Interconnected

The Economic and Climate Change Benefits of Accelerating Repair and Replacement of America's Natural Gas Distribution Pipelines

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

BLUEGREEN ALLIANCE

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

The AFL-CIO is the umbrella federation for U.S. unions, with 56 unions representing 12.5 million working men and women.

BLUEGREEN ALLIANCE PARTNER ORGANIZATIONS

United Steelworkers USW · Sierra Club Founded 1892 · CWA · NRDC · National Wildlife Federation · SEIU Stronger Together · SMART · Union of Concerned Scientists · Utility Workers Union of America AFL-CIO · aft · Amalgamated Transit Union · UAW · UA · International Union of Bricklayers and Allied Craftworkers · EDF Action Political action partner of Environmental Defense Fund

TABLE OF CONTENTS

Authors:

Jim Barrett, PhD.
Rob McCulloch

Acknowledgements

We are grateful for the assistance of Dave Barnett (United Association of Journeymen and Apprentices of the Plumbing and Pipe Fitting Industry of the United States, Canada and Australia), Vignesh Gowrishankar (Natural Resources Defense Council), Jim Harrison (Utility Workers Union of America), Roy Houseman (United Steelworkers), Dean Hubbard (Sierra Club), and Brad Markell (AFL-CIO Industrial Council).

Thank you to colleagues David Foster, Kim Glas, Kelly Schwinghammer, Roxanne Johnson, Erin Bzymek, and Eric Steen.

Design by Winking Fish.

Errors remain the responsibility of the authors.

EXECUTIVE SUMMARY

As the United States continues a slow but steady recovery from the recession triggered by the financial crisis of 2007 and 2008, investment is desperately needed to fuel economic growth and job creation—including modernizing large swaths of our nation's infrastructure.

Repairing the system of distribution pipelines that deliver natural gas to homes and businesses offers an opportunity to drive significant investment in our economy. Doing so will help to fix a critical part of our aging infrastructure while creating jobs and cutting global warming pollution—a winning proposition for both the environment and the economy.

While the repair and replacement of natural gas distribution pipes is underway in many parts of the country, the nation won't see an overhaul of the estimated 9 percent of distribution pipeline comprised of aging, leak-prone materials for three decades at the current rate of progress. This report considers an alternative, accelerated scenario whereby this rate of repair and replacement activity would be tripled—a goal not inconceivable were ideal policy and finance mechanisms in place.

The report findings include:

- Accelerating the timeframe of pipe replacement would increase Gross Domestic Product (GDP) by over $37 billion by 2024, leaving GDP $30 billion higher in that year compared to the 30-year repair and replacement schedule.
- By the end of the 10-year replacement timeline, over 313,000 people would be employed, with nearly 250,000 more jobs created than in the 30-year repair and replacement scenario.
- Over three decades, the accelerated 10-year scenario would save nearly $4.4 billion worth of gas. Those savings are $1.5 billion more than under the current rate of repair and replacement.
- The faster replacement rate prevents an additional 81 million metric tons of greenhouse gases from being emitted into the atmosphere, roughly equivalent to taking 17 million cars off the road for one year.

Investing in our infrastructure is a winning proposition for consumers, the environment, and the economy as a whole. Accelerating the timeline will provide those benefits at a time when America needs them the most, and provide a net benefit to sectors throughout the economy.

1. INTRODUCTION

The United States continues to slowly climb out of the recession triggered by the financial crisis of 2007 and 2008. As measured by Gross Domestic Product (GDP), overall economic growth is on the rise again, and the stock market is reaching new heights. At the same time, however, the economy struggles to create jobs. While the unemployment rate is below 7 percent for the first time since 2008, as Figure 1 below shows, overall employment—and employment in the construction and manufacturing sectors—remains below their pre-recession levels. Part of the reason for this is that, despite historically low interest rates, money spent on machinery and other physical capital used to create goods and services in the U.S. economy also remains below pre-recession levels.

