Testimony on
Realigning Federal Infrastructure Policy to Mitigate and Adapt to Climate Change

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Before the

Committee on Transportation and Infrastructure
U.S. House of Representatives

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SUMMARY STATEMENT

I wish to thank the chairman, ranking member, and other members of the Committee for inviting me to today's hearing. My name is Tom Lyon and I am a professor of economics at University of Michigan, with appointments in both the Ross School of Business and the School of Environment and Sustainability. The views I am presenting today are my own personal views and do not represent those of the University or any funders of my research.

There is no question that US infrastructure is in bad shape. The American Society of Civil Engineers gives US infrastructure an overall grade of D+, with roads receiving a D. The time is ripe to come together to improve the situation. And it is wise to consider how infrastructure funding might affect greenhouse gas emissions. Total carbon emissions from the U.S. transportation sector rose 22% between 1990 and 2017, and in 2017 transportation surpassed electricity as our largest emitter.

My remarks today make two main points. First, market-oriented solutions offer incentives for innovation and cost-reduction that can help to contain the social costs of addressing climate change. Second, the history of US government policy for alternative fuels displays an inconsistency that illustrates why it is wise to be cautious about picking particular technology solutions.

Economists have long advocated market-based solutions to environmental problems. This approach minimizes the total cost of achieving a given level of environmental protection, and provides dynamic incentives for innovation in pollution control.

A famous example of a market-oriented policy is congestion pricing, used in London since 2003. A related example comes from Los Angeles, where Single-Occupancy Vehicles can use the High-Occupancy Vehicle lane by paying a toll that depends on the level of highway congestion. These programs use market mechanisms to reduce congestion at a much lower cost than building more highways.

Another market-based policy is funding roads through a tax on vehicle miles traveled (VMT), as has been supported by Chairman De Fazio and ranking member Graves. Economic research suggests that if the current schedule of increases in fuel economy standards is maintained, and if the VMT is differentiated for urban and rural driving, then the VMT tax is likely to outperform a gasoline tax.

Market-based instruments allow for innovation and flexibility on the part of the private sector. This is especially important in the heavy truck market, which relies primarily on diesel fuel. Cummins and Tesla are producing electric heavy trucks. Toyota is testing heavy trucks powered by hydrogen fuel cells. Natural gas trucks are also being developed. It is too early to tell which of these fuels will be best, so it's important for policy to allow for flexibility. Mandating a specific technology could lock the industry into an inferior option.

This brings me to my second point. U.S. policy towards alternative fuels has vacillated over time as favored technologies rose and fell. Policy support has switched from methanol to natural gas to battery electric vehicles to hydrogen to hybrid electric vehicles to biofuels and now back to battery electrics. This has sent confusing signals, making it hard for the auto industry to make long-term investment plans for alternative fuel vehicles.

A market-oriented approach would take a modest view of government's ability to lead the deployment of any particular technology. Mandating technology choices in downstream markets risks creating cycles of hype and disappointment or creating "lock in" to an inferior technology.

When it comes to encouraging the adoption of electric vehicles, research suggests that financing electric charging stations is more effective than subsidizing vehicle purchases directly. However, there are many possible sources of funding for charging stations, and a thoughtful approach to creating public/private partnerships seems warranted. It may also be useful to require compatibility in charging standards across manufacturers, which would decrease duplicative investments and expand the size of the electric vehicle market.

In summary, economic analysis cautions against picking technological winners and supports the use of market-based instruments that allow flexibility and encourage innovation. This is especially important for medium- and heavy-duty trucks, where multiple technologies all offer promise, and for the deployment of fueling infrastructure for alternative fuels such as electricity.

Thank you again for allowing me to share my views, and I look forward to your questions.

