America’s surface transportation system is composed of a vast array of interstate highways, state roads, local streets, bridges, overpasses, and tunnels. The 46,876 miles of interstate highways in the United States contain 55,512 bridges and 82 tunnels, and the National Highway System includes an additional 117,000 miles of major roads (US Department of Transportation, “Eisenhower”). The overall road system covers more than 4 million miles of state roads and millions of miles of local streets. Those facilities together constitute a crucial public asset—vitally important for the movement of both people and goods—valued at almost $3 trillion in 2009 dollars (US Department of Commerce).

Americans traveled almost 3 trillion miles on US roads in 2011, which was nearly double the amount traveled in 1980 (US Department of Transportation, “New FHWA Report”). They also spend almost 175 billion hours in transit each year, valued at some $760 billion in 2007 dollars (Winston 2013).

Unfortunately, America’s transportation system is dogged by an array of problems that hinder its performance. Traffic congestion is a mounting concern, particularly in urban areas. In 2014, congestion wasted 6.9 billion hours of motorists’ travel time and almost 3.1 billion gallons of fuel (Schrank, Eisele, Lomax, and Bak 2014). Moreover, congestion’s overall social costs are growing rapidly over time. The congestion “invoice” in the United States for added fuel and time costs grew from $42 billion in 1982 to about $160 billion in 2014 (in 2014 dollars)—almost a three-fold increase—in the 471 urban areas studied by the Texas Transportation Institute (Schrank, Eisele, Lomax, and Bak 2014).

Furthermore, the revenue sources available to operate, maintain, and—where necessary—expand the road network are often unstable and inadequate. Large segments of the system are well past their original design lives and in need of major renovation. Deferred maintenance of roads, bridges, and tunnels in the United States is endemic and growing, and its long-term social costs are high. New approaches to funding, financing, operating, and maintaining the US transportation system are necessary. Policies that were crucial to the construction of a new, far-flung transportation network are inadequate for the maintenance and improvement...
of today’s mature highway system. This policy brief suggests several steps that could better match US transportation policy with today’s needs.

First, I describe the fundamental challenge facing the US highway system today. I stress the distinction between the funding for roads and highways versus the financing of them. Creating a reliable funding stream involves different types of challenges than those of securing adequate financing. Next, I lay out two core principles to guide policy reform: (1) adherence to the basic user-pays principle and adoption of direct user fees, rather than general taxes, as a funding mechanism wherever possible; and (2) promotion of greater private participation in project delivery. I discuss each principle and then articulate several specific steps that can be taken to further each principle. Finally, I briefly discuss some policy considerations raised by rapidly emerging technologies in transportation.

Infrastructure Funding versus Infrastructure Financing

The challenges facing the US transportation system are usefully divided into funding, financing, operation, maintenance, and technological innovation. Funding for transportation infrastructure refers to the substantial underlying financial resources necessary to construct, renovate, operate, and maintain transportation facilities. Such revenues can be derived from only two broad categories: (1) some type of user fee related to road use; or (2) revenue from a broader-based tax unrelated to the intensity of road use. Possible user fees include fossil fuel taxes on gasoline or diesel fuel, facility-specific tolls such as on a bridge or tunnel, value-added tolling, tax-increment financing, value capture, and mileage-based user fees.

The United States has historically relied heavily on hypothecated user fees in the form of fossil fuel taxes to fund its network of roads, bridges, and tunnels. Taxes on fossil fuels (for example, gasoline and diesel) account for more than 90 percent of the federal Highway Trust Fund’s revenues and more than 50 percent of highway spending at all levels of government. Taxes are levied on a cents-per-gallon basis that does not change with inflation. The federal fuel-tax rate has not been increased since 1993; the purchasing power of those revenues has declined by well over a third since that time.