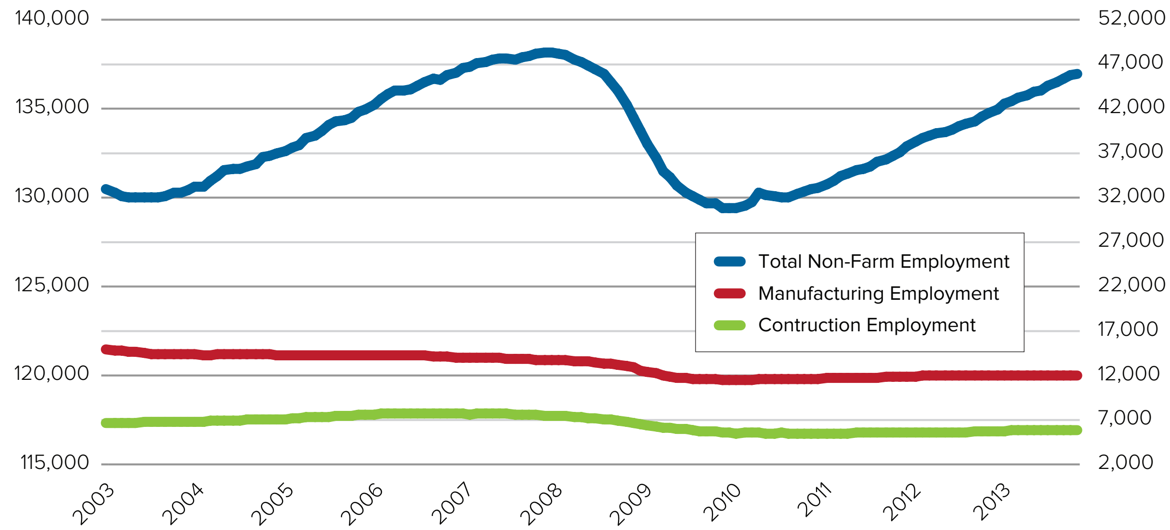
At the same time that investment is desperately needed to fuel economic growth and job creation, investment is also desperately needed to update and repair large swaths of our infrastructure. The American Society of Civil Engineers (ASCE) produces assessments of the state of the U.S. infrastructure and regularly gives it barely passing grades. In its most recent 2013 infrastructure scorecard, our infrastructure, and the subset of energy infrastructure including our natural gas distribution systems, got an overall score of "D+." This is sadly a minimal improvement from the previous scorecard in 2009, which gave America's overall infrastructure systems a "D" grade.[1]

In this economic environment, we also face the challenge of addressing the looming problem of global climate change, driven mainly by anthropogenic emissions of greenhouse gas pollution. The scientists of the Intergovernmental Panel on Climate Change have amplified their warning that humans burning fossil fuels are pouring greenhouse gases into the atmosphere at a rate that is causing an unprecedented and likely devastating threat to civilization and the biosphere.[2]

We must face the news that after declining by 12 percent since 2005, U.S. carbon emissions rose by 2 percent in 2013.[3] Despite the substantial dangers posed by a disrupted climate, some claim that the economic recovery is too fragile to embark on major efforts to reduce emissions. Others, however, are noting the opportunity for new sectors, like the clean economy, to power a robust and healthy 21st century economy.

Repairing the system of distribution pipelines that deliver natural gas to homes and businesses offers an opportunity to address all of these issues at the same time. A significant investment in our domestic economy—one that will help fix a critical part of our aging infrastructure while simultaneously creating jobs and cutting global warming pollution—replacing aging and leak-prone pipes in the natural gas distribution system is a winning proposition for both the environment and the economy.

FIGURE 1. Historical U.S. Employment, Thousands of Jobs



Note: Total Employment is measured on the left axis, Manufacturing and Construction Employment on the right. Both are in thousands of jobs.

Source: U.S. Bureau of Labor Statistics

2. THE NATURAL GAS PIPELINE SYSTEM

The U.S. consumes approximately 25 trillion cubic feet of natural gas annually. Extracted from wells, the gas travels through a web of gathering lines to processing and treatment plants, where it is purified and any useful byproducts of the gas are removed to be marketed separately. The gas is compressed and fed into the 300,000-mile transmission pipeline system that carries the gas over long distances. Electricity generators and large industrial facilities will often draw gas directly from the transmission system before the gas arrives at a "city gate" where an odorant is added to give the otherwise odorless gas its smell (to aid in leak detection) and it is pumped into a system of distribution pipelines that deliver the gas to homes, businesses and smaller industrial consumers.

There are roughly 1.25 million miles of natural gas distribution pipeline in the U.S. The pipes tend to be much smaller than the ones used in transmission, typically ranging from 2 to 12 inches in diameter, whereas transmission pipes can be as large as 48 inches wide. Many of the pipes in use in the distribution system are old, having been put in service as many as 50 years ago or more. Many of these older pipes are made of relatively brittle and leak-prone materials—like cast iron and unprotected steel—which is more likely to suffer from heavy corrosion problems. These older and leak-prone materials currently account for about 9 percent of the total distribution pipeline mileage.