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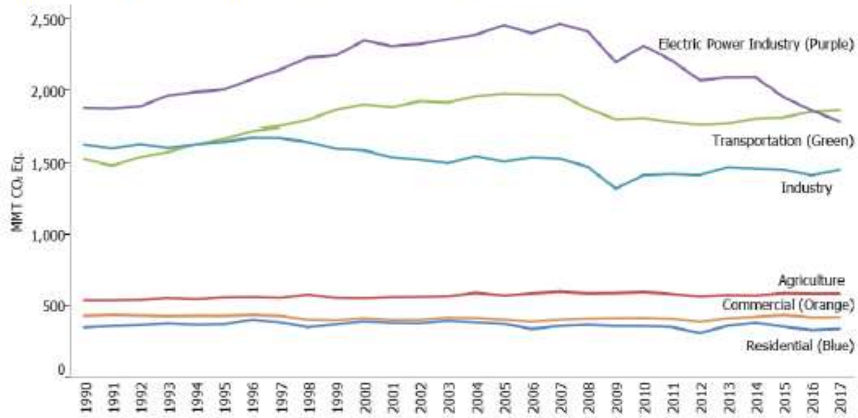
I wish to thank the chairmen, ranking members and other members of the Subcommittees and full Committee for inviting me to today's hearing. My name is Thomas Peyton Lyon and I hold the Dow Chemical Chair of Sustainable Science, Technology and Commerce at the University of Michigan, with appointments in both the Ross School of Business and the School of Environment and Sustainability. I am an economist by training, and at the Ross School my home department is Business Economics and Public Policy. At Michigan I teach an MBA-level graduate course entitled "Energy Markets and Energy Politics." I have served as Director of the Erb Institute for Global Sustainable Enterprise and as Associate Director for Policy and Social Science at the UM Energy Institute. In the latter capacity I helped to launch the Transportation, Economics, Energy and Environment (TE3) conference, which for the last five years has brought together top academic researchers with leaders from industry and government to discuss these important issues. I have received research grants on transportation from the Sloan Foundation and the U.S. Environmental Protection Agency. I am currently the President of the Alliance for Research on Corporate Sustainability (ARCS), an international alliance of top business schools that have a commitment to understanding the links between business and sustainability.

There is little question that US infrastructure is in bad shape. The American Society of Civil Engineers (ASCE)'s 2017 Infrastructure Report Card gave US infrastructure an overall grade of D+. Transit received a D-, Roads a D, and Bridges a C+; Rail topped the list at a grade of B. The relatively good performance of rail is largely due to private industry investment by the rail freight industry, although federal funding also contributes. Passenger rail, in contrast, exhibits a "large and growing backlog of capital needs." (ASCE, p. 75). "More than two out of every five miles of America's urban interstates are congested and traffic delays cost the country $160 billion in wasted time and fuel in 2014. One out of every five miles of highway pavement is in poor condition." (ASCE, p. 77) "The U.S. has been underfunding its highway system for years, resulting in a $836 billion backlog of highway and bridge capital needs…The Federal Highway Administration estimates that each dollar spent on road, highway, and bridge improvements returns $5.20 in the form of lower vehicle maintenance costs, decreased delays, reduced fuel consumption, improved safety, lower road and bridge maintenance costs, and reduced emissions as a result of improved traffic flow." (ASCE, p. 78) Similarly, "Despite increasing demand, the nation's transit systems have been chronically underfunded, resulting in aging infrastructure and a $90 billion rehabilitation backlog." (ASCE, p. 89)

Total greenhouse gas emissions from the U.S. transportation sector rose from 1,469.1 million tons of CO_2-equivalent (MMTCO2E) in 1990 to 1,794.2 (MMTCO2E) in 2017 (USEPA, 2019, p. 2-3), an increase of 22%. Although emissions dropped sharply in 2008 and 2009 as a result of the Great Recession, they have been rising again since 2013. In fact, as of 2017, the transportation sector in the U.S. has surpassed the electricity sector as the largest emitter of greenhouse gases, as shown in the figure below (from USEPA, p. ES-24). Light-duty vehicles account for 60% of transportation emissions, with medium- and heavy-duty vehicles accounting for 23% of the total.[1]

[1] https://www.epa.gov/greenvehicles/fast-facts-transportation-greenhouse-gas-emissions

Figure ES-14: U.S. Greenhouse Gas Emissions Allocated to Economic Sectors (MMT CO_2 Eq.)



