Developing U.S. Infrastructure In An Era Of Emerging Challenges

Observations From Key Sectors

S&P Global Ratings
Emerging challenges – including the impact of disruptive technology and the demand for sustainable projects – are adding to traditional financing pressures facing America’s infrastructure industry. S&P Global Ratings has observed that there are various tools being used by the public sector to collaborate with the private sector to bridge the financing gap and address these challenges. This paper discusses our observations on policies and financing techniques applied to various infrastructure sectors.

The pressure on governments in the U.S. – whether at the federal, state, or municipal level – has mounted as they face the twin challenges of fiscally constrained budgets and aging infrastructure. Across the country, municipalities are struggling to manage the repair of roads and bridges reaching the end of their life cycles. U.S. airports fall short compared with international peers in terms of passenger comfort and overall investment with an increasingly outdated air navigation traffic control network constraining long-term growth. Even with the most fundamental of services, water supply, we observe funding shortfalls (particularly with respect to midsize and smaller systems), significant levels of deferred maintenance, and only nascent asset management leading to higher operating costs for the taxpayer over the long term.

The country has been fortunate that decades ago (in some cases, up to 70 years ago), engineers built safety margins into their infrastructure designs. Yet today, the U.S. has found itself beyond the useful life of many infrastructure assets.
Chart 1: The U.S. infrastructure need in figures
Much Needed Funds To Improve Our Economy And Quality Of Life

56,007² DEFICIENT structurally deficient bridges
$90 BILLION² REPAIRS needed for public transit
$62 BILLION³ BACKLOG construction projects by U.S. Corps of Engineers
$160 BILLION²,4,5 LOST sitting in traffic each year

240,000² BROKEN water main breaks
900 BILLION² DISCHARGED gallons of untreated sewage
$25 BILLION⁶ WASTED by antiquated power transmission and distribution per year
$232⁷ OVERPAID per household annually for delayed goods

$7 TRILLION lost in business sales
$3.9 TRILLION lost in gross domestic product
$3,400 PER YEAR lost by households
2.5 MILLION fewer jobs in U.S.

Paying the price of inaction by 2020¹

⁴“2012 Urban Mobility Report,” Texas Transportation Institute, December 2012.
⁶“Two Years, Not Ten Years: Redesigning Infrastructure Approvals,” Common Good, https://commongood.3cdn.net/c613b4cfd2a58a5fc_e8m6b5t3x.pdf.”
Emerging risks add to traditional infrastructure pressures

Crucially, as the global trends of digitalization and sustainability increase, we expect the U.S. will need new infrastructure development to increase competitiveness, enhance productivity and efficiency, generate jobs, and attract investment and talent. New challenges exacerbate the concern that America’s prevailing infrastructure funding model in sectors such as transport, social infrastructure, and water – which relies predominately on traditional municipal financing – will be hard-pressed to satisfy the country’s evolving infrastructure needs over the next 50 years.

Much has changed since the days of President Dwight Eisenhower and the great interstate highway buildout of the 1950s: The U.S. has entered the age of information and development of smart cities. Based on observations of disruption in other industries, we believe that new infrastructure investment is needed for the U.S. to stay relevant and competitive in a world measured by smartphones and other connected devices, rather than the clunky solid state calculators engineers used 50 or more years ago. And accompanying the rise of digitalization is the growing risk of cybercrime.

While technology permeates nearly every aspect of modern life, America still struggles to integrate it into its aging infrastructure. In fact, as things stand, some elements of U.S. infrastructure may hinder technological advancement. The state of U.S. roads and airports may be obstacles to – rather than facilitators of – driverless cars and next-generation aircraft. Big data has the potential to lead to radical changes in physical urban infrastructure. Tomorrow’s infrastructure projects are likely to include sophisticated information systems and other advanced technologies to support U.S. productivity and keep pace with growth seen across the globe.

There is also a greater call for eco-friendly and environmentally sustainable infrastructure that can adapt to adverse weather conditions in a world increasingly affected by climate change, can offer long-term resilience to its effects, and can even contribute to the reduction and mitigation of global warming.

Importantly, some governments are placing greater focus on life-cycle management and looking for more strategic and efficient use of taxpayer monies over the long term. But the question remains: How can government revitalize infrastructure and ensure that it stays relevant in the digital and sustainable era – and do it in a cost-effective manner?

