more than a million miles of pipe in the distribution system alone. While communities rely on these pipes to supply energy to homes and businesses, significant portions of this network were constructed during the 1930's or earlier; these old pipelines are degraded and are more prone to leakage than coated steel and other advanced materials available now. Older materials—like cast iron, unprotected steel and some plastics—were used in critical segments of the overall system that now need to be replaced or repaired.

In addition to raising reliability concerns, America's aging pipeline system is making climate change worse because the deterioration of the network results in the accidental release of methane, a highly potent GHG and the second largest contributor to climate change after CO_2.[64] While some of these releases are unavoidable results of repair or operations, leaks due to corrosion, mechanical failure, control system failure, accidental or third party disruptions and excavations, and natural forces—temperature swings, floods, hurricanes and earthquakes— can be addressed by a comprehensive approach to repair and replace critical segments of the distribution pipeline system.

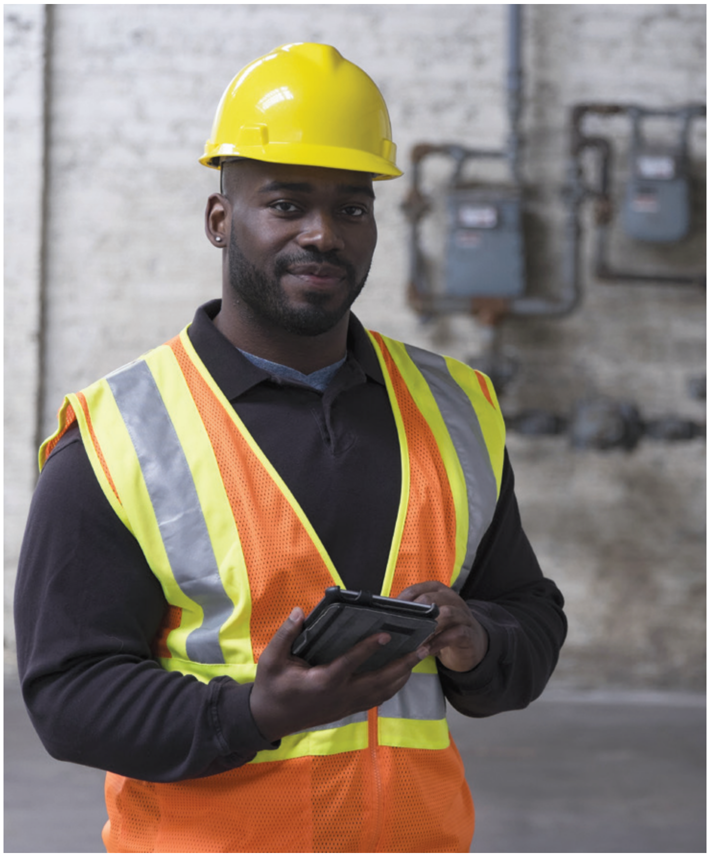
America's gas companies have recognized the problems with the nation's pipeline system and there is work underway to replace troublesome portions of the network. However, current efforts to upgrade all of the nation's leak-prone pipes, which comprise approximately 112,000 miles of pipes and services throughout the pipeline system, could take 30 years or longer to complete.[65]

Large-scale investment will allow us to modernize the natural gas pipeline network and accelerate current efforts to repair America's distribution pipelines. These investments will enhance system reliability, ensure customers pay for the gas they actually use, and increase public safety. These investments will also create and sustain tens of thousands of new direct and indirect jobs, and strengthen the economy by expanding the market for pipe manufacturing, fabrication, installation, and operations. According to our modeling, efforts to repair and replace natural gas distribution pipes at the current rate support an estimated $1.8 billion a year market and create and sustain 68,000 jobs throughout the economy each year. Additionally, these investments will curtail the release of methane into the atmosphere, reducing contributions to climate change.

ACCELERATED REPAIR AND REPLACEMENT – AN ECONOMIC OPPORTUNITY

Accelerating the rate of repair and replacement of the leak-prone segments of the natural gas distribution system creates the potential to expand this market and create and support tens of thousands of additional jobs, as well as reduce more methane emissions than business as usual. A study by the BlueGreen Alliance[66] examined a scenario whereby the current rate of replacement and repair were tripled—a rate of activity already underway in some communities. This analysis updated with 2015 data shows accelerating this investment to a 10-year time frame will increase job creation by an average of 115,000 job-years annually per year, and result in:

- The creation of over 2 million additional job-years over ten years, creating more jobs over a shorter period of time than the business as usual scenario;
- An average increase in GDP of $22 billion per year, with a total increase of $224 billion over ten years; and.
- Additional savings of 81 million metric tons of CO_2-equivalent emissions compared to the current rate of repair. This reduction in emissions would be comparable to taking 17 million cars and trucks off the road for one year.



Roads & Transit Systems

Getting our road and transit systems to a "B" grade over the next 10 years could support or create over 6.6 million job-years across the U.S. economy.

SURFACE TRANSPORTATION

EXPECTED JOB-YEAR GROWTH

+1.2M THROUGH 2022

+6.6M THROUGH 2027

Modernized integrated transportation systems—like roads, bridges, and transit networks—are critical infrastructure for a prosperous and competitive economy, both nationally and locally. In 2017, America's roads, bridges, and transit networks received the grades of "D", "C+", and "D-", respectively.[67] Investment in transportation generates jobs and economic growth while building the next generation of transportation technology. Investing in a more efficient system also has positive environmental outcomes, as transportation accounts for 27 percent of total GHG emissions in the United States.[68]

America has more than 4 million miles of public roads facilitating the movement of people and goods. Maintenance, as well as capital investment for improved condition and performance, is needed to sustain this crucial network and ensure it can function well as part of a modernized multi-modal transportation system.

According to the ASCE, 20 percent of major roads are currently in poor condition. Chronic underinvestment combined with an increase in drivers is leading to deteriorating roads and damage to vehicles. A funding backlog of $836 billion has accumulated across our highway system, two-thirds of which is just for repairs on existing roads and bridges.[69]

Delays caused by congestion and re-routes to avoid structurally deficient bridges or poor pavement conditions add time, fuel costs, and increased emissions for commuters, as well as companies transporting goods across the country. According to the Texas A&M Transportation Institute, congestion-related costs have risen every year since 2009. In 2014, congestion in urban regions caused Americans to spend 6.9 billion extra hours in traffic—costing $160 billion, wasting 3.1 billion gallons of fuel, and pumping 25 million metric tons of carbon dioxide equivalent (MMTCO2e) into the atmosphere during congestion. If our current trajectory continues, those figures could rise to $192 billion in costs and 3.8 billion gallons of fuel wasted by 2020.[70]

The deterioration of America's roads and bridges means all too often major repairs—instead of minor maintenance—are needed, worsening congestion. In 2016, Americans made 188 million trips every day across structurally deficient bridges, a category that covers 9.1 percent of bridges in the country. This translates to a $123 billion funding gap for proper rehabilitation. That deficiency is felt on a daily basis by commuters and businesses transporting goods across the one in ten bridges with weight or speed restrictions due to structural concerns. As the average age of bridges in the United States reaches 43 years, when most were designed for a lifespan of 50, it is more important than ever to designate funding for these crucial surface transportation connections.[71]

While advances in clean vehicle technology are a crucial factor in improving efficiency and reducing energy use and pollution in the transportation sector, optimizing road capacity to ensure our roads are in good repair, designed for intelligent management, and integrated with multiple modes and technologies will help ensure that travel—both for people and goods—operates more effectively and efficiently across the transportation system.