There are many opportunities to reduce transportation sector emissions, including reducing travel demand, making greater use of public transit, switching to more fuel-efficient vehicles, and adopting a wide range of alternative fuels such as electricity, hydrogen, biodiesel, and compressed natural gas. Emerging connected and automated vehicles (CAVs) offer opportunities to improve highway safety and fuel efficiency, although they may ultimately increase overall fuel consumption (Stephens et al., 2016).

My remarks today will make two main points. First, market-oriented solutions offer incentives for innovation and cost-reduction that can help to contain the social costs of addressing climate change. Second, the history of US government policy for alternative fuels displays an inconsistency that illustrates why it is wise for government policy to be cautious about picking particular technology solutions.

The Value of Market-Oriented Policies

Economists have long argued for market-based instruments for the solution of environmental problems, such as emissions fees (Pigou, 1920) or systems of tradable permits (Montgomery, 1972). The advantages of this approach are that it minimizes the aggregate cost of achieving a given level of environmental protection (Baumol and Oates, 1988), and provides dynamic incentives for the adoption and diffusion of cheaper and better pollution control technologies (Milliman and Prince, 1989). One of the most prominent applications of the approach was the US sulfur dioxide (SO_2) trading program, which is credited with reducing acid rain in the Northeastern U.S. at a cost lower than initially projected (Schmalensee and Stavins, 2013).

In the transportation sector, a prominent example of a market-oriented policy is the use of congestion pricing, as was famously done in London beginning in 2003 (Leape, 2006) and more recently in Gothenburg, Sweden (Hysing et al., 2015). Because London exempted hybrid electric vehicles (HEVs), the congestion tax has also increased their use (Morton et al., 2017).

A less familiar example comes from Los Angeles, where beginning in 2013 the High-Occupancy Vehicle (HOV) lane on Interstate I-10 has been converted to a High-Occupancy Toll (HOT) facility, under the city's ExpressLanes program (Bento et al., 2017). The program allows Single-Occupancy Vehicles (SOVs) to travel in the HOV lane by paying a toll that ranges from $0.10 to $15.00 depending on the level of congestion on the highway. The toll is adjusted dynamically to keep travel speeds in the HOV lane at roughly 45 miles per hour. The program uses market mechanisms to reduce congestion at a much lower cost than highway expansion.

Another market-based policy is funding roads through a tax on vehicle miles traveled (VMT), as has been supported by Chairman De Fazio and ranking member Graves.[2] Oregon has experimented with such a policy, California has initiated a pilot project, and other states have shown interest as well (Langer et al., 2017). Economic research suggests that a VMT tax can have substantial benefits. Parry and Small (2005) calculate that the optimal VMT tax would be more economically efficient than the optimal gasoline tax, would raise more revenue, and would be better at reducing congestion and accidents than a gasoline tax. However, a gasoline tax would more directly target the environmental performance of vehicles, as well as the increased accident hazards created by driving heavier and less fuel-efficient vehicles (Anderson and Aufhammer, 2013). Langer et al. (2017) use a unique dataset on individual driver behavior to estimate the effects of a VMT, and conclude that its performance is likely to be very similar to that of a gasoline tax in terms of overall social welfare. However, if the Obama-era increases in

[2] https://www.ttnews.com/articles/missouri-rep-sam-graves-consistent-support-vmt-funding-approach

Corporate Average Fuel Economy (CAFÉ) standards are maintained, and if the VMT is differentiated for urban and rural driving, then the VMT outperforms a gasoline tax.