Taxes on fossil fuels account for more than 90 percent of the federal Highway Trust Fund’s revenues and more than 50 percent of highway spending at all levels of government. Second, vehicles using the US road system are rapidly becoming more fuel efficient, partly due to policies designed to discourage fossil fuel use. For example, Corporate Average Fuel Economy standards, adopted in the wake of the 1973 oil embargo, are minimum requirements for the average fuel economy (that is, miles per gallon) for a manufacturer’s fleet of cars or light trucks. The standards have become more stringent over time. In December 2007, President George W. Bush signed into law a bill requiring auto companies to achieve a fuel-economy standard of 35 miles per gallon (mpg) by 2020, with substantial improvements by 2015. In May 2009, President Barack Obama further increased stringency to an average of 39 mpg for cars and 30 mpg for trucks by 2016 (Allen and Javers 2009). Auto manufacturers have responded: the average sales-weighted mpg of new vehicles sold in the United States increased from about 20 in October 2007 to more than 25 mpg in April 2015 (University of Michigan Transportation Research Institute 2015). Such efficiency improvements are likely to continue.

Third, motorists are now driving vehicles that burn no fossil fuels whatsoever. Developments include all-electric and hydrogen fuel cell vehicles, among others. Such vehicles obviously rely on roads as much as any, but they do not contribute to roads’ operation and maintenance (O&M) through fuel taxes, which shifts overall road-system costs to the general taxpayer and to poorer motorists who disproportionately use older, less fuel-efficient vehicles. The role of alternative-fuel vehicles is likely to grow in the future because of innovation in batteries and engines, wider availability of charging stations, and policy incentives. That will further erode the traditional equity attributes of fossil fuel taxes.
Finally, fuel-tax revenues are often unstable because of market forces that affect fuel prices. Crude oil prices are set in a large global market. When prices fluctuate, motorists make a variety of adjustments, such as using more fuel-efficient vehicles (including electric cars, hybrids, motorcycles, and scooters), changing driving habits (such as driving more slowly and combining shopping trips), using public transit, carpooling, walking, biking, changing home or work locations, or telecommuting. Those adjustments all impact the amount of fuel consumed and thus fuel-tax revenue.

The confluence of these forces is predictable. Revenue into the federal Highway Trust Fund has fallen faster than expected, creating a cumulative deficit of $62 billion since 2008 (Sargent 2015). Congress has used general funds to fill the deficit, weakening the user-pays principle. The situation will worsen over time. The Highway Trust Fund is expected to run a cumulative deficit of $180 billion over the next 10 years under current conditions. Unsurprisingly, many states that rely on fossil fuel tax revenue are experiencing similar funding challenges and are relying on a variety of mechanisms to fill the gap. Federal and state highway policy should move toward, rather than away from, the user-pays principle. Fortunately, Congress can take several straightforward steps to achieve that goal.

**Recommendations for Policy Reform**

These challenges suggest that a new transportation policy framework is needed. Reform should be based on clear, core policy principles. The recommendations in this section are based on the two key principles already mentioned. I discuss the motivation for each principle and then offer several concrete policy actions to further each.

**Adhere to the User-Pays Principle.** Many economists and policy analysts believe that the best solution to America’s ongoing infrastructure funding problem is widespread adoption of direct road-user charges. Such charges go by several names, including mileage-based user fees (MBUFs) and road-usage charges (RUCs). Each assigns a price per unit (for example, per mile) of road use that may or may not vary depending on the scarcity of road space at that specific time.

Per-unit fees are used to fund other network industries, including communications and electricity. Indeed, variable per-unit prices that, to different degrees, respond to changes in supply and demand are the way in which the vast majority of goods and services, from oranges to window washing, are successfully provided. Similarly, variable MBUFs will help mitigate traffic congestion and create new revenue for infrastructure O&M.

Importantly, MBUFs should be viewed as a replacement for fuel taxes rather than an additional tax. Fuel taxes paid should thus be rebated when MBUFs are applied. That crucial point must be clear to garner motorist support for MBUFs.

The **Highway Trust Fund is expected to run a cumulative deficit of $180 billion over the next 10 years under current conditions.**

The congestion-reduction benefit of variable MBUFs is often noted. However, a less appreciated but equally important benefit is that they help direct scarce investment resources toward projects where those dollars are most highly valued by customers (that is, motorists) and away from lower-valued uses. MBUFs thus provide a crucial link between customers’ value of a facility and investment flows. Stated differently, variable road prices create objective market signals about where additional investment should be directed based on motorists’ willingness to pay. This helps address one of the most challenging problems facing transportation policy today: the perceived misdirection of scarce funding dollars caused by widespread earmarking and high-profile, pork-barrel projects.