America's transit systems—buses, subways, streetcars, light rail and commuter trains—provide crucial transportation for millions of Americans, connecting workers, students, and families with access to employment, medical care, education, shopping, and recreation. Demand has outstripped supply across the board, with urban, suburban, and rural residents all lacking sufficient access to the efficient multimodal transportation options they need.

Americans who do have access to transit have consistently increased their use of these systems, tallying more than 10.5 billion trips in 2015 and making more than 10 billion trips annually for the past decade. From cities to small towns, system expansions as well as transit ridership show a long-term trend of public transportation growth. For example, from 2004 to 2014, transit systems across the United States gained 26 percent more urban route miles of rail and 11 percent more non-rail route miles.[72]

Although investment in transit has also increased, 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—especially in rural areas. At present, the ASCE estimates a maintenance backlog of nearly $90 billion in funding to bring all transit systems up to a state of good repair. If current trends continue, this funding gap could reach $122 billion by 2032. Without a significant increase in funding for maintenance and operations of these systems, conditions will inevitably decline as systems and assets age.[73]

In addition to the tens of thousands of Americans employed operating and maintaining transit systems, investing in transit also provides an opportunity to strengthen local economies through domestic manufacturing, maximizing the benefit of federal transportation dollars in communities across the United States. Smart procurement, financing, and manufacturing assistance policies and programs can have a huge impact on the more than 2,000 facilities involved in transit bus and rail supply chains,[74] as well as the surrounding communities they support. Data from the American Public Transportation Association shows that every $1 billion invested in public transit creates more than 50,000 jobs and returns $3.7 billion over 20 years.[75] Conversely, unpredictable and insufficient funding makes it challenging for communities to plan for transit improvements and maintenance, creating instability for domestic manufacturers and transit riders alike.

Strengthening our transit system also has notable environmental benefits. Today's level of transit ridership (10.5 billion trips in 2015) saves approximately 4.1 billion gallons of gasoline,[76] equaling the amount of gasoline used by more than 7.7 million cars a year, which helps avert more than 36.3 MMTCO2e annually.[77] If we drive adequate levels of investment to our existing transit networks to support a level of ridership growth commensurate with the rate of population growth, we could reach 11.3 billion transit rides by 2025. This would result in savings of nearly 4.4 billion gallons of fuel and avert the release of over 39 MMTCO2e per year. This would approximate the oil and pollution savings equivalent to the use of 8.3 million cars.[78] Expanding reliable transit access to the majority of Americans who are not presently served or are underserved could drive these benefits substantially higher.

INNOVATIVE MOBILITY

Transportation technology is changing rapidly, not only in use of new cleaner fuels and vehicles, but in use of data and sensing to enable vehicles and infrastructure to communicate with each other and to manage transportation provision in much more sophisticated real-time ways. A new generation of transportation investment should both be able to integrate these technologies and ensure that transportation systems continue to uphold and improve service, safety, equity, and other public obligations. Investing in modern updates to our transit system could not only improve service reliability, but also reduce our transportation-related GHG emissions, improving both environmental and public health.

Rail

Getting our passenger and freight rail systems to a "B" grade over the next 10 years could create 187,000 job-years across the U.S. economy.

RAIL

EXPECTED JOB-YEAR GROWTH

+35K THROUGH 2022

+187K THROUGH 2027

In addition to the sizable network of commuter rail mentioned in the transit section above, intercity passenger rail, operated by Amtrak, is a key piece of our transportation network. Amtrak operates a 21,356-mile network in over 500 communities, which served 31.3 million passengers in 2016. Amtrak includes the national network, which runs on tracks mostly owned by local and state governments and freight rail companies, and the Northeast Corridor (NEC), which stretches from Washington, D.C. to Boston, and runs on track that is mostly owned and operated by Amtrak, with the rest owned by local transit agencies. The NEC comprises more than half of Amtrak's ridership, and offers the highest speed service in the country, reaching speeds of 150 mph on some stretches. Between Amtrak and the commuter railroads that operate on the NEC, there are approximately 750,000 passenger trips each day on the NEC.[79] The ridership numbers on the national network are rapidly growing, and with strong investment, the successes of the NEC can be translated to other states and regions like California, Texas, and the Midwest.

Passenger rail provides many environmental and economic benefits to communities. Traveling by rail is highly efficient and reduces congestion at airports and on highways, especially in major corridors like the NEC. Passenger rail accounts for only 0.3 percent of all transportation-related emissions. Traveling by rail is 30 percent more fuel efficient than travelling by car, and 8 percent more fuel efficient than traveling by air.[80] Rail also boosts the economies of communities—$10 million of investment results in $30 million in increased business sales.[81]

Operating and maintaining rail also employs thousands across the country. Passenger and freight rail manufacturing supports an estimated 90,000 jobs across hundreds of manufacturers in almost every state in the country.[82] Investment in rail not only drives jobs with locomotive and railcar assemblers, but also supports a large number of component manufacturers in many diverse industries. Currently, rail manufacturing, especially passenger rail, suffers from boom and bust cycles, as they are dependent on unreliable funding and as a result, many jobs are not secure and subject to frequent layoffs. With continued, stable investment in rail infrastructure, we can protect and create thousands of manufacturing jobs.

Amtrak's ridership is continuing to increase, and there is strong local interest in improving passenger rail networks around the country—specifically high-speed rail. Construction is underway to build a high-speed rail network in California, and improved passenger rail lines that reach speeds of over 100 mph are currently under construction in Illinois and Florida. The NEC is currently upgrading its stations and track to support higher speeds and reduce bottlenecks, and recently purchased 28 new high-speed trains that can reach top speeds over 180 mph.[83]

Not only would an expanded high-speed rail system benefit travelers, but it would help support increased rail manufacturing on U.S. soil. In recent years, insufficient and uncertain levels of rail investment have made it difficult to build a robust, globally competitive domestic railcar manufacturing industry in the U.S. Despite the more than 1,400 U.S. facilities supplying to the rail sector,[84] many crucial components are still purchased from foreign companies in China or Europe, where thriving rail systems support a more robust supplier network. Assemblers and suppliers in the U.S. have incredible potential for meeting the demands of a larger rail system, but will not expand without the promise of sustained, reliable investment in high-speed rail.

Even Amtrak's existing rail system in the U.S. is lacking sufficient investment. Amtrak infrastructure and rolling stock is aging due to long-term shortages in funding, especially on the NEC. While the network is still safe to operate, some of its infrastructure is far past its useful life and Amtrak is forced to be reactive to failures instead of proactively improving their infrastructure. This results in delays and loss of system reliability. The NEC has a repair backlog of $28 billion: $11 billion is needed to fund basic infrastructure projects and $17 billion is needed for deferred projects.[85] While there has been some encouraging investment in passenger rail recently, it has not come close to meeting the growing list of projects.

Meanwhile, commercial freight rail is a highly efficient mode of transporting bulk goods, especially over long distances. In 2015, on average, one gallon of diesel fuel moved a ton of freight 473 miles. 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 42 percent since 1990.[86] American companies are developing and producing many of these pollution reducing and energy-saving vehicles here in the United States—strengthening both our domestic economy and rail manufacturing expertise.

Railroads continue to implement new technology to improve engineers' ability to maximize fuel savings and minimize safety concerns, when applied with the full training and support of the workforce. Railroads have also invested in lighter freight cars and more efficient locomotives to reduce fuel consumption, and are able to pack more cargo onto each car. 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 2011, this increased to 1.725 trillion ton-miles,[87] but fuel consumption remained steady at nearly 4 billion gallons over those three decades.[88] Additional strides in locomotive efficiency—like diesel and hybrid systems, drivetrains, lighter materials, and improved logistics and controls—hold the potential to significantly reduce fuel consumption and particulate and GHG pollution, while also improving safety.