Tools traditionally used to help develop U.S. infrastructure

Historically, the U.S. has largely used municipal bond financing to fund the country’s transportation, water, social, and airport infrastructure. Largely built with federal gasoline taxes, America’s vast interstate highway system is a hallmark example of how public investment financing can produce large-scale assets, facilitating economic growth.¹ By S&P Global Ratings’ estimates, the decades-long interstate highway buildout achieved substantial returns on the public’s investment – boosting GDP by a factor of 6x.²

²Infrastructure investment creates a so-called “multiplier effect” in the wider economy. It is estimated that an additional 1% of real GDP spent on U.S. infrastructure would boost GDP by a factor of about 1.2x. In other words, $1.20 would be added for every $1 spent (see S&P Global Ratings reports “Global Infrastructure Investment: Timing Is Everything (And Now Is The Time),” Jan. 13, 2015, and “Much Ado About Nothing: The Trump Administration’s First 100 Days,” April 28, 2017). This does not include potential productivity gains in the medium to long term from well-thought-through projects.
Meanwhile, according to organizations such as the National Governors Association (NGA), tax-exempt municipal bonds have financed more than $2 trillion in new infrastructure investments over the past 10 years. Such funding has been used to construct and finance repairs to transportation projects, social infrastructure (such as schools, hospitals, prisons, housing, and court buildings), publicly owned electric power, water, and natural gas assets, and other projects. Over 50,000 state and local governments, authorities, and nonprofits have used municipal bonds. According to the NGA, nearly 75% of all public infrastructure financing comes from tax-exempt bonds. The remainder comes primarily from bank and private placement financings. Chart 2 illustrates different types of federally subsidized bonds that have been used to finance infrastructure in the U.S. and particular features as described by the Bipartisan Policy Center.

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**Chart 2: Different types of federally subsidized bonds**

<table>
<thead>
<tr>
<th>How they work</th>
<th>Tax-exempt or municipal bonds</th>
<th>Build America bonds</th>
<th>Private activity bonds</th>
<th>QPIBS¹</th>
<th>Move America bonds²</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>How they work</strong></td>
<td>American households and some companies hold debt through municipal bond funds.</td>
<td>- Taxable municipal bonds with tax credits and federal subsidies.</td>
<td>Issued by state or local government on behalf of a private partner.</td>
<td>- Special form of Private Activity Bonds.</td>
<td>- Special form of Private Activity Bonds.</td>
</tr>
<tr>
<td><strong>Subsidies / Incentives</strong></td>
<td>Tax-exempt municipal bonds allows bond owners to earn interest without being taxed.</td>
<td>- Either a 35% direct federal subsidy (direct payment BABs)² or a federal tax credit worth 35% of the interest owed to the investor (tax credit BABs).</td>
<td>Interest can be tax-exempt if issued for an infrastructure project owned by a state or local government with a public purpose.</td>
<td>- Not subject to any state borrowing caps.</td>
<td>- Interest exempt from alternative minimum tax as well as federal income tax.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- The subsidy rate could be lowered.</td>
<td></td>
<td>- Interest exempt from alternative minimum tax in addition to federal income tax.</td>
<td>- Can exchange for “Move America Credits:” transferable tax credits.</td>
</tr>
</tbody>
</table>

Source: Bipartisan Policy Center

¹ As proposed in Obama administration Budget for FY2016.

² As proposed by Senators Wyden and Hoeven in S. 1186.

³ This subsidy was later reduced by 7.3% during the sequester.

Despite this progress, and as previously discussed, investment in infrastructure continues to lag (see chart 3 also). Contributing factors include increasingly fiscally constrained municipal balance sheets, concerns about local governments’ ability and willingness to raise rates, and federal laws limiting revenue-raising flexibility of airport operators and state departments of transportation that maintain the interstate highway system.