Although leak-prone pipes make up a small share of the overall distribution system, they are 18 times more leak-prone than plastic and 57 percent more leak-prone than the steel pipes specially treated for handling gas that make up the majority of pipes in service today.[4] The EPA estimates roughly 69 billion cubic feet (bcf) of natural gas leaks from the distribution system every year. Of that total, around 32 bcf leaks from the pipes themselves, and we estimate that the small minority of leak-prone pipes account for roughly 23 bcf of leaked gas every year.[5]

These leaks come with a substantial economic and environmental cost. Every cubic foot of gas that leaks from the distribution system wastes the energy and financial resources that went into producing and delivering it to the city gate, and because uncombusted natural gas is a powerful greenhouse gas, this leakage represents a significant addition to global climate change, equivalent to adding almost two million cars to the road every year.[6, 7]

In addition to these readily identified and calculated impacts, the leak-prone pipes in the distribution system carry significant economic costs in terms of reduced reliability of the natural gas system as a whole. While leaks from the gas distribution pipeline system pose a costly problem, the fact that the majority of the risks lie in a small minority of the distribution system makes repairing this aging and leak-prone part of the pipeline an obvious and high-return step in reducing these risks.

In 2011, Ray LaHood, then Secretary of the U.S. Department of Transportation, issued a "Call to Action" to state pipeline regulators (who have responsibility for intrastate pipelines including most natural gas distribution systems) to "accelerate the repair, rehabilitation, and replacement of the highest risk gas and liquid pipeline infrastructure."[8] According to the American Gas Foundation, the number of miles of gas distribution served by leak-prone materials fell by about 43 percent from 1990 to 2011, marking significant progress in addressing the problem. However, at the current pace it would take another 30 years to finish the job.[9]

This is simply time we do not have, given 1) the scientific consensus that we must act now to drastically reduce greenhouse gas emissions to prevent irreversible harm to the biosphere and human civilization, 2) the threats to our communities and economy posed by leaking distribution pipelines, and 3) the economic need to address long-term structural unemployment, especially in construction and manufacturing.

This paper examines the economic and other implications of accelerating the current timeline so that the remaining leak-prone distribution pipes are replaced over 10 years instead of 30. Adopting a more aggressive timeframe for replacing leak-prone pipes in the distribution system meets the Department of Transportation's call to accelerate the pace of addressing the problem and would provide significant job creation, climate, and community benefits as well.

3. WHY ACCELERATE LEAK-PRONE PIPELINE REPLACEMENT?

The obvious answer to the question is simply that an accelerated replacement schedule would reduce the amount of gas leaking from the system, return value for gas customers paying for lost gas, improve safety, and cut greenhouse gas pollution. In addition, as the economy recovers slowly from the financial crisis of 2007-2008 and the recession that followed, accelerating the pace of pipeline replacement would increase GDP and employment in the short run—when the economy needs it most.

It would also take advantage of the relatively low costs of capital needed to finance the work. It would encourage natural gas utilities to actually perform repair and maintenance functions that have been built into their rate structures by regulators. Speeding the rate of replacement of older pipes would help ensure that funds being collected from consumers are put to use in a timely fashion.

The focus of this report is on the economic impact of accelerating the pace of replacement of leak-prone pipelines. We find one benefit of expediting these activities would be to drive economic investment more quickly into various sectors of the economy, in addition to reducing the climate impact of escaping methane and making our natural gas distribution system more reliable.

Rather than stretching this work out across 30 years, accelerated modernization would provide a much-needed economic "shot in the arm" just when it is needed. There are also benefits from prioritizing repair of problematic pipeline segments and performing other activities in lieu of replacement that still ensure a safe pipeline network and curtail methane losses. Policies should ensure leaking pipes are immediately addressed while ensuring integrity of all pipes without expanding capacity. Given capacity and still-recovering labor demand in many pipeline-related sectors—such as construction and manufacturing—accelerating upgrades at the level we are suggesting will not have an adverse impact on the costs of projects due to increased demand for materials and workers.

Table 1. Materials Used in America's Natural Gas Distribution Lines

Material	Miles	Share of Total
Bare Steel	62,329	5.1%
Unprotected Coated Steel	15,935	1.3%
Cast Iron	34,329	2.8%
Subtotal, Leak Prone Materials	**112,593**	**9.1%**
Protected Coated Steel	473,871	38.5%
Plastic	644,418	52.3%
Other	893	0.1%
Total, All Materials	**1,231,775**	**100.0%**

Source: American Gas Foundation. *Gas Distribution Infrastructure: Pipeline Replacement and Upgrades. Cost Recovery Issues and Approaches*.

A. ESTIMATING REPLACEMENT COSTS

The natural gas distribution system consists of roughly 1.25 million miles of pipeline. The majority of the pipeline consists of plastic and protected steel pipes that have a relatively low risk of leakage. A minority of the system consists of leak-prone materials: bare steel, unprotected coated steel, and cast iron. Table 1 above shows the breakdown of the system by materials.