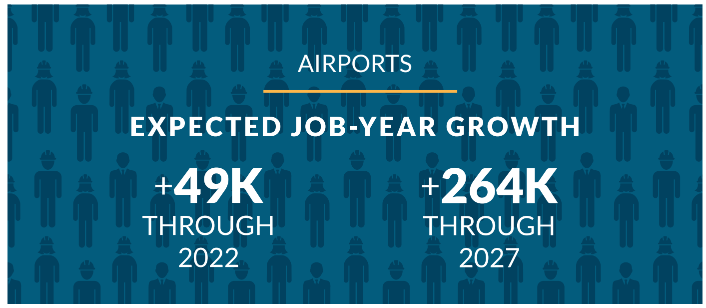
Even though rail carries 40 percent of all freight traffic, freight rail currently contributes only about 2.3 percent of transportation-related CO_2 emissions.[89] A single freight train replaces several hundred trucks, and moving freight by rail instead of trucks reduces highway wear and tear, the need for new costly infrastructure, and highway congestion. 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 multimodal freight system.

The freight rail industry invests more than four times the proportion of revenues into capital investment compared to most other industries. Class I railroads invested $27 billion into improving their infrastructure in 2015,[90] and freight railroads are continuing to make large infrastructure investments. Shortline and regional railroads have access to government tax credits and loans for capital investment, and therefore are able to keep up and compete with large railroads.

Freight and passenger rail is expanding rapidly, and requires corresponding infrastructure investment. By growing capacity, freight and intercity rail can seize significant opportunities to meet projected demand for cargo and passenger traffic, save energy, reduce pollution, and support tens of thousands of new jobs throughout the economy.

Airports

Getting our airports to a "B" grade over the next 10 years could create an estimated 264,000 jobs-years across the U.S. economy.



America's airports, which received a "D" grade by the ASCE, provide a critical passenger and freight conduit for both the domestic and international economy.[91] Airport infrastructure in the United States includes more than 3,000 airports, more than 209,000 aircraft, and the air traffic control system. The Federal Aviation Administration (FAA) reported in 2012 aviation was a $1.5 trillion industry that supported more than 11.8 million jobs.[92] Aviation generated more than 159 MMTCO2e in 2015,[93] and aviation generally is estimated to produce between 2.6 and 3.4 percent of emissions in the United States.[94] Airlines have set 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).[95]

According to the FAA, the number of passengers boarding planes across the country is expected to grow from 786 million in 2015 to 1.24 billion in 2036. Additionally, airfreight tonnage is expected to double by 2034.[96] 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: 30 "core" airports serve approximately 70 percent of commercial passengers, and these markets are expected to grow more than the national average. It is expected 24 of the top 30 major airports will experience "Thanksgiving-peak traffic volume" at least one day every week by the end of the decade. These airports are also vital to the movement of international and domestic freight; the top 30 airports handled 79 percent of all air freight by weight in 2015.[97]

Airport facilities and operations should be upgraded and become more efficient to keep up with demand and changing FAA regulations. While almost all facilities are in good condition, the largest airports are dealing with chronic congestion and delays, which cause ripple effects in the national aviation system.

Improving facility capacity provides opportunities to make facilities and operations more sustainable, while also creating more good quality jobs for the surrounding community. Airports are heavy energy users, and by controlling energy usage and emissions, they can lead the way on sustainability. Airports and airport tenants are also a key part of local economies and major employers. It is therefore critical that investments in capacity and improved operations are made in a way that supports good jobs across the air industry, while creating greener facilities.

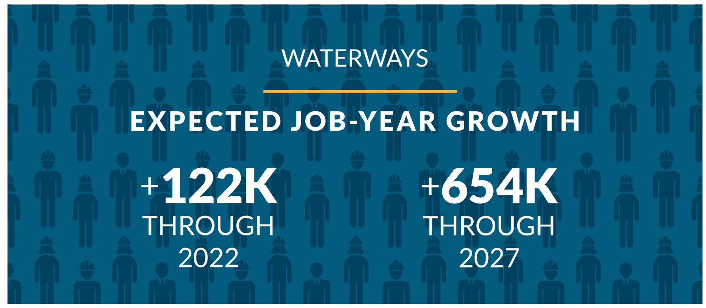
Another necessary infrastructure investment is technology. The FAA is currently replacing old radar technology with a satellite air traffic control system, The Next Generation Air Transportation System (NextGen). NextGen will improve efficiency and safety as well as minimize delays associated with congestion. It provides quicker and easier communications, reducing confusion and delays; better tracking and navigation at every step of the flight process; and it maximizes runway capacity by improving flight paths while allowing planes to land and take off closer together. These efficiencies reduce emissions and fuel usage from planes circling, inefficient flight paths, and waiting on the runway. One example of a successful NextGen project, "Greener Skies over Seattle," utilizes satellite-based navigation for arrivals. These new procedures optimize landing routes by allowing more arrivals per hour while minimizing environmental impacts, and allow planes to idle while descending. Greener Skies is estimated to reduce fuel consumption 2.1 million gallons a year—cutting CO2 emissions by 22,000 metric tons. [98]

According to ASCE, the implementation of NextGen is still in progress, and is on track for completion by 2025. In the Failure to Act report, the FAA estimates that implementing and maintaining NextGen will require an investment of $19.9 billion through 2025, and $38.2 billion through 2040. By 2020, NextGen implementation could result in a cumulative reduction in fuel consumption of 1.46 billion gallons and a projected 41 percent reduction in aircraft delays.

Airports face a $42 billion funding gap between 2016 and 2025. Airport funding comes from airport revenue, bonds, and federal/state/local grants like the Airport Improvement Program. One cause of the gap in funding comes from the failure of Congress to reauthorize FAA programs in some years, causing the FAA to operate only on short-term funding. This causes stoppage in work and project delays due to inconsistent funding. Failure to keep up with growing demands will cause serious negative impacts across the whole economy.

Water

Getting our drinking and clean water systems to a "B" grade over the next 10 years could create about 654,000 job-years across the U.S. economy.



Our nation's drinking water, wastewater, and stormwater infrastructure is vital to the protection, treatment, and distribution of clean water resources. Yet age, strain from population growth, lack of investment, and emerging threats from climate change have increased the burden on the current water infrastructure system. The nation's wastewater and drinking water infrastructure received grades of "D+" and "D" by the ASCE, respectively.[99]

U.S. cities rely on pipes that are, on average, a century old. These pipes leak 6 billion gallons of clean drinking water daily—approximately 14 percent of treated water—that wastes energy and water and disrupts businesses and communities. Additionally, there are an estimated 240,000 water main breaks per year in America—a rate of approximately 700 per day.[100]

All of that waste adds up to $2.6 billion dollars a year the U.S. loses to ineffective water distribution systems,[101] or enough water for 68 million Americans.[102] With aggressive action to remedy our ailing network, some estimate that we could save $1.7 billion of that.[103] A 2009 Chicago State University study showed that, at the time, reducing the amount of water leaked annually in the U.S. by only 5 percent would save enough energy to power 31,000 homes for a year and cut 225,000 metric tons of CO2 emissions.[104]

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, shifting demographics and business activities, the need for water treatment methods that address all pathogens, and environmental constraints all demand a more integrated, holistic approach to water services.

Climate change is straining our nation's water infrastructure. Shifting precipitation patterns throughout the country contribute to flooding and other problems. In some cases, such as the 2014 water main breaks in southern California, practices designed to conserve water produce drastic fluctuations in water supply and demand, stressing aging systems.[105] Investments in water recapture, reuse, and transport will save water and energy, reduce the carbon dioxide emissions from pumping water, and create jobs to improve our nation's water infrastructure.

