



# **PERFORMANCE-BASED INFRASTRUCTURE:** Making The Shift

*A Leadership and Economic Competitiveness Opportunity  
for Maine and the Northeast*

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Northeast Infrastructure Accelerator

## Acknowledgments

Launched in 2014, the Beeck Center for Social Impact + Innovation is a social innovation startup inside of Georgetown University. Part lab, part think tank and part classroom, we work with practitioners and students to innovate scalable solutions to systemic social problems. Building on Georgetown University's core values and global reach, we conduct academic research, hold convenings and drive creative thinking around issues at the intersection of data, technology, capital and policy innovation.

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# Introduction

The U.S. infrastructure system is in the midst of profound transformation. This is particularly true for Maine and the Northeast region.

Declining federal and state funding for infrastructure is creating a significant backlog of deferred maintenance. According to the American Society of Civil Engineers, the national deferred maintenance backlog is estimated at more than \$3 trillion. Federal and state contributions are projected to continue their decline in years to come.

Responding to this fiscal challenge, policy-makers and the public are demanding new ideas and approaches that deliver greater value for scarce public investment dollars.

Finding efficient ways to stretch public investment in infrastructure is a critical question for the Northeast region. For example, based on historic bonding rates and surveys of regional infrastructure needs, this report estimates that Maine's infrastructure "needs versus funding" gap will range between \$5-8 billion over the next 25 years. A \$15 billion gap exists across the Maine-New Hampshire-Vermont (Northeast) region. Unless addressed, these gaps threaten to render not only Maine, but also the entire Northeast region less competitive due to lost business productivity and unrealized economic opportunities.

There is good news: successful models for building and funding new infrastructure have been implemented globally; from Canada and Australia to New Zealand and the United Kingdom. These models provide new methods for getting taxpayers more "bang for the buck" and for attracting much needed capital from private investment in public infrastructure.

Yet these infrastructure asset management methods, known as *performance-based infrastructure*, remain highly underdeveloped in the U.S., however.

An earlier Working Paper, *Performance-Based Infrastructure: An Acceleration Agenda for the United States* (May, 2016), examined some of the opportunities and recommendations necessary to make this shift at the national level.

This report, supported by funding from the Rockefeller Foundation, examines the best options and strategies available to make this important shift in infrastructure innovation happen in Maine and the surrounding region. The report is also intended to provide a template for *other regions* interested in transforming their infrastructure systems to be competitive in the 21<sup>st</sup> century.

Maine and the Northeast region are poised to take advantage of new opportunities in water, energy, broadband and other "new infrastructure basics" and could become a leader in 21<sup>st</sup> century infrastructure innovation – if Maine and regional partners act soon to develop the right tools and strategies to guide the transition to a new business model for integrated infrastructure investment, operation and maintenance to maximize taxpayer value. This report offers a playbook for action.



# The National Infrastructure Crisis and the U.S. Infrastructure System

America's infrastructure systems are aging and undermining national economic competitiveness. The World Economic Forum's 2015 Global Competitiveness report ranked the U.S. 12th in the world due to underinvestment in both critical *core* infrastructure systems (water, wastewater, roads, bridges and ports) and in *21st-Century innovative* infrastructure services such as high-speed broadband and energy innovation.<sup>1</sup>

A recent report by the Bipartisan Policy Center's Executive Council on Infrastructure further underscores the importance of strong infrastructure systems to healthy and competitive local economies: "If we hope to foster the next generation of entrepreneurs that can push our economy forward and maintain our quality of life, we must invest in our infrastructure. Wise infrastructure investments would create millions of jobs, maintain the health, safety, and security of our communities, and set our nation on track for decades of greater prosperity."<sup>2</sup>

The problem will only get worse without changes in how we fund, finance and maintain our nation's infrastructure systems. By 2045, an additional 70 million Americans will need basic infrastructure, such as clean water and roads, as well as new essentials like broadband, a distributed electric grid, and modern transportation systems.<sup>3</sup> A decade ago, high-speed broadband was a communications luxury. Today, it is a fundamental driver of economic growth, a tool for capital access, and an essential element of the digital economy. The American infrastructure challenge must be met on two front: both in better maintaining the valuable infrastructure assets we now have in place and wise investment in critical new systems we will need to be competitive in the 21st century.

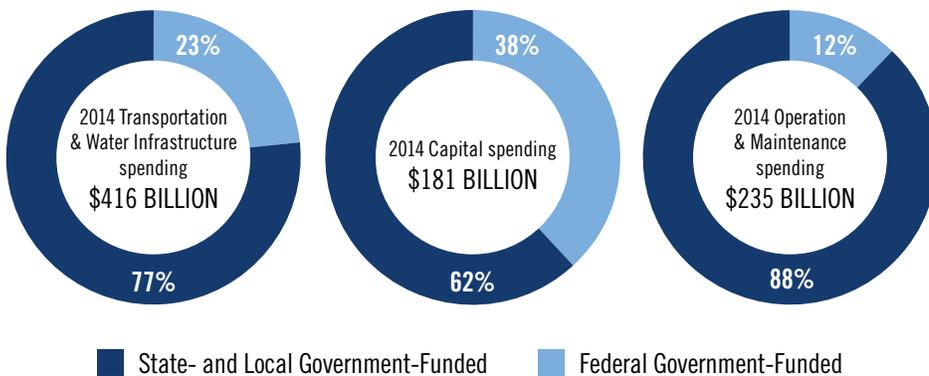
Despite these complex changes, the key question for policymakers and the public remains the same: How can investments in public infrastructure yield the highest benefits to the public and deliver improved, measurable outcomes? The answer? An emerging consensus of experts believe the key – based on success in other nations – is building out new, performance-based infrastructure programs in the United States from the bottom up.<sup>4</sup>

In moving toward a performance-based model in the United States, here are three key facts and takeaways about America's current infrastructure system to keep in mind.

### FACT #1

***Financing infrastructure is not a monolithic system (e.g., water, transportation, ports, utilities). Business models differ by infrastructure type and management, and financing is distributed across different levels of government.*** Most infrastructure spending (three-fourths) comes from state and local governments, according to the U.S. Congressional Budget Office.<sup>5</sup>

**Key Takeaway:** Policy makers have an opportunity to shift the system by 1) increasing federal spending to keep the U.S. infrastructure system competitive; 2) focusing federal investment on creating the right incentives for local and state reforms to drive better infrastructure performance.



**Key Takeaway:** Public policy needs to consider the life-cycle of the investment. The current project development process in the United States is biased for choosing the lowest cost bid to build a project—not maintain it over its entire service life. Cost efficiency is not the same as cost effectiveness. The tragedy in Flint, Michigan clearly illustrates the problem. Decision makers tried to save a few thousand dollars of maintenance to ensure public health. Their actions will now cost local, state and U.S. taxpayers untold millions. This is the tip of the iceberg. The U.S. needs systemic reform to create incentives for life-cycle management of expensive and valuable taxpayer assets.

### FACT #2

***The core of America's current infrastructure problem is a consequence of deferred maintenance. There is a strong public sector bias to invest in new capital projects rather than effectively maintaining and extending the life of public infrastructure assets meant to last 30-50 years.*** The American Society of Civil Engineers estimates over \$3 trillion of investment is needed by 2020 to rectify the deferred maintenance backlog.<sup>6</sup>

## Deferred Maintenance: The Crisis Is Here and Now

In addition to the Flint, Michigan public health tragedy—and other cases of lead poisoning in U.S. water systems—the very real costs of deferred maintenance are being felt by citizens and businesses **right now**.

### South Carolina Dams (2015)

In October 2015, heavy rainfall and flooding in South Carolina led to the failure of at least 36 dams, causing 19 deaths and the displacement of 20,000 people. After the storm, the U.S. Army Corps of Engineers identified 167 *additional* dams in need of repairs.



### Washington, DC, Metro (2016)

Once the shining model of U.S. subway systems, Washington, DC's entire metro system recently shut down for 29 hours to deal with a growing safety crisis—mysterious electrical fires that have resulted in injuries and one fatality. The culprit: an estimated 15-year backlog in foregone track and transformer maintenance.

### Aliso Canyon, CA, Methane Leak (2015)

A natural gas leak—from underground equipment not inspected since 1976—released methane and other chemicals into the atmosphere for four months, causing the evacuation of 4,400 households in Porter Ranch. Described as the worst natural gas leak in U.S. history, the incident has so far cost SoCal Gas more than \$50 million and could cause statewide power outages this summer.<sup>7</sup>



### Maine, Vehicle Repair costs

Beyond the headlines caused when deferred maintenance leads to human tragedies, there are high costs for citizens and motorists using poorly maintained infrastructure systems. The American Society of Civil Engineers, for example, notes that driving on roads in need of repair costs Maine motorists \$454.6 million, or \$450.86 per motorist, in extra vehicle repairs and operating costs.

**Key Takeaway:** There is a need for a more innovative, system-wide approach for managing our infrastructure systems, to include:

- Developing more effective partnerships. America needs innovative approaches to leverage private sector expertise and create the appropriate incentives for the capital markets to invest in U.S. infrastructure, for instance, engaging companies like Swiss Re as well as other insurance companies on how cost savings from well-designed smart infrastructure designed to avoid future storm damage can be monetized.<sup>9</sup>
- Developing more integrated planning and data systems to better help local, state and federal agencies manage infrastructure. For example, better timing of street repairs, water line repairs and broadband installations could save millions of dollars and reduce business disruption.

**FACT #3:**

***21st-century infrastructure systems need innovative methods to reduce waste in the system.***

If infrastructure owners were to adopt life-cycle efficiency policies across the globe, as well as employ new data and sensor systems to monitor infrastructure, a recent McKinsey study projected net savings up to 40 percent of current investment levels. More specifically, a performance-based approach that scales best practices could save an average of \$1 trillion a year in global infrastructure costs between now and 2030.<sup>8</sup> Deployed in the U.S., such better performance measures could save \$150-\$250 billion annually across all infrastructure modes. Those savings could be re-invested in cash-strapped communities to help overcome what Moody's and other public sector financial experts are calling the "new normal" —the dire state of local fiscal capacity limiting infrastructure investment since the 2008 recession.

Bipartisan Policy Center has identified similar opportunities for efficiency through greater attention to asset management. Experts at key federal agencies, including the Department of the Treasury and the National Institute for Standards and Technology, have identified similar opportunities in re-designing the U.S. infrastructure system, by highlighting important federal "principles for outcomes-based predevelopment."<sup>10</sup>

This paper builds upon this work and offers recommendations on how to **create enhanced performance for local, state and regional infrastructure systems.**

*"Most of the public sector innovation is happening either overseas or in energy." — Allan Emkin, Pension Fund Manager and Advisor*

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# The Infrastructure Investment Gap in Maine and Northeast

*“It’s imperative if we’re going to move Maine from poverty to prosperity that we have good infrastructure.” —Maine Governor Paul LePage*

***Based on current and historical trends, this report estimates that there will be at least a \$5 billion infrastructure funding gap for Maine and more than \$15 billion for the Northeast region between now and 2040.*** These estimates are based on an analysis of actual infrastructure needs and projections from various sources (e.g., state and federal surveys, the American Society of Civil Engineers) and actual rates of bond financing by the states of Maine, New Hampshire, and Vermont.<sup>11</sup> The current funding gap is likely to grow in the next 25 years. With permanent fiscal shortfalls caused by the 2008 economic recession, Moody’s calls this fiscal outlook the “new normal” for state and local government.<sup>12</sup>

## Northeast

Infrastructure Needs Estimate, 2040 (\$\$ in billions)

Infrastructure System	Maine	New Hampshire	Vermont	Region
Drinking Water	>1.5	.17	.96	>4.1
Municipal Wastewater	>1.5	>1.2	3.7	>6.4
Bridges	>2.5	>.65	>2.6	>5.7
Ports/Freight	.5-2.0	N/A	N/A	>.5
Roads	.54	>1.2	N/A	>.5
Public Buildings	>2.0	N/A	N/A	>1.7
Energy and Transmission	1.5-3.0	2.5-5.0	1.0	>5.0
Broadband	.5	N/A	N/A	>.5
Other (Dams, Transit)	.5	>.2	N/A	>.5
Storm Damage	1	.5	.5	>2.0
Total Needs	\$12-16	\$8.0	\$9.0	\$29
Total Bond Capacity	\$7.5	\$5.0	\$2.5	\$15
2040 Funding Gap	\$ 4.5-8.5	\$3.0	\$7.5	\$15

Sources: Estimate based on ASCE surveys, EPA, ME DOT, Maine Power, and Bond Buyer

In Maine, Vermont, New Hampshire and other New England states, funding and financing competitive infrastructure systems remains a challenge. In Maine, for example, a number of business groups and academic experts – from the Maine Economic Growth Council to the Maine Chapter of the American Society of Civil Engineers (ASCE) – have warned that Maine is chronically underinvesting in critical infrastructure and undermining regional economic competitiveness. As a result, these experts argue, Maine’s economic strength and public health has been undermined.<sup>13</sup>

The importance of infrastructure to economic vitality is well-documented by a broad-based and bi-partisan group of economists, business leaders and elected leaders.

For example, the National Association Manufacturers (NAM) states emphatically: “America needs an updated and modern infrastructure system to remain competitive in a global economy. Over the past decade, troubling trends in infrastructure investment have emerged. The NAM supports broad-based, jobs-creating investment in expansion and modernization, including advocating for increased public and private infrastructure funding, developing an interstate system focused on moving goods to market, investing in ports and inland waterways, supporting efforts to reduce traffic congestion and modernizing drinking water and wastewater systems as well as modernizing information and telecommunications infrastructure.”<sup>14</sup>

For middle and lower class families, sub-par infrastructure is especially costly. Transportation and energy are usually the second largest expenses for most households after housing.