**Other financing tools used to help develop infrastructure**

In addition to the traditional approach to financing infrastructure, the U.S., in our view, benefits from deep capital markets and sources of private-sector capital available to help finance infrastructure (see chart 4 for the BPC’s summary description of these sources).
<table>
<thead>
<tr>
<th>Institutional investor</th>
<th>Description</th>
<th>Investor requirements (Risk/Return)</th>
<th>Global investment in infrastructure</th>
</tr>
</thead>
</table>
| **Pensions**           | - May be tax-exempt  
- May be limited in types of investments they can make  
- Tend to invest relatively conservatively  
- Wide range of internal staff capacity | - Fiduciary board typically sets risk tolerance and desired rate of return  
- Desire to match investment returns to long-term liabilities | - $80 billion\(^1\)  
- 1% of total assets\(^2\) |
| **Insurance companies**| - Invest mostly in bonds, common stock, and first-lien mortgages  
- Tend to invest conservatively | - Desire to match returns to liabilities  
- Regulated by government | - $271 billion\(^3\)  
- 1.9% of total assets |
| **Family offices**      | Family may be hands-on or hands-off in setting investment strategies | - Investments may be mission-oriented or guided by risk/return  
- Risk tolerance varies by office, some offices are more risk-averse than others | Not readily available |
| **Sovereign wealth**    | - Investment funds owned by governments, funded by foreign exchange and reserve assets  
- Have shown serious interest in the infrastructure asset class | - Long-term outlook  
- Lack of liabilities to meet | - 14% of all investments (as of 2010)\(^4\)  
- $883 billion if total assets are assumed at $6.31 trillion\(^5\)  
- 57% invest in infrastructure to some degree (as of 2013)\(^6\) |
| **Endowments**          | - Donations to non-profit groups  
- Tend to invest in alternative assets (which includes) | Have varying rules regarding investment, withdrawal, and fund usage policy | - $15 billion\(^7\)  
- 4.3% of total assets |
| **Banks**               | - May act as an intermediary account manager.  
- May act as a loan provider. | - Regulated by government.  
- Prohibited from taking on high-risk or doing anything that constitutes a conflict of interest. | $55 billion total capital formed by bank-affiliated funds in 2012\(^8\) |

Source: Bipartisan Policy Center
\(^2\) Ibid.
\(^8\) https://www.infrastructureinvestor.com/uploadedFiles/Infrastructure_Investor/Non-Pagebuilder/Non-Aliased/Widget_Content/II_30.pdf.
Both in the U.S. and abroad, the public sector is using a variety of financing tools to fund infrastructure.

**P3s**

A public-private partnership (P3) is a procurement model in which a private-sector partner – normally under a long-term, fixed-price contract – takes responsibility for some combination of designing, building, financing, maintaining, or operating a public infrastructure asset. P3s provide the opportunity to put private capital to work developing, building, repairing, and maintaining the public’s significant infrastructure needs. They also allow for risks to be allocated to various parties based on their capacity and willingness to best manage them. A set of incentives and penalties are put in place to ensure that the private sector delivers a well-built and well-maintained asset on time and on budget. The private sector provides the financing for P3s, which acts as a key incentive for optimal performance.

According to the BPC’s Executive Council on Infrastructure, a P3 can help reduce the current and future infrastructure risk facing public agencies in several ways:

- Aligning incentives to take a life-cycle approach to operating and maintaining the asset to maximize useful life;
- Sharing or transferring risks to the private partner;
- Reducing pressure on public budgets; and
- Enabling innovation.

P3s are used widely and have an established track record (see chart 5). Notably, in Canada, the P3 model has been used for about 250 projects. Those that have reached financial close have estimated savings to the government of up to $27 billion.

**Chart 5: Selected public-private partnership projects rated by S&P Global Ratings**

<table>
<thead>
<tr>
<th>Social infrastructure</th>
<th>Rail and mass transit</th>
<th>Airports/ports</th>
<th>Roads and bridges</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ancora (RCH) Pty Ltd, (Hospital, Australia)</td>
<td>Line Transit Partners LLC (Light rail transit, US)</td>
<td>Arctic Infrastructure Limited Partnership (Airport, Canada)</td>
<td>Elizabeth River Crossings Opco LLC (Bridge and tunnel, US)</td>
</tr>
<tr>
<td>- InspirED Education (South Lanarkshire) PLC (School, U.K.)</td>
<td>- High Speed Rail Finance - 1 PLC (Rail, U.K.)</td>
<td>Lima Airport Partners SRL (Airport, Peru)</td>
<td>ITR Concession Company LLC (Toll road, US)</td>
</tr>
<tr>
<td>Properties LTAP LP (Civic building, Canada)</td>
<td>- Reliance Rail Finance - Pty Ltd. (Rail, Australia)</td>
<td>- ACI Airport Sudamerica - S.A./Cerealsur S.A. (Airport, Uruguay) - Terminales Portuarios - Euroandinos Paita S.A (Port, Peru)</td>
<td>95 Express Lanes LLC (Managed lanes, US)</td>
</tr>
</tbody>
</table>