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

Implementing low-and no-water technologies can support sustainability in the energy sector as well. The water dependence of many power plants creates a strain on the nation's water resources, especially as these plants meet rising electricity demands. Modernizing fossil fuel and nuclear plants with more water-efficient cooling technologies and investing in renewable energies will save water and energy, lessen risks of water-related power conflicts, benefit local ecosystems, and create jobs in an innovative 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 passing through sewage systems before spilling into rivers and streams that serve as drinking water supplies and sites for aquatic recreation.[106] This untreated runoff increases health risks, degrades ecosystems, and damages tourist economies. The EPA calls runoff, "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."[107]

As conventional development covers land with impermeable surfaces, the volume of stormwater running off buildings, streets, and parking lots into nearby waterways increases. The pollutants carried within this stormwater degrade the quality of local and regional waterways.[108]

During dry periods or typical rainfall events, combined sewer systems (CSSs) carry sewage and stormwater to municipal wastewater treatment plants, where the mixture 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.[109]

CSSs are employed in 772 communities nationwide, which are home to more than 40 million Americans.[110] According to the most recent CSO assessment, 43,000 overflow events occur per year, discharging 850 billion gallons of raw sewage and stormwater annually.[111] One 2014 flood event in Detroit, Michigan led to the discharge of nearly 10 billion gallons of sewage and stormwater into nearby waterways.[112] Under the National Pollutant Discharge Elimination System (NPDES) program, CSSs are required to implement measures that increase capture and treatment capacity during rain storms, and reduce the volume of runoff entering the system. However, one-fifth of CSSs still lack plans to reduce their sewage overflows or to separate their sewer systems into stormwater and sewage pipe networks. Those CSSs with plans are frequently years, and some decades, from full implementation.[113]

THE SOLUTION TO URBAN STORMWATER: GREEN INFRASTRUCTURE

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

Because of the health, ecological and economic benefits of green infrastructure approaches, cities across the country, including Seattle, Chicago, New York City, Philadelphia, and Nashville have embraced these techniques as part of their stormwater infrastructure programs.[114] In Nashville, a citywide green infrastructure plan identified potential runoff reductions of 3.5 billion gallons of water a year—a huge improvement for an area that annually sees 756 million gallons of sewer overflow into surrounding rivers and streams. The city is currently implementing pilot projects on a public high school, farmer's market, neighborhood street right of way, high-rise public housing for seniors, parks facility and a public works complex, with estimated runoff reductions ranging from 340,000 to over 6 million gallons a year.[115]

These cities' investments are also supporting local economies by creating jobs. The 2012 joint policy statement from the BlueGreen Alliance, *Clean Water, Good Jobs*, notes that 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—estimated 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 had slightly lower estimated development costs—approximately $400 less per acre than conventional stormwater/CSS construction—while also being more cost effective, providing more relief to existing stormwater systems per dollar than traditional management strategies.[116] This is in line with additional research on the subject, which found green infrastructure/LID, when compared to conventional approaches, costs approximately 17 cents less per gallon in mitigating combined sewer overflows.[117]

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 year 12 of the system's operations.[118]

Overall, if the full array of green infrastructure techniques were adopted at a nationwide scale for new construction projects above one acre in size, the job creation potential is estimated at approximately 84,000 direct, indirect, and induced jobs created and supported throughout the U.S. economy per year.[119] 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.

Lead Service Line Replacement – An Infrastructure Opportunity

The water crisis in Flint, Michigan, is a tragic example of the problem of lead service lines—pipes that carry water from utilities' water main into private homes—and how they can affect thousands of people without their knowledge. When Flint's water supply was switched from Lake Huron to the Flint River, residents started to complain about the water's smell, taste, and appearance. But it wasn't until 18 months after the state switched the water supply that physicians found extremely elevated lead levels in children. Today, more than three years after Flint's water was switched, over 100,000 residents have been exposed to dangerous levels of lead via their tap water.[120] Flint residents have only recently been advised that their city water is safe to bathe in,[121] while still being encouraged to filter their water before drinking it.[122]

This crisis is even more devastating when you realize the residents had no control over the situation or the permanent health effects that result from the exposure. Lead is a toxic metal that harms the brain and nervous system and is especially harmful during pregnancy and infancy, when it can decrease IQs, diminish academic abilities, and increase attention deficits and problem behaviors.

The Centers for Disease Control and Prevention (CDC) uses a reference level of 5 micrograms of lead per deciliter of blood to identify children whose blood lead levels are much higher than most children's levels and recommend initiation of public health actions. Approximately 500,000 children ages one to five years exceed the reference level, which is based on the U.S. population of children in that age range who are in the highest 2.5 percent of children when tested for lead in their blood. However, no safe blood lead level in children has been identified.[123] Even the lowest blood lead levels can affect the developing brain and central nervous system, and the effects can never be reversed.

Unfortunately, while Flint was the most visible example, across the country, many homes, schools, and other buildings still have service lines and other fixtures that contain lead. Across the country, there are an estimated 6.5 to 10 million homes with lead service lines serving 15 to 22 million Americans and millions of older buildings with lead solder.[124] As these materials corrode, lead can enter the drinking water supply. Individuals and communities across the country are therefore at risk to the host of health and societal problems associated with lead exposure. Communities of color and lower-income communities often bear a disproportionate brunt of the hazards of lead water contamination.

Eliminating lead exposure in our water systems can not only keep communities safe and healthy, but also create family-sustaining jobs, and boost local economies across the country, particularly if members of the impacted communities themselves are hired to do this work. The ASCE estimates that replacing lead service lines will cost $30 to $40 billion.[125]

Schools

Getting our schools to a "B" grade over the next 10 years could support or create an estimated 2.3 million job-years across the U.S. economy.

SCHOOLS

EXPECTED JOB-YEAR GROWTH

+426K	+2.3M
THROUGH 2022	THROUGH 2027

The ASCE 2017 Report Card gave America's schools a "D+" grade and identified three significant issues for education facilities in the United States.[126] First, nearly half of America's school buildings were built in the 1950s and 1960s 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 decreased significantly after the recession. While some states and communities have improved funding, many others have continued to cut funding despite growing enrollments and needs.[127] Third, the 2017 ASCE Report Card identifies a lack of data on school facilities—even though there have been several reports over the last few years, the actual condition of school infrastructure across the country remains difficult to quantify.

In the United States, some 50 million students attend almost 100,000 public schools in grades K-12. These school buildings are estimated to have a cumulative $271 billion in deferred maintenance costs needed to bring them to a state of good repair.[128] Additionally, the condition of school facilities affects student attitudes, health, and achievement, and can also affect staff morale and retention. Twenty-four percent of school buildings are rated as "poor" or "fair" quality. There are not just issues with the permanent buildings, outdoor facilities like parking or playgrounds also require repairs. For example, 27 percent of playgrounds and 31 percent of athletic fields were rated to be in "fair" or "poor" condition. In all, 53 percent of all schools need investments in repairs and modernization to be considered in "good" condition. [129]

Many of these facilities have maintenance issues that seriously affect student performance and may have lasting negative health impacts to occupants. Poorly maintained facilities may have insufficient lighting, or require repairs to windows, HVAC systems, or plumbing. A common issue that can have health and learning impacts on occupants is poor climate control from drafty windows and broken HVAC systems, resulting in poor air circulation, uncomfortable temperatures, and increased energy costs. Failing HVAC systems can also cause serious air quality issues, spreading allergens and mold, causing health problems in building occupants. The American Lung Association reported that in 2013, 13.8 million school days were lost in the United States due to absenteeism caused by asthma.[130] Poor air quality inside schools is responsible for at least some of these absences.