A new study by Groundswell, a non-profit energy services provider, finds that low income households spend 10% of their income on electricity, which is over four times higher than the average consumer.<sup>15</sup> Aging infrastructure systems also threaten public health and safety, most recently seen in the forced evacuation of nearly 200,000 residents living near the Oroville, California dam.

## Maine Infrastructure: Key Challenges and Takeaways

*Maine faces many of the same fiscal challenges regarding infrastructure as the United States at large.* Most recently, the Maine ASCE has issued its 2016 quadrennial report card, giving the state an overall grade of C-. Four categories (dams and levees, wastewater, roads and passenger transport systems) were rated D+ or lower.<sup>16</sup> For example, over the next 20 years, Maine will face an estimated \$2 billion shortfall in capital and maintenance needs. Take water and wastewater, for example the U.S. EPA's most recent Clean Watershed Needs Survey found that approximately \$1 billion in water infrastructure projects were needed over the next 20 years to maintain clean drinking water and waterways; that total was essentially unchanged from the 2008 Needs Survey due to limited new investment.

Other areas of underinvestment raise public safety concerns: 153 of Maine's 1,000 registered dams were classified by the ASCE as high hazard potential for failure due to extreme weather and flooding. Deferred maintenance is also a major concern for the state. As noted by the ASCE, many dam owners can't afford to maintain or repair their dams and the Maine Dam and Reconstruction Loan fund hasn't been utilized since its inception in 2011. As one Maine civil engineer stated "people get credit for building the new school, not maintaining what we already have."<sup>17</sup>

**Key Takeaway:** Maine's public spending on infrastructure is not keeping pace, neither to maintain current infrastructure assets nor to build needed new facilities.

### Maine's Infrastructure Crisis: Deferred Maintenance Facts

**Roads and Bridges:** Maine's bridges and rural roads are among the worst in the nation, according to a report by TRIP, a national research group. Over 25% percent of Maine's rural roads have pavement that is in poor condition, ranking Maine 43rd nationally. Poor transportation in Maine is a "red-flag" issue for the Maine Economic Growth Council. 1 in 7 bridges are structurally deficient, far higher than the national average.

**Dams:** The majority of Maine's dams are more than 50 years old. Of these, 191 are classified as dams of significant and high-hazard potential, in which failure would result in considerable damage or loss of life.

**Water:** Nearly 1,000 miles of Portland Water District pipe transports water from Sebago Lake to serve over 200,000 people in the Portland area. About 20 percent of the district's piping is more than 80 years old. Portland water district estimates that a \$140 million investment will be needed in the next 20 years to prevent disruptive breaks.

**Wastewater Treatment:** According to the Maine Department of Environmental Protection, Maine currently has 32 municipalities with untreated sewerage issues that are out of compliance with Clean Water Act requirements.

**Key Takeaway:** Maine's low national per capita ranking for infrastructure spending suggests challenges ahead to attract new business and remain economically competitive. To close this funding gap without putting Maine's AAA bond rating at risk, new financing tools and infrastructure system innovation will be needed.

*Maine's infrastructure spending gap is not new; the state ranked 51st in per capita public investment in infrastructure in 2006, and 46<sup>th</sup> in percentage of state GDP for infrastructure investment.*<sup>18</sup> Updated data from the Census Bureau for 2013 (see table below) indicates that Maine has not been able to close the gap: it now ranks 46th in per capita public investment in infrastructure.

### Northeast States – General Infrastructure Expenditures Rankings

	Connecticut	Maine	Massachusetts	New Hampshire	New York	Rhode Island	Vermont
Education	8	44	11	26	6	15	3
Hospitals	32	43	41	48	9	47	50
Health	30	8	35	49	13	41	7
Highways	38	12	42	18	28	45	5
Airports	48	24	10	31	8	41	37
Parking Facilities	6	19	28	11	24	39	14
Ports	34	22	17	35	14	28	37
Natural Resources	44	16	45	37	49	35	14
Housing	4	8	2	16	3	6	5
Sewerage	18	30	3	34	5	31	25
Solid Waste Management	11	12	33	9	1	21	27
General Utilities	32	48	11	49	2	36	31
Water Supply	50	43	11	41	28	13	36
Electric Supply	33	46	23	45	7	47	19
Gas Supply	28	36	26	36	33	36	36
Transit	10	38	3	44	1	15	31

***Extreme weather will also heavily affect infrastructure investment in the Northeast region between now and 2040.***

Nationally, weather-related infrastructure outages cost the U.S. economy between \$18 and 33 billion each year. Extreme weather conditions threaten to place further stress on aging infrastructure in the Northeast.<sup>19</sup> Between 1958 and 2012, the region has experienced a 70% increase in the amount of rainfall. Private insurance industry projections are planning for a 9-foot sea level rise by mid-century. These effects will not only tax coastal infrastructure, but also sewer and stormwater systems. Overflows in these systems could severely damage the quality of recreational and drinking water. In addition, sea level rise and flooding could disrupt communication systems, energy production, electric transmission, transportation, and waste management.<sup>20</sup> Given extreme weather costs, a shift to performance-based infrastructure techniques to help save taxpayers and ratepayers billions of dollars over the life of these assets makes good sense.<sup>21</sup>

**Key takeaway:** Because of extreme weather, local communities, businesses, investors, private utilities, and the U.S. Department of Homeland Security need to increase planning and focus to build more storm-resistant infrastructure. The effect of extreme weather can be incredibly expensive, as illustrated by the impact of Tropical Storm Irene in Vermont in 2011 (see inset box). Communities need to factor in these costs in their planning. Nationally, energy companies like Entergy have begun quantifying risks and identifying economically viable investments to improve infrastructure resiliency. For example, Entergy's strategic consulting arm found that assets along the Gulf Coast are at risk; these assets are worth \$2 trillion and deliver \$634 billion in gross domestic product.<sup>22</sup>

## **Vermont Storm Costs: Tropical Storm Irene 2011**

Recent storms, like Tropical Storm Irene, have dramatically highlighted the risk that transportation infrastructure faces at stream crossings in Northeast. In Vermont, where Irene was particularly destructive, estimates of damages for state highways alone were \$175-\$250 million, with an added \$21.5 million in damages to state-owned railroads (Vermont Agency of Natural Resources, 2012). Two hundred bridges on state highways were damaged, and municipalities reported 960 culvert failures. Total damage to roads and bridges in Vermont was estimated to exceed \$700 million (Kinzel, 2011).

Utility costs are also high during extreme weather incidents, and unless there are early investments in resilience, higher electric rates can be expected. For example: during Irene, there were \$110.5 million storm restoration costs for Connecticut utilities; Hurricane Sandy in New Jersey caused over \$1 billion in damages to the state's biggest utilities.<sup>23</sup>

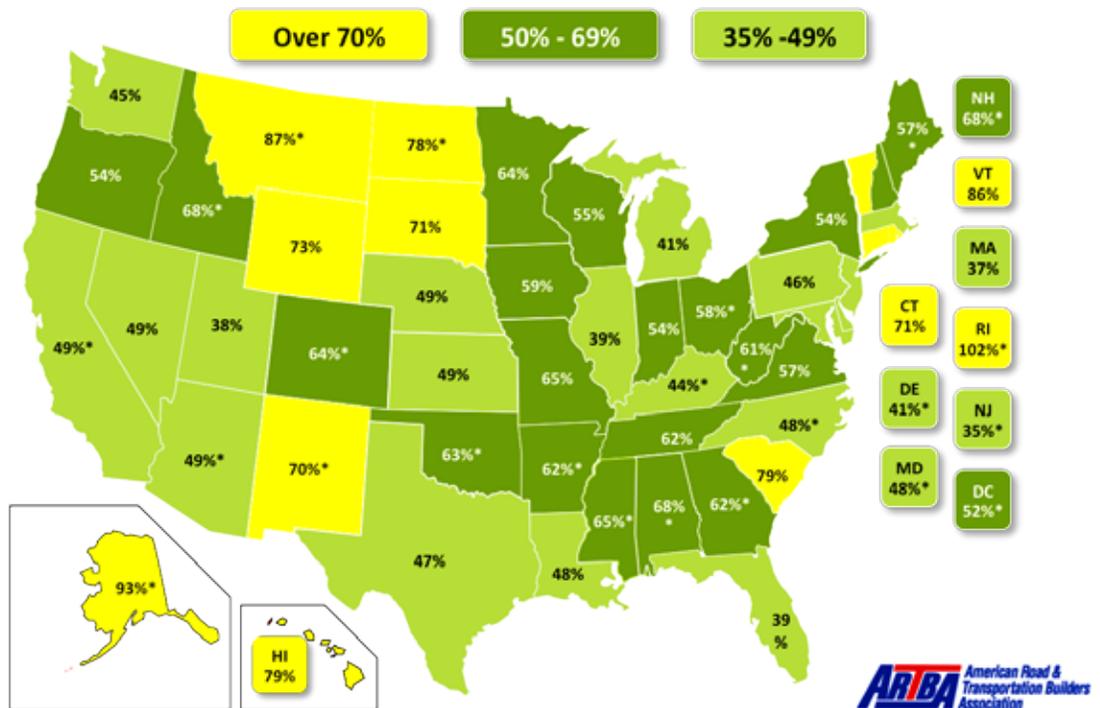
Extreme weather has also been costly to Maine, which has been affected by 11 separate, multi-billion-dollar federal natural disasters from 1980-2016.<sup>24</sup>

**Key takeaway:** Maine can't "go it alone" to fund infrastructure; it needs substantial federal and outside capital to close its funding gaps. Fully 57% of Maine's highway funding now comes from the U.S. government.

*Maine needs an all-of-the-above combination of funding sources (federal, state, local, and private) and financing innovations.* As an example, Governor LePage's three-year work plan on transportation anticipates a broad range of funding from state and federal sources, as well as some borrowing. The \$1.4 billion budget for capital projects in 2014 and 2015 was funded with 42 percent from the state highway fund, 34 percent from federal sources and 13 percent from bonds, with the remainder paid for by other sources.<sup>25</sup>

*The decline of public support and dollars for infrastructure spending demands new tools and sources of capital to leverage existing resources and drive infrastructure innovation and efficiency.* As noted earlier, a 2013 study by McKinsey Global suggests that 40% of an expected \$57 trillion global infrastructure bill between now and 2040 can be saved through *performance-based infrastructure innovation*.<sup>26</sup> Enhanced local capacity and training could also further leverage existing sources of capital, such as Maine's revolving loan fund for water.<sup>27</sup>

## Federal funds, on average, provide 52% of annual State DOT capital outlays for highway & bridge projects



Source: ARTBA analysis of "FHWA Highway Statistics" data, total 10-year average 2001-2011 from Tables SF-1 and SF-2. The percent is the ratio of federal-aid reimbursements to the state and total state capital outlays and is indicative of the importance of the federal-aid program to state capital spending for highways and bridges. Does not include local capital spending. Federal highway reimbursements are primarily used for capital outlays, including construction, right-of-way acquisition and engineering, but are also used for debt service for GARVEE bonds.

\* States that have issued GARVEE bonds before 2011.

*Some experts are calling for greater use of public-private partnerships to help close the funding gap. A number of other countries, including Australia, the United Kingdom and Canada, have successfully attracted greater levels of private investment in public infrastructure than the U.S.*

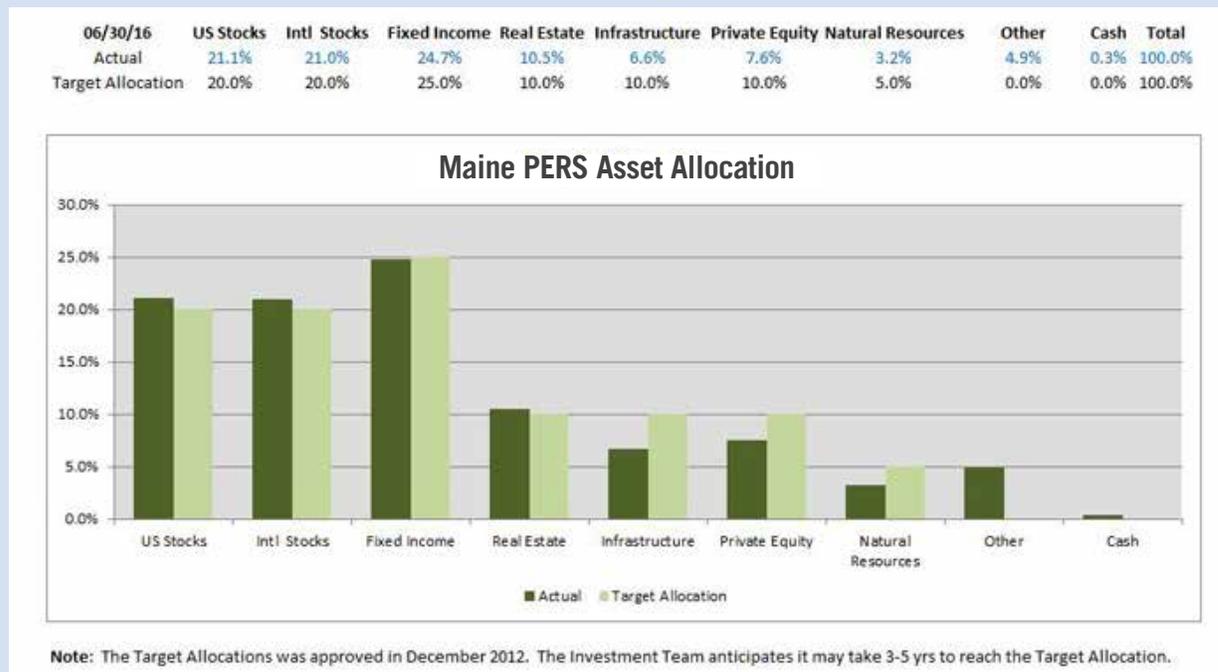
**Key takeaway:** While not a panacea for a core level of taxpayer investment in public infrastructure, engaging private sector capital and expertise is an important tool to consider to help end the current cycle of underinvestment and limited maintenance of the Northeast's infrastructure base.