A crucial advantage of market-based instruments is that they allow for innovation and flexibility on the part of the private sector. This is of particular importance with regard to the heavy truck market, which currently relies primarily on diesel fuel. As mentioned above, medium- and heavy-duty trucks only produced 23% of the emissions from the transportation sector in 2016, but the relative impact of trucks is likely to increase over time as the efficiency of light-duty vehicles continues to improve (see the figure below, which is from USEPA 2019, p. 3-23).

Figure 3-13: Sales-Weighted Fuel Economy of New Passenger Cars and Light-Duty Trucks, 1990–2017 (miles/gallon)

Different companies are pursuing different technological solutions for reducing carbon emissions from trucks. Cummins and Tesla are producing electric heavy trucks.[3] Toyota is testing heavy trucks powered by hydrogen fuel cells.[4] Natural gas trucks could also offer climate advantages, but these are dependent on reduced leakage of methane across the supply chain and engine efficiency improvements (Camuzeaux et al., 2015). It is too early to tell which of these fuels will prove to be best in particular uses, so it is important for policy to allow for flexibility as innovation advances. Mandating a particular

[3] https://www.forbes.com/sites/joannmuller/2017/08/29/take-that-tesla-diesel-engine-giant-cummins-unveils-heavy-duty-truck-powered-by-electricity/#7dabd12278f1
[4] https://www.trucks.com/2017/10/12/toyota-hydrogen-fuel-cell-electric-truck-hits-road/

type of technology for these vehicles could lock the industry into an option that ends up being less than optimal.

History of Alternative Fuels Policy

U.S. policy towards alternative fuels has vacillated over time as favored technologies become the “fuel du jour” and then lose ground to a new alternative. The pattern is illustrated in the following figure (from Melton et al., 2016, p. 3).

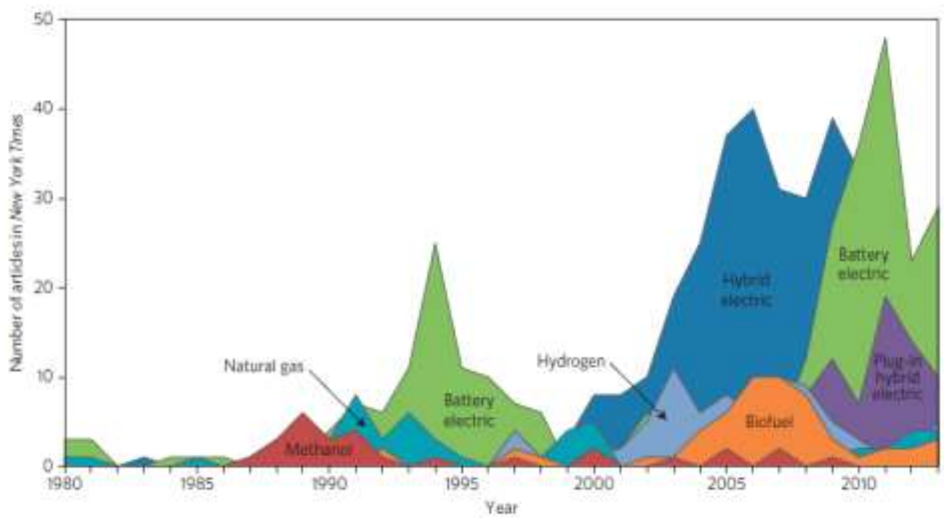


Figure 2 | Media attention for all alternative fuel vehicle technologies for 1980–2013. Media attention skipped among numerous AFV technologies between 1980 and 2013. These waves of attention are indicative of sequential and repeated shifts in society’s focus from one emerging technology to another over time.