Another major issue with aging building stock is lead exposure from drinking water and paint. While the EPA action level for lead is at 15 parts per billion (ppb), there is no safe level of lead children can be exposed to. Even very low levels of lead exposure can cause damage to the brain and organs, resulting in developmental delays, loss of IQ, and behavioral issues. In a recent study, 8 percent of outlets at New York City schools had lead levels above 15 ppb, and the vast majority of school buildings in New York City—83 percent—had at least one outlet with a lead level above the threshold.[131] Many other schools around the country are discovering elevated levels of lead in their drinking water.

Modernizing school facilities provides opportunities to reduce energy costs and GHG 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.[132] According to the U.S. Green Building Council, a green school achieves the maximum level of energy and water efficiency possible and is built with the health of occupants in mind. Green schools use an average of 33 percent less energy and 32 percent less water, lowering utility costs of a typical green school by an estimated $100,000 per year.[133] These savings can be achieved from a variety of efficiency initiatives like energy efficient heating and air conditioning systems, lighting, window replacement, water efficient fixtures, Leadership in Energy and Environmental Design (LEED) certification, and choosing healthy building products.

School facilities affect the entire community—schools are often used as community emergency shelters, and housing values near good schools tend to be higher. Schools can also be a way to demonstrate the effectiveness of green practices and energy efficiency to communities. Since school funding often comes mostly from property taxes, there is a large disparity between schools in high-income and low-income neighborhoods. Many of the worst facilities are in low-income urban and rural communities. As a result, inefficient, unsafe facilities perpetuate inequalities between poor and wealthy students. Many studies show that after controlling for income, students in poor quality school buildings score between 5 to 11 percentile points lower on standardized tests than students in modernized buildings, and the longer that students are in deteriorating facilities, the more performance is affected.[134] The lowest quality facilities are often the least efficient, so not only will greening facilities impact achievement and attendance, but also dramatically lower energy costs, freeing up much needed money.

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 784,000 job-years across the U.S. economy.

Dams

There are more than 90,000 dams in the United States, which collectively received a "D" grade,[135] that provide energy generation, allow inland river navigation and flood control, store water for municipal and irrigation uses, and ensure hazardous waste retention.[136]

DAMS

EXPECTED JOB-YEAR GROWTH

+46K THROUGH 2022

+248K THROUGH 2027

The average age of these dams is 56 years old and, by 2025, 70 percent of our nation's dams will be more than 50 years old.[137] An estimated 11,882 dams are currently labeled as significant hazard, meaning a failure could result in substantial economic loss, but is unlikely to result in high mortality. [138]

The overall number of high-hazard dams—dams where a mistake or failure would result in loss of life—is on the rise, representing nearly 15,500 in 2015. An estimated 2,170 of those high-hazard dams are considered deficient and susceptible to failure.

At the time of their construction, many of the United States' dams were built as low-hazard dams to protect undeveloped agricultural land. As people settle below these dams, an increasing number of communities are at risk from dam failure.

Levees

LEVEES

EXPECTED JOB-YEAR GROWTH

+81K THROUGH 2022

+102K THROUGH 2027

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. Levees increasingly 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 2005, contributing to devastating floods throughout the New Orleans metro area and resulting in more than 1,000 deaths,[139] 124,000 jobs lost,[140] and total costs to the economy exceeding $200 billion.[141]

Following Hurricane Katrina, efforts were redoubled to assess and address the state of the nation's levee system, but the nation's levees still receive a "D" grade.[142] The United States Army Corps of Engineers (USACE) maintains a National Levee Database (NLD) of the nearly 30,000 miles of levees in the United States. The USACE estimates that nearly 67 percent of the nation's population lives in a county with at least one levee. The levees in the NLD average 50 years old, and protect approximately 14 million people and $1.3 trillion in property.[143] In the summer 2015, levees were estimated to have prevented $13.1 billion in flood damages.[144] Some larger levee systems along the Mississippi River network are estimated to provide as much as a 24 to one return on investment in prevented damages.

Significant development in floodplains and rising sea levels demand a comprehensive assessment of our levee system and upgraded systems to mitigate future hazards. Investing in sustainable upgrades to existing systems can create jobs and prevent future catastrophes like Hurricane Katrina.

Marine Ports and Inland Waterways

MARINE PORTS AND INLAND WATERWAYS

EXPECTED JOB-YEAR GROWTH

+19K THROUGH 2022

+99K THROUGH 2027

The United States has more than 920 coastal and inland ports, which received the grades of "C+" and "D", respectively,[145] that support substantial economic activity. In 2014, U.S. ports enabled $4.6 trillion in economic activity, produced $321 billion of taxes, and supported 23 million jobs.[146] The U.S.'s growing export markets in agricultural products, manufactured goods, energy, and refined petroleum depend on ports. In 2015, U.S. ports handled 99 percent of the United States' overseas trade.[147]

American ports and related transportation infrastructure can be upgraded to support larger ships and greater economic activity while reducing waste and pollution. Ports have dedicated $155 billion by 2020 for improvements and repairs to their facilities. These investments can reduce energy use and emissions from port operations by installing advanced technology for port administration vehicles, cargo storage facility temperature control systems, electric and fuel-powered cargo handling equipment, and harbor craft. For example, using advanced technology for the more than 110,000 heavy-duty vehicles offloading cargo at maritime ports would immediately cut emissions and fuel consumption by 10 percent.[148] This technology can also reduce heavy carbon pollutants that affect the more than 87 million Americans living in port communities.[149]

Cleaner technologies at ports must be coupled with investments that help ports experiencing decreased productivity due to landside congestion. According to a 2015 American Association of Port Authorities (AAPA) survey, one-third of ports have operated at 75 percent or less of their optimal efficiencies for the last decade due to landside congestion.[150] Truck, rail, pipeline, and inland waterway infrastructures require maintenance and improvement to efficiently transport goods passing through U.S. ports. Reducing this intermodal transport bottleneck will lower emissions from port operations as well as emissions from the other forms of transportation.

One critical form of landside transportation is shipping along inland waterways. The United States relies on its inland waterways and rivers to ship an estimated 410 million tons of freight a year.[151] The inland waterway system includes 25,000 miles of commercially navigable channels serviced by nearly 239 locks. The average age of commercially active locks in the United States now exceeds their 50-year design life by nine years.[152] Many locks in operation today were constructed during the 1930s, including most locks on major systems as the Mississippi, Illinois, and Tennessee Rivers. Even many "second generation" higher-lift locks on the Ohio River were built largely in the 1950s.[153]

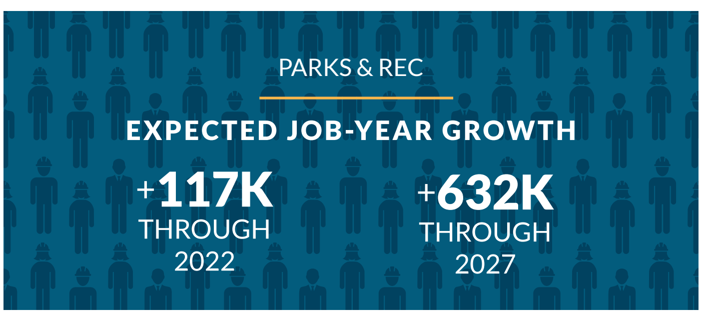
Aging locks have led to increasing delays for freight ships. Forty-nine percent of vessels traveling U.S. inland waterway systems in 2014 experienced a delay at locks, with the average delay lasting two hours.[154] As of 2014, delays had grown 189 percent longer than in 2000 and affected 14 percent more ships. While recent investment has accelerated repairs at many inland locks, these projects are racing against increasing freight loads. Shipment loads on inland waterways are expected to grow 40 percent from 2010 levels by 2040.[155]

The U.S. should make every effort to accommodate this anticipated aquatic shipping expansion, as freight ships reduce strain on the nation's multimodal freight network and save energy. Waterway transport averages 616 ton-miles per gallon of fuel, versus 478 per ton-mile for rail and 150 per ton-mile for trucking.[156]

Investing in U.S. dams, levees, ports, and inland waterways is vital for the future of the U.S. economy and the safety of American communities. Thoughtful investment will expand the resilience and efficiency of U.S. aquatic infrastructure and create up to 169,000 good jobs for American workers.