The cost of replacing distribution gas pipelines depends heavily on the diameter of the pipe being replaced. In a report on the cast iron inventory, the American Gas Association (AGA) estimates that the cost of replacing pipelines ranges from approximately $1.5 to $5.0 million per mile, depending on diameter and other factors.[10] Based on the average costs for various ranges of pipeline diameters, the AGA estimates that replacing just the cast iron share of the system would cost roughly $82.6 billion. Applying their methodology to the entire stock of leak-prone pipelines, we estimate the total cost of replacing the leak-prone pipelines to be approximately $275 billion.[11]

As mentioned above, the industry is currently on pace to complete this investment on a nationwide scale over 30 years. This paper aims to examine the impacts of completing it in 10 years, instead, and how a comprehensive approach to fix the most critical portion of pipes would have implications in terms of the phasing of such investment.

Augmenting this to offer substantial economic and environmental benefits versus costs would be a multi-pronged approach whereby leak detection methods are significantly improved and deployed to address critical parts of the system, and subsequently specifically focused repairs are the most effective response to avert methane loss.[12] These critical portions vary widely among communities, many of which are identified through the Pipeline Hazardous Material and Safety Administration as well as state and utility inventories of leak-prone pipe. Ideally, a concerted effort to drive investment would prioritize those systems with the most imme-diate need for repair.

B. ECONOMIC IMPACTS

The recession triggered by the financial crisis of 2007-2008 has slowed the economy significantly, lowering overall GDP and employment. As the economy recovers, both overall income and particularly employment levels lag well behind where they would likely have been. Accelerating the replacement of leak-prone distribution pipelines would add an immediate boost to both jobs and GDP. As shown in Figure 2, **accelerating the timeframe of pipe replacement would increase GDP by over $37 billion by 2024, leaving GDP $30 billion higher in that year compared to the 30-year replacement schedule.**

Employment at the national level would increase as well, following a similar pattern as shown in Figure 3:

By the end of the 10-year replacement timeline, over 313,000 people would be employed, with nearly 250,000 more jobs created than in the 30-year replacement scenario. Many of these jobs are in the service sectors, reflecting the structure of the overall economy. However, due to the high material requirements to supply replacement pipes and other materials, the jobs created are more heavily concentrated in manufacturing industries than the economy at large. These jobs typically require skilled labor and are more likely to help rebuild the middle class.

Other sectors like services as well as wholesale and retail trade show large job gains as well, reflecting not only the direct requirements from those sectors needed to replace the pipelines but also the fact that workers in manufacturing and other sectors spend their increased incomes on a wide variety of goods and services, so that the benefits filter throughout the economy. Table 2 shows the employment results by sector.