President Reagan was a promoter of methanol, a fuel that quickly fell out of favor. A few years later, California imposed a zero-emissions vehicle (ZEV) mandate, with the expectation that this would drive deployment of electric vehicles, but the policy had little impact on actual deployment. Hydrogen fuel cells attracted attention with the passage of the Spark M. Matsunaga Hydrogen Research, Development, and Demonstration Act of 1990, whose purpose was to “accelerate efforts to develop a domestic capability to economically produce hydrogen in quantities that will make a significant contribution toward reducing the Nation’s dependence on conventional fuels.” The Partnership for a New Generation of Vehicles (PNGV) was launched in 1993, with the goal of producing a new set of highly fuel-efficient vehicles, and emphasizing hybrid diesel-electric vehicles. Each of the big domestic manufacturers produced fully operational concept cars that got at least 72 miles per gallon, but a lack of ongoing support meant that none actually made it to market. Government attention shifted back to hydrogen in 2003 with President George W. Bush's "Hydrogen Fuel Initiative," which provided $1.2 billion of funding to develop hydrogen fuel cells. This was bolstered by the FreedomCAR and Vehicle Technologies Partnership between the Department of Energy and the US Council for Automotive Research (consisting of Ford, GM, and Chrysler). At around the same time, however, political attention began to turn to biofuels, and the 2002 Renewable Fuels Standard provided strong policy support for corn-based ethanol, the climate benefits of which have been questioned by numerous authors (DeCicco et al., 2015; Hill et al., 2016). In 2007, California Governor Arnold Schwarzenegger issued an executive order creating a low-carbon fuel standard, and the climate benefits of this policy have also been questioned (Holland et al., 2009).

This history of jumping from one favored technology to another in rapid succession has sent a confusing set of signals to the automobile industry, making it difficult for the auto industry to make long-term investment plans for alternative fuel vehicles. As Melton et al. (2016, p. 8) point out, "goals are often announced…without consideration for factors such as supply constraints, rate of innovation adoption, and consumer acceptance." It is little wonder that these government-led calls to action might be considered non-credible by industry actors and investors.

What lessons are to be drawn from this experience? One response would be to build government capacity in technology assessment and forecasting, hoping to render future government programs more credible (Melton, et al., 2016). A market-oriented approach would take a more modest view of government's ability to lead the deployment of any particular technology. Of course, it is widely acknowledged that government needs to play a key role in fundamental research and development (Jaffe et al., 2005), and that this may entail funding a wide range of promising early-stage technologies. However, attempts to dictate technology choices to downstream markets run the risk of either creating cycles of hype and disappointment (Melton et al., 2016) or creating "lock in" to an inferior technology (Cowan, 1990). An alternative could be to create more research tournaments by offering prizes for technological breakthroughs (Taylor, 1995), such as the Breakthrough Prizes funded by Silicon Valley leaders.[5]

What might these considerations imply for the financing of electric charging stations, a potentially important infrastructure policy? Li et al. (2017) find that funding charging stations instead of subsidizing vehicle purchases would have been twice as effective in encouraging the adoption of electric vehicles. This is promising, but it is not obvious that such funding must be provided by the federal government. There are many possible sources of funding for charging stations, including vehicle manufacturers such as Tesla, electric utilities,[6] employers, retail establishments, and municipalities, as well as state and federal governments. In light of this array of options, a thoughtful approach to creating a public/private partnership seems warranted. It is also worth noting that the less costly policy of mandating compatibility in charging standards would decrease duplicative investment in charging stations by car manufacturers and increase the size of the electric vehicle market (Li, 2019).

In summary, economic analysis cautions against picking technological winners and supports the use of market-based instruments that allow flexibility and encourage innovation. This is especially important for medium- and heavy-duty trucks, where multiple technologies all offer promise, and for the deployment of fueling infrastructure for alternative fuels such as electricity.

[5] https://www.nationalgeographic.com/science/2018/11/news-breakthrough-prizes-2019-award-winners-biology-physics-math/

[6] https://www.forbes.com/sites/constancedouris/2017/11/08/who-should-pay-for-electric-vehicle-chargers-who-should-profit/#4c8518d34aa5

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