## Public Pension Investment In U.S. Infrastructure?

A number of U.S. public pensions led by CalPERS, the largest public pension fund in the U.S., are actively exploring how they can invest in American infrastructure.

The Maine Public Employees Retirement System recently made two new infrastructure funding commitments totaling up to \$180 million.<sup>28</sup> The \$11.9 billion pension fund committed up to \$150 million to Stonepeak Infrastructure Fund II and up to \$30 million to Rubenstein Properties Fund III, a value-added real estate fund.

Maine's fund has also allocated a fixed percentage of its \$12 billion in assets to future infrastructure investments.



While many U.S. pension funds like Maine's are allocating funds for investment, finding investable deals in the U.S. is difficult.

The reason: a lack of investible projects and limited local and state expertise to develop this project pipeline.<sup>29</sup>

*Despite these challenges and chronic underinvestment in core infrastructure, there is good news. With the right investment strategy and policy toolkit, Maine's distinct geography and natural assets could spring it ahead of other states and regions that are already working to build a 21<sup>st</sup> century innovation infrastructure.* Deploying innovative tools and techniques for water finance and building on existing investments in innovative energy and broadband, like the 3-Ring Binder, Maine could achieve better outcomes for its citizens even with limited new public and federal funding. Maine is already becoming a leader by utilizing low-cost renewable power sources. In 2014, three-fifths of Maine's net electricity generation came from renewable energy resources, with about 25% from hydroelectricity, 27% from biomass, and 8% from wind.<sup>30</sup>

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# Making the Shift to a Performance-Based System

As noted, most U.S. infrastructure projects (be it a public university building or a transportation project) are promoted by a single public agency and only the capital costs of the project are initially funded by the governing legislative authority. The winning bid is usually the lowest capital cost bid. Unfortunately, studies show that construction cost escalation for a statistically significant number of analyzed public sector projects ranges between 20% and 45%.<sup>31</sup>

Little regard is given to the life-cycle costs of the project over its 30-year or more life, which studies show is fueling the nation's extreme deferred maintenance gap. Even less consideration is given to managing life-cycle operational risks or performance outcomes that drive up project costs.<sup>32</sup>

**What we need, therefore, is a top-to-bottom shift in how U.S. infrastructure projects are funded, maintained, procured and permitted.**

To remedy these persistent problems and boost infrastructure innovation, productivity and performance, there is growing interest in new practices and policies to scale up what is being called “*performance-based infrastructure*.” These methods have been developed extensively in the UK, Australia and Canada in the past 15 years. This model is now being developed in the United States through:

- Creation of regional infrastructure accelerators to help advise public sector agencies on best practices and performance.<sup>33</sup>
- New asset management methods in the United States to help local and state chief financial officers value infrastructure assets as part of a portfolio approach.<sup>34</sup>
- Innovative procurement reforms that focus on defining the desired public services that taxpayers are seeking without first proscribing detailed project designs and characteristics.<sup>35</sup>
- Permitting reforms that are based on new forms of data (see box, page 37).

## Infrastructure Project Development: The Current Model is Inadequate

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Each public agency sponsors individual projects (roads, wastewater treatment plants, hospitals) based on its own needs assessments and past design concepts.

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Project conceived and designed internally to agency; limited consultation with other agencies or the public.

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Strong bias for new construction (political ribbon cuttings) over proper maintenance of 30- to 50-year public assets.

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Individual projects' capital costs sought from legislature or city/county council.

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Low-bid capital construction contracts win the work; then the public gets to provide largely canned "input" about highly similar project alternatives.

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No plan for life-cycle maintenance or performance guarantees on construction.

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Frequent cost overruns on construction and infrastructure performance; current deferred maintenance bill in U.S. is above \$3 trillion and growing (ASCE, 2013).

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More Flints are likely as local and state finances continue to tighten.

## Performance-Based Infrastructure (PBI): Defined

While difficult to explain in a seven second sound bite to an inquiring reporter or aspiring legislator, infrastructure projects with the lowest construction costs do not always deliver the best lifetime value to the public. One need only look at recent examples (San Francisco-Oakland Bay Bridge and the Hawaii Transit Line, to name two) where the public is absorbing multibillion-dollar cost overruns for construction and operational risks that could have been shared with the builders.<sup>36</sup>

*“This is the crux of (performance-based infrastructure). It forces policymakers to confront the true life-cycle cost of a project up-front. The accepted rule of thumb for capital projects is that for every \$1 of design costs, \$10 will be spent for construction and \$100 for maintenance over the life of the asset. But since most of the public discussion focuses only on the money for construction, the public is horribly misled about real long term costs.”*

*— Mark Funkhauser, Governing Institute and former Mayor of Kansas City*

By contrast, performance-based infrastructure proponents aim to shift the conversation from its typical starting point of *lowest estimated construction cost* to a new metric—*best overall value to taxpayers*.

## Performance-Based Infrastructure

PBI uses methods and techniques to incentivize life-cycle thinking and risk management for expensive taxpayer investments in public works projects meant to last 30 or more years.

**Public procurement:** PBI uses public project delivery methods that consolidate responsibility for the key phases of a project’s full life cycle—design, construction, and maintenance—into a performance-based contract with a private partner. The physical infrastructure assets remain in public ownership throughout the process. Simplified procurement documents ask bidders to specify their life-cycle performance strategies to meet desired outcomes for the project, rather than simply what it will cost to build it.

**Public sector budgeting and asset management:** PBI supports the full implementation of Governmental Accounting Standards Board rule 34, which requires local and state chief financial officers to begin reporting the accrued value of their infrastructure assets in their annual financial reports on an accrual accounting basis rather than on a cash basis where the value of all physical assets is off the

books once construction is complete. Using accrual accounting, GASB 34 can raise attention to the need for proper maintenance of valuable assets.

**Public sector risk management and taxpayer investment protection:** PBI emphasizes avoided costs and risk transfer. Effective project risk management from cradle to grave can create additional public benefits when compared with traditional procurement methods—e.g., shorter design and construction timelines, increased cost and schedule certainty, lower total life cycle costs, and long-term performance guarantees.

**Public-private partnerships:** PBI procurements can sometimes include private sector financing and/or operational responsibility using a “pay for performance” model—i.e., if the private sector doesn’t deliver as promised, it doesn’t get the payments it expected. This pay-for-performance approach, enforced by detailed performance contracts, shifts risks typically retained by the public (performance, cost overruns) over to the private sector.

## Performance-Based Infrastructure: A Growing Field Delivering New Value for Taxpayers

The use of performance-based infrastructure internationally is well-known. In countries like Canada (see box below), New Zealand, United Kingdom and Australia, hundreds of infrastructure projects are now being delivered with greater rates of on-time and on-budget performance.

### Canada's Successful Shift to Performance-Based Infrastructure (PBI)

Fifteen years ago, Canada was in the same boat as the United States: a massive infrastructure deficit and a system that was stuck.

Then things changed. The key was shifting to the PBI method that does *all* the math and making sure that taxpayers were no longer always on the hook for all of the risks of construction and operating a complicated project.

It started in the province of British Columbia, spread to Ontario and Quebec, and now every Canadian province does it this way. New, impartial infrastructure stewards were hired to advise Canadian provincial infrastructure agencies to utilize performance-based infrastructure methods when appropriate. The results: more projects delivered on time, on budget, over 500,000 full-time jobs in the past decade and \$100 billion in new projects.

#### *Evidence*

A report released in 2014 by the Canadian Council for Public-Private Partnerships confirmed that P3s are contributing significantly to Canada's economy.

Based on an assessment of 121 P3 projects over 2003-2012, the report finds that P3 projects across Canada have generated more than 517,000 jobs, \$32.2 billion in income, \$48.2 billion in total GDP and \$92.1 billion in economic output.<sup>37</sup>

The Altus Group released a report assessing the track record of Infrastructure Ontario's Alternative Financing and Procurement (AFP) model that employs P3 methodologies. Out of 37 Infrastructure Ontario projects that have reached substantial completion, **the group found that 97% of projects were delivered on budget and 73% were delivered on time or within one month of their planned completion date.**<sup>38</sup>

Notably, Canada's performance-based infrastructure shift started in the provinces; only recently has the national government created its own center of expertise.

McKinsey Global has also issued a series of well-researched studies showing how much additional value these new “performance-based infrastructure” techniques could generate. The core findings: if infrastructure owners were to adopt life-cycle infrastructure outcome and efficiency policies across the globe, McKinsey projects net savings of 40 percent from current investment levels. Deployed in the U.S., such better performance measures could save \$150-\$250 billion annually across all infrastructure modes.

As McKinsey Global Institute notes in a recent report: “beyond ramping up (private) finance, there is even bigger potential in making infrastructure spending more efficient and effective.”<sup>39</sup> Results in the United States, while still early, are very positive. For example:

- Under a performance infrastructure agreement with the Plenary Group, 450 bridges are being re-built in Pennsylvania in 3 years. This work had been stalled in the legislature for lack of funds.
- Using performance-based infrastructure permitting innovation, The Freshwater Trust worked with the City of Medford, Oregon to use river restoration methodology to save Medford taxpayers almost \$10 million over building a traditional wastewater treatment plant.<sup>40</sup>
- Using PBI to build the Sea to Sky Highway yielded \$100 million greater value for British Columbia taxpayers.
- PBI saved Denver’s Regional Transportation District \$300 million of design and construction costs on its Eagle commuter rail project.
- The West Coast Infrastructure Exchange worked with the Pacific Forest Trust to develop critical financing analyses that linked water conservation to life cycle asset management.<sup>41</sup>

## Performance-Based Infrastructure Overview of Case Studies

In support of this report’s analysis, the Beek Center examined a number of illustrative case studies to highlight key lessons learned in the field.

Case	Country	Timeframe	Lessons Learned / Innovation	Related Examples
Canada’s Performance-Based Infrastructure System	Canada and key provinces including Ontario and British Columbia	2002-present	New life-cycle infrastructure program—not single projects—are key to driving broad-scale efficiency, innovation and outside investment	Specialized infrastructure investment units in Denmark, UK, Australia, Colorado and Indiana, new U.S. regional accelerator pilot program (Sec 1441 of FAST Act)
Auckland’s Outcome-Based Prison Design	New Zealand	2012-present	Unique procurement linking performance contracting with bonus payments for reduced recidivism	Resilience By Design
Pennsylvania Bridge Replacement Program	USA	2014-present	Construction and operational efficiencies realized through bundling multiple investments in standardized project design of similar project types	Alberta, Canada, schools
San Francisco-Oakland Bay Bridge	USA	2014-present	Lack of public sector risk transfer and outcome-based contracting places 100% of any cost overruns with the taxpayer	Toronto Blue Jays Stadium, Hawaii Transit Line
Goethals Bridge	USA (NY)	2013-present	Design-Build-Finance-Maintain “availability” performance financing model; public pays only when the work is done and when the bridge operates as advertised	Miami Port Tunnel, British Columbia’s Sea to Sky Highway, Long Beach Courthouse
Flint, Michigan	USA	2013-present	Deferred maintenance and public participation disaster	Southern Cal Edison’s Porter Ranch methane leak
Medford Water Quality Trading Program	USA (OR)	2014-present	Water Market and Regulatory Innovation	DC Water Green infrastructure/social impact bond (expected Fall 2016)
Pacific Forest Trust and West Coast Infrastructure Exchange	USA (CA)	2015-present	Value of working with owner-advisor; early scoping of financial alternatives in design process	Reinvest Initiative’s El Paso design

Case	Country	Timeframe	Lessons Learned / Innovation	Related Examples
U.S. 36 Managed Lanes/Bus Rapid Transit	USA (CO)	2015-present	Merit-Based Funding and Design Innovation	TIGER grants, National Disaster Resilience Competition
Public Sector Building Reforms	USA (NC)	2015-present	Implementing fee for performance incentives	GASB 34, Executive Order 12-17 (Oregon)
Bath, NY, Integrated Utility	USA (NY)	2015-present	21st-century utility combines broadband, water, wastewater and energy services in one entity for efficiency	Chattanooga Broadband, Connecticut Green Bank, Maine 3-Ring Binder, Kentucky Wired Initiative
Wichita Wastewater Treatment	USA (KS)	2015-present	Procurement innovation and simplification focusing on outcomes and use of triple bottom line analysis	Envision (Dallas water pipeline) and Autocase (SFO Airport) design and business case analysis tools
EmNet Wastewater Sensor	(USA)	2015-present	Data innovation	Freshwater Trust, Trust's Streambank tools, NEST smart meters
Tappan Zee Bridge	USA (NY)	2014-present	Permitting and regulatory innovation	CA and Pacific Northwest Regulatory Innovation Teams Federal permitting improvement council (Title 41, FAST Act)
Rialto water utility financing	USA (CA)	2014-present	Contracting innovation, management of public sector union engagement	Boston-AFSCME LED lighting program, Seattle Seawall community workforce agreement
Value Capture	Singapore and USA	2015-present	Equity and value capture	NOMA transit stop (Wash DC), Singapore Air Rights, Enhanced Infrastructure Financing Districts (CA)
Blue Forest Resilience bond	USA	2015-present	Monetizing avoided costs	Swiss RE Catastrophe bonds, Entergy's resilience program, St. Bernard Project
Chicago Parking Meters	USA (IL)	2008	Privatization of public assets and lack of life-cycle cost controls financially and politically risky	

## Implementing PBI: Lessons Learned to Date

Below are some key findings about what it will take to drive a shift to a performance-based infrastructure system in the U.S.