Although these are core benefits, MBUFs are appealing for several additional reasons, which include: (1) creating sustainable, long-term transportation system funding; (2) divorcing charges for use of road space from fuel type used, which makes road charges independent of evolving engine technology; (3) adopting the basic fairness principle that motorists who use roads should pay for them, which enhances equity; (4) allowing scarce road space to be allocated to motorists who value it most highly at that particular time of day; and (5) encouraging commuters to explore travel alternatives during peak times by providing current toll prices. Although partial, that list suggests that the social benefits realized from variable per-unit road charges are substantial.

Commentators have been aware of road pricing’s many benefits for decades. Writing in the early 1950s, Milton Friedman and Daniel J. Boorstin noted that:

> At first glance, it seems hardly possible that this apparently trivial problem of how to charge
people for the highway services they use is a key to the whole problem of how to plan and pay for better highways; yet it is just that. This fact cannot be too strongly emphasized. It is a key not only for a system that would involve operation of roads by private enterprise but equally for the present system of public operation. Should a particular road be built? How should it be built? How should it be financed? Should an existing road be maintained, improved, or allowed to deteriorate? If we could charge directly for the service of the road, we could answer those questions—whether under private or public ownership—in the same way that we now decide how many automobiles should be manufactured, what kind of automobiles should be manufactured, how their production should be financed, whether a particular model should be discontinued, and so on. (Friedman and Boorstin 1996)

At the time Friedman and Boorstin were writing, tolls were paid exclusively in cash. Widespread tolling implied stopping to pay tolls, thus slowing down travel. All-electronic tolling is now feasible and growing cheaper, which diminishes that concern.

Despite broad academic agreement, use of direct road-user fees has been limited in the United States. Although Oregon recently debuted a system-wide MBUF program (Morris 2015), road pricing is most often utilized on new lanes, such as high-occupancy toll (HOT) lanes, or on conversions from high-occupancy vehicle (HOV) to HOT lanes. This has left existing transportation facilities—often older roadways in need of fresh investment—out of the fresh funding streams generated by that pricing. Moreover, only a few small sections of the highway system, such as the I-35W MnPass Express Lanes in Minneapolis, are variably priced.

Analysts have attributed the limited use of MBUFs in the United States to motorists’ opposition to new rates and fees. Because motorists often think roads are already paid for through gas taxes, MBUFs may initially be viewed as new taxes, which is why state fuel-tax rebates are crucial. Such issues are particularly important for existing transportation facilities, where MBUF revenues are usually focused on improving road quality but less often on adding additional capacity easily visible to motorists. Many commentators believe that displaying tangible improvements from road pricing greatly enhances motorists’ acceptance.

A new approach is needed for gaining taxpayers’ acceptance of better infrastructure-funding solutions such as MBUFs. Federal, state, and local policymakers should focus carefully on facilitating movement toward direct user charges that have long been recognized as the key to numerous transportation-policy problems.

Displaying tangible improvements from road pricing greatly enhances motorists’ acceptance.

The first and most crucial reform is to adopt new policies that change the way customers pay for road usage and thus the way America’s road system is funded. The fossil fuel taxes that support the Highway Trust Fund were reasonable proxies for user fees when they were adopted, because the trust fund ensured that those revenues were separated from pressures on the broader budget. That link has eroded over time as more trust fund dollars have been spent on nonroad activities, such as transportation museums and bike paths, sometimes referred to as “leakage” or “diversion” out of the trust fund. Such diversion is likely to reduce public support for greater road-user fees in general, thus precluding its social benefits from being realized, which means Congress should focus on reducing or eliminating the diversion of user-fee revenue.

Although the academic community broadly agrees that system-wide MBUFs are desirable, they are challenging to implement. MBUFs should thus be viewed as the long-term, sustainable solution to America’s transportation-infrastructure funding challenge. Fortunately, Congress can take a number of intermediate steps in the meantime.