**Bundling**

Bundling is the combination of separate smaller ventures into one larger infrastructure entity. Bundling infrastructure assets has taken on many forms, including corporate roll-ups such as acquisitions of smaller water systems by larger utilities, the securitization of municipal assets, and the bundling of loans in state revolving funds.

Since infrastructure is, by its nature, capital intensive, scale is an important factor in achieving cost-efficient financing of construction and/or operations. We have observed governments utilizing P3 bundling as an alternative funding approach to attract private capital to smaller assets. When bundled into a single, larger transaction, we have observed that P3 structures...
have been implemented to address either a group of similar assets across multiple sites or an assortment of different assets at a single site. With bundling, we have observed entities combining individual smaller projects to an aggregate level that has attracted private capital and the expertise needed to manage such projects.

The bundling of infrastructure assets as an alternative financing approach is, in our view, gaining momentum. Examples of bundling projects include the Penn Bridges project in Pennsylvania and the Los Angeles Courthouse project in California, schools in Alberta and Saskatchewan, Ontario Provincial Police facilities, On Route service stations along Ontario’s highways, and the North Commuter Bridge and Parkway project, also in Saskatchewan.⁴

### Asset recycling

Asset recycling involves governments leasing existing publicly owned infrastructure to long-term private investors. This generates proceeds that authorities may choose to re-deploy, including the development of new priority infrastructure whose revenue-payment model may not be so clear.

Australia has been active with infrastructure asset recycling and has funded upgrades of roads, airports, and seaports from the leasing of existing operating government-owned assets. In the U.S., the $3.8 billion lease of the Indiana Toll Road to investors is a high-profile example of both asset recycling and the risk transfer mechanisms in P3 procurement methods. For instance, as an example of the risk transfer, we observed that even during the restructuring, the road continued to operate generally in line with the performance standards set by the State of Indiana.

### Regulatory frameworks

We have observed that regulation can be a benefit to creditworthiness – particularly in capital-intensive industries. Utilities can enjoy stability of payments from supportive rate regimes. In fact, significant capital financings have already been facilitated as a result of supportive regulations. Regulated utilities within our ratings universe have raised over $450 billion since 2007. Similarly, U.S. project-financed power assets have relied on secure revenues from power-purchase agreements aligned with the Public Utilities Regulatory Policies Act, 1978 (PURPA) and, more recently, state renewable portfolio standards that require utilities to procure renewable energy. We expect that the regulated utilities will smooth the integration of new technologies – including battery storage, for instance – and negotiate the disruption brought on by their development.

Regulatory frameworks are in governments’ hands and continue to evolve. This means, even in those industries such as power and telecommunications have significant private investment and risk and asset management, governments can still determine the performance metrics required of parties managing infrastructure assets and hold them accountable. This is not so dissimilar to concession P3 arrangements that we have analyzed in our rated P3 projects that establish contractual points of reference for required performance at the project level.

### Tax-advantaged structures

Tax incentives can also stimulate private investment in infrastructure. In this respect, tax-advantaged structures including master limited partnerships (MLPs) and real estate investment trusts (REITs) have facilitated enormous flows of capital.

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MLPs have been instrumental financing vehicles in the energy sector for many years, contributing to the buildout of new pipelines and other midstream assets crucial for the delivery of natural gas, liquefied natural gas (LNG), and crude oil from shale gas projects. By confining themselves to such infrastructure, MLPs enjoy certain tax benefits. Unlike traditional corporations, MLPs do not pay federal income tax at the entity level.

REITs are structured to offer the opportunity to obtain exposure to baskets of real estate assets including office buildings, shopping malls, and mortgages. These trusts source funds from a wide range of investors who are unlikely to invest in large-scale real assets on an individual basis – unlocking a substantial financing compliment to institutional real estate investment. Like MLPs, REITs do not pay taxes at the corporate level.