Outdoor Economy

Getting our parks and recreation facilities to a "B" grade over the next 10 years could support or create an estimated 632,000 job-years across the U.S. economy.



America's public lands are noteworthy not just for their environmental value, but also for the deep cultural heritage and the economic opportunity they offer to the nation. In 2016, there were over 331 million visits to national parks alone,[157] with another 791 million at state parks.[158] These visitors play a huge role in local and national economies, contributing to both local jobs near park facilities as well as the broader outdoor recreation economy. The outdoor economy is an $887 billion industry in the United States—responsible for 7.6 million jobs—as well as $65.3 billion in federal and $59.2 billion in state and local tax revenue.[159]

According to the National Park Service (NPS), in 2016 park visitors spent $18.4 billion within 60 miles of NPS lands, supporting 318,000 jobs in rural gateway communities.[160] Similarly, activity on Forest Service lands supports more than 205,000 jobs with $11 billion in local economic impact, and visitors to U.S. Army Corps of Engineers lands sustain 187,000 jobs with $13 billion economic influx.[161]

At the federal level, the Bureau of Land Management, Forest Service, Fish and Wildlife Service, and National Park System manage the vast majority of public lands,[162] while states and localities host the majority of park and recreational facilities that Americans use on a day-to-day basis.[163] State parks and recreation areas cover nearly 19 million acres,[164] while our nation's federally maintained lands cover an estimated 640 million acres.[165] Almost 34 percent of America's land is forested,[166] almost a quarter of which is designated national forest.[167]

America's public lands also act as critical environmental regulators. For one, forests play a major role in the carbon cycle, acting as carbon sinks by uptaking and storing carbon. 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.[168] These areas, along with grasslands and other open space, also play a large role in our nation's water quality. The water supply of 180 million Americans is captured and filtered by national forests and grasslands. The ASCE values the water coming from U.S. Forest Service land alone is worth $7.2 billion annually.[169]

Despite the role that public lands play in our nation's economic and environmental well-being, governing agencies at all levels are challenged to support these resources and our parks and recreation facilities receiving a "D+" grade.[170] Across the country, cities and localities have increasingly been faced with declining state and federal funding for parks. Chronic underfunding of National Park Service budgets has led to an $11.9 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 $5.1 billion. At the state level too, state parks are facing a $95.3 billion funding gap. These deficiencies present huge challenges to the agencies responsible for our public lands, and are only worsening as visitation continues to increase.[171]

For over 50 years the Land and Water Conservation Fund (LWCF) has generated funding to protect some of these public lands. Using fees collected on offshore drilling, it provides management for habitat corridors, and critical lands throughout national parks, national wildlife refuges, national forests, Civil War battlefields, and other federally managed areas. Each year energy companies contribute $900 million to this fund, but Congress diverts much of it to other areas (awarding only $306 million to conservation in 2014), worsening the aforementioned funding gap.[172]

Recently introduced legislation to permanently authorize the LWCF program would help protect public landscapes and wildlife for future generations of hunters, anglers and outdoor enthusiasts, while boosting local economies. The Department of the Interior spent $214 million on land acquisition in 2010, which spurred $442 million in economic activity and created 3,000 jobs.[173] Additional studies show that 20 jobs are generated for every $1 million invested in park and recreation conservation projects.[174] To date, over $4 billion in federal LWCF funding has leveraged over $8 billion in matching funds for states and localities.[175]

Along with protecting public lands, the federal government plays a large role in environmental remediation. Established through the Surface Mining Control and Reclamation Act in 1977, the Abandoned Mine Land (AML) Reclamation Program provides funding to states and tribes to clean up legacy mine pollution, while regulating current mining to ensure that reclamation occurs simultaneously. The program is funded by fees on coal mine operators, amounting to over $10.5 billion since its inception.[176] Additionally, interest on those fees amounting to $1.5 billion has partially covered costs for health care plans for the United Mine Workers of America (UMWA).[177] While those figures are significant, government estimates show a remaining funding gap of $9.8 billion required to reclaim coal-related AML areas.[178]

Federal efforts have been put forward that would expedite the use of existing funds in the Abandoned Mine Land Fund to reclaim abandoned mines and stimulate economic development on that reclaimed land. Not only would efforts like this benefit communities by restoring the natural environment, they would also invest long-term in the economic diversification of these communities.

America's forests and outdoor spaces provide carbon benefits while also providing other important benefits like clean water, flood control, outdoor recreation opportunities, wildlife habitat, and job creation. Protecting these valuable resources is of crucial public value, but faces significant financial constraints and opposition. Current efforts to roll back National Monument designations put over 11 million acres of public lands at risk, as well as nearly 218 million acres in Marine National Monuments.[179] Continued policy protection is necessary to keep these environmentally and culturally significant lands protected for future public use. Investing in public lands will deliver many benefits to quality of life, through improved recreation, economic opportunities, and greater sustainability for communities across the country.

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 26,000 job-years across the U.S. economy.

Our solid waste and hazardous waste systems received grades of "C+" and "D+" respectively.[180] In 2014, Americans generated 258 million tons of trash, of which 89 million tons were recycled and 33 million tons were combusted for energy production.[181] This represents a 34.6 percent recycling rate, more than double the 14.5 percent in 1980.[182] Per capita generation rates of waste have been steady over the past 20 years and have declined slightly after peaking in 2000.[183] As we see progress in reducing solid waste, cutting the amount of waste Americans generate by another 5 percent could reduce GHG emissions by another approximately 10 MMTCO2e—the equivalent emission of 6 million U.S. households.[184]

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 116 MMTCO2e in 2015.[185] About half of all GHG pollution from landfills is comprised of methane, which has at least 25 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.[186]

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 United States in 2009 was slightly above 35 million tons. An estimated 53 percent of Americans live within three miles of a hazardous waste site.[187]

Hazardous waste sites are mitigated through three major cleanup and preventative permitting designations: Superfund, brownfield, and RCRA. These programs cover 18,000 sites on 22 million acres of land,[188] with the goal of turning contaminated land into environmentally safe, economically productive areas. A study of 458 Superfund sites shows businesses on formerly vacant lots employing over 131,000 people, with annual sales revenues of $34 billion—nearly four times the EPA's cost of cleanup.[189] Brownfield cleanup similarly provides an 18 to 1 return on investment ratio for every federal dollar spent.[190]

Clearly there has been significant progress in the cleanup of the nation's hazardous waste and brownfields sites. However, funding for cleanup of the 1,337 sites remaining on the National Priorities List (identified by EPA as releasing or threatening release of hazardous substances, pollutants, or contaminants) is estimated to be as much as $7 billion short of what is needed.[191]

VI. HIGH-ROAD STANDARDS TO ENSURE INVESTMENTS DELIVER TO WORKERS AND COMMUNITIES

Investments to rebuild our infrastructure must support a prosperous, clean economy and should be implemented with smart planning and sound standards that ensure American communities and workers—as well as the environment and economy—see the full benefits of these investments now and for decades to come.