Remove Transit Subsidies from the Highway Trust Fund. Although the Highway Trust Fund has many sources of diversion, the largest is to subsidies for urban transit systems. Urban transit systems require direct subsidies from the fund to operate because farebox revenue (fares paid directly by transit users) does not typically cover operating costs, much less contribute to the substantial required capital costs. Those subsidies are an important part of Highway Trust Fund expenditures. For example, about 21 percent of the fund’s expenditures authorized by the 2005 SAFE-TEA-LU highway bill were spent on transit subsidies.

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1 The Oregon Department of Transportation has stressed that its RUC program rebates the state’s fuel taxes that motorists likely paid, ensuring that double taxation does not result.

2 In addition to transit, other sources of diversion include bikeways, scenic trails, and transportation enhancements.
contract. Competitive bidding ensures that each subsidy dollar creates the greatest benefit for the taxpayers offering those subsidies. This valuable but underutilized approach will improve the delivery of transit services in the United States while enhancing governance.

Support Conversion of HOV Lanes into HOT Lanes. A second intermediate step toward broader use of direct user fees is to support the conversion of existing HOV lanes into HOT lanes. This allows motorists to use HOT lanes if they either have the minimum number of occupants or are willing to pay the toll. An important advantage of a HOT lane is that it can be variably priced, thus approximating market-based pricing depending on supply and demand for that road space at that particular time. HOT lanes have, conversely, suffered from a variety of weaknesses, including underutilization.

Congress can support constructing new roads as HOT lanes from the outset. It also can take specific policy actions to support the conversion of HOV into HOT lanes, such as allowing metro areas to count all HOT-lane miles as fixed guideway miles (miles with fixed railroad tracks) for purposes of transit funding, regardless of whether they were newly created or converted HOT lanes (Poole 2015b).

Under current federal transit policy, an HOV lane converted into a variably priced HOT lane is recognized as providing buses with a virtually exclusive guideway. A metro area may count those HOT-lane miles toward theoretical fixed guideway miles for funding purposes if they are used by transit buses. However, if the same HOT lanes were not converted but newly created, then the metro area may not count those HOT-lane miles as fixed guideway miles for funding purposes. This distinction has no economic or policy rationale. Given that new HOT-lane miles are being added annually, eliminating the distinction is an important step in supporting the creation of more variably priced road capacity.

Expand the Interstate System Reconstruction and Rehabilitation Pilot Program. As noted, a crucial national transportation-infrastructure challenge in the United States is the aging interstate highway system. Construction on that system was authorized by the Federal Aid Highway Act of 1956. Large sections will need major renovation and additional lanes, at an anticipated cost of some $1 trillion (Poole 2015a).
Importantly, the 1958 bill contained a prohibition on the tolling of interstate highways, which stemmed from concerns that the necessary tollbooths would slow traffic, defeating the purpose of a large divided highway with limited access. Modern all-electronic tolling, however, alleviates such concerns.

One important program to facilitate user fees is the Interstate System Reconstruction and Rehabilitation Pilot Program (ISRRPP), which was authorized under section 1216(b) of the TEA-21 highway bill (US Department of Transportation, “Road Pricing”). It permits up to three existing interstate facilities to be tolled to fund reconstruction or rehabilitation on interstate corridors that otherwise could not be adequately maintained or expanded (Poole 2015a). The constraint of three facilities is arbitrary, however, and prevents a greater number of states from utilizing the program. Moreover, it allows toll funding to be used on one corridor only, limiting a state’s ability to utilize system-wide tolling. System-wide road pricing is crucial in reducing diversion from tolled to non-tolled roads and for generating a sustainable long-term funding source for all of a state’s interstate highways.

The program should be expanded, which would have two dimensions: permitting all 50 states to utilize tolling and permitting states to utilize tolls on more than one interstate facility. This increased tolling must be as close as possible to true user fees for motorists to support their implementation.

Poole (2015a) suggests four protections for motorists under the ISRRPP to help achieve that goal: (1) ensuring through statutory requirements that all toll revenue is channeled back into only urban and rural interstates; (2) implementing tolling only after reconstruction is complete so that motorists can see value creation before paying tolls; (3) making tolling electronic and interoperable across systems; and (4) ensuring that motorists obtain a rebate of state fuel taxes paid for miles driven on interstate highways tolled under the program.