Tax credits form another way that governments have helped to channel sources of capital into infrastructure investment. In our view, the U.S. renewable energy sector, in particular, has benefited from an increase in access to capital from the implementation of production tax credits (PTCs), investment tax credits (ITCs), and similar mechanisms.

**Sector overview**

All infrastructure sectors face financing challenges – particularly in this digital and sustainability-focused era. For example, the transportation, water, and social infrastructure sectors have more significant financing challenges than the energy and telecommunication sectors. Here we offer a high-level overview of selected key infrastructure sectors, an observation of disruptive changes in these sectors, and some of the various tools we see being used to address them.

Transport, water, social infrastructure, and airports: segments in which traditional municipal financing has been the primary means of investment.

**Transport: Roads and bridges**

The U.S. infrastructure gap can be explained as the sum of deferred maintenance (not budgeted and spent due to fiscal limitations) and capital expenditure needed to replace assets that are at or beyond their useful life. Currently, most American roads and bridges are publicly owned, leaving government with the problem of revitalizing these aging assets. For example, in California, we have observed external estimates of the state highway infrastructure backlog of deferred maintenance of approximately $78 billion, demonstrating the public funding model’s limited capacity to sustain a major state’s infrastructure needs — let alone build the infrastructure of tomorrow.

These issues are expected to be exacerbated by the proliferation of autonomous vehicles (AVs), which will likely boost overall miles driven over the coming decades. While we believe the arrival of AVs is inevitable, their adoption will likely be slower and take longer than expected while they overcome legal, regulatory, social (i.e., market acceptance), infrastructural, and technological impediments. Research indicates that full-AV sales would account for only about 5%-15% of total vehicle sales by 2030-2035. As such, we believe significant penetration that could have a profound impact on the transportation industry is likely to be far off. That said, both private and public transportation projects’ debt issuances with long debt maturities or concessions could be affected by this disruptive transformation.

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A simultaneous boom in car- or ride-sharing schemes and robo-taxis could, however, have a more substantial impact on commuter toll roads (both public and private toll and managed lanes) that allow free access to high-occupancy vehicles (HOVs). Though these managed lanes will likely benefit from early adoption of AVs, they may see reduced usage in the long term as congestion decreases on general-purpose lanes due to the higher lane capacity facilitated by HOVs. However, the risk of increased HOV usage is somewhat mitigated in privately financed managed lanes because there are typically protections in the concession agreement up to a specified limit. Still, for publicly owned toll roads and managed lanes, a significant rise in HOVs under their concessions could lead to policy changes at the state level as officials address lost revenues.

P3s could be a differentiating factor for state and local governments that use them more actively to transfer long-term operational risks to the private sector, and to embed lifecycle thinking and technological innovation provided by the private sector’s technological expertise. We have observed that P3s have already made strong progress with the development of roads. Yet, according to the BPC’s report, “Bridging the Gap Together: A New Model to Modernize U.S. Infrastructure,” only $61 billion was spent on highway P3s from 1989-2013, which represents only 1.5% of overall highway project spending in the U.S. in the same period.

Water

The public health crisis in Flint, Mich., has cast a bright spotlight on both the aging, deteriorating condition, and the management practices of U.S. water infrastructure. In 2015, the U.S. Environmental Protection Agency (EPA) reported more than 15,000 health-based drinking water violations in the country. This figure has stayed consistently around this level since 2006 and the majority of violations are concentrated in small to very small water systems.

The vast U.S. networks of underground pipes, which span over one million miles, many of which were installed more than 50 years ago, are now either approaching – or have exceeded – the end of their useful lives. The cost to maintain, expand, and upgrade water infrastructure in the country is significant, with many water service providers having struggled to fund all the necessary repairs and replacements for pipes and other facilities. The EPA’s surveys on drinking water and clean water (i.e., sanitary sewers) estimate a $655 billion bill over the next 20 years. The American Water Works Association suggests the figure could be as high as $1 trillion. These figures are particularly daunting for the local governments that own about 88% of the country’s fragmented water system (see chart 6).

