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**Questions for the Record for the Subcommittee on Environment Hearing that took place on March 7, 2018: “The Future of Transportation Fuels and Vehicles”**

- 1. What types of financial incentives currently exist through the federal government and private sector, to encourage this type of innovation?*

There are several forms of incentives for innovation: federal research grants, consumer subsidies, and vehicle standards. Federal research grants come from a number of programs, including the Advanced Research Projects Agency-Energy (ARPA-E). This program funds research and development of energy technologies that address energy security, environmental, or other problems. Since 2009, ARPA-E has had an annual budget of about \$300 million, which has funded a range of research on power generation, storage, transportation fuels, vehicles, and other technologies. Universities and private companies have benefited (directly or indirectly) from ARPA-E funding. Only a fraction of the overall funding has been devoted to vehicle technologies, although vehicle technology researchers can apply for funding from other federal programs.

The objective of ARPA-E is to fund innovative research that ultimately benefits society, and yet is too early-stage to receive private funding. This objective is inherently challenging to meet, because evaluators of funding proposals must identify the research that has the best chance of benefiting society, and yet can't receive private funding.<sup>2</sup> That is, it would be wasteful to fund projects that the private sector would have funded anyway, or to fund projects that have a very low probability of success and a low societal payoff if they do succeed. Yet, there are strong economic arguments supporting federal research grant programs, because private markets may not create the societally optimal level or mix of innovation activity, given market failures in research and development.<sup>3</sup> Consequently, ARPA-E and other federal funding may benefit society in the long run; in fact, many technologies today, such as solar photovoltaics, would probably not be as inexpensive, efficient, and environmentally beneficial if it were not for past federal research funding.

The other innovation incentives operate via the private sector, and arise from consumer vehicle subsidies and the vehicle standards. Buyers of plug-in vehicles can receive a federal tax credit of up to \$7,500, and many states offer subsidies on top of the federal tax credit. As I noted

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<sup>1</sup> Resources for the Future (RFF) is an independent, nonprofit research institution focused on environmental, energy, and natural resource economics and policy. The opinions I expressed in these responses are my own, and represent positions of neither the University of Maryland nor RFF.

<sup>2</sup> See for example this article I wrote in 2012, about a similar set of challenges for loan guarantee programs: <http://www.rff.org/research/publications/commentary-loan-guarantees-reconsidered>.

<sup>3</sup> See Fischer and Newell (2008): “Environmental and Technology Policies for Climate Mitigation.”

in my testimony, there are also many indirect incentives, such as offering plug-in drivers access to high occupancy vehicle (HOV) lanes. These policies encourage plug-in vehicle innovation by increasing consumer demand, which raises the profitability of selling plug-ins and attracts private investment.

Vehicle standards also provide an indirect incentive for private funding of innovation. By vehicle standards, I include the EPA greenhouse gas standards, the NHTSA fuel economy standards, and California's Zero Emission Vehicle program. Automakers can comply with the EPA and NHTSA standards by improving the average fuel economy of their gasoline-powered vehicles, or by selling more plug-in and fuel cell vehicles (the EPA program allows automakers to use a limited number of "off-cycle" emissions reductions as well). Perhaps the most obvious way that the standards incentivize plug-in and fuel cell vehicles is the fact that for each of those vehicles sold, the automaker generates compliance credits that it can sell to other companies. Or alternatively, the automaker selling those vehicles can use the credits for its own compliance, reducing the need to improve the average fuel economy of its gasoline-powered vehicles.

The federal standards further incentivize plug-in and fuel cell vehicles.<sup>4</sup> Specifically, the EPA includes only liquid fuel consumption when calculating a vehicle's emissions, and does not count emissions associated with electricity generation. Moreover, EPA counts each plug-in vehicle sold as more than one toward compliance, and effectively the EPA is overcrediting those vehicles. In recent research, I estimated that these provisions of the standards effectively subsidize each plug-in by \$3,000 to \$10,000. Note that this is not a direct subsidy that the manufacturer actually receives, but instead it represents the benefits to the manufacturer of selling an additional plug-in. Note that the dollar amounts of these various incentives cannot be added to one another to compute the total incentive for these vehicles, but the dollar amounts give a sense of the overall level of support these vehicles receive.

2. *How would such a company present these types of ideas to the federal government for consideration?*

Of the three forms of incentives described above, only federal research grants constitute direct funding by the federal government to a company. As noted above, ARPA-E funds a wide range of research besides vehicle research, although there are other sources of federal research funding that a company interested in vehicle research might receive.

The federal standards and various policies subsidizing plug-in vehicles incentivize new research ideas. The incentives may be strongest for the automakers themselves, rather than other potential innovators, because the automakers can profit directly from the innovation. As noted above, federal funding for vehicle research at other organizations, such as universities or other companies, has been limited.

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<sup>4</sup> See Linn and McConnell "The Role of State Policies under Federal Light-Duty Greenhouse Gas Emissions Standards."