The lack of consideration to manufacturing and labor standards in many projects has meant that major public investments have not resulted in the good jobs and the economic development communities expected. Short-sighted planning with minimum standards has meant some projects are utilizing cheaper, weaker, imported materials that threaten safety and result in costly repairs, and deliver fewer jobs, lower wages, and less successful projects and services over the long term.

With forward-looking planning, leadership in manufacturing, and use of clean and efficient technology, as well as high standards for materials, projects, and operations, rebuilding our infrastructure systems can be a powerful driver of economic growth and high-quality, family-supporting jobs. Building for the type of future we expect and want can also ensure that infrastructure investments result in communities that are healthier, stronger, and more resilient.

Key measures to achieve these goals include:

Implementing Labor Standards — Ensuring Good, Safe Jobs

The people who build and rebuild our infrastructure projects should be well-trained, make a decent living, and work in a safe environment. To achieve this, all major projects should include a Project Labor Agreement, Community Workforce Agreement, or Responsible Contractor standard. Community Benefits Agreements can also ensure that projects deliver benefits and opportunities for local workers and communities. In addition, these agreements should include "Davis-Bacon"[192] requirements for payment of prevailing wages and state-certified apprenticeship training with targeted hire and funding for pre-apprenticeship programs for local disadvantaged communities, low-income households, and veterans.[193]

In addition to lifting families out of poverty and supporting American companies that invest in the safety and economic security of their employees, infrastructure employment policies can save workers' lives. Infrastructure investments require a large number of skilled workers in the building and construction industry. This industry, however, is hazardous: it employs about 8 percent of the national workforce (about 11 million workers), yet it accounts for more than 20 percent of all traumatic on-the-job fatalities—more than any other industry.[194] In 2014, approximately 1,000 U.S. construction workers died on the job out of 4,800 total on-the-job traumatic fatalities, according to the Bureau of Labor Statistics.[195] For every construction worker fatality, there are about 100 on-the-job injuries in construction that require time away from work.[196]

These national numbers obscure large differences in the fatality rates among states, and they obscure the policy decisions that play a role in determining those differences. During the period 2012 to 2014, for example, the Texas and California construction industries employed about the same number of workers (616,000 in TX and 634,000 in CA), but nearly twice as many construction workers died on the job in Texas (326) as in California (166) (Figure 6).[197]

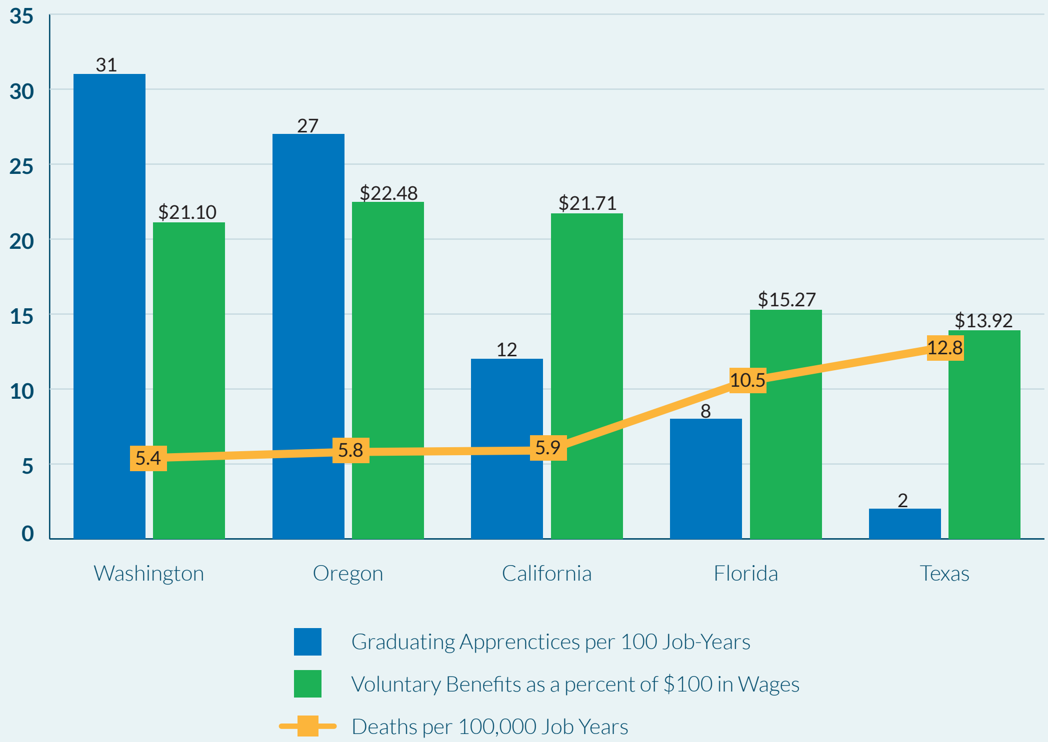
These differences reflect public policies and laws in each state that protect—or fail to protect—the safety and health of workers in the construction industry. The most successful policies are worth replicating at the national level as the country considers investing in large-scale infrastructure projects.

In the area of training, for example, in 2012, Texas invested $54 million in construction apprenticeship programs, compared to $300 million in California, for a workforce of comparable size.[199] The fatality statistics in Texas are an indicator of the implications in that state of lower investments in construction apprenticeship training (Figure 6).

To protect worker safety and health, infrastructure policies should:

- Require and verify that all firms and subcontractors seeking to perform work on funded or subsidized projects demonstrate compliance with: all applicable license, bonding, and insurance requirements; wage and hour, safety and health, and other employment requirements; and permitting that includes successful completion of all code inspections.
- Establish wage floors, develop career ladders, and allocate funding for training programs linked to local-hire guidelines.
- Require all firms and subcontractors to collect and report all required data in a transparent manner.
- Encourage participation by contractors who have a record in apprenticeship training and effective worker safety and health programs. Contractors who appear on federal OSHA's Severe Violator list should be prohibited from submitting bids to perform work.
- Fund federal and state OSHA enforcement and consultation programs to assist employers in abating hazards; prevent non-compliant employers from gaining a competitive advantage; and ensure regulatory compliance with workplace safety and health regulations, before workers are injured, sickened, or killed on the job.
- Fund an occupational health and safety research program to track, identify, and reduce worker injuries, illnesses, and fatalities at infrastructure investment sites.

Figure 6: Voluntary benefits, apprenticeship training, and construction industry fatality rates, 2012.[198]



- Fund a national clearinghouse of technical information and assistance on safer chemicals and products and on the proper handling and disposal of hazardous chemicals and products for use by contractors working on infrastructure sites.
- Where needed, fund local government agencies to support effective management of large quantities of demolition debris and hazardous waste.
- Fund apprenticeship training in the building and construction trades. Funding should be provided to trade union apprenticeship programs, vocational schools, and community colleges, including those in small and mid-size cities, to carry out this training.
- Ensure that at least 60 percent of workers at infrastructure sites are OSHA 10-hour General Industry Safety and Health Certified, and that at least one worker is OSHA 30-hour General Industry Safety and Health Certified.
- Fund training for building and construction industry professionals, such as engineers, supervisors, trainers, environmental assessors, planners, and others. Require the Department of Labor to coordinate with EPA and its delegated states to ensure a sufficient supply of lead hazard professionals to oversee lead abatement work at demolition sites.

For primarily non-union industries, such as forestry and agriculture, it is important to establish wage floors based on a local living wage for all contractors and subcontractors. These businesses also must create career ladders for advancement linked to local communities.