**Chart 6: U.S. population served by water system type**

<table>
<thead>
<tr>
<th>Water system type</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Government owned</td>
<td>87.9%</td>
</tr>
<tr>
<td>Investor owned</td>
<td>12.1%</td>
</tr>
</tbody>
</table>

Source: EPA DDWIS data

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Yet water rates have been steadily rising each year. In the U.S., typical residential water, sewer, and trash bills have grown by 4.2% from 2011 to 2016, over 3x the rate of CPI growth⁸ and at a much sharper rate of growth than other utility bills. According to Black & Veatch (B&V),⁹ the compound average annual increase in residential water bills alone was 5.6% from 2011 through the first quarter of 2013 with sewer bills rising by more than 20.1%. Longer-term risks such as population growth and the need to adapt to an increasing frequency of extreme weather events related to climate change will likely add further upward pressure to rates.

Given the infrastructure gap in the water sector, we expect governments are likely to increasingly consider P3s, asset recycling, bundling, and other alternative sources of financing for water and waste-water system upgrades. For example, in some instances governments have packaged assets into a single financing to meet scale requirements or to improve credit strengths by attracting larger, more experienced contractors. And while bundling can complicate the credit analysis of a transaction, we’ve observed that it can also, when executed, lead to the opening of new sources of capital for infrastructure. An example of this approach is the Penn Bridges project (Plenary Walsh Keystone Partners LLC), in which the state’s Department of Transportation (PennDOT) bundled 558 bridges.

Social infrastructure

The social infrastructure sector represents another area where funding has been challenged – to build and maintain, for example, modernized schools, hospitals, and courthouses, and to ensure that this vital sector meets standards and serves the public interest.

As highlighted earlier, governments have used P3s and bundling to provide capital, control risk, and bring technological expertise from the private sector for social infrastructure. We expect this trend to continue.

Airports

As well as being significant employers within their local communities, airports have been identified as a prerequisite for cities’ capacity to grow. Next-generation technologies are growing. For instance, airlines are buying larger and more fuel-efficient airplanes, leading, in turn, to greater traffic. Unless airports stay up to date to accommodate these trends, passenger comfort, terminal capacity, air traffic control, and transit and parking systems could deteriorate.

The Airports Council International (ACI) estimates that U.S. airports will require $99.9 billion of infrastructure investment between 2017 and 2021. According to the ACI, this translates into a capital investment shortfall of roughly $20 billion a year – which is double what the ACI projects American airports’ expected annual revenue to be. We note that the ACI’s biannual report’s five-year needs assessment has increased by 32% since 2015, partly because of increasing passenger traffic and aging facilities. Terminal buildings and airfield capacity projects – which represent the majority of demand – are projected by the ACI to require $38 billion and $19 billion respectively. Though needs vary among airports, these aggregate figures are fueled by the capacity constraints of large hubs.

We anticipate that governments will increasingly look to financing techniques such as asset-recycling initiatives and P3s to access capital to accommodate airport growth and development.

⁹50 Largest City Water/Wastewater Utility Rate Survey, B&V, April 2013.
We have observed that P3s and asset recycling in the airport sector are not as prevalent in the U.S. as they are in some other countries. In our view, this is partly due to existing limitations by current FAA regulations that restrict reallocation of airport “profits” to any off-airport public projects, with limited exceptions provided by the Pilot Privatization Program introduced by the FAA in 1996. In the absence of other mechanisms that help facilitate long-term private equity investment in airports, funding sources for airports in the U.S. have largely been limited to the Passenger Facility Charge – which Congress has not increased since 2000 – relatively limited government grant programs, and the debt that airports and their municipal owners can raise in the municipal bond market.

Observations of the integration of the private sector into certain infrastructure sectors

A supportive regulatory environment has helped with the availability of capital

Both developers and investors have choices to make as to the degree of risk they are willing to take when funding infrastructure investments. We believe the juxtaposition of regulated utilities and merchant generators illustrates how regulatory support has worked within a liberalized infrastructure sector and provides insights into how this approach could be applied in infrastructure sectors predominately financed by municipal debt.

Unregulated power producers are particularly susceptible to disruptive innovation. Conventional generators with material pricing exposure are already losing revenues as renewables penetrate further into the U.S. energy mix. In the grid managed by the Energy Reliability Council of Texas (ERCOT), for instance, over-performing low-cost wind assets are putting additional pressures on higher-cost merchant fossil fuel plants, which are already suffering from low gas prices and flat demand. As battery technology improves – and with it – the ability to store intermittent renewable energy at a distributed (household) level, conventional generators will be pressured further.