### LESSON 1

**Countries, regions and states that have committed to create long-term PBI *infrastructure investment programs* have fared much better than governments which have tried to chase *one-time, private investment in a single big project*.** Given fiscal shortfalls for infrastructure spending, there have been discussions for years in the United States about the idea of attracting public pension fund and other private capital “sitting on the sidelines” to invest in U.S. infrastructure projects and lighten the load on public sector investment. The reality is that building a successful market for what are known as PPPs (public-private partnerships) has largely stalled in the U.S. **These investment partnerships have succeeded when government leaders have created full-bore infrastructure programs based on improving lifetime operational performance of *all* infrastructure investments; Canada alone has accounted for over \$100 billion of infrastructure investment since 2002, of which approximately \$15 billion is private sector capital.** See box on page 23.

### LESSON 2

***In most cases, public infrastructure assets should remain publicly held but private sector expertise, innovation and capital can and should be employed when appropriate.*** There has been ongoing controversy in the United States about whether privatizing publicly held assets is a better way to deliver infrastructure outcomes for the public. Case study analysis suggests<sup>42</sup> that in most cases full privatization is neither politically nor economically expedient. That said, private sector innovation, operation and financing of infrastructure projects that remain publicly held assets do offer many benefits to the taxpayer, including transferring substantial operational risks to the private sector and avoiding massive cost overruns<sup>43</sup> or for bundling smaller projects together to streamline construction and operational expertise.<sup>44</sup>

### LESSON 3

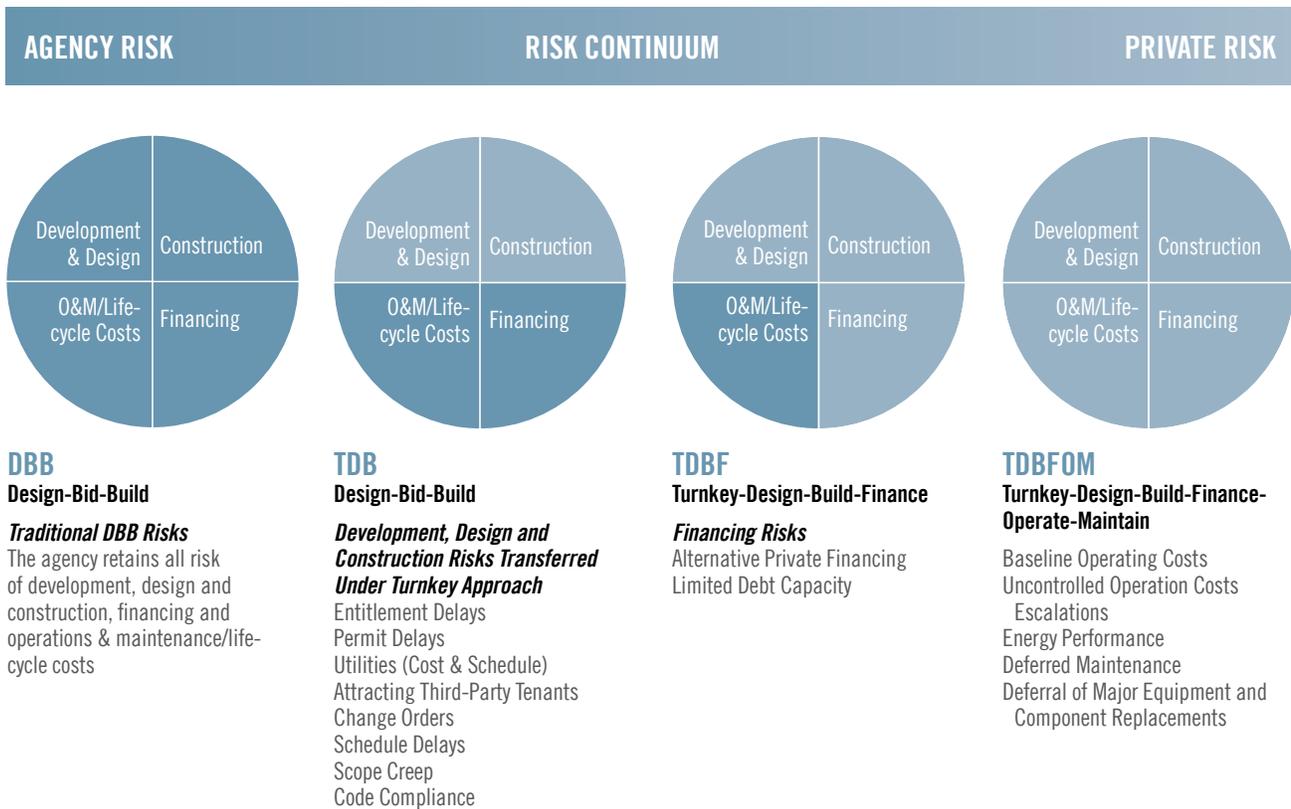
***Rather than have the public sector spend time and energy developing complex procurement and design documents, public agencies should shift to performance-based procurements.*** More innovative thinking and taxpayer value occurs when bidders are asked to look at life-cycle performance and the availability of services without the public sector pre-judging how that will happen and be designed. This process starts with shorter and simpler procurement documents that simply call out how much taxpayers have to spend and what outcomes they seek. Recent examples include the proposed Wichita (KS) wastewater treatment facility and outcome-based procurements for road maintenance and building services in New Zealand.<sup>45</sup>

## LESSON 4

*To address permitting delays, the public sector should pilot efforts that link project permitting and data innovation to measurable performance.* Estimates of the costs of federal permitting delays to the U.S. economy—in excess of \$3 trillion—rival the numbers often cited by the ASCE for the U.S. infrastructure funding gap.<sup>46</sup> While reducing legal and permitting delays is critical, promising new approaches can accelerate better outcomes by using data innovation and systems thinking to measure results. For example, a new water quality trading system approved by regulators in Oregon, Washington and Idaho uses stream bank restoration to meet federal water quality goals at lower costs than expensive new central station treatment costs.<sup>47</sup> Given the national backlog of unfunded wastewater treatment facilities, these and other performance-based innovations could be game changers.<sup>48</sup>

## LESSON 5

*Public sector infrastructure cost overruns and maintenance costs can be substantially reduced by looking at every element of a project risk to make sure that the right person is managing that problem.* Doing this not only cuts project costs to the taxpayer; it opens up financing opportunities by potentially monetizing avoided costs.<sup>49</sup> A key step in the PBI planning process is conducting a risk assessment workshop to identify and assign project risks to the right party. See graphic.



Source: Oregon Public Infrastructure Commission, testimony by Edgemoor Construction, March 2016.

For example, a recent risk analysis conducted by the University of Southern Maine shows that the use of innovative natural infrastructure techniques over a thirty-year period would yield a present value of \$275 million in flood control avoidance benefits. These benefits are then compared to the present value of the cost of conserving land to mitigate damage over the same thirty-year period - an estimated \$15 million.<sup>50</sup>

## LESSON 6

*A final lesson for public sector leaders looking to implement performance-based infrastructure is the importance of multi-modal integration.* Current infrastructure funding and finance systems are largely siloed across different modes—water, transit, highways, broadband and the like—which makes it harder to find efficiencies and implement innovation. In many communities, for example, the biggest energy user is often the city’s wastewater treatment plant, and separate power and water utilities operate under different management and financial incentives. The rise of distributed power systems, wireless technology and driverless cars will further strain our current way of managing and thinking about infrastructure, let alone delivering desired outcomes to taxpayers.

### **Bath (NY) Electric, Gas & Water Systems: Integration and Innovation**

In 2015, Bath Electric, Gas & Water Systems (BEGWS) launched an innovative effort to transform its existing wastewater treatment facility into a “resource recovery hub,” capable of turning waste into power. The city’s existing wastewater treatment facility was energy-intensive, released methane and other harmful pollutants into the atmosphere, and expensive to operate. The new resource recovery hub offers an environmentally safe, profitable and self-sustaining option for Bath. The plan will also ensure that the city meets EPA regulations.

Guy Hallgren, director of municipal utilities at BEGWS, predicts that the upgraded plant that integrates water-wastewater and energy operations will result in increased revenues and decreased operational costs. By securing waste disposal business from food producers and restaurants in the region, and selling energy back to the grid, the city will generate revenues to pay back the 30-year, \$15.5 million state bond needed for the upgrade.<sup>51</sup>



# Making The Shift to PBI: Ten Key Steps

For cities, states and regions interested in accelerating the use of performance-based infrastructure, the following 10 action and policy recommendations can help build a new PBI program:

## Assessment and Research

### 1. Conduct an assessment and inventory of your jurisdiction's current tools and authorities available to implement performance-based infrastructure.

For example, over 30 states have infrastructure banks but in most states these authorities don't apply to infrastructure modes outside transportation.<sup>52</sup> Keep in mind that passing new legislation, such as creating a new state infrastructure bank, can take time.<sup>53</sup> While assessing these options, other executive actions, budgeting reforms and innovation incentives are available to begin shifting agency project planning toward an outcomes mindset.<sup>54</sup>

**2. Meet with your city and state's municipal finance experts and the state treasurer's office to assess long-term needs, gaps and efficient use of existing revolving loan funds.** The primary financing tool that finances infrastructure in every community is municipal bond financing, created in 1914. As your community projects future capital and infrastructure needs, understanding the gap between future bonding capacity and actual needs is essential to determine. For example,

the California treasurer's office just released an excellent report estimating the state's infrastructure funding gap to be \$358 billion over the next 10 years and proposing a number of action steps to close the gap.<sup>55</sup>

### 3. Create a plan for cutting deferred maintenance, boosting enhanced infrastructure efficiency and closing your infrastructure funding gap.

Traditional municipal bonding authorities are not organized to measure whether or not your asset is well-maintained or subject to a pay-for-performance payment to protect taxpayers from construction or operational risk. But elected leaders and chief budget officers should fill this management gap.<sup>56</sup> Notable here: North Carolina voters recently approved a \$2 billion state infrastructure investment program anchored by the governor's commitment to maintaining existing infrastructure better and instituting fee-for-performance initiatives.<sup>57</sup>

## Key Performance-Based Infrastructure Reforms

### 4. Require an Infrastructure Risk and Resilience Assessment (IRRA) for major projects:

Governors, mayors, state legislatures and local governments should consider requiring life-cycle cost and risk analyses of all new taxpayer investments in public infrastructure above \$25 million to ensure that both capital and O&M costs are considered for the life of the asset. These IRRA's can also be implemented through legislation, executive orders and budgeting incentives. These critical early project assessments can also serve as a first chance for the state's budgeting team to assess exactly what outcomes and services are to be purchased; whether innovative design and data could be applied to reduce long-term operational risks and costs, and if there is cross-agency duplication. Typically these reviews are conducted by the CFO, state treasurer or Ministry of Finance<sup>58</sup> but they can also happen voluntarily when far-sighted agencies add them to procurement requirements.<sup>59</sup>

### **5. Institute 10-year infrastructure**

**investment plans:** State legislatures, city councils or county councils should work with their governor to develop a 10-year infrastructure project investment plan to promote long-term integrated planning and investment across individual infrastructure modes that are now siloed. Infrastructure Ontario is a great example where developing this plan changed the game from an annual budget skirmish about whose project would be on the funded “list” to instead building a more deeply vetted long-term pipeline of projects focused on life-cycle costs and benefits.<sup>60</sup>

### **6. Fully Implement Governmental Accounting Reforms for Smart Asset Management.**

Approved in 1999, rule 34 of the Governmental Accounting Standards Board establishes new financial reporting requirements for state and local governments throughout the United States. A key aspect of GASB 34 is its call for accrual accounting of governmental assets and liabilities, *including infrastructure*. Unlike government, most utilities and private sector companies use accrual accounting. Elected officials should encourage local and state CFOs to fully implement GASB 34 as a critical step for cutting deferred maintenance and protecting the value of important public assets.

### **7. Pilot the use of new outcome measures and business case tools in the development of performance-based infrastructure procurements.**

Canada’s Sea to Sky Highway simplified procurement asked bidders to achieve seven transportation outcomes using a total of \$600 million. Innovative responses and designs provided \$700 million in measurable value, more than expected. More recently, the San Francisco International Airport Terminal 1 project required project bidders to do a triple bottom line business case analysis as part of their submission. These simple no-cost changes to public sector procurement could be transformative if adopted across the country.