Such protections are important since some states have in the past diverted revenue from tolling interstates to non-interstate purposes, thus making motorists leery of further tolling. These changes will help ensure that a dedicated funding source exists to cover the $1 trillion renovation cost, which currently is not in place.

**Encourage Greater Private Participation in Project Delivery.** One major development in global transportation policy in recent years is increased reliance on industry partners to deliver a variety of public services via contracts. Financing is a particularly important role and raises a different set of issues relative to infrastructure funding. Industry participation in infrastructure delivery can take on a variety of forms. For example, it may include simple O&M contracts, under which a private firm or group of firms takes over specified O&M duties for a fixed period of time. It can include design-build contracts, which combine those two key functions under one contractual structure. More extensive participation can also take the form of a more complex design-build-finance-operate-maintain contract.

**System-wide road pricing is crucial in reducing diversion from tolled to non-tolled roads and for generating a sustainable long-term funding source for all of a state’s interstate highways.**

The financing element of a contract between the public and private sectors is particularly important since many states and localities face tight borrowing constraints. Serial downgrades of state debt such as in New Jersey, municipal debt such as in Chicago, and high-profile municipal bankruptcies—such as in Detroit, Michigan; Stockton, California; and Jefferson County, Alabama—underscore such limits.

Increased reliance on private partners is driven by several widely recognized benefits to this sector. To quickly summarize several, private participation can:

- Accelerate infrastructure delivery by transferring the risk of time delays to private partners including via contractual penalties and rewards;
- Improve project-cost certainty by transferring the risk of cost overruns to private partners;
- Assure maintenance of the infrastructure asset over its entire life cycle for contracts including an O&M component;
- Improve the rate of technological adoption by allowing private partners to capture a portion of the gains generated by new technologies that are adopted;

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7 See Geddes (2011) for a more detailed discussion.
• Provide access to equity investors—a new class of infrastructure financiers unable to participate under traditional approaches to US infrastructure delivery—which is particularly important to investors with long-dated liabilities such as pension funds and insurance companies;

• More accurately price the substantial risks inherent in infrastructure delivery into the cost of risk-bearing capital;

• Provide objective information on the viability of infrastructure projects and thus improve the allocation of the scarce funding resources that are available;

• Facilitate innovation in design and construction through alternative technical concepts, which offer innovative solutions to a design or construction problem; and

• Use innovative designs to promote efficiency, reduce risks, accelerate project delivery schedules, and reduce project costs.

The benefits of O&M contracts are worthy of elucidation. Via such a contract, the public sector precommits to spending the resources necessary to effectively maintain a transportation facility over its entire life cycle. This helps address a pressing issue currently facing American infrastructure: deferring crucial asset maintenance. Deferred maintenance allows infrastructure to degrade, leading to far more costly subsequent repairs (Orr 2006). By contractually binding the private sector to precommit sufficient resources for infrastructure O&M, private participation ensures appropriate life-cycle asset maintenance while enhancing the transparency of an infrastructure facility’s true life-cycle costs. Congress can take several concrete steps to encourage greater private participation in infrastructure delivery to capture such benefits.

Support the Transportation Infrastructure Finance and Innovation Act Program. A step toward facilitating private participation in infrastructure delivery is to improve and expand the Transportation Infrastructure Finance and Innovation Act (TIFIA) process. TIFIA was passed in 1998 to provide credit assistance in the form of loans or loan guarantees for surface infrastructure projects. It has been an important aspect of the US public-private partnership (PPP) market for more than 20 years. The law was intended to provide gap financing for socially beneficial infrastructure projects that have secured explicit funding sources. TIFIA loans offer low interest rates and, as originally conceived, could account for no more than one-third of the project’s total funding. Since 1998, TIFIA has granted 26 loans totaling $8.6 billion, which has supported approximately $33 billion in total infrastructure investment. Six of those loans have been repaid thus far.