FIGURE 2. GDP Impacts by Scenario, Millions of Dollars

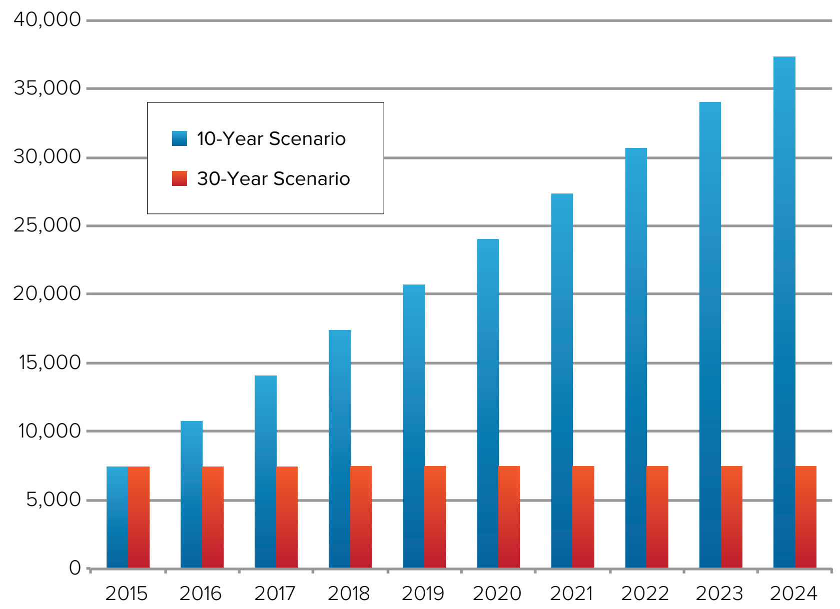


FIGURE 3. Employment Impacts

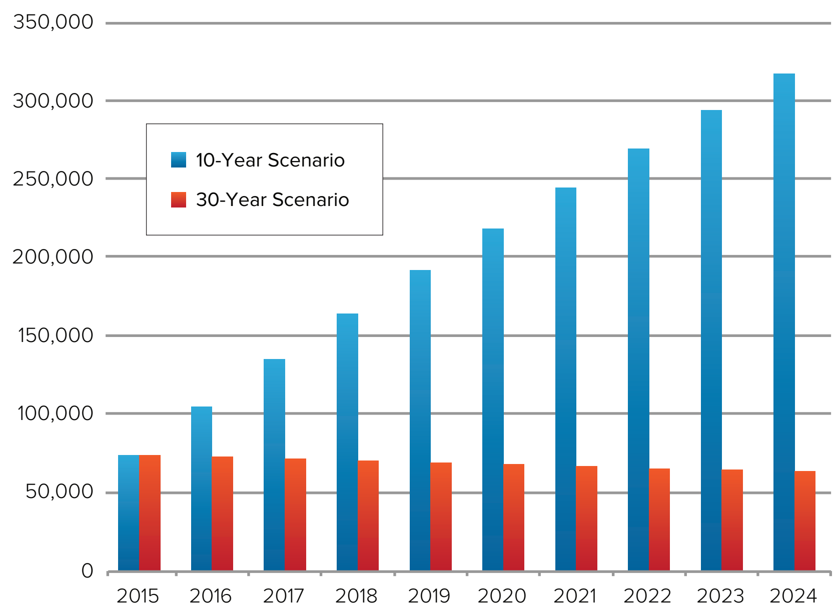


Table 2. Employment Increases by Sector and Scenario

	2019		2024	
	30-Year	10-Year	30-Year	10-Year
Agriculture	1,200	3,300	1,100	5,300
Electric Utilities	200	500	200	800
Transportation and Public Utilities	3,600	9,900	3,300	16,600
Construction	1,200	3,200	1,100	5,500
Steel Manufacturing	800	2,200	700	3,600
Other Manufacturing	5,300	14,800	4,600	23,000
Trade	10,500	29,100	9,400	46,600
Services	37,900	105,200	35,600	177,500
Finance and Real Estate	6,600	18,300	5,700	28,600
Government	1,300	3,500	1,300	6,200
Total	**68,600**	**190,000**	**63,000**	**313,700**

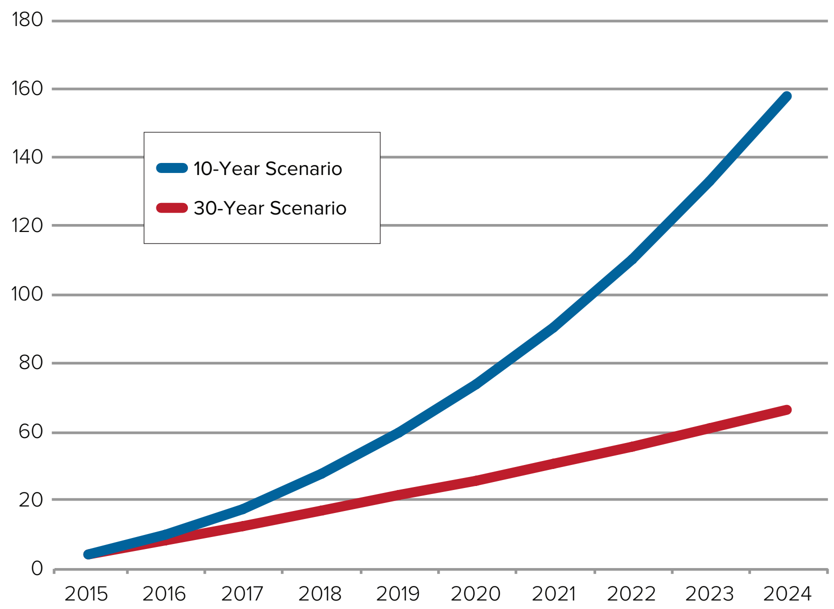
*The sources and methodology for these estimated employment increases are outlined in the following sections.

C. GAS SAVINGS

One obvious result of accelerating the pace of pipeline replacement is that leaky pipes are replaced more quickly and less gas escapes over the course of the replacement project. Using projections for city gate natural gas prices from the U.S. Energy Information Agency (EIA), we projected total savings to the economy from reducing gas leakages. Both project timeframes yield significant cost savings by reducing leakage of valuable gas, but while the 30-year replacement scenario will eventually achieve the same annual reduction in gas leakage, the 10-year replacement scenario will reach the maximum level of savings more quickly.

Figure 4 shows the value of the annual gas saved over the first 10 years of each scenario. **Over the course of the 30 years required to replace all of the leak-prone pipes in the slower scenario, the 10-year replacement scenario will save nearly $4.4 billion worth of gas—$1.5 billion more than the 30-year scenario.**[13]