The following priorities should be used in choosing contractors and subcontractors[200]:

- Hire a certain percentage of residents who are from the project area (local hire) and/or disadvantaged (i.e. recently or currently in receipt of public benefits, formerly incarcerated, formerly or currently homeless, single parents, or graduates of targeted career training programs).
- Establish wage floors, develop career ladders, and allocate funding for training programs linked to local-hire guidelines.
- Establish pre-selection certification based on data on responsible contractor criteria, with provisions to facilitate participation by targeted diversity groups. Pre-selection can screen out contractors who have a history of code or labor law violations, and reward contractors who adhere to a set of standards (i.e. regarding worker skill, wages and benefits, local hire, etc.).

- Allow no utilization of unpaid volunteer labor, which undermines paid workers and erodes a high-road work environment. The use of volunteer labor inadvertently rewards workers who do not require compensation because they have other sources of income and business models that do not support the long-term vitality and resilience of low-income communities and residents.
- These workers must be given the right and opportunity to collectively bargain.

Procurement — Leveling the Playing Field

Investing in infrastructure has the potential to lead a major revival of the U.S. manufacturing sector, with the expansion of good job opportunities at all levels of the domestic supply chain. This potential depends in large part on the inclusion of measures to stimulate U.S. manufacturing of the products and materials used in infrastructure development. Effective procurement policies, both longstanding measures and new, innovative approaches can help infrastructure projects achieve these objectives.

Any infrastructure package should utilize and enforce enhance long-standing Buy America and Buy American provisions for public and critical infrastructure, and seek to increase domestic content of machinery and materials used in the program. Federal or state funds should be designed to incentivize domestic content and manufacturing. For over thirty years, the Federal Highway Administration (FHWA) has maintained Buy America provisions related to iron and steel production. The Federal Transit Administration (FTA) issued guidance in 2016 that advises transit agencies and transit vehicle manufacturers how to implement a phased increase in domestic content requirements for transit rolling stock procurements from 60 percent to more than 70 percent by the year 2020.

Effective policy tools exist to encourage the use of domestically manufactured materials beyond traditional Buy American provisions, such as the following:

- Use precedent such as the National Defense Authorization Act of 2011 and 2015, which required that contracts for photovoltaic (PV) devices installed on Department of Defense (DoD) property must meet "domestic photovoltaic device" criteria, defined as a PV device that is manufactured in the United States and for which the cost of its components mined, produced, or manufactured in the United States exceeds 50 percent of the cost of all components.
- State utilities regulators can give a domestic content bonus under their Renewables Portfolio Standards to renewable energy generators that build new facilities with a to-be-determined percentage of their parts made by in-state manufacturers.

Additionally, innovative new procurement policies and approaches are being used to enhance the local economic benefits of major infrastructure investments. These "Buy Fair" procurement agreements—like the U.S. Employment Plan adopted in many major transit procurements—reward companies that do more to boost local hiring, training, and career paths; engage underserved communities and disadvantaged workers; and improve wages, benefits, and safety.[201] These agreements also encourage domestic manufacturing and sourcing and can be combined with community benefit agreements. Programs like DOT's place-based technical assistance projects and Ladders of Opportunity can further aid in ensuring infrastructure projects are planned and executed in ways that maximize their benefits to local communities.

Finally, through smart procurement practices, we have a significant opportunity to cut GHG emissions and improve worker health and safety. Through a "Buy Clean" policy, specific consideration can be given to the pollution associated with the manufacturing and transport of infrastructure materials. This approach incentivizes customers to select materials that have a lower carbon footprint, thus helping to create a market for low-carbon products. Buying cleaner infrastructure materials will help ensure tax dollars are spent on cleaner products, while encouraging manufacturers to improve processes to stay competitive, thus driving improvement across industrial sectors.

For example, San Francisco's Bay Bridge was built using steel from a foreign competitor's heavily polluting factory, which resulted in additional emissions of roughly 180,000 tons of additional C02, equivalent to adding 38,000 cars to the road. Utilizing a Buy Clean policy will allow purchasers to avoid products that significantly impact workers and the environment, and reward companies who invest in cleaner, more efficient methods of production.

Transparency and Data Collection

An infrastructure package should require that its administrators adopt key indicators of job creation and duration, job quality, training, and inclusion, in consultation with labor force experts, and should require all contractors and subcontractors to report this information via participation in a confidential online jobs reporting system based on certified payroll data. All manufacturers, contractors, and subcontractors should be required to disclose domestic content commitments on manufactured goods over a value to be determined by administrators. Manufacturers should also describe efforts to work with local and regional suppliers to meet and exceed Buy America goals, as well as provide supply chain job creation by location. Administrators should make public comprehensive summaries of all data on a regular basis.[202]

Building Smart and Clean

As we build out the next generation of infrastructure, it is critical that we design for the future that we want and expect. Climate change is projected to put intense strain on our infrastructure. Sea level rise, extreme weather events, and more will compromise systems from tunnels, bridges, and roads to ports and harbors. In urban communities, essential services like energy and water supply are interdependent, so climate-related disruptions of one system will most likely result in disruptions in others.[203] Strategic investments in climate-resilient infrastructure, and a workforce well trained in climate resilience, can ensure that our communities are prepared for these impacts and come out stronger, more sustainable, and more resilient to meet the challenges of the next century.

Infrastructure investments should be forward-looking and deliver environmental benefits, like cleaner air and water and fewer GHG emissions. It is clear that the climate's historical trend is no longer a reliable predictor of future scenarios. Therefore, investing in infrastructure for conditions that used to exist in the past will leave communities even more vulnerable to climate risks.[204] Instead, it is essential for projected climate conditions to be considered in the decision making process for future infrastructure developments.

Any infrastructure package should also follow processes that ensure effective environmental review and public participation in infrastructure decisions while also prioritizing the resources needed to ensure these projects move forward quickly and deliver benefits to communities and workers quickly.

Policies That Create Quality Jobs

To ensure we maximize the benefits of our infrastructure investments for communities, the environment, jobs, wages, benefits and retirement security, we suggest the following recommendations:

- Ensure all projects built with public resources are subject to "Buy America" standards that maximize the return to taxpayers and the American economy by utilizing American-made building products, parts, and components;
- Enforce Davis-Bacon[205] prevailing wage provisions that ensure workers are paid prevailing wages on public works projects;
- Utilize project labor agreements (PLAs), a collective bargaining tool establishing terms and conditions for employment on the projects, as well as community benefits agreements;
- Utilize public interest procurement provisions and practices, such as those that prioritize improving training, working conditions, and community benefits, and those that prioritize use of the most efficient, cleanest materials and products with the lowest carbon and toxicity footprints. These measures help ensure that public investments strengthen domestic manufacturing;
- Instill forward-looking planning that meets environmental standards and builds resilient infrastructure systems;
- Enhance workforce training and development programs to expand the number of skilled workers in new and existing industries and increase economic opportunities for communities and local workers, especially for people of color and low-income communities; and
- Prioritize public funding and financing for infrastructure investment to ensure projects are completed in a timely way and built with products and materials that are of the highest quality and are produced with the lowest carbon intensity. While it is appropriate to consider innovative financing tools to leverage federal funds, like infrastructure banks, grant and loan programs, and public-private partnerships, all financing methods should be held to strong public interest standards.

VII. CONCLUSION

The U.S. employment situation and our physical infrastructure are both well below their potential. It is heartening that the state of our nation's 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 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.

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BLUEGREEN ALLIANCE

bluegreenalliance.org

1300 Godward Street NE, Suite 2625
Minneapolis, MN 55413

1020 19th Street NW, Suite 600
Washington, D.C. 20036

155 Montgomery Street, Suite 1001
San Francisco, CA 94104