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The Moving Ahead for Progress for the 21st Century Act (MAP-21) in 2012 increased the resources available for loans from $750 million in FY 2013 to $1 billion in FY 2014. MAP-21 mandated that projects must be awarded on a first-come, first-served basis. It also allowed for the financing of projects supported by taxes instead of by direct revenue sources such as tolls. In addition, MAP-21 expanded the percentage of total costs that TIFIA loans can fund from 33 to 49 percent. Some commentators have suggested increasing the percentage of project cost that TIFIA loans may cover. Others have advised against such a change because, as noted, TIFIA’s purpose is to provide gap financing as opposed to primary financing. Covering a greater fraction of project costs increases the riskiness of TIFIA’s loan portfolio while decreasing the number of projects it can support. Moreover, a benefit of gap financing is that the remaining portion must be obtained from other financing sources, which provides a valuable market signal regarding which projects are economically viable and which are not. As TIFIA’s portion of financing grows, the signaling value of market-based financing is diluted.

Several examples illustrate appropriate use of TIFIA and demonstrate how PPPs offer long-term investors valuable opportunities to invest in US infrastructure. Teachers Insurance and Annuity Association–College Retirement Equities Fund (TIAA-CREF) is a 50 percent equity partner in a private company that will design, build, finance, operate, and maintain the I-595...
roadway in Broward County, Florida, over a period of 35 years. That project received a TIFIA loan of $603 million in 2009. Similarly, the Dallas Police and Fire Pension System became a partner in the North Tarrant Express project in 2009 after securing a $650 million TIFIA loan and raising $398 million from the issuance of private activity bonds (PABs).

The TIFIA loan program is widely viewed as a success. However, the Highway Reauthorization Bill that was reported out of the Senate’s Committee on Environment and Public Works on June 24, 2015, included an almost 33 percent cut in TIFIA funding. More precisely, the $675 million authorized for TIFIA in 2015 is $325 million less than the $1 billion allocation in 2014. That same bill also widened the scope of TIFIA to include transit-oriented development projects, environmental mitigation projects, and projects in rural areas (Reinhardt 2015).

Commentators have observed that TIFIA’s allocation may have been reduced in that bill due to the program’s slow uptake in recent years, as past allocations have not been fully spent, with surplus contracting authority reverting back to the federal highway program. That is clearly related to the relatively low number of PPP contracts being consummated in the United States in recent years, which is widely expected to increase.

Congress can and should adopt several steps regarding TIFIA in a highway reauthorization bill. First, TIFIA loans may not be as compelling in the current financial environment, where interest rates are historically low. However, if interest rates from other financing sources rise in the medium term, then TIFIA loans will become relatively more attractive, increasing uptake. Congress should prepare for that contingency by at least maintaining the 2014 TIFIA budget allocation of $1 billion.9

Second, industry experts have expressed concerns about how slowly TIFIA loans are approved, noting that approval times of a year or more are costly to project managers who must keep funding sources in place while waiting for a decision. They have suggested streamlining the process—perhaps by accepting the due diligence from other sources rather than requiring a separate TIFIA-specific process—as well as augmenting the 17-person TIFIA office to expedite loan decisions. This implies that taxpayers may bear greater project risk, but that seems prudent within the context of TIFIA’s role in promoting the use of risk-taking private capital.

Third, some states may not be fully aware of the details of TIFIA and its potential benefits. Educational outreach directed to various state and local entities may thus be appropriate.

Expand the Cap on Private Activity Bonds. A major impediment to private investment in US infrastructure is tax-induced differentials in debt costs. The holders of tax-exempt municipal bonds receive a federal-tax exemption on interest income generated by those bonds. Bondholders are thus willing to accept a lower interest rate to hold the bonds.10 That in turn reduces the interest rate that municipal bond issuers must pay to induce investors to hold them, which lowers their borrowing costs.11

The $675 million authorized for TIFIA in 2015 is $325 million less than the $1 billion allocation in 2014.

In contrast, private debt issuers do not benefit from an income tax exemption for interest paid and therefore must pay higher interest rates to induce investors to hold debt with identical project risk. US tax law thus creates an artificial—in the sense that it is not driven by inherent project risk—interest-rate differential between privately issued and publicly issued debt. Infrastructure projects are capital intensive, so the cost of money is a leading driver of their overall cost.