### **8. Public sector training and engagement are critical for the success of PBI.**

Shifting to PBI involves big changes for most governments to make, and bureaucratic, agency and legislative incentives now in place generally discourage new approaches. To have a chance of success, performance-based infrastructure and risk management tools and expertise should be made readily available at low or no cost to all public infrastructure project sponsors interested in using these methods.<sup>61</sup>

### **9. Incorporate new resilience data, design and disaster planning tools.**

Extreme weather and storms are costing insurance companies and ratepayers an extra \$150 billion per year worldwide. As a result, new tools to monetize avoided storm damage are being piloted by Swiss Re, MyStrong Home and other insurance companies.<sup>62</sup> The Department of Homeland Security is working with Northeastern University, the West Coast Infrastructure Exchange and others to educate local officials about regional resilience and infrastructure asset management.

### **10. A new role for the public and communities is needed for 21st-century infrastructure innovation.**

The mismanagement and public health disaster in Flint has shone a new light on the need for more meaningful public participation and attention to proper infrastructure maintenance. Not unrelated, citizens and small businesses interested in using new forms of distributed energy sources are increasingly coming into conflict with the desires of longstanding public utility monopolies that consider these changes disruptive to their business model. While PBI is not a panacea for all society’s ills, a key feature of the work is the creation of transparent decision-making processes that can help meet these challenges and focus the debate on outcomes.

## Performance-Based Infrastructure: The New Model

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As part of normal needs assessment, project sponsors and public sector leaders look at alternative approaches and partnerships for delivering optimum infrastructure outcomes; CFOs track asset condition.

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Public/community/business plays an early role in identifying alternative strategies to realize the same or better outcomes; best-in-class designers compete for project outcomes based on innovation and performance guarantees.

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Enhanced focus on how new distributed models to deliver transportation, energy and water savings overlap and interplay for new efficiencies.

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Project added to a 10-year infrastructure asset management plan approved by the legislature, prioritized based on compelling need and benefit.

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Legislature requires an Infrastructure Risk and Resilience Assessment (IRRA) to ensure taxpayer investment minimizes life-cycle project management risks and enhances performance.

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An enforceable plan exists for performance guarantees on construction, to prevent cost overruns and provide for life-cycle maintenance.

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Strong on-time, on-budget construction results plus infrastructure assets are better maintained as taxpayers pay agreed-upon costs to contractors only when infrastructure assets are available and meet performance requirements.

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Better outcomes for taxpayers and communities measured in net costs, controlled risk, better design, climate resiliency and equitable community investment outcomes.

## Value v. Cost

We know that Maine, the Northeast region, and the United States at large face a huge deferred maintenance gap. One key reason: government officials and the press corps tend to choose the “low-cost” bid as the best option, when sometimes the low-cost bid does not provide the best overall lifetime value to the taxpayer.

A recent study by the Lawrence National Centre for Policy and Management does an excellent job of explaining the difference:<sup>63</sup>

“A (performance-based) project will rarely be the cheapest option when one looks at the short-term infrastructure costs (brick-and-mortar, building systems, etc). However, when the (full) spectrum of risks is considered, lifecycle costs and other qualitative factors tip the balance...”

Life cycle methods for planning infrastructure offers further benefits to the taxpayer -- the potential for what experts call “value capture”. In Hong Kong and Brazil, for example, transit agencies use a variety of tools to “capture” the property and social value that their projects create.”<sup>64</sup>

In the United States, new efforts to do more effective “value capture” for public infrastructure investments are beginning. For example, creating what are known as Enhanced Infrastructure Financing Districts would allow taxpayers who foot the bill for transit to share in the upside of real estate and property value increases that often result.<sup>65</sup>

The case is compelling: “Currently...increased value flows primarily to private developers and property owners. They get to charge higher rents and enjoy increasing property values. Fairness suggest that the taxpayers who are footing the bill for the transit lines should share in the wealth that rail creates.”

## Performance-Based Permitting: The Medford Water Quality Trading Program

Innovative permitting systems that are outcomes-focused and data-driven are allowing the use of natural infrastructure and land restoration tools that can save money over traditional centralized waste water treatment systems. These pay for success efforts pay landowners for land restoration, and achieve the same or better outcomes for communities. The approach by the Willamette Partnership, described below, could be applied to many Maine communities facing wastewater treatment challenges.

The Regional Water Reclamation Facility in Medford, Oregon, releases about 17 million gallons of warm water into the Rogue River every day. Given population growth and an increase in wastewater volume, the city realized that the warm water released by the plant was raising the temperature of the river and severely endangering fish populations. In order to comply with the Clean Water Act and maintain its National Pollutant Discharge Elimination System Permit, the city needed to implement a system to cool the river. Traditional solutions of using cooling towers and other mechanisms of redirecting water elsewhere ranged from \$15-\$40 million (Freshwater Trust).

In 2011, the City of Medford entered into an agreement with The Freshwater Trust to implement an innovative water quality trading program. Offering a host of environmental benefits, the program requires Medford to pay landowners to plant shade trees along the river, to keep the river cool. First, The Freshwater Trust identifies private properties and streambank restoration methods, including tree planting and maintenance. A third-party certifies the site and assigns credits based on the shade generated. Measured in kilocalories of energy, each credit tracks the energy needed to raise the water temperature by onedegree Celsius. Then, the city purchases credit from landowners to continue its water treatment system. The Freshwater Trust monitors progress through a software system called “Shade-a-lator” that quantifies thermal load reductions from shade achieved in a certain area (Environmental Health News).

The total cost of the trading system is \$6.5 million, and provides \$8 million in savings (Freshwater Trust). As an innovative, cost-effective solution that leverages data and provides measurable outcomes through tangible benefits for all stakeholders, the Medford Water Quality Trading Program is a national model that other cities can emulate.<sup>66</sup>

## Bringing PBI to Full Realization: Create a Center of Expertise to Anchor the Work

The top 10 list of PBI reforms above involves a number of complicated, multi-year changes. Taking any of these steps is a good idea for public sector leaders who want to begin realizing better value for taxpayer investment in infrastructure and drive public sector innovation.

Given this paper's earlier finding regarding the value of programmatic reform rather than single project success, most experts recommend that PBI work ultimately be anchored in one place by creating a center of expertise to serve a metropolitan area, state or region.

## Infrastructure Accelerators Explained

According to the U.S. Congressional Budget Office, most of the over \$500 billion in U.S. annual infrastructure spending happens at the state and local level, but most infrastructure projects cross political boundaries. The objective of the infrastructure accelerator model is to facilitate project development through a uniquely flexible metro/regional platform.

*"The accelerator model does this by serving as the translation point between the public and private sectors: public sector decision-makers leverage the accelerator to develop best practices and access expertise in project financing they currently lack, while potential investors and stakeholders have welcomed the accelerator's efforts at developing standards common to multiple projects and infrastructure types." — Denis Hughes, Stonepeak Investors*

Accelerators are intended to anchor a major shift in public sector infrastructure development practices, productivity and performance in a number of key areas, including:

- Helping localities utilize outcome-based and life-cycle infrastructure methods to ensure project risks are properly allocated and key outcomes like enhanced infrastructure resilience are realized.
- Providing assistance with critical predevelopment activities such as feasibility analysis, stakeholder engagement, data innovations and other best practices.

- Breaking inter-agency silos and finding integration opportunities between capital projects and investments.<sup>67</sup>
- Acting as an owner-advisor to public agency project sponsors to help assess how and when to engage private sector expertise and capital into complex public infrastructure projects (the use of traditional PPPs).
- Instituting models of transparency for procurement reform and clearly defined criteria for doing business case analyses of taxpayer value for money for projects of a certain investment size or type.
- Bundling smaller-scale and distributed “green infrastructure” and rural projects into outcome-based and efficiently scaled projects.
- Developing meaningful 10- and 20-year infrastructure investment programs that reflect best practices in asset management (GASB 34).

The goal of accelerators is to serve regional interests through the planning, delivery and oversight of complex infrastructure projects using innovative approaches. As an example, British Columbia has implemented a regional accelerator model as part of its infrastructure delivery system in Canada. The end result is that Partnerships BC, Infrastructure Ontario and other Canadian accelerators have accounted for over \$100 billion of infrastructure investment since 2002, of which approximately \$15 billion is private sector capital.<sup>68</sup>

As importantly, these centers of expertise have shifted public sector focus from funding just the upfront capital costs of a project to a new model called “performance-based infrastructure” where the full life cycle of operation and operating risks, including resilience issues, is considered upfront.

Several states, led by Virginia and Colorado, have created transportation centers of expertise to advance high-performance infrastructure investments in their state. Most recently, the California treasurer has called for the creation of such an accelerator in his state,<sup>69</sup> and other experts are advocating for expansion of similarly conceived intermediaries.<sup>70</sup>

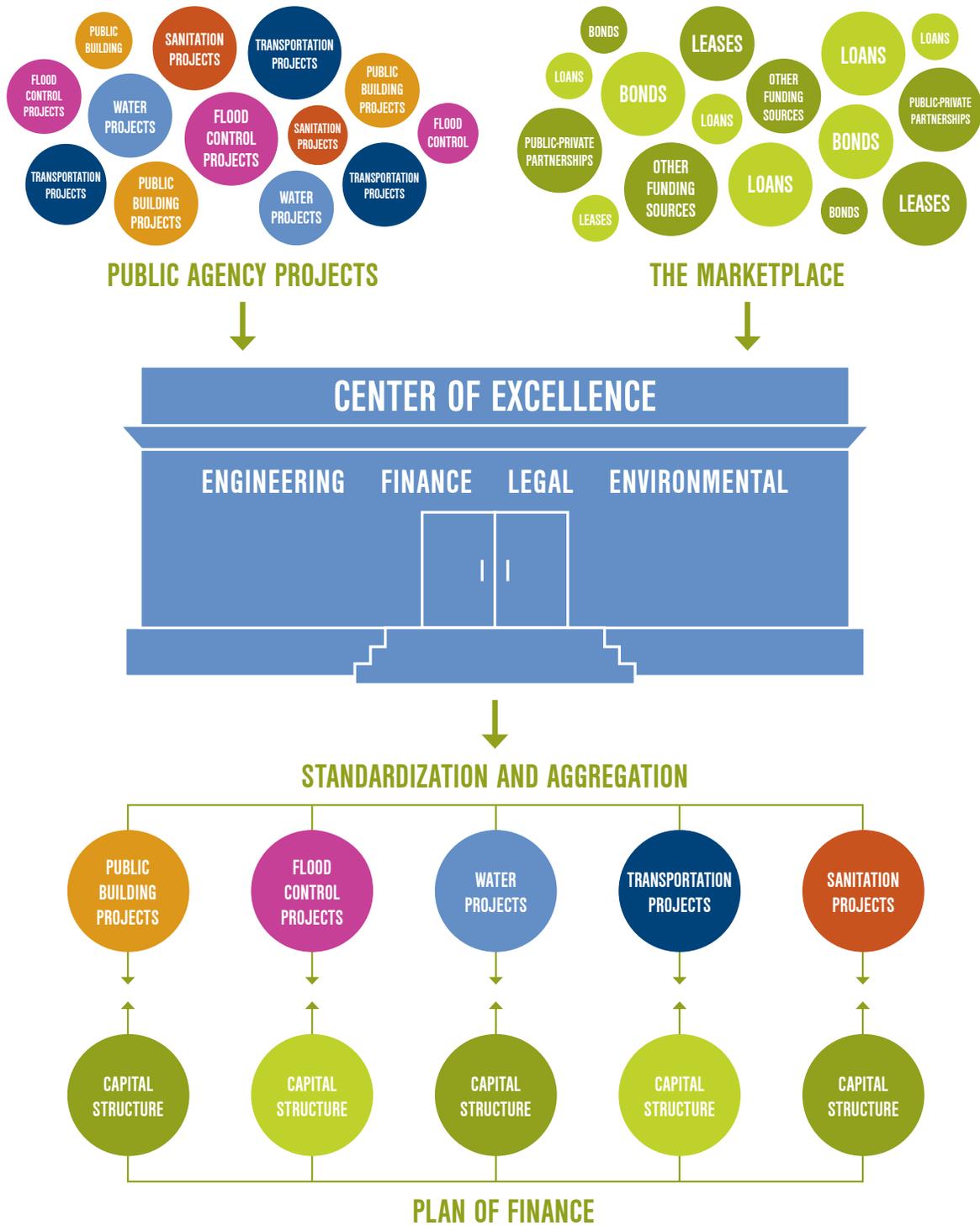
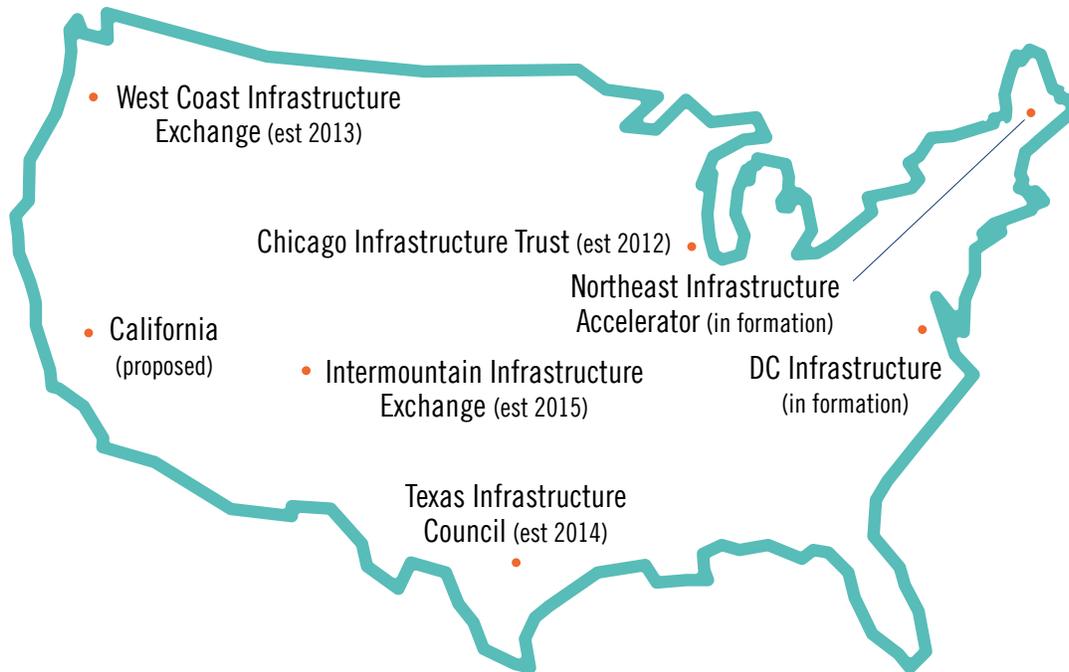


image credit: [www.treasurer.ca.gov/publications/biennial/2016.pdf](http://www.treasurer.ca.gov/publications/biennial/2016.pdf)

## Infrastructure Accelerators in the U.S.

In its early adolescence in the United States, the infrastructure accelerator movement is beginning to serve as a critical resource for infrastructure development and planning—providing a unique opportunity to embed standards, budget reforms and other best practices for system-wide implementation.