Regulated utilities, on the other hand, enjoy readily available capital and generally supportive regulations, which we believe better positions them to address the expansion of renewable and distributed generation (DG) capacity. In Hawaii, California, Arizona, and Nevada (states with abundant solar capacity), utilities have worked with their regulators to manage market incentives that might otherwise compel consumers to make the transition to distributed rooftop solar generation. For example, in 2015, Hawaii regulators reduced the retail rate DG customers receive for the excess electricity they sell back into the grid, in addition to establishing a minimum monthly bill for these customers. However, we

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expect DG to continue growing in Hawaii and in similar regions where DG remains cost competitive with utility generation. Over the very long-term, we could see utilities with generation transitioning to transmission and distribution (T&D) – as seen in California at this time – increasing their reliance on DG.

Still, regulated utilities are not entirely insulated from disruptive changes. In our opinion, they too would have to evolve should increasingly efficient battery technology prompt consumers to disconnect from the grid entirely (also known as “going behind the meter”). The costs associated with household battery systems continue to trend aggressively downward while conventional power costs are likely to remain flat at best. In S&P Global Ratings’ view, these costs could decline to about 24¢–25¢ per kilowatt hours (KWh) by 2020. At such a pricing point, solar power, for example, could become extremely competitive and data suggests that customers could start dropping off the grid. We see this phenomenon already playing out to a great extent in Australia and South Africa.

As a result, progressive utilities are proactively leveraging their regulatory support, low cost of capital, and scale to develop higher-efficiency utility-scale solar and storage resources that can meet state renewable portfolio standards. Utility-scale solar generation currently exceeds DG and continues to grow.

**Significant private investment in infrastructure has been driven by tax incentives**

Tax-advantaged structures such as MLPs, REITs, and renewable energy tax credits have created attractive incentives for private-sector investment in capital-intensive projects and the development of new technologies. These vehicles have channeled significant capital flows into the pipeline and real-estate sectors, while also sponsoring the expansion of renewable energy capacity as green technology evolves.

As chart 8 illustrates, MLP market capitalization is currently around $335 billion\(^\text{11}\) — and reached a high of around $500 billion in 2014.\(^\text{12}\) This investment was instrumental in the buildout of the North American pipeline system in response to the shale boom. While we see that the growth of MLPs is now leveling off, these partnerships offer insights into how similar structures may drive investment in infrastructure in the future.

**Chart 7: U.S. utility scale generation in 2016**

| Source: U.S. Energy Information Administration (EIA) |

**Chart 8: MLP Market Capitalization**

\(^\text{11}\)https://www.alerian.com/indices/amz-index/.
REITs have channeled significant capital flows into real estate as MLPs did for midstream energy. REITs own approximately $1.8 trillion of commercial real estate assets, including listed and nonlisted public equity and mortgage REITs. In 2016, 196 REITs traded on the New York Stock Exchange, with an equity market capitalization of $998 billion.

Tax credits have similarly incentivized investment in renewable energy. The Energy Policy Act of 2005, which created a 30% investment tax credit for selected solar units, was a significant show of support for what was then an underutilized resource in the U.S. with enormous potential. The ensuing investment and technological development can be attributed to the relatively rapid growth illustrated in chart 9.

**Conclusion**

Over the next 50 years, emerging disruptive risks will add to the challenges facing the nation’s existing infrastructure. But experience shows that tools exist in the market to help channel much-needed capital investment. While some infrastructure sectors have yet to bring significant private-sector expertise and risk management to bear, those that have already done so offer crucial insights into how the public and private sectors may seek to collaborate to address infrastructure challenges in the future.

![Chart 9: Solar electricity net generation](source)

**Chart 9: Solar electricity net generation**

Generation (Million kilowatthours)

<table>
<thead>
<tr>
<th>Year</th>
<th>Solar electricity net generation</th>
<th>Utility-scale solar electricity net generation</th>
<th>Distributed solar photovoltaic generation</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>2001</td>
<td>10000</td>
<td>10000</td>
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Source: U.S. Energy Information Administration (EIA)