Municipalities therefore rationally choose municipal-only finance over inclusion of private investors—such as under a PPP approach with a financing component—because the former costs less from their perspective, as opposed to an overall social perspective. This has the unintended consequence of artificially reducing the amount of private investment in infrastructure, compared to other developed nations. It has also stunted other aspects of the US infrastructure delivery sector that are often combined with financing, such as O&M, which is currently dominated by non-US firms. As a result, it reduces opportunities for long-term investors, such as pension funds and insurance companies, to invest in US infrastructure.

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9 Fortunately, the Senate version of the recent bill would allow unspent funds from the $300 million to carry over annually.

10 The value of the federal tax exemption rises as income taxes increase.

11 Experts often view that differential as between 150 and 200 basis points, depending on a variety of factors. Although many countries utilize municipal debt, the United States is the only one I am aware of that maintains this tax treatment.
Tax-exempt municipal bonds remain a crucial source of US infrastructure finance, with a broad, deep, and liquid market for this type of debt. Indeed, they have been state and local governments’ primary source of financing since the adoption of the federal income tax in 1913. It is thus very difficult to repeal the exemption from a political perspective.

Rather than eliminating the federal tax exemption, there have been legislative attempts to reduce the tax-induced distortion of financing decisions by leveling the interest-rate playing field. The main policy tool has been PABs, which are issued by or on behalf of a state or local government to provide lower-cost capital to private investors for qualified projects that generate a public benefit. The Tax Reform Act of 1986 set a volume cap for each state’s issuance of PABs at $50 per capita or $150 million as of 1988. The volume cap’s objective was to limit the amount of tax revenue forgone due to PABs.

The federal government increased the volume cap for PABs that are issued for “highway and freight transfer facilities” through section 11143 of Title XI of the Safe, Accountable, Flexible, and Efficient Transportation Equity: A Legacy for Users Act (SAFETEA-LU) in 2006. It provided a $15 billion allocation for the secretary of transportation to distribute to qualified projects, in addition to what states may issue. This creates an environment more conducive to PPP infrastructure projects. Importantly, such bonds are an obligation of the PPP project in question, not of government.

The United States offers an attractive institutional setting for private investment in infrastructure. As a result, there is growing interest in PABs. The current $15 billion cap on PABs is inadequate given current take-up rates. Policy analysts increasingly agree that Congress should increase the cap on PABs to at least $30 billion, if not more, in a multiyear highway bill to sustain additional PPP investment.

Develop Qualified Public Infrastructure Bonds.
Another related step is to implement Qualified Public Infrastructure Bonds (QPIBs). The Obama administration’s 2016 budget included a provision to create this new type of bond. QPIBs would extend the benefits of municipal bonds (that is, low-cost borrowing) to PPPs to attract private capital. They would also expand the scope of PABs to include financing for airports, ports, mass transit, solid waste disposal, sewer, water, and additional surface transportation projects (Sabol and Puentes 2015).

QPIB bonds are in some ways more aggressive than PABs in promoting private investment in infrastructure. They have no expiration date, no volume issuance caps, and interest on them would not be subject to the alternative minimum tax. Although QPIBs would not be available for privately owned facilities or privatizations of public facilities, such improvements will magnify their impact relative to PABs. Congress can enhance private participation by supporting the development of the QPIB market, which offers a more comprehensive solution to the uneven-playing-field problem created by tax-exempt municipal debt.

Technology and Transportation Policy
A crucial issue is developing policies that encourage, complement, and accelerate the adoption of emerging technologies. Rapid innovation on several fronts is changing the nature of road and highway transportation. Currently available vehicles incorporate cameras, sensors, global positioning systems (GPS), and high-speed computing. Those features offer varying degrees of autonomy from the driver. Vehicles can parallel park, stay in marked lanes, self-brake, and self-drive in simple—but increasingly complex—environments, such as interstate highways. They will become progressively more integrated with the infrastructure itself and with one another via vehicle-to-vehicle communications. The pace of vehicle technology ensures that additional autonomous features will be available soon. Full autonomy is likely in the long run.

Vehicles can parallel park, stay in marked lanes, self-brake, and self-drive in simple—but increasingly complex—environments, such as interstate highways.