In the United States there are currently six PBI-accelerators and more are likely to form under Section 1441 of the FAST (Fixing America's Surface Transportation) Act.



## Regional Infrastructure Accelerator Pilot Program

Section 1441 of the FAST ACT, enacted in December 2015, establishes a competitive grant program to demonstrate the concept through at least five state or regional infrastructure accelerator programs.

Regional accelerators will:

- provide assistance with predevelopment activities and costs such as feasibility analysis, stakeholder engagement, permitting road maps, etc;
- screen local projects seeking national support or national technical assistance;
- ensure multi-modal integration;
- institute models of transparency such as standardized processes and clearly defined criteria for infrastructure investment projects;
- utilize performance-based infrastructure methods to ensure product risk is properly allocated;
- bundle smaller-scale and rural projects into investable project pools;

- commission and review Value for Money analyses;
- prepare and review requests for qualifications and proposals from private sector partners; and
- apply regional approaches for advancing innovative investment in public infrastructure projects that span all types of infrastructure including surface transportation, freight infrastructure, ports, inter-coastal waterways, clean water initiatives, water storage and irrigation, and others.

## A Northeast Regional Accelerator?

*In this context, establishing a Northeast Infrastructure Accelerator would reflect the reality of Maine’s various infrastructure systems (water, energy, ports, broadband and so on), that operate within different regional market and regulatory structures.* Including a regional center of expertise for performance-based infrastructure in Maine’s innovation toolkit—could serve as a critical missing link to ensure that Maine can stay connected to regional partners, capital sources, and critical conversations that might otherwise overlook the state in the race for 21st century competitiveness. Another advantage of this model: a regional accelerator could provide added bandwidth to focus on new areas and also serve as a key facilitator to advance efforts in areas that are currently “stuck” for one reason or another.

### Northeast Infrastructure Accelerator (NEX) in Action: Broadband

As discussed, one of the advantages of the infrastructure accelerator model is the ability to be innovative and identify local infrastructure opportunities that are ready to move from a local perspective. One great example of that locally is the Northeast Infrastructure Accelerator’s current work on Maine broadband infrastructure.

In the past, broadband has not been considered public infrastructure. The ASCE report card does not give grades on broadband. However, that is changing. There is a major push across the country to ensure broadband is treated just like roads, bridges, water and other infrastructure at both the state and federal level.

NEX has been in front of this trend for over a year, partnering on the ground locally with public, private, municipal, state, congressional, investors and other players around the country to figure out how Maine can develop and finance a plan to build “top 25 in the country” broadband infrastructure statewide as a critical economic development tool. That work with stakeholders is continuing with new research on its way.

## Modern broadband is being deployed at greater levels throughout Top 25 markets...

In Maine, the current policy debate calls for competitive broadband speed to be at the 10 mbps level. Nationally, the debate calls for higher speed (1000 mbps).

Top 25 Best Performing Cities <sup>71</sup>	>100 Mbps access, June 2014 (% pop) <sup>72</sup>	Fiber in place or in plans (July 2016)
San Jose	95	Potential Google Fiber City
San Francisco	96	Upcoming Google Fiber City
Provo	94	<b>In place. Google Fiber City</b>
Austin	19	<b>In place. Google Fiber City</b>
Dallas	48	Potential Google Fiber City
Raleigh	13	Upcoming Google Fiber City
Seattle	99	Feasibility study complete
Portland, OR	91	Potential Google Fiber City
Greeley	71	Unknown
Paso Robles	87	Unknown
Salt Lake City	98	<b>In place. Google Fiber City</b>
San Antonio	12	Upcoming Google Fiber City
Charlotte	70	<b>In place. Google Fiber City</b>
Ft. Collins	87	<b>In place.</b>
Naples/Marco	95	Unknown
Denver	92	Unknown
Charleston	79	Unknown
Nashville	91	<b>In place. Google Fiber City</b>
San Diego	73	Potential Google Fiber City
Madison	91	Feasibility study in process
Grand Rapids	84	Unknown
Boulder	91	Feasibility study in process
Fayetteville	85	Unknown
Santa Rosa	93	Unknown
Portland, ME	18	Limited study underway
Lew/Aub, ME	4	No stated intention
Bango, ME	3	No stated intention

SOURCE: Milken Institute 2016, Ookla via Brookings 2014, National Broadband Map 2014, web search



# Getting to Scale: How Maine and the Northeast Can Lead The Way

*Performance-based infrastructure is a form of public-private partnership that combines the strengths of the public and private sectors through contractual arrangements in which government and private companies assume shared responsibilities for the delivery of public infrastructure services.*

*These partnerships produce results by combining the advantages of the private sector — dynamism, access to finance, knowledge of technologies, management efficiency, and entrepreneurial spirit — with the social responsibility, environmental awareness, local knowledge, safety requirements, and job generation concerns of the public sector.<sup>73</sup>*

— *Maine Development Foundation, 2008*

## Recommendations for Maine

So how can Maine and Northeast lead the shift to innovative infrastructure methods and reap the economic advantages. Building on the previous section, this section spells out a number of specific recommendations to make sure that Maine no longer undercuts its ability to create jobs and be economically competitive by under-investing in its infrastructure base.

*These low-cost but high-impact measures would be designed to ensure that Maine's investment in public infrastructure is managed as a portfolio of assets that will last 30 years or more – not as a one-time, capital investment.*

If implemented expeditiously, these bi-partisan policy initiatives could allow Maine to become a leading innovator in 21st century infrastructure partnerships and successfully attract private sector capital and expertise to the region.

## Seven Maine Specific Recommendations for Implementing PBI

The following policy recommendations are advised for Maine and the Northeast region to realize 21st century efficiencies and innovations in infrastructure and to attract outside capital.

**1. Lifecycle cost and risk analysis:** The Governor, the State Legislature, and local government leaders should consider requiring life-cycle cost and risk analyses of all new Maine taxpayer investments in public infrastructure above \$25 million. Such analyses will ensure that both capital and O&M costs are considered for the life of the asset. An Infrastructure Risk Assessment (IRA) Requirement for Maine would ensure that taxpayer dollars are invested in the best lifetime value, not just the low capital bid.

**2. Risk and fiscal management tools:** Risk and fiscal management tools offer potential taxpayer savings and should therefore be made readily available to all public infrastructure project sponsors interested in using performance-based infrastructure methodology.

**3. Project bundling:** Special consideration should be given to developing new techniques and capacity to allow smaller Maine communities to bundle projects so that they can access private investment and operational efficiencies that reduce taxpayer costs.

**4. 10-Year Infrastructure plan:** The State Legislature should work with the Governor to develop a 10-year infrastructure project investment plan to promote long-term, integrated planning and investment across individual agencies and siloed infrastructure modes.

**5. GASB compliance program:** A Governmental Accounting Standards Board (GASB) compliance program should be instituted for Maine.<sup>74</sup> GASB Statement 34 establishes new financial reporting requirements for state and local governments throughout the United States. A key aspect of Statement 34 is that it calls for accrual accounting of governmental assets and liabilities, including infrastructure.

**6. Legislative review:** Review existing legislation and assess tools to ensure Maine has the complete, requisite “policy toolkit” to allow the state to attract private sector capital and expertise. For example, Maine could expand its current authority to do “public-private partnerships” by including more than just transportation projects.<sup>75</sup>

**7. Regional center of excellence:** To complement its state infrastructure financing authorities, Maine should consider supporting the creation of a regional infrastructure center of expertise that can concentrate skills and best practices in one dedicated enterprise. This will replicate a successful model that has been utilized and documented in other countries.

## Bundling Small Projects for Performance Efficiency

As noted earlier, major institutional investors, such as the Maine Public Employees Retirement System, are interested in investing pension funds in local infrastructure projects, but they often need to spend more than \$1 million on required due diligence to justify such an investment for the pensioners. This makes it cost prohibitive for major pension funds to look at investing in smaller infrastructure projects.<sup>76</sup>

As a result, there are hundreds of smaller (below \$50 million in size) public infrastructure projects that are priced out of the market. Government bidding and contracting processes can also be time-consuming and expensive, which limits the ability of prospective performance-based infrastructure innovators to participate.

Bundling smaller projects together through performance-based infrastructure creates operational efficiencies and enables smaller projects and cities to access outside capital. Taxpayer dollars are protected; payments aren't made unless the infrastructure is "available" and performing adequately.

- ***Pennsylvania Bridges (U.S.):*** \$1.1 billion project for replacement of 558 bridges across Pennsylvania to reduce the large state backlog of structurally deficient and unsafe bridges. The private company that has been building and maintaining these bridges for 25 years is under a performance warranty. Replacements to be done in 3 years; rather than PennDOT's projection of 20 years to do this.<sup>77</sup>
- ***Alberta Schools (Canada):*** Built 18 schools in phase I of \$412 million bundling project. This was such a successful undertaking that 10 schools will be built in phase II for \$253 million.<sup>78</sup>
- ***Health facilities (UK):*** 339 new integrated facilities built with £2.5 billion invested over 10 years. Joint ventures between Community Health Partnerships and private sector partners.<sup>79</sup>

***One issue that comes up with project bundling programs:*** how can it be ensured that smaller contractors are able to compete and won't get unfairly crowded out by bigger international engineering and financial experts. In Ontario, this issue was dealt with by creating set aside funding through the Ontario Strategic Infrastructure Financing Authority for smaller communities to get the technical assistance they needed to access funding. Maine communities have another tool they can use: The Interlocal Agreement Act which allows Maine communities to create special purpose financing districts without legislative approval.

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# The Federal Role: Capacity Building and Standard Setting

The U.S. infrastructure system is in the midst of profound transformation. The long-term effects of decades of deferred maintenance and local fiscal challenges are revealing themselves in dramatic new ways, from Flint’s water crisis to the massive Porter Ranch methane leak to the closure of the Washington metro system in March.

New 21st-century challenges, needs and opportunities—from big data, disruptive weather and distributed electricity generation—are also challenging the public sector to innovate, or else.

*The next major round of federal investment in infrastructure must include funding to “teach” local and state governments how to “fish” for the innovative methods and new funding models they will need to survive in the days of disruption that lie ahead.*

Successful models for building and funding new infrastructure are out there, and new methods to get more taxpayer bang for the buck and private investment in public infrastructure have been developed in other countries and regions, including Canada. These new methods, including performance-based infrastructure and procurement innovation, are proven methods.

Yet as discussed in this Report, these infrastructure innovation tools remain highly underdeveloped in the U.S. and need to be scaled.

So what is the federal role in incentivizing the use of PBI? Here are a few recommendations:

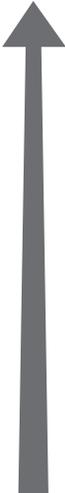
## PHASE 1: 2016-2017

### Begin Building a PBI Infrastructure Accelerator Network from the Bottom Up

Although last year the Canadian national government authorized the creation of a national infrastructure center of expertise, **the growth of the performance-based infrastructure system began at the local and provincial level in 2002**. Partnerships BC led the way as it faced the challenges of financing new infrastructure for the coming Winter Olympics; Ontario followed suit after a \$400 million stadium cost overrun crowded out funding for other critical infrastructure. Now about 10 provincial centers are advancing performance-based infrastructure and attracting private sector capital into public infrastructure projects.

Mimicking this bottom-up growth makes sense for the U.S. as well, as over two-thirds of all infrastructure projects are funded and sponsored at the local and state levels. But as expert studies have shown, there is limited to no capacity or skill set for PBI.

**It is recommended therefore that the federal government take steps to support the shift to PBI from the bottom up with initial capacity, grants and dissemination of best practices.** Performance-based infrastructure and risk management tools and expertise should be made readily available to all public infrastructure project sponsors interested in using these methods. At scale, in 10 years, the U.S. would rely on a local, state and regional network of accelerators to support this shift to performance-based infrastructure.