FIGURE 4. Gas Savings, Millions of Dollars

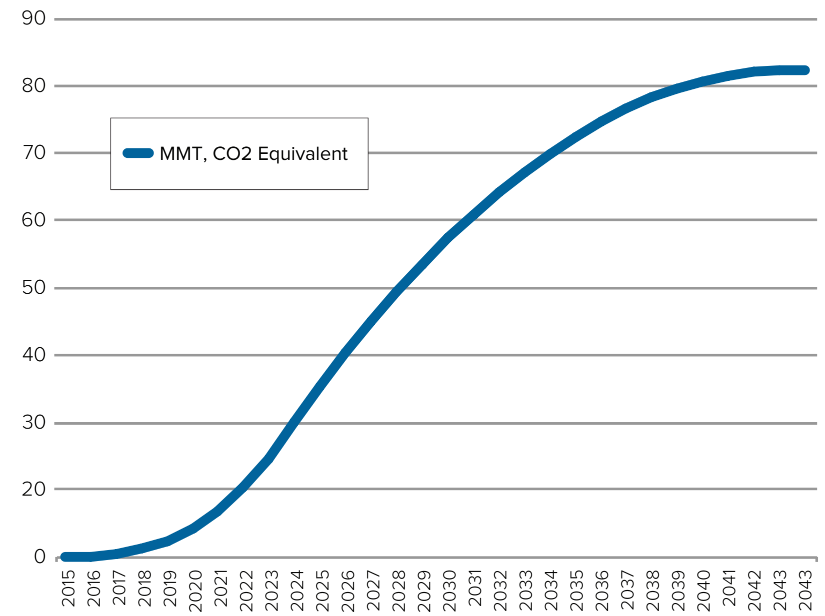


D. AVOIDED GREENHOUSE GAS EMISSIONS

In addition to the economic value of the natural gas saved by the accelerated replacement rate, replacing leak-prone natural gas pipes more quickly also significantly reduces the amount of global warming pollution that escapes from the distribution pipeline system. Uncombusted methane (the primary component of natural gas) is a highly potent greenhouse gas.

Figure E shows the cumulative greenhouse gas emissions avoided by replacing leak-prone pipes over 10 years rather than 30—as measured in tons of carbon dioxide equivalent. As the chart shows, over 30 years, **the faster replacement rate prevents an additional 81 million metric tons of greenhouse gases from being emitted into the atmosphere, roughly equivalent to taking 17 million cars off the road for a year.**

FIGURE 5. Cumulative Avoided Emissions, 10-Year vs 30-Year Scenario



THE IMPORTANCE OF REPAIR

While this analysis takes a look at nationwide impacts of an accelerated pipe replacement scenario, it is important to note that repair activities—the necessity of which vary widely from market to market and are often correlated to the age and condition of pipes—are a critical part of mitigation and prevention of deleterious pipeline methane leaks.

Safety is of paramount importance. For example, in 2012 an assessment of distribution pipe in Boston identified 3,300 gas leaks in the city of Boston, six of which had levels higher than the threshold at which explosion could occur. More recently, a survey of gas lines in Washington D.C. identified more than 5,900 leaks—with a dozen of these potentially reaching explosion threshold (prompting swift responses to mitigate the hazard).

Explosions tied to leaking pipelines have resulted in numerous fatalities. Since 2010, in the U.S. alone, explosions traceable to leaking gas pipelines have led to multiple fatalities in New York City (2014), Allentown, PA (2011), and San Bruno, CA (2010), among others. Scores of other accidents resulted in injuries and extensive property damage in the same time period.

Depending on the nature or location of leaks, full pipe replacement may be more time and/or resource intensive than necessarily warranted, and repair activities—including joint repair/replacement, pipe protection, and repair of faulty equipment—may offer the best course to ensure integrity and deliver a more reliable distribution system. Again, this report examines but one approach to arrive at this outcome (the replacement of leak-prone pipe). Consideration of complementary repair and/or replacement approaches—often best directed at the state or local level—must also be given to factor the effects of weather conditions, logistical elements such as traffic and population density, accidental disruptions, and other factors that affect not just leak-prone portions but also the system as a whole.

One potential area of improvement is reducing the direct venting of natural gas to downgrade the hazard level of a leak. Managed venting of natural gas allows responders time to implement permanent fixes while reducing imminent hazards. However, in many states this managed venting can be permitted in excess of a year. Eliminating methane escape *as soon as possible* in these responses is critical given that methane prevents more of the emissions driving climate change—thereby lessening the climate change impact.

4. METHODOLOGY

The estimates developed for this report are based on relatively straightforward input-output analysis. The model is based on core data from the IMPLAN group, their 2011 U.S. national model, with modifications for productivity trends and other factors. Using data on pipeline mileage, diameter, and replacement costs from the sources noted above, we calculated the total final demand requirements needed to replace all of the leak-prone pipes in the distribution system. We allocated this expenditure across the 14 sectors listed in Table 2, using a combination of the pre-defined IMPLAN industry spending patterns for pipeline manufacturing and construction activities.

Using these spending patterns and overall costs, we created two sets of final demand vectors—one that spread the expenditure evenly across 30 years and one that started at that level and increased by a constant amount each year until all of the required investment was complete in the tenth year.

How the required investment in replacing the pipelines is to be financed is an open question. While utilities are likely to argue that a share of the cost should be financed through cost recovery from gas consumers—which would be partially offset by savings from reduced leakage—in many cases it is a matter of ensuring utilities are held accountable to perform repair and replacement activities already scheduled in approved rate cases.