Vehicle autonomy generates a variety of social benefits. The most obvious is increased traffic safety. Autonomous vehicles can be programed to stay in their lane, which reduces driver-induced lane departures, a main source of traffic fatalities. Autonomy will also reduce vehicle-to-vehicle collisions and pedestrian injuries.

As an example, the City Safety Collision Avoidance System available on Volvo’s XC60 models incorporate forward-looking censors and loud alarms to warn the driver of an impending collision. The system will also automatically apply the car’s brakes if the driver does
not respond. Vehicles with that feature experience 27 percent fewer minor accidents (Garrett 2014). Such features also reduce the lost time and environmental damage associated with those accidents, which often result in congestion and delays.

Increased vehicle autonomy also produces environmental benefits. Optimal vehicle weight will fall as autonomy increases because collisions will be less likely. This will improve fuel economy. Moreover, vehicles will be able to stack more closely on highways in caravans, reducing wind resistance and making more effective use of existing road capacity. That will reduce the need for additional road capacity in the future. Cars incorporating vehicle-to-vehicle communications will also require less stopping and starting at intersections, which means reduced idling at intersections while waiting for street lights to change.

Full vehicle autonomy will eventually allow smaller, lighter, driverless vehicles to complete trips using less energy. For example, they may collect and analyze enough information to make pizza deliveries while picking up dry cleaning and prescription drugs on the same trip, known as trip chaining. Currently available autonomous features will lay the groundwork for those future advances.

The potential benefits of enhanced vehicle autonomy are massive. Road infrastructure is inherently long-lived and slow to change, so policymakers must forecast how decisions made today will impact future infrastructure-vehicle interaction well into the future. Several basic actions can be taken. For example, autonomous vehicles often rely on cameras, sensors, and GPS to navigate the roadway. The public sector can facilitate the use of technology by maintaining line paint, signage, reflectors, and other visual markers. It can also encourage the use of materials that complement vehicle autonomy. For example, reflective glass beads embedded in line paint may help autonomous vehicles navigate the roadway at night. Those should be viewed as basic steps in facilitating the integration of road infrastructure with vehicle autonomy.

Steps can also be taken on the state level to encourage the adoption of vehicle autonomy. Those include the use of preferential parking places (as is currently offered in some states for electric vehicles), special access to HOV lanes, and tax credits. Such incentives would likely have important benefits in accelerating the adoption of these crucial technologies.

**Conclusion**

America’s surface transportation system is facing an array of new challenges. The immense system includes interstate highways, state routes, rural roads, and local streets. It is aging, with major segments near or past their design lives and in need of major renovation. Those problems are exacerbated by deferred maintenance on many sections.

The task of public policy is no longer to fund and finance extensive highway design and construction but to most efficiently operate and maintain existing transportation facilities. Fortunately, many developed countries have been addressing those challenges for decades, so related policies are well developed. For example, more extensive use of O&M contracts can help reduce the problem of deferred maintenance by precommitting the public sector to a preset maintenance schedule, which makes deferred maintenance more difficult.

Although international experience can help inform US policy toward O&M, rapidly emerging technologies, which stand to revolutionize transportation, are creating a series of new challenges. Vehicles will have more autonomous features that will allow them to navigate increasingly complex environments. Such improvements will occur rapidly and will generate numerous environmental and safety benefits.

To fully realize such benefits, however, policymakers must anticipate how to operate and maintain the infrastructure to complement and encourage such technologies. Basic steps include new line paints and signage, proper drainage, keeping trees and brush away from visual markers, and more creative use of policy to generate incentives for adoption. Such incentives may be necessary given drivers’ natural reluctance to relinquish vehicle control.

Two major themes of this policy brief are that policy should move toward direct mileage-based user fees as its key funding source and that greater private-sector participation should be encouraged. The fundamental
economic paradigm for the new system is that of a public utility. Policy insights regarding such issues as control of market power, service quality, and asset maintenance can then be gleaned from both US and international experience in a variety of other network industries, such as electricity, natural gas, drinking water, wastewater treatment, and telephony. I have offered several specific steps that policymakers can take to move in that direction.

About the Author

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