### Building a Better U.S. Infrastructure System from the Bottom Up

5. The result: a growing national marketplace of projects attractive to investors
4. New infrastructure accelerators acting as project intermediaries strengthen local and state project quality, delivery, cost to taxpayers
3. A single center of expertise in local/state government is most efficient way to assess project alternatives, including private financing and small project bundling
2. Success in Canada and elsewhere suggest key is considering life-cycle costs and benefits not just capital costs of each project
1. Local and state agencies originate projects but lack capacity and expertise to look at alternative procurement and financing methods

## PHASE 2: 2017-2018

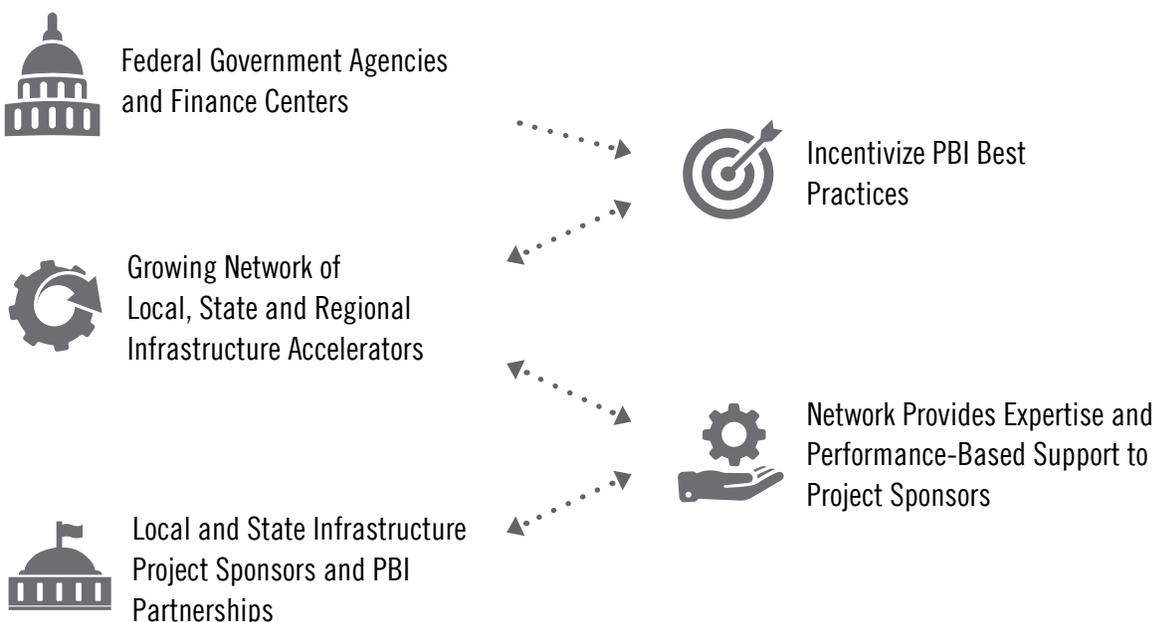
### Link Federal Infrastructure Finance Centers and Local Infrastructure Accelerators through Best Practice Incentives

One major outcome of the Obama Administration’s Build America Investment Initiative in the past 18 months has been the creation of new infrastructure best practice and finance centers at the following federal agencies: EPA, DOT, DOI, USDA, and the DOE. The Trump Administration would do well to build upon these centers of expertise as it looks to scale US-Based success in infrastructure partnerships.

To further leverage this federal investment, linking these Federal Finance Centers to the emerging network of metro and regional accelerators created by Section 1441 of the FAST Act could help extend the reach of these centers and serve more local project sponsors in the process. Both the American Enterprise Institute and the American Council of Life Insurance have called for expanding the use of regional entities to accelerate this shift to PBI.

Access to predevelopment support in Federal Finance Centers and regional accelerators should depend on local project sponsors doing 10-year capital plans, procurement and permitting reform and conducting/funding an Infrastructure Risk and Resilience Assessment.

### Future U.S. Infrastructure System



## PHASE 3: 2018-2020

### Additional Federal Reforms

President Trump and Congress will clearly have their own ideas about infrastructure funding and finance, but it would be a good idea to make sure that the U.S. public sector continues to shift toward life-cycle management of infrastructure assets. In addition to supporting the growth of the PBI field, local and state incentives for reform and standing up a network of regional accelerators, here are six more areas of federal reform that could create the outcomes we seek: a more efficient U.S. infrastructure system.

- Create a predevelopment innovation fund to incentivize the use of performance-based infrastructure methods and the creation of local, state and regional accelerators.
- Support new state training programs to promote better utilization of state revolving funds for water.
- Support efforts by the Department of Homeland Security to implement additional regional infrastructure resilience reviews.
- Fund research on infrastructure data innovation and best practices, including full value capture for public investments in infrastructure.
- Link innovative efforts in performance-based infrastructure procurement to the future work of the Federal Infrastructure Improvement Council created by the FAST Act of 2015.
- Require environmental mitigation and maintenance set-aside funding in tandem with new federal investments in accelerated permitting and project deployment.

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# Appendix: Interview List

In developing this paper, we consulted a number of experts whose insights and experience have added great value to our paper. Our thanks to all.

Interviewee	Organization
Don Sherman	American Council of Engineering Companies
Dan Pedrotty	American Federation of Teachers Investments
Marcia Hale	Building America's Future
Clifford Ham	California Court System
Al Puchala	Capitol Peak
Max Holtzman	Capitol Peak
Jeff Schub	Coalition of Green Capital
Nathan Music	Congressional Budget Office
Robert Kolasky	Department of Homeland Security
Jane Silfen	Encourage Capital
Alex Eidson	Encourage Capital
Anthony Williams	Federal City Council
Emeka Moneme	Federal City Council
Joe Whitworth	Freshwater Trust
Michelle Moore	Groundswell
Harriet Tregoning	HUD Resilient Communities
John Williams	Impact Infrastructure
Bill Butera	Institute for Sustainable Infrastructure
Zach Schafer	Infrastructure Week
Judson Greif	K&L Gates

Interviewee	Organization
Larry Blaine	KPMG
Alex Bernhardt	Mercer Investments
Joe Aiello	Meridiam Capital
Stephen Flynn	Northeastern University
David Caplan	Ontario Minister of Infrastructure (fmr)
Samara Barend	Performance-Based Building Coalition
Eric Letsinger	Quantified Ventures
Shalini Kapadia	ReFocus Partners
Susan Tinker	Shaw
Denis Hughes	Stonepeak Advisors
Alex Kaplan	Swiss RE Insurance
Megan Matson	Table Rock Capital
Will Hughes	Table Rock Capital
Sonia Axter and Ed Smith	ULLICO Investment Fund
Matt McKenna	USDA
Dan Flanagan	U.S. Infrastructure Investment Commission (fmr)
Jonathan Trutt	West Coast Infrastructure Exchange

# Endnotes

- 1 Public spending on infrastructure in the United States, at every level, has declined as a percentage of GDP since the recession, falling well below its lowest point in the past 20 years. Frank Holmes, “What China Can Teach U.S. About Infrastructure Investing,” Forbes Investing blog, May 19, 2015, <http://www.forbes.com/sites/greatspeculations/2015/05/29/what-china-can-teach-u-s-about-infrastructure-investing/#5f5ea6d05df5>. America’s infrastructure asset base is also aging. See Figure 6.3, “Economic Report of the President,” Office of the President of the United States, February 2016.
- 2 Bipartisan Policy Center, 2016. <http://bipartisanpolicy.org/events/recommendations-for-a-new-american-model-for-infrastructure-investment/>
- 3 U.S. Department of Transportation. [https://cms.dot.gov/sites/dot.gov/files/docs/Draft\\_Beyond\\_Traffic\\_Framework.pdf](https://cms.dot.gov/sites/dot.gov/files/docs/Draft_Beyond_Traffic_Framework.pdf)
- 4 Beeck Center, 2016. <http://beeckcenter.georgetown.edu/shifting-infrastructure-debate/>
- 5 U.S. CBO, 2014. Measured another way: Between 2003 and 2013, states, counties, and other localities invested \$4.2 trillion in infrastructure through long-term tax-exempt municipal bonds; the federal government provided \$1.43 trillion. Bond Buyer/Thomson Reuters 2014 Yearbook; NCO analysis, 2015.
- 6 ASCE, 2013 and 2017. For another useful take on deferred maintenance and the importance of fixing it first, see Eric Jaffe, “America’s Infrastructure Crisis Is Really a Maintenance Crisis,” CityLab, *The Atlantic*, February 12, 2015, <http://www.citylab.com/cityfixer/2015/02/americas-infrastructure-crisis-is-really-a-maintenance-crisis/385452/>.
- 7 See “Development boom in Columbia S.C. area contributed to dam failures, researchers say,” South Carolina Herald, April 2, 2016, <http://www.heraldonline.com/news/state/south-carolina/article69662202.html>; “Metro’s Failures,” Washington Post, October 2, 2015, [https://www.washingtonpost.com/opinions/metros-spectacular-failures-have-earned-it-greater-federal-oversight/2015/10/02/6fc4c48e-6883-11e5-9ef3-fde182507eac\\_story.html](https://www.washingtonpost.com/opinions/metros-spectacular-failures-have-earned-it-greater-federal-oversight/2015/10/02/6fc4c48e-6883-11e5-9ef3-fde182507eac_story.html); “Fear of Health Problems Plagues Porter Ranch, Calif., Gas Leak Victims,” March 11, 2016 <http://www.usnews.com/news/articles/2016-03-11/fear-of-future-health-problems-plagues-porter-ranch-calif-gas-leak-victims> “Southern California braces for summer blackouts due to Porter Ranch gas leak,” April 5, 2016 <http://www.latimes.com/local/lanow/la-me-ln-aliso-canyon-blackouts-20160405-story.html>
- 8 Richard Dobbs, Herbert Pohl, Diaan-Yi Lin, Jan Mischke, Nicklas Garemo, Jimmy Hexter, Stefan Matzinger, Robert Palter, and Rushad Nanavatty, “Infrastructure Productivity: How to Save \$1 Trillion a Year,” McKinsey Global Institute, January 2013, <http://www.mckinsey.com/industries/infrastructure/our-insights/infrastructure-productivity>.
- 9 See “Leveraging Catastrophe Bonds,” Rebound/Swiss Re report, December 2005, <http://www.refocuspartners.com/reports/RE.bound-Program-Report-December-2015.pdf>.
- 10 See “Recommendations of the Build America Investment Initiative Interagency Working Group,” U.S. Department of the Treasury and U.S. Department of the Treasury, January 2015, <https://www.treasury.gov/resource-center/economic-policy/Documents/Build%20America%20Recommendation%20Report%201-15-15%20FOR%20PUBLICATION.pdf>; and “Federal Resource Guide for Infrastructure Planning and Design,” Build America Investment Initiative, May 2015, <http://portal.hud.gov/hudportal/documents/huddoc?id=BAInfraResGuideMay2015.pdf>.
- 11 We measured the gap between needs and bonding capacity based on an assumed average annual financing cap; the estimate stays within that cap because we presume that going higher would lead to an unacceptable drop in the State of Maine’s bond rating, which currently stands at AAA. Bond Buyer State Series, 2005-2016.
- 12 Presentation by Daniel White of Moody’s to NGA, February 2015.
- 13 See Maine Development Fund <http://www.mdf.org/publications/Measures-of-Growth-2016/859/>
- 14 National Association of Manufacturers, 2016. <http://www.nam.org/Issues/Infrastructure/#sthash.hxWIQSid.dpuf>
- 15 Groundswell, 2016. <http://groundswell.org/study-finds-that-working-families-pay-the-most-for-electricity-despite-lower-price-trends-and-affordable-clean-energy-alternatives/>
- 16 Maine ASCE Report (<http://www.infrastructurereportcard.org/maine/maine-overview/>)
- 17 <http://www.ooyuz.com/geturl?aid=8569131>
- 18 University of Massachusetts, 2014. [http://www.peri.umass.edu/fileadmin/pdf/other\\_publication\\_types/green\\_economics/PERI\\_Infrastructure\\_Investments](http://www.peri.umass.edu/fileadmin/pdf/other_publication_types/green_economics/PERI_Infrastructure_Investments)
- 19 Insurance Journal, 2016. <http://www.insurancejournal.com/news/national/2016/04/12/405089.htm>
- 20 U.S. EPA, 2015. <https://www3.epa.gov/climatechange/impacts/northeast.html>
- 21 Governing, 2016. <http://www.governing.com/gov-institute/voices/col-put-chief-financial-officers-charge-infrastructure.html>; [http://www.swissre.com/rethinking/climate\\_and\\_natural\\_disaster\\_risk/](http://www.swissre.com/rethinking/climate_and_natural_disaster_risk/)
- 22 [http://www.energy.com/news\\_room/newsrelease.aspx?NR\\_ID=2443](http://www.energy.com/news_room/newsrelease.aspx?NR_ID=2443) ; <http://www.mercer.com/content/dam/mercer/attachments/global/investments/mercer-climate-change-report-2015.pdf>
- 23 <http://www.njspotlight.com/stories/13/07/28/the-list-what-it-cost-nj-s-utilities-to-recover-from-the-superstorm/>