Additionally, consideration should be given that the bills of low to moderate income and/or lower-use gas consumers not be adversely impacted, and that if necessary a portion of the costs should be paid by various levels of government, as well as by industry.

COST–BENEFIT ANALYSIS

Cost-benefit analysis is a tool commonly used in economic analyses such as this to try to distill a large amount of information into a single variable. Typically, cost-benefit calculations sum up all of the benefits of a policy or other action, subtract the costs of required to achieve those benefits, and calculate the net present value of the result. These not only include direct impacts in terms of goods produced and revenue generated, but also savings accrued by improved public health and productivity, averted impacts of climate change and extreme weather events, quality of life improvements, and reduced health care costs. Often, it is calculated as a ratio of benefits to costs, rather than subtracting costs from benefits. The net present value is used to account for the fact that individuals and society as a whole typically put more significance on costs and benefits that happen in the present and near future than they do on those that will occur in the more distant future.

This analysis lacks such a calculation. Cost-benefit analyses are appropriate and relatively straightforward to conduct for investments that generate some kind of easily captured and measured economic benefit—such as the purchase of a stock or investing in energy efficient equipment. In these cases, the cost of the investment is known, and the projected returns in terms of capital gains or energy savings are relatively simple to estimate. The primary benefit is economic and can be included in a benefit cost calculation in a straightforward manner, and this report moves to establish some of these tangible benefits in the form of averted carbon emissions, GDP effects and job creation potential. A fuller cost-benefit assessment would be a natural follow up to this study.

We imposed a balanced budget constraint on the model, i.e. all of the costs of undertaking the projects—including the costs of borrowing money—would be accounted for by the model as an expenditure. This avoids overstating the economic benefit of the projects by assuming that these costs were simply "found money." For the sake of simplicity—and in the absence of solid guidance otherwise—we assumed that the projects would be entirely financed at utility bond rates, and that the costs would be recovered by the residential, commercial, and industrial sectors based on their share of natural gas consumption. We assumed that bonds would be issued each year to cover all of the concurrent spending, that the bonds would have a tenor of 20 years, and that the rate on the bond would be equal to the AA utility rate as projected by the EIA in its *2013 Annual Energy Outlook*.

While we model a relatively simple cost recovery mechanism, there are a variety of approaches to implementing such a system. For example, in the aftermath of the August 2003 electricity blackout, the U.S.-Canada Power System Outage Taskforce recommended a more stringent set of reliability standards with increased fines for non-compliance that cannot be passed through to consumers. It also clarified the rules around which investments in grid stability can be passed through to consumers' transmission rates, thus reducing the financial risk to utilities of such investments.[14] Approaches like these may be applicable to the pipeline distribution system.

Annual gas savings were determined by first taking the total amount of gas leaking from distribution pipelines, as estimated by the U.S. Environmental Protection Agency (EPA).[15] Then, by allocating that total to the leak-prone portion of the system based on relative leakage rates by material based on emissions factors assigned by the EPA.[16] We then projected annual reductions in gas leakage based on concurrent expenditures on pipeline replacement, assuming a fixed reduction per dollar of expenditure. This assumption may have the effect of underestimating the rate of leakage reductions and savings because under either scenario, the oldest and most leak-prone sections of pipe are likely to be replaced first. With this caveat, we calculated dollar savings by multiplying gas savings in billions of cubic feet (bcf) by the city gate price of gas—again using projections from EIA's *2013 Annual Energy Outlook*. We calculated the carbon dioxide equivalents by multiplying the gas savings by the EPA's Global Warming Potential (GWP) factor of 21 for methane.[17]

5. CONCLUSIONS

The U.S. economy is in need of revitalization, the natural gas distribution system is in need of repair, and the climate is in need of drastic reductions of greenhouse gas emissions. The slow pace of economic recovery means that the economy is not creating new jobs quickly enough to both absorb new workers and re-employ those that lost their jobs during the recession. At the same time, a significant share of the distribution pipeline system is generations old and the current pace of replacement means that it will take another generation before the most problematic sections of pipe have all been dealt with.

The fact that replacement is underway is a recognition of the importance of maintaining a reliable distribution system and of reducing the environmental and economic costs associated with leaks. The fact that it is on track to take 30 years represents not only an inevitable economic opportunity, but a missed opportunity to reduce high global-warming potential methane emissions. Acting now to reduce methane emissions would reduce climate disruption caused by anthropogenic greenhouse gas emissions and lower the future cost of mitigation and adaptation.

Versus a "business-as-usual" approach, accelerating the replacement of leak-prone pipes in the distribution system would drive investment and job creation when the economy needs it most, creating nearly 250,000 additional jobs by 2024 compared to the 30 year scenario. In addition, it would add much needed demand for manufactured products and the high-skilled middle class workforce it supports, increase economic activity and GDP—while averting lost gas charged to business and consumers—and avoid 81 million metric tons (CO_2 equivalent) of global warming pollution going into the atmosphere.

Investing in our infrastructure is a winning proposition for consumers, the environment, and the economy as a whole, and accelerating the timeline will provide those benefits at a time when America needs them the most.

ENDNOTES

1 American Society of Civil Engineers, *Report Card for Americas Infrastructure 2013* and *Report Card for Americas Infrastructure* 2009. Available at http://www.infrastructurereportcard.org, accessed on 1/24/2014.

2 Intergovernmental Panel on Climate Change (IPCC), Working Group I Contribution to the IPCC Fifth Assessment Report, *Climate Change 2013: The Physical Science Basis*, Summary for Policy Makers (September 27, 2013). Available online at http://www.climatechange2013.org.

3 U.S. Department of Energy (DOE), Energy Information Administration, Jan 2014. *EIA Short Term Energy Outlook*. U.S. DOE: Washington, D.C., Jan 2014.

4 Based on EPA leakage factors in the Code of Federal Regulations, 40 CFR 98, Subpart W.

5 U.S. Environmental Protection Agency (EPA), 2013. *EPA Inventory of U.S. Greenhouse Gas Emissions and Sinks*: *1990-2011.* EPA: Washington, D.C. Available at http://www.epa.gov/gasstar/methaneemissions/distribution.html.

6 Comparison done using the EPA Greenhouse Gas Equivalencies Calculator available at: http://www.epa.gov/cleanenergy/energy-resources/calculator.html. Accessed on 1/24/2014.

7 The EPA assigns uncombusted methane a Global Warming Potential (GWP) factor of 21, indicating that over a 100-year time frame it has about 21 times the heat trapping capacity of carbon dioxide. The United Nations Intergovernmental Panel on Climate Change (IPCC), which the EPA factor is based on, has revised its estimate of methane's forcing capacity significantly upward from 25 to 34 over 100 years, and from 72 to 86 times the GWP of carbon dioxide over 20 years. See Working Group I Contribution to the IPCC *Fifth Assessment Report Climate Change 2013: The Physical Science Basis*. Since methane only remains in the atmosphere for about a decade, according to the EPA, there is a compelling argument to use the shorter term and more potent GWP for methane. Nevertheless, in this report, we use the more conservative and longer-term GWP factor of 21—currently in use by the EPA—even though the IPCC estimate on which the EPA bases its factor has been revised upward. Whichever measure is used, it is indisputable that methane is a far more potent greenhouse gas than carbon dioxide, especially in the short term.

8 U.S. Department of Transportation (DOT) Pipeline and Hazardous Materials Safety Administration available at https://opsweb.phmsa.dot.gov/pipelineforum/dot-action/. Accessed 1/23/14.

9 American Gas Foundation (AFG), 2012. *Gas Distribution Infrastructure: Pipeline Replacement and Upgrades. Cost Recovery Issues and Approaches.* AGF, Washington, D.C.

10 American Gas Association, 2013. *Managing the Reduction of the Nation's Cast Iron Inventory.* AGA, Washington, D.C.

11 Unless otherwise noted, all dollar values in this paper are inflation-adjusted to real 2011 dollars.

12 The paper does not consider alternatives to replacement, such as an extensive repair program. Such a program might be sufficient to address many of the problems with leak-prone pipes. However, given their current advanced age, a more permanent long-term fix seems to be in order, and the industry and Department of Transportation both appear to be moving toward replacement as that solution. At the same time, it is entirely possible that repair rather than replacement may be a cost-effective approach in some situations. Estimating that is beyond the scope of this report, however.

13 On a net present value basis, using a 5 percent discount rate, this is equivalent to $1.38 billion. Based on projected city gate natural gas prices forecasted by the U.S. Energy Information Administration in *Annual Energy Outlook 2013.*

14 U.S.-Canada Power System Outage Task Force, 2006. *Final Report on the Implementation of the Task Force Recommendations.* U.S. DOE, Washington, D.C.

15 U.S. Environmental Protection Agency (EPA), 2013. *EPA Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2011.* EPA, Washington, D.C. Available at http://www.epa.gov/gasstar/methaneemissions/distribution.html.

16 See 40 CFR 98, Subpart W. at http://www.law.cornell.edu/cfr/text/40/part-98/subpart-W.

17 U.S. Environmental Protection Agency (EPA), 2004. *Unit Conversions, Emissions Factors, and Other Reference Data.* EPA, Washington, D.C.

BLUEGREEN ALLIANCE

AMERICAN FEDERATION OF LABOR & CONGRESS OF INDUSTRIAL ORGANIZATIONS

AFL CIO