- 24 U.S. Department of Commerce, 2015. <https://www.ncdc.noaa.gov/billions/summary-stats>
- 25 Governor LePage, 2015 Transportation Work Plan
- 26 McKinsey Global report, Infrastructure Productivity, 2013
- 27 Piper Jaffray analysis, 2015. As of June 2015, Maine currently ranks 38th in the effective utilization of its state revolving fund for water projects; New Hampshire is 45th and Vermont is 51st.
- 28 <http://pension360.org/maine-pers-commits-185-million-to-infrastructure-real-estate/> and <http://researchcenter.pionline.com/rankings/plan-sponsor/profiles/429759/overview>
- 29 For more on this issue of a weak pipeline of investable projects, see critical U.S. market gap in studies by CALPERS (2012-2013) and the Build America Investment Initiative (2014-2015). "Infrastructure Investment Outreach Review: Laying the Groundwork for Collaboration," California Public Employees' Retirement System, October 2012, <https://www.calpers.ca.gov/docs/forms-publications/infrastructureinvestment-outreach.pdf>.
- 30 U.S. Energy Information Administration, 2014.
- 31 See Bent Flyvbjerga, Mette K. Skamris holma, and Søren L. Buhla, "How Common and How Large Are Cost Overruns in Transport Infrastructure Projects?" *Transport Review* 23, no. 1 (2003).
- 32 Additional factors undermining infrastructure productivity and performance include persistent biases in forecasting, biases toward building new rather than getting more out of existing assets, and a huge capacity and skill shortfall in local and state government to improve project delivery and focus on outcomes. Dobbs et al., "Infrastructure Productivity."
- 33 The use of accelerators is expected to grow following the recent bipartisan passage in Congress of a \$12 million regional accelerator pilot (Section 1441 of the 2015 FAST Act). "Hitting the Road: FHWA Mile Markers in Implementation of the FAST Act—Year 1," Federal Highway Administration, May 2016, <https://www.fhwa.dot.gov/fastact/>. These provisions are based on work of West Coast Infrastructure Exchange, winner of the 2014 JFK School Ash Innovation award.
- 34 See "Summary of Statement No. 34: Basic Financial Statements—and Management's Discussion and Analysis—for State and Local Governments," Governmental Accounting Standards Board, June 1999, which requires government CFOs to use accrual accounting and track infrastructure asset value. The GASB chairman characterized the statement as "the most significant change to occur in the history of government financial reporting."
- 35 Sea-to-Sky Highway is a key example. See "Sea-to-Sky Highway: Project Details," Partnerships BC, 2014, <http://www.partnershipsbc.ca/projects/operational-complete/sea-sky-highway/>.
- 36 Adam Nagourney, "Hawaii Struggles to Keep Rail Project From Becoming a Boondoggle," *New York Times*, March 20, 2016, [http://www.nytimes.com/2016/03/21/us/hawaii-struggles-to-keep-rail-project-from-becoming-a-boondoggle.html?\\_r=0](http://www.nytimes.com/2016/03/21/us/hawaii-struggles-to-keep-rail-project-from-becoming-a-boondoggle.html?_r=0).
- 37 "10-Year Economic Impact Assessment of Public-Private Partnerships in Canada (2003–2012)," Canadian Council for Public-Private Partnerships, June 2014, <http://www.pppcouncil.ca/web/pdf/eco-impact-of-p3-report.pdf>.
- 38 Altus Group, "Infrastructure Ontario AFP Track Record Report," Infrastructure Ontario, October 2014, <http://altusgroup.com/newsroom/blog/2014/infrastructure-ontario-afp-track-record-report>.
- 39 <http://www.mckinsey.com/industries/capital-projects-and-infrastructure/our-insights/Bridging-global-infrastructure-gaps?cid=other-eml-alt-mip-mgi-oth-1606>
- 40 <http://www.thefreshwatertrust.org/case-study/medford-waterquality-trading-program/> and <http://www.environmentalhealthnews.org/ehs/news/2015/jul/rogue-river-oregon-salmon-water-quality-trading-thermalpollution-drought>
- 41 <http://westcoastx.com/news/wcx-plays-vital-role-in-ca-legislative-effort.html>
- 42 In 2008, the City of Chicago struck a deal with a consortium led by Morgan Stanley to lease the city's parking meters for 75 years for \$1.6 billion. The agreement resulted in a significant hike of meter rates, changes in hours of operations, meter malfunctions, traffic congestion on side streets, all leading to public outrage over the deal. For more, see David H. Hoffman, "Report of Inspector General's Findings and Recommendations: An Analysis of the Lease of the City's Parking Meters," City of Chicago Office of the Inspector General, June 2009.
- 43 As noted, many experts believe that the new San Francisco-Oakland Bay Bridge is a perfect example of where PBI would have protected the taxpayer.
- 44 Pennsylvania bridges (lead contractor: Penary Group) and the Alberta school district (lead contractor: AECOM) are two excellent examples of this method.
- 45 Request for Proposals, Wichita Water and Sewer Utilities Optimization, May 14, 2015, [https://ep.wichita.gov/e-proc\\_upload/SOHDKY00000000012363/Water%20%20Sewer%20Utilities%20Optimization%20Specifications.pdf](https://ep.wichita.gov/e-proc_upload/SOHDKY00000000012363/Water%20%20Sewer%20Utilities%20Optimization%20Specifications.pdf). For more on New Zealand model, see Joost M. van Beek, "New Models for Procurement of Public Services," KPMG, 2013, <https://www.kpmg.com/NZ/en/IssuesAndInsights/ArticlesPublications/SmarterProcurement/Documents/Procurement-models-of-public-services.pdf>.
- 46 Philip K. Howard, "Two Years, Not Ten Years: Redesigning Infrastructure Approvals," *Common Good*, September 2015, [http://commongood.3cdn.net/c613b4cfda258a5fcb\\_e8m6b5t3x.pdf](http://commongood.3cdn.net/c613b4cfda258a5fcb_e8m6b5t3x.pdf).

47 See regulatory agreement, “Draft Regional Recommendations for the Pacific Northwest on Water Quality Trading,” Willamette Partnership and The Freshwater Trust, August 2014, [http://willamettepartnership.org/wp-content/uploads/2014/09/PNW-Joint-Regional-Recommendations-on-WQT\\_ThirdDraft\\_2014-08-05\\_full1.pdf](http://willamettepartnership.org/wp-content/uploads/2014/09/PNW-Joint-Regional-Recommendations-on-WQT_ThirdDraft_2014-08-05_full1.pdf), and see data innovation, “5 Q’s for Joe Whitworth, President of the Freshwater Trust,” Center for Data Innovation, December 7, 2015, <https://www.datainnovation.org/2015/12/5-qs-for-joe-whitworth-president-of-the-freshwater-trust/>.

48 EmNet uses sensors to reduce and manage stormwater flows and costs. See John Nagy, “A Sewer System to Make Others Flush with Envy,” *Notre Dame*, Winter 2010–11; “The City of South Bend, Indiana Is EmNet’s Flagship Client,” EmNet, 2015; and David Z. Morris, “Smart Cities Think Big with \$160 Million White House Program,” *Fortune* Data Sheet, September 16, 2015.

49 See “Leveraging Catastrophe Bonds.”

50 University of Southern Maine. <http://muskie.usm.maine.edu/Publications/AssessmentWaterResourcesMaine.pdf>

51 “A Proposal for Economic and Environmental Improvement,” Bath Electric Gas and Water Systems Waste Water Treatment Plant, February 2015, [http://sunnybest.binghamton.edu/wp-content/uploads/2015/02/Hallgren\\_WWTP-Plan.pdf](http://sunnybest.binghamton.edu/wp-content/uploads/2015/02/Hallgren_WWTP-Plan.pdf).

52 Robert Puentes and Jennifer Thompson, “Banking on Infrastructure: Enhancing State Revolving Funds for Transportation,” Brookings/Rockefeller Project on State and Metropolitan Innovation, September 2012, <http://www.brookings.edu/~media/research/files/papers/2012/9/12-state-infrastructure-investment-puentes/12-state-infrastructure-investment-puentes.pdf>.

53 Recent examples include the Rhode Island Infrastructure Bank, the NY Green Bank and the Connecticut Green Bank.

54 For example, Executive Order No. 12-17: Infrastructure Planning and Investment, Office of the Governor, State of Oregon, November 13, 2012, which created new budgeting incentives and offered agencies extra inclusion points in the state’s capital budget for doing life-cycle assessments in agency budget requests. New Oregon prioritization criteria:

<http://www.oregon.gov/das/Financial/CapFin/Documents/Final%20SFPP%20Manual%202017-19.pdf>

[https://www.oregon.gov/HigherEd/Documents/HECC/FA/2016/02\\_Feb-10-16/6.0%20Public%20University%20Capital%20Prioritization.pdf](https://www.oregon.gov/HigherEd/Documents/HECC/FA/2016/02_Feb-10-16/6.0%20Public%20University%20Capital%20Prioritization.pdf)

55 “Building California’s Future Begins Today: Modernizing Public Finance and the Treasurer’s Office,” Office of the State Treasurer, State of California, February 2016, <http://www.treasurer.ca.gov/publications/biennial/2016.pdf>. The California treasurer recommended the state annually track these four factors: (1) condition of infrastructure assets; (2) estimate of when they may wear out; (3) replacement cost; and (4) cost of deferred maintenance.

56 See “Capital Budgeting in the States,” National Association of State Budget Officers, 2014, <http://www.nasbo.org/sites/default/files/pdf/Capital%20Budgeting%20in%20the%20States.pdf>.

57 “Mapping Our Future: Governor McCrory’s 25-Year Vision for North Carolina,” Office of the Governor, State of North Carolina, 2014, <http://www.ncdot.gov/ncvision25/>.

58 The recent California treasurer’s report is blunt in assessing the need for action, stating that: “public agencies have historically failed in their efforts to identify, parse and measure project risk.”

59 SFO Terminal 1 bid specifications explicitly call for bidders to conduct a comprehensive business case and value for money analysis of all economic, social and environmental risks and benefits. SFO specifically recommends the use of Autocase.com tool. Another assessment tool in wide use is the Institute for Sustainable Infrastructure’s Envision tool.

60 Infrastructure Ontario (IO) was created after massive cost overruns on the Toronto Blue Jays Stadium wiped out a \$400 million infrastructure pipeline for smaller projects. IO primed the pipeline with an initial five-year investment plan totaling \$1 billion; now the agency maintains a 10-year list of projects above \$100 million that have received a life-cycle review.

61 See “WCX Conducts PBI Training with Stanford University,” West Coast Infrastructure Exchange, 2016, <http://westcoastx.com/news/wcx-conducts-pbi-training-with-stanford-university.html>.

62 MyStrongHome is a new benefit corporation that fortifies houses against hurricane and storm risk, in partnership with insurance carriers that provide substantial discounts to the properties after they’ve been mitigated. MSH uses the insurance savings as a payment stream, turning a cost center for homeowners into an investment in their homes. MSH has started operations in South Carolina, Louisiana and Alabama and has found that state regulatory environments are key to the viability of its operations.

63 [http://www.ivey.uwo.ca/cmsmedia/1964203/comparing-p3-and-traditional-approaches.pdf?\\_cldee=ZGFuQGRhbmNhcj9sLmNvbQ%3d%3d&utm\\_source=ClickDimensions&utm\\_medium=email&utm\\_campaign=Project%20Update%20|%20Infrastructure%20Financing%20CEO%20Council](http://www.ivey.uwo.ca/cmsmedia/1964203/comparing-p3-and-traditional-approaches.pdf?_cldee=ZGFuQGRhbmNhcj9sLmNvbQ%3d%3d&utm_source=ClickDimensions&utm_medium=email&utm_campaign=Project%20Update%20|%20Infrastructure%20Financing%20CEO%20Council). Also see: <http://www.ncsl.org/documents/transportation/PPPTOOLKIT-AppendH.pdf>

64 See California Forward Issue Brief on EIFDs (2016) and Los Angeles Times, Op Ed by USC Professor Marlon Boarnet, 5/16/2016

65 Professor Marlon Boarnet, University of Southern California, Los Angeles Times, May 16, 2016.

66 <http://www.thefreshwatertrust.org/case-study/medford-water-quality-trading-program/>

67. A couple of illustrative examples: (1) agencies should dig once, not three times, to install new broadband, sewer, and power lines; (2) usually the biggest power user in a region is the wastewater treatment plant, so finding ways to share revenues and savings to generate better outcomes is critical.

68. "10-Year Economic Impact Assessment of Public-Private Partnerships in Canada (2003–2012)," Canadian Council for Public-Private Partnerships, June 2014, <http://www.pppcouncil.ca/web/pdf/eco-impact-of-p3-report.pdf>.

69. "Building California's Future."

70 High Road Working Group on Infrastructure, report to the Ford Foundation, 2015.

71 2015 Milken Institute, 70% based on job and wage growth, 30% based on high-tech GDP growth and location quotient

72 Requires cable at DOCSIS 3.X or fiber

73 [http://www.mdf.org/documents/mdc\\_renewing\\_downtowns.pdf](http://www.mdf.org/documents/mdc_renewing_downtowns.pdf)

74 source: Iowa State Center for Transportation <http://www.ctre.iastate.edu/gasb34/gasb341.pdf>

75 See <http://www.brookings.edu/-/media/research/files/papers/2012/9/12-state-infrastructure-investment-puentes/12-state-infrastructure-investment-puentes.pdf> and <http://www.ncppp.org/new-report-examines-state-transportation-p3-laws/>

76 Interview with Laurie Weir, CALPERS.

77 Plenary Group US Case Study, 2016

78 <http://graham.ca/project-profiles/alberta-schools-alternative-procurement/>

79 <http://www.gponline.com/successful-lift-been/article/1194884> and <http://www.communityhealthpartnerships.co.uk/lift